Haryana Rail Infrastructure Development Corporation Ltd

Tender No. HORC/HRIDC/C-23/2022 Date 02.01.2023

Reference: Specific Procurement Notice dated 09.11.2022.

CORRIGENDUM No. 3

Name of Work: C-23: Design and Construction of Civil Works (Earthwork, Bridges, Station Buildings, Retaining Walls and other miscellaneous Works) from km 29.58 to km 49.70 & from km 55.60 to km 61.50 and its connectivities to IR network from New Patli to Patli station & New Patli to Sultanpur station including modifications/civil works at Sultanpur Station in connection with laying of New BG Double Railway line of HORC project.

The E-tender No. 2022_HBC_245408_1 for the above-mentioned work was published on 11.11.2022. The third and final Corrigendum to the above- mentioned Works is issued herewith as Corrigendum No. 3.

Final Tender Documents is hereby issued with Corrigendum No. 3 incorporating all the modifications carried out vide Corrigendum No. 1 dated 16.12.2022 and Corrigendum No. 2 dated 30.02.2022. Final Tender Documents issued on 02.01.2023 supersedes previously issued Tender Documents dated 11.11.2022 which was available to Tenderers for downloading from 11.11.2022.

Tenderers are advised to download Final Tender Documents issued vide Corrigendum No. 3 dated 02.01.2023 on e-procurement portal of Govt. of Haryana (https://etenders.hry.nic.in) and submit their Tenders based on the requirements of Final Tender Documents. In order to facilitate Tenderers with high quality of drawings, Section VII-8: Tender Drawings and Documents is available for downloading in Active Tender section on HRIDC website (http://www.hridc.co.in/active-tender.php). Tender drawings uploaded on HRIDC website for Package C-23 shall be deemed to form part of Final Tender Documents.

In case of any discrepancy noticed at any stage i.e. evaluation of Tenders, execution of work or final payment of the Contract, the contents of Final Tender Document shall supersede previously issued Tender Documents dated 11.11.2022 & Corrigendum No. 1 and Corrigendum No.2.

HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LIMITED

Specific Procurement Notice (SPN)

Procurement of Works

(e-Tendering Process Without Prequalification)

Tender No. HORC/HRIDC/C-23/2022 **Date: 09.11.2022**

Country **:** India

Employer **:** Haryana Orbital Rail Corporation Limited

Tender Inviting Authority: Haryana Rail Infrastructure Development Corporation Limited (HRIDC)

Project **:** Haryana Orbital Rail Corridor Project

Loan No **:** 000370

Contract Title: C23- Composite Works Contract (Civil and General Electrical Services) on EPC basis

Tender Document Issued on: 11.11.2022

1. The Government of Haryana (GoH) has applied for financing from the **Asian Infrastructure Investment Bank (AIIB or the Bank)** towards the cost of the **Haryana Orbital Rail Corridor (HORC) Project**, and intends to apply part of the proceeds towards payments under the contract for "**C-23:** Design and Construction of Civil Works (Earthwork, Bridges, Station Buildings, Retaining Walls and other miscellaneous Works) from km 29.68 to km 49.70 & from km 55.60 to km 61.50 and its connectivities to IR network from New Patli to Patli station & New Patli to Sultanpur station including modifications/civil works at Sultanpur Station in connection with laying of New BG Double Railway line of HORC project."

2. Haryana Rail Infrastructure Development Corporation Limited (HRIDC), an implementing agency, now invites online Tenders through e-tendering portal of Govt. of Haryana from eligible Tenderers for **Package C-23** fulfilling the qualification criteria as mentioned in the Tender Document. The completion period of work is ***910 days***. Tenderers are advised to refer the Clauses on eligibility (Section I-ITT, Clause 4) and minimum qualification criteria (Section III – Evaluation and Qualification Criteria) given in Part 1 of Tender Document, to qualify for the participation in the Tender.

3. Tendering will be conducted through International Open Competitive Tendering (IOCT) procedures as specified in the Bank's Procurement Instructions for Recipients (PIR) and is open to all eligible Tenderers.

4. Interested eligible Tenderers may obtain further information from the office of Chief Project Manager, HRIDC and inspect the Tender Document during office hours from 0930to 1800 hours at the address given below:

Chief Project Manager,
Haryana Rail Infrastructure Development Corporation Limited,
Plot No 143, 5th Floor, Railtel Tower,
Sector-44, Gurugram,
Haryana-122003
Tel No: +91 9311478893
Email id: horc.etendering@gmail.com

5. The Tender Document in English will be available online on e-procurement portal of Govt.of Haryana (https://etenders.hry.nic.in) from **11.11.2022 at 1700 hrs. IST** till ***20.01.2023*** **at 1500 hrs. IST.** The start date of submission of tender on e-procurement portal is ***05.01.2023*** **at 1100 hrs. IST**. There is no cost of Tender Document. However, at the time of submission of Tender, the Tenderer is required to submit a non-refundable **E-Service fee of INR 1180** as indicated in the table at the end of thisSPN. The method of payment of E-Service fee will be online in the e-procurement portal using the electronic payment gateway service. Tenderers will be required to register in the above website.

6. For submission of the Tenders, the Tenderer is required to have Digital Signature Certificate (DSC) from one of the Certifying Authorities (CAs), authorized by Government of India for issuing DSC. Tenderers can see the list of licensed CAs from the link (www.cca.gov.in). Aspiring Tenderers who have not obtained the user ID and password for participating in e-procurement in this Project, may obtain the same from the website: https://etenders.hry.nic.in.

7. Tender comprise two Parts, namely the Technical Part and the Financial (Price) Part, and both parts must be simultaneously submitted online on e-procurement portal (https://etenders.hry.nic.in) before ***20.01.2023*** **at 1500 hrs**. **IST.** Tender validity shall be 180 days from the last date of submission of Tenders. Any Tender or modifications to Tender received outside e-procurement system will not be considered. The electronic tendering system would not allow any late submission of Tenders. The "TECHNICAL PART" of theTenders will be opened online on ***20.01.2023*** **at 1530 hrs. IST** and this could be viewed by theTenderers online on e-procurement Portal. The "FINANCIAL PART" shall remain in encrypted form in the e-procurement system until the opening. If the office happens to be closed on the date of opening of the Tenders as specified, the Tenders will be opened on the next working day at the same time and venue.

8. All Tenders must be accompanied by a Tender Security of the amount in the currency specified for the Work in the table at the end of this SPN. Tender Security can be paid online on e-procurement Portal in INR in favour of Haryana Rail Infrastructure Development Corporation Limited using the electronic payment gateway service or Tender Security can be submitted in the form of unconditional Bank Guarantee in INR or USD as per Clause ITT 19.3 of TDS. In case the Tenderer has opted for Tender security in the form of an unconditional Bank guarantee, the Tenderer should upload the scanned copy of Bank Guarantee with the Tender. The original Bank Guarantee shall be delivered either by Registered Post / Speed Post/Courier or by hand within ten (10) days of deadline of submission of Tender at the address given below:

Chief Project Manager,
Haryana Rail Infrastructure Development Corporation Limited,
Plot No 143, 5th Floor, Railtel Tower,
Sector-44, Gurugram, Haryana-122003

9. A **Pre-Tender Meeting** will be held on **08.12.2022 at 1100 hrs. IST** through online video conferencing as well as offline in the Conference room of HRIDC office, Plot No 143, Railtel Tower, Sector-44, Gurugram, Haryana-122003 to clarify the issues and to answer questions on any matter that may be raised at that stage as stated in ITT Clause 7.4 of 'Instructions to Tenderers' of the Tender Document. Tenderers are advised to download the Tender Document prior to the Pre-Tender Meeting in order for Tenderers to have a good understanding of the scope of the requirements under this contract for discussion and clarification at the Pre-Tender Meeting. Last date for submission of Pre-tender queries to the Employer a **by 1800 hrs. IST** after which no queries will be acknowledged. HRIDC's response to Pre-tender queries will be uploaded on or before ***28.12.2022***.

10. Other details can be seen in the Tender Document. The Employer shall not be held liable for any delays due to system failure beyond its control. Even though the system will attempt to notify the Tenderers of any updates, the Employer shall not be liable for any information not received by the Tenderer. It is the Tenderers' responsibility to verify the HRIDC website (http://www.hridc.co.in) and e-procurement portal of Govt. of Haryana (https://etenders.hry.nic.in) for the latest information related to this Tender.

TABLE

Package No.	**Name of Work**	**Tender Security**	**Cost of Tender Document**	**E-Service fee**	**Time for Completion**
1	2	3	4	5	6
C-23	**C-23**: Design and Construction of Civil Works (Earthwork, Bridges, Station Buildings, Retaining Walls and other miscellaneous Works) from km 29.68 to km 49.70 & from km 55.60 to km 61.50 and its connectivities to IR network from New Patli to Patli station & New Patli to Sultanpur station including modifications/civil works at Sultanpur Station in connection with laying of New BG Double Railway line of HORC project.	**INR 10 Million** **OR** **USD 121,000**	**NIL**	**INR 1180** (including GST)	***910 days***

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Chief Project Manager,
Haryana Rail Infrastructure Development Corporation Limited
Plot No 143, 5th Floor, Railtel Tower,
Sector-44, Gurugram,
Haryana-122003

Final Tender Document for Works

(Two-Envelope Tendering Process Without Prequalification)

Procurement of:

Contract Package C-23: Design and Construction of Civil Works (Earthwork, Bridges, Station Buildings, Retaining Walls and other miscellaneous Works) from km 29.68 to km 49.70 & from km 55.60 to km 61.50 and its connectivities to IR network from New Patli to Patli station & New Patli to Sultanpur station including modifications/civil works at Sultanpur Station in connection with laying of New BG Double Railway line of HORC project.

Tender No: HORC/HRIDC/C-23/2022
Contract title: Composite Works Contract (Civil and General Electrical Services) on EPC basis (C-23)
Project: Haryana Orbital Rail Corridor Project
Loan No.: 000370
Employer: Haryana Orbital Rail Corporation Limited
Country: INDIA
Issued on: ***02.01.2023***

Summary

Specific Procurement Notice (SPN)

PART 1 – Tendering Procedures

Table of Contents

Section I - Instructions to Tenderers (ITT)

Contents

Section I - Instructions to Tenderers (ITT)

A. General

1. Scope of Tender

1.1 In connection with the Specific Procurement Notice (SPN) indicated in the **Tender Data Sheet (TDS)**, the Employer, as specified in the **TDS**, issues this Tender Document for the provision of Works on EPC basis as specified in Section VII, Employer's Requirements. The name, identification, and number of lots (contracts) of this tender are specified in the **TDS.**

1.2 Throughout this Tender Document:

(a) the term "in writing" means communicated in written form (e.g., by mail, e-mail, fax, including, if specified in the **TDS**, distributed or received through electronic-procurement system used by the Employer) with proof of receipt;

(b) if the context so requires, "singular" means "plural' and vice versa;

(c) "Day" means calendar day, unless otherwise specified as a "Business Day." A Business Day is any day that is a working day of the Recipient. It excludes the Recipient's official public holidays;

(d) "ESHS" means environmental, social, health and safety; and

(e) the word "tender" is synonymous with "bid" and "tenderer" with "bidder", and the words "tender documents" with "bidding documents".

2. Source of Funds

2.1 The Recipient specified in the **TDS** has received or has applied for financing (hereinafter called "funds") from the Asian Infrastructure Investment Bank (hereinafter called ("AIIB" or "the Bank") in an amount specified in the **TDS**, toward the project named in the **TDS**. The Recipient intends to apply a portion of the funds to eligible payments under the contract(s) for which this Tender Document is issued.

2.2 Payment by the Bank will be made only at the request of the Recipient and upon approval by the Bank, and will be subject, in all respects, to the terms and conditions of the Loan (or other financing) Agreement. The Loan (or other financing) Agreement prohibits a withdrawal from the loan account for the purpose of any payment to persons or entities, or for any import of goods, equipment, plant, or materials, if such payment or import is prohibited by a decision of the United Nations Security Council taken under Chapter VII of the

Charter of the United Nations. No party other than the Recipient shall derive any rights from the Loan (or other financing) Agreement or have any claim to the proceeds of the Loan (or other financing).

3. Prohibited Practices

3.1 The Bank requires compliance with the Bank's Policy on Prohibited Practices as set forth in Section VI.

3.2 In further pursuance of this policy, Tenderers shall permit and shall cause their agents (whether declared or not), subcontractors, sub-consultants, service providers, suppliers, and their personnel, to permit the Bank to inspect all accounts, records and other documents relating to any prequalification process, tender submission, proposal submission, and contract performance (in the case of award), and to have them audited by auditors appointed by the Bank.

4. Eligible Tenderers

4.1 A Tenderer may be a firm that is a private entity, a state-owned enterprise or institution subject to ITT 4.6 or any combination of such entities in the form of a joint venture (JV) under an existing agreement or with the intent to enter into such an agreement supported by a letter of intent. In the case of a joint venture, all members shall be jointly and severally liable for the execution of the entire Contract in accordance with the Contract terms. The JV shall nominate a Representative who shall have the authority to conduct all business for and on behalf of any and all the members of the JV during the Tendering process and, in the event the JV is awarded the Contract, during contract execution. Unless specified in the **TDS**, there is no limit on the number of members in a JV.

4.2 A Tenderer shall not have a conflict of interest. Any Tenderer found to have a conflict of interest shall be disqualified. A Tenderer may be considered to have a conflict of interest for the purpose of this Tendering process, if the Tenderer:

a) directly or indirectly controls, is controlled by or is under common control with another Tenderer; or
b) receives or has received any direct or indirect subsidy from another Tenderer; or
c) has the same legal representative as another Tenderer; or
d) has a relationship with another Tenderer, directly or through common third parties, that puts it in a position to influence the Tender of another Tenderer, or influence the decisions of the Employer regarding this Tendering process; or
e) or any of its affiliates participated as a consultant in the preparation of the design or technical specifications of the Works that are the subject of the Tender; or
f) or any of its affiliates has been hired (or is proposed to be hired) by the Employer or Recipient as Engineer for the Contract implementation; or

g) would be providing goods, works, or non-consulting services resulting from or directly related to consulting services for the preparation or implementation of the project specified in the TDS ITT 2.1 that it provided or were provided by any affiliate that directly or indirectly controls, is controlled by, or is under common control with that firm; or

h) has a close business or family relationship with a professional staff of the Recipient (or of the project implementing agency, or of any other beneficiary of the Bank's financing, or of any other party representing or acting on behalf of the Recipient) who: (i) are directly or indirectly involved in the preparation of the Tender Document or specification of the Contract, and/or the Tender evaluation process of such Contract; or (ii) would be involved in the implementation or supervision of such Contract unless the conflict stemming from such relationship has been resolved in a manner acceptable to the Bank throughout the Tendering process and execution of the Contract; or

i) is an affiliate of the Recipient, or of a procurement agent engaged by the Recipient, unless the Recipient demonstrates to the satisfaction of the Bank that there is no significant degree of common ownership, influence or control between the Recipient on the one hand, and the Recipient's agent and the affiliate on the other.

4.3 A firm that is a Tenderer (either individually or as a JV member) shall not participate in more than one Tender, except for permitted alternative Tenders. Such participation shall result in the disqualification of all Tenders in which the firm is involved. However, this does not limit: (a) the inclusion of the same Subcontractor in more than one Tender for the same contract; or (b) the ability of one Tenderer to be a Subcontractor in another Tender for the same contract.

4.4 A Tenderer may have the nationality of any country, subject to the restrictions pursuant to ITT 4.8. A Tenderer shall be deemed to have the nationality of a country if the Tenderer is constituted, incorporated or registered in and operates in conformity with the provisions of the laws of that country, as evidenced by its articles of incorporation (or equivalent documents of constitution or association) and its registration documents, as the case may be. This criterion also shall apply to the determination of the nationality of proposed subcontractors or sub-consultants for any part of the Contract including related Services.

4.5 A Tenderer that has been declared, and remains, as at the relevant date, ineligible pursuant to the Bank's Policy on Prohibited Practices as described in Section VI, shall be ineligible to be prequalified for,

tender for, propose for, or be awarded a Bank-financed contract or benefit from a Bank-financed contract, financially or otherwise, during such period of time as the Bank shall have determined. The list of debarred firms and individuals is available at the electronic address specified in the **TDS**.

4.6 Tenderers that are state-owned enterprises or institutions in the Employer's Country may be eligible to compete and be awarded a Contract(s) only if they can establish, in a manner acceptable to the Bank, that they (i) are carrying-out or are established for a business purpose, and are operating on a commercial basis; (ii) are financially and managerially autonomous; (iii) are not controlled by the government on day-to-day management; and (iv) are not under the supervision of the Employer or its procuring agency.

4.7 A Tenderer shall not be under suspension from Tendering by the Employer as the result of the operation of a Tender–Securing or Proposal-Securing Declaration.

4.8 Firms and individuals may be ineligible if so indicated in Section V and (a) as a matter of law or official regulations, the Recipient's country prohibits commercial relations with the firm or individual's country, provided that the Bank is satisfied that such exclusion does not preclude effective competition for the supply of goods or the contracting of works or services required; or (b) by an act of compliance with a decision of the United Nations Security Council taken under Chapter VII of the Charter of the United Nations, the Recipient's country prohibits any import of goods or contracting of works or services from the firm or individual's country, or any payments to any country, person, or entity in that country. When the Works are implemented across jurisdictional boundaries (and more than one country is a Recipient, and is involved in the procurement), then exclusion of a firm or individual on the basis of ITT 4.8 (a) above by any country may be applied to that procurement across other countries involved, if the Bank and the Recipients involved in the procurement agree.

4.9 A Tenderer shall provide such documentary evidence of eligibility satisfactory to the Employer, as the Employer shall reasonably request.

4.10 A firm that is under a sanction of debarment by the Recipient from being awarded a contract is eligible to participate in this procurement, unless the Bank, at the Recipient's request, is satisfied that the debarment; (a) relates to fraud or corruption or other prohibited practices, and (b) followed a judicial or administrative proceeding that afforded the firm adequate due process.

5. Eligible Materials, Equipment, and Services

5.1 The materials, equipment and services to be supplied under the Contract and financed by the Bank may have their origin in any country subject to the restrictions specified in Section V, Eligible Countries, and all expenditures under the Contract will not contravene such restrictions. At the Employer's request, Tenderers may be required to provide evidence of the origin of materials, equipment and services.

B. Contents of Tender Document

6. Sections of Tender Document

6.1 The Tender Document consists of Parts 1, 2 and 3, includes all the sections specified below, and should be read in conjunction with any Addenda issued in accordance with ITT 8.

PART 1 Tendering Procedures

- Section I - Instructions to Tenderers (ITT)
- Section II - Tender Data Sheet (TDS)
- Section III - Evaluation and Qualification Criteria
- Section IV - Tender Forms
- Section V - Eligible Countries
- Section VI - Prohibited Practices

PART 2 Employer's Requirements

Section VII - Employer's Requirements

PART 3 Conditions of Contract and Contract Forms

- Section VIII - General Conditions of Contract (GCC)
- Section IX - Particular Conditions of Contract (PCC)
- Section X - Contract Forms

6.2 The Specific Procurement Notice issued by the Employer is not part of the Tender Document.

6.3 Unless obtained directly from the Employer, the Employer is not responsible for the completeness of the Tender Document, responses to requests for clarification, the minutes of the pre-Tender meeting (if any), or Addenda to the Tender Document in accordance with ITT 8. In case of any contradiction, documents obtained directly from the Employer shall prevail.

6.4 The Tenderer is expected to examine all instructions, forms, terms, and specifications in the Tender Document and to furnish with its

Tender all information and documentation as is required by the Tender Document.

7. Clarification of Tender Document, Site Visit, Pre-Tender Meeting

7.1 A Tenderer requiring any clarification of the Tender Document shall contact the Employer in writing at the Employer's address specified in the **TDS** or raise its enquiries during the pre-Tender meeting if provided for in accordance with ITT 7.4. The Employer will respond in writing to any request for clarification, provided that such request is received no later than 22.07.2022,1800 Hrs IST. The Employer shall forward copies of its response to all Tenderers who have acquired the Tender Document in accordance with ITT 6.3, including a description of the inquiry but without identifying its source. If so, specified in the **TDS**, the Employer shall also promptly publish its response at the web page identified in the **TDS**. Should the clarification result in changes to the essential elements of the Tender Document, the Employer shall amend the Tender Document following the procedure under ITT 8 and ITT 22.2.

7.2 The Tenderer is advised to visit and examine the Site of Works and its surroundings and obtain for itself on its own responsibility all information that may be necessary for preparing the Tender and entering into a contract for construction of the Works. The costs of visiting the Site shall be at the Tenderer's own expense.

7.3 The Tenderer and any of its personnel or agents will be granted permission by the Employer to enter upon its premises and lands for the purpose of such visit, but only upon the express condition that the Tenderer, its personnel, and agents will release and indemnify the Employer and its personnel and agents from and against all liability in respect thereof, and will be responsible for death or personal injury, loss of or damage to property, and any other loss, damage, costs, and expenses incurred as a result of the inspection.

7.4 If so specified in the **TDS**, the Tenderer's designated representative is invited to attend a pre-Tender meeting and/or a Site of Works visit. The purpose of the meeting will be to clarify issues and to answer questions on any matter that may be raised at that stage.

7.5 The Tenderer is requested to submit any questions in writing, to reach the Employer not later than one week before the meeting.

7.6 Minutes of the pre-Tender meeting, if applicable, including the text of the questions asked by Tenderers, without identifying the source, and the responses given, together with any responses prepared after the meeting, will be transmitted promptly to all Tenderers who have acquired the Tender Document in accordance with ITT 6.3. If so, specified in the **TDS,** the Employer shall also promptly publish the Minutes of the pre-Tender meeting at the web page identified in the **TDS**. Any modification to the Tender Document that may become necessary as a result of the pre-Tender meeting shall be made by the Employer exclusively through the issue of an Addendum pursuant to ITT 8 and not through the minutes of the pre-Tender meeting. Nonattendance at the pre-Tender meeting will not be a cause for disqualification of a Tenderer.

8. Amendment of Tender Document

8.1 At any time prior to the deadline for submission of Tenders, the Employer may amend the Tender Document by issuing addenda.

8.2 Any addendum issued shall be part of the Tender Document and shall be communicated in writing to all who have obtained the Tender Document from the Employer in accordance with ITT 6.3. The Employer shall also promptly publish the addendum on the Employer's web page in accordance with ITT 7.1.

8.3 To give Tenderers reasonable time in which to take an addendum into account in preparing their Tenders, the Employer may, at its discretion, extend the deadline for the submission of Tenders, pursuant to ITT 22.2.

C. Preparation of Tenders

9. Cost of Tendering

9.1 The Tenderer shall bear all costs associated with the preparation and submission of its Tender, and the Employer shall not be responsible or liable for those costs, regardless of the conduct or outcome of the Tendering process.

10. Language of Tender

10.1 The Tender, as well as all correspondence and documents relating to the Tender exchanged by the Tenderer and the Employer, shall be written in the language specified in the **TDS**. Supporting documents and printed literature that are part of the Tender may be in another language provided they are accompanied by an accurate translation of the relevant passages in the language specified in the **TDS**, in which case, for purposes of interpretation of the Tender, such translation shall govern.

11. Documents Comprising the Tender

11.1 The Tender shall comprise two Parts, namely the Technical Part and the Financial Part. These two Parts shall be submitted simultaneously in two separate sealed envelopes (two-envelope tendering process). One envelope shall contain only information relating to the

Technical Part and the other, only information relating to the Financial Part. These two envelopes shall be enclosed in a separate sealed outer envelope marked "ORIGINAL TENDER".

11.2 The Technical Part shall contain the following:

(a) Letter of Tender – Technical Part: prepared in accordance with ITT 12;

(b) Tender Security or Tender-Securing Declaration: in accordance with ITT 19.1;

(c) Alternative Tender – Technical Part: if permissible, in accordance with ITT 13;

(d) Authorization: written confirmation authorizing the signatory of the Tender to commit the Tenderer, in accordance with ITT 20.3;

(e) Eligibility: documentary evidence in accordance with ITT17.1 establishing the Tenderer's eligibility to tender;

(f) Qualifications: documentary evidence in accordance with ITT 17.2 establishing the Tenderer's qualifications to perform the Contract if its Tender is accepted;

(g) Conformity: a technical proposal in accordance with ITT 16;

(h) Any other document required in the **TDS**.

11.3 The Financial Part shall contain the following:

(a) Letter of Tender – Financial Part: prepared in accordance with ITT 12 and ITT 14;

(b) Price Schedule: completed in accordance with ITT 12 and ITT 14;

(c) Alternative Tender - Financial Part: if permissible in accordance with ITT 13; and

(d) Any other document required in the **TDS**.

11.4 The Technical Part shall not include any information related to the Tender price. Where material financial information related to the Tender price is contained in the Technical Part, the Tender shall be declared non-responsive.

11.5 In addition to the requirements under ITT 11.2, Tenders submitted by a JV shall include a copy of the Joint Venture Agreement entered into by all members. Alternatively, a letter of intent to execute a Joint Venture Agreement in the event of a successful Tender shall be

signed by all members and submitted with the Tender, together with a copy of the proposed Agreement.

11.6 The Tenderer shall furnish in the Letter of Tender – Financial Part information on commissions and gratuities, if any, paid or to be paid to agents or any other party relating to this Tender.

12. Letter of Tender and Schedules

12.1 The Letter of Tender – Technical Part, the Letter of Tender – Financial Part, Schedules and all documents listed under ITT 11 including the Price Schedule, shall be prepared using the relevant forms furnished in Section IV, Tender Forms. The forms must be completed without any alterations to the text, and no substitutes shall be accepted except as provided under ITT 20.3. All blank spaces shall be filled in with the information requested.

13. Alternative Tenders

13.1 Unless otherwise specified in the **TDS**, alternative Tenders shall not be considered.

13.2 When alternative times for completion are explicitly invited, a statement to that effect will be included in the **TDS**, and the method of evaluating different alternative times for completion will be described in Section III, Evaluation and Qualification Criteria.

13.3 Except as provided under ITT 13.4 below, Tenderers wishing to offer technical alternatives to the requirements of the Tender Document must first price the Employer's design as described in the Tender Document and shall further provide all information necessary for a complete evaluation of the alternative by the Employer, including drawings, design calculations, technical specifications, breakdown of prices, and proposed construction methodology and other relevant details. Only the technical alternatives, if any, of the Tenderer with the Most Advantageous Tender conforming to the basic technical requirements shall be considered by the Employer.

13.4 When specified in the **TDS**, Tenderers are permitted to submit alternative technical solutions for specified parts of the Works. Such parts will be identified in the **TDS** and described in Section VII, Employer's Requirements. The method for their evaluation will be stipulated in Section III, Evaluation and Qualification Criteria.

14. Tender Prices and Discounts

14.1 The prices and discounts (including any price reduction) quoted by the Tenderer in the Letter of Tender – Financial Part and in the Price Schedule shall conform to the requirements specified below.

14.2 Unless otherwise specified in the TDS, Tenderers shall quote for the entire Works on a "single responsibility" basis such that the total lump sum Tender price, subject to any adjustments, in accordance with the Contract, covers all the Contractor's obligations mentioned in or to be reasonably inferred from the Tendering document for complete execution of the Works on EPC basis. This includes all

requirements under the Contractor's responsibilities for design, construction, procurement, erection, installation, subcontracting (if any), testing, pre-commissioning and commissioning (as applicable) of the Works and, where so required by the Tendering document, the acquisition of all permits, approvals and licenses, etc.; the operation, maintenance and training services and such other items and services as may be specified in the Tendering document, all in accordance with the requirements of the General Conditions.

Tenderers shall give a breakdown of the prices in the manner and detail called for in the Schedule of Rates and prices (if any) included in Section IV, Tender Forms. These will not in any way limit the Tenderers' single point total responsibility for the complete Scope of Work and for all contractual responsibilities/ obligations as stated in the Tendering Document.

14.3 The price to be quoted in the Letter of Tender – Financial Part, in accordance with ITT 12.1, shall be the total price of the Tender, excluding any discounts offered.

14.4 The Tenderer shall quote any discounts and the methodology for their application in the Letter of Tender – Financial Part, in accordance with ITT 12.1.

14.5 Unless otherwise specified in the **TDS** and the Conditions of Contract, the rates and prices quoted by the Tenderer are subject to adjustment during the performance of the Contract in accordance with the provisions of the Conditions of Contract. In such a case, the Tenderer shall furnish the indices and weightings for the price adjustment formulae in the Table of Adjustment Data in Section IV, Tender Forms, and the Employer may require the Tenderer to justify its proposed indices and weightings.

14.6 If so specified in ITT 1.1, Tenders are being invited for individual lots (contracts) or for any combination of lots (packages). Tenderers wishing to offer discounts for the award of more than one Contract shall specify in their Tender the price reductions applicable to each package, or alternatively, to individual Contracts within the package. Discounts shall be submitted in accordance with ITT 14.4, provided the Tenders for all lots (contracts) are opened at the same time. If, however, rated criteria are used in accordance with ITT 30.2, discounts on condition of award of more than one Contract shall not be used for Tender evaluation purpose.

14.7 All duties, taxes, and other levies payable by the Contractor under the Contract, or for any other cause, as of the date 28 days prior to the deadline for submission of Tenders, shall be included in the rates and prices and the total Tender Price submitted by the Tenderer.

15. Currencies of Tender and Payment

15.1 The currency (ies) of the Tender and the currency (ies) of payments shall be the same and shall be as specified in the **TDS.**

15.2 Tenderers may be required by the Employer to justify, to the Employer's satisfaction, their local and foreign currency requirements, and to substantiate that the amounts included in the unit rates and prices and shown in the Table of Adjustment Data in the Appendix to Tender in Section IV, Tender Forms, are reasonable, in which case a detailed breakdown of the foreign currency requirements shall be provided by Tenderers.

16. Documents Comprising the Technical Proposal

16.1 The Tenderer shall furnish a technical proposal in the Technical Part of the Tender including a statement of work methods, equipment, personnel, schedules and any other information as stipulated in Section IV, Tender Forms, in sufficient detail to demonstrate the adequacy of the Tenderer's proposal to meet the Employer's requirements and the completion time.

17. Documents Establishing the Eligibility and Qualifications of the Tenderer

17.1 To establish Tenderer's eligibility in accordance with ITT 4, Tenderers shall complete the Letter of Tender – Technical Part, included in Section IV, Tender Forms.

17.2 In accordance with Section III, Evaluation and Qualification Criteria, to establish its qualifications to perform the Contract, the Tenderer shall provide the information requested in the corresponding information sheets included in Section IV, Tender Forms.

17.3 If provisions for development of domestic industry (such as a margin of domestic preference) apply as specified in accordance with ITT 38.1, domestic Tenderers, individually or in joint ventures, applying for eligibility for domestic preference shall supply all information required to satisfy the criteria for eligibility specified in accordance with ITT 38.1.

18. Period of Validity of Tenders

18.1. Tenders shall remain valid for the Tender Validity period specified in the **TDS**. The Tender Validity period starts from the date fixed for the Tender submission deadline (as prescribed by the Employer in accordance with ITT 22). A Tender valid for a shorter period shall be rejected by the Employer as nonresponsive.

18.2. In exceptional circumstances, prior to the expiration of the Tender validity period, the Employer may request Tenderers to extend the period of validity of their Tenders. The request and the responses shall be made in writing. If a Tender Security is requested in accordance with ITT 19, it shall also be extended for a corresponding period. A Tenderer may refuse the request without forfeiting its Tender security. A Tenderer granting the request shall not be required or permitted to modify its Tender, except as provided in ITT 18.3.

18.3. If the award is delayed by a period exceeding fifty-six (56) days beyond the expiry of the initial Tender validity period, the Contract price shall be determined as follows:

(a) in the case of fixed price contracts, the Contract price shall be the Tender price adjusted by the factor specified in the **TDS**;

(b) in the case of adjustable price contracts, no adjustment shall be made; or

(c) in any case, Tender evaluation shall be based on the Tender price without taking into consideration the applicable correction from those indicated above.

19. Tender Security

19.1 The Tenderer shall furnish as part of the Technical Part of its Tender, either a Tender Security or a Tender-Securing Declaration, as specified in the **TDS**, in original form and, in the case of a Tender Security, in the amount and currency, or in the case of a Tender-Securing Declaration, for the period of ineligibility, as specified in the **TDS**.

19.2 A Tender-Securing Declaration shall use the form included in Section IV, Tender Forms.

19.3 If a Tender Security is specified pursuant to ITT 19.1, the Tender Security shall be a demand guarantee in any of the following forms at the Tenderer's option:

(a) an unconditional guarantee issued by a bank;

(b) an irrevocable letter of credit;

(c) a cashier's or certified check; or

(d) another security specified in the **TDS**,

from a reputable source from an eligible country. In the case of a bank guarantee, the Tender Security shall be submitted either using the Tender Security Form included in Section IV, Tender Forms, or in another substantially similar format approved by the Employer prior to Tender submission. The Tender Security shall be valid for twenty-eight (28) days beyond the original validity period of the Tender, or beyond any period of extension if requested under ITT 18.2.

19.4 If a Tender Security or Tender-Securing Declaration is specified pursuant to ITT 19.1, any Tender not accompanied by a substantially responsive Tender Security or Tender-Securing Declaration shall be rejected by the Employer as non-responsive.

19.5 If a Tender Security is specified pursuant to ITT 19.1, the Tender Security of unsuccessful Tenderers shall be returned as promptly as

possible upon the successful Tenderer's signing the Contract and furnishing the Performance Security pursuant to ITT 50.

19.6 The Tender Security of the successful Tenderer shall be returned as promptly as possible once the successful Tenderer has signed the Contract and furnished the required Performance Security.

19.7 The Tender Security may be forfeited, or the Tender-Securing Declaration executed:

(a) if a Tenderer withdraws its Tender during the period of Tender validity specified by the Tenderer on the Letter of Tender, or any extension thereto provided by the Tenderer; or

(b) if the successful Tenderer fails to:

(i) sign the Contract in accordance with ITT 49; or

(ii) furnish a Performance Security in accordance with ITT 50.

19.8 The Tender Security or the Tender-Securing Declaration of a JV shall be in the name of the JV that submits the Tender. If the JV has not been legally constituted into a legally enforceable JV at the time of Tendering, the Tender Security or the Tender-Securing Declaration shall be in the names of all future members as named in the letter of intent referred to in ITT 4.1 and ITT 11.5.

20. Format and Signing of Tender

20.1 The Tenderer shall prepare one original set of the Technical Part of the Tender and one original set of the Financial Part of the Tender as described in ITT 11 and ITT 21, and clearly mark them "ORIGINAL". Alternative Tenders, if permitted in accordance with ITT 13, shall be clearly marked "ALTERNATIVE." In addition, the Tenderer shall submit copies of the Tender, in the number specified in the **TDS** and clearly mark them "COPY". In the event of any discrepancy between the original and the copies, the original shall prevail.

20.2 Tenderers shall mark as "CONFIDENTIAL" all information in their Tenders which is confidential to their business. This may include proprietary information, trade secrets, or commercial or financially sensitive information.

20.3 The original and all copies of the Tender shall be typed or written in indelible ink and shall be signed by a person duly authorized to sign on behalf of the Tenderer. This authorization shall consist of a written confirmation as specified in the **TDS** and shall be attached to the Tender. The name and position held by each person signing the authorization must be typed or printed below the signature. All pages of the Tender where entries or amendments have been made shall be signed or initialed by the person signing the Tender.

20.4 In case the Tenderer is a JV, the Tender shall be signed by an authorized representative of the JV on behalf of the JV, and so as to be legally binding on all the members as evidenced by a power of attorney signed by their legally authorized representatives.

20.5 Any amendments such as inter-lineation, erasures, or overwriting shall be valid only if they are signed or initialed by the person signing the Tender.

D. Submission of Tenders

21. Sealing and Marking of Tenders

21.1 Tenderers may submit their Tenders by mail or by hand. If so specified in the TDS, Tenderers shall have the option of submitting their Tenders electronically. Procedures for submission, sealing, and marking are as follows:

(a) Tenderers submitting Tenders by mail or by hand shall enclose the original Technical Part of the Tender, the original Financial Part of the Tender, and the respective copies of the Tender, including Alternative Tenders if permitted in accordance with ITT 13, in separate sealed envelopes. The envelopes shall be duly marked as "ORIGINALTECHNICAL PART", "ORIGINAL-FINANCIAL PART", "COPY-TECHNICAL PART", "COPY-FINANCIAL PART", "ALTERNATIVE-ORIGINAL-TECHNCIAL PART", "ALTERNATIVE-ORIGINAL-FINANCIAL PART", "ALTERNATIVE-COPY-TECHNCIAL PART", and "ALTERNATIVE-COPY-FINANCIAL PART". These envelopes shall then be enclosed in one single package. The rest of the procedure shall be in accordance with ITT 21.2 through ITT 21.5.

(b) Tenderers submitting Tenders electronically shall follow the electronic tender submission procedures specified in the **TDS**.

21.2 The inner and outer envelopes shall:

(a) bear the name and address of the Tenderer;

(b) be addressed to the Employer in accordance with ITT 22.1; and

(c) bear the specific identification of this Tendering process specified in accordance with TDS ITT 1.1.

21.3 The outer envelopes and the inner envelopes containing the Technical Part of Tender shall bear a warning not to open before the time and date for the opening of Technical Part of Tender, in accordance with ITT 25.1.

21.4 The inner envelopes containing the Financial Part of Tender shall bear a warning not to open until advised by the Employer in accordance with ITT34.

21.5 If all envelopes are not sealed and marked as required, the Employer will assume no responsibility for the misplacement or premature opening of the Tender.

22. Deadline for Submission of Tenders

22.1 Tenders must be received by the Employer at the address and no later than the date and time specified in the **TDS**.

22.2 The Employer may, at its discretion, extend the deadline for the submission of Tenders by amending the Tender Document in accordance with ITT 8, in which case all rights and obligations of the Employer and Tenderers previously subject to the deadline shall thereafter be subject to the deadline as extended.

23. Late Tenders

23.1 The Employer shall not consider any Tender that arrives after the deadline for submission of Tenders, in accordance with ITT 22. Any Tender received by the Employer after the deadline for submission of Tenders shall be declared late, rejected, and returned unopened to the Tenderer.

24. Withdrawal, Substitution, and Modification of Tenders

24.1 A Tenderer may withdraw, substitute, or modify its Tender after it has been submitted by sending a written notice, duly signed by an authorized representative, and shall include a copy of the authorization in accordance with ITT 20.3 (except that withdrawal notices do not require copies). The corresponding substitution or modification of the Tender must accompany the respective written notice. All notices must be:

(a) prepared and submitted in accordance with ITT 20 and ITT 21 (except that withdrawals notices do not require copies), and in addition, the respective envelopes shall be clearly marked "WITHDRAWAL", "SUBSTITUTION", "MODIFICATION"; and

(b) received by the Employer prior to the deadline prescribed for submission of Tenders, in accordance with ITT 22.

24.2 Tenders requested to be withdrawn in accordance with ITT 24.1 shall be returned unopened to the Tenderers.

24.3 No Tender may be withdrawn, substituted, or modified in the interval between the deadline for submission of Tenders and the expiration of the period of Tender validity specified by the Tenderer on the Letter of Tender or any extension thereof.

E. Public Opening of Technical Parts of Tenders

25. Technical Part Opening

25.1 Except in the cases specified in ITT 23 and ITT 24.2, the Employer shall publicly open and read out in accordance with this ITT all Tenders received by the deadline, at the date, time and place specified in the **TDS**, in the presence of Tenderers' designated representatives and anyone who chooses to attend. Any specific electronic Tender opening procedures required if electronic Tendering is permitted in accordance with ITT 21.1, shall be as specified in the **TDS**.

25.2 First, envelopes marked "Withdrawal" shall be opened and read out and the envelope with the corresponding Tender shall not be opened, but returned to the Tenderer. No Tender withdrawal shall be permitted unless the corresponding withdrawal notice contains a valid authorization to request the withdrawal and is read out at Tender opening.

25.3 Next, envelopes marked "Substitution" shall be opened and read out and exchanged with the corresponding Tender being substituted, and the substituted Tender shall not be opened, but returned to the Tenderer. No Tender substitution shall be permitted unless the corresponding substitution notice contains a valid authorization to request the substitution and is read out at Tender opening.

25.4 Next, envelopes marked "Modification" shall be opened and read out with the corresponding Tender. No Tender modification shall be permitted unless the corresponding modification notice contains a valid authorization to request the modification and is read out at Tender opening.

25.5 Next, all remaining envelopes marked "TECHNICAL PART" shall be opened one at a time. All envelopes marked "FINANCIAL PART" shall remain sealed, and kept by the Employer in safe custody until they are opened, at a later public opening, following the evaluation of the Technical Part of the Tenders. On opening the envelopes marked "TECHNICAL PART" the Employer shall read out: the name of the Tender, the presence or the absence of a Tender Security, or Tender-Securing Declaration, if required, and whether there is a modification; and Alternative Tender - Technical Part; and any other details as the Employer may consider appropriate.

25.6 Only Technical Parts of Tenders and Technical Parts of Alternative Tenders that are opened and read out at Tender opening shall be considered further for evaluation. The Letter of Tender – Technical Part and the separate sealed envelopes marked "FINANCIAL PART" are to be initialed by representatives of the Employer attending Tender opening in the manner specified in the **TDS**.

25.7 At the tender opening the Employer shall neither discuss the merits of any Tender nor reject any Tender (except for late Tenders, in accordance with ITT 23.1).

25.8 The Employer shall prepare a record of the Technical Part of Tender opening that shall include, as a minimum:

(a) the name of the Tenderer and whether there is a withdrawal, substitution, or modification;

(b) the receipt of envelopes marked "FINANCIAL PART;

(c) the presence or absence of a Tender Security or Tender-Securing Declaration, if one was required any alternative Tenders; and

(d) if applicable, any Alternative Tender – Technical Part.

25.9 The Tenderers' representatives who are present shall be requested to sign the record. The omission of a Tenderer's signature on the record shall not invalidate the contents and effect of the record. A copy of the record shall be distributed to all Tenderers who submitted Tenders in time and posted online when electronic Tendering is permitted.

F. Evaluation of Tenders – General Provisions

26. Confidentiality

26.1 Information relating to the evaluation of Tenders and recommendation of contract award shall not be disclosed to Tenderers or any other persons not officially concerned with the Tendering process until information on Intention to Award the Contract is transmitted to all Tenderers in accordance with ITT 45.

26.2 Any attempt by a Tenderer to influence the Employer in the evaluation of the Tenders or Contract award decisions may result in the rejection of its Tender.

26.3 Notwithstanding ITT 26.2, from the time of Tender opening to the time of Contract award, if a Tenderer wishes to contact the Employer on any matter related to the Tendering process, it shall do so in writing.

27. Clarification of Tenders

27.1 To assist in the examination, evaluation, and comparison of the Tenders, and qualification of the Tenderers, the Employer may, at its discretion, ask any Tenderer for a clarification of its Tender, allowing a reasonable time for response. Any clarification submitted by a Tenderer that is not in response to a request by the Employer shall not be considered. The Employer's request for clarification and the

response shall be in writing. No change, including any voluntary increase or decrease, in the prices or substance of the Tender shall be sought, offered, or permitted, except to confirm the correction of arithmetic errors discovered by the Employer in the evaluation of the Tenders, in accordance with ITT 36.

27.2 If a Tenderer does not provide clarifications of its Tender by the date and time set in the Employer's request for clarification, its Tender may be rejected.

28. Deviations, Reservations, and Omissions

28.1 During the evaluation of Tenders, the following definitions apply:

(a) "Deviation" is a departure from the requirements specified in the Tender Document;

(b) "Reservation" is the setting of limiting conditions or withholding from complete acceptance of the requirements specified in the Tender Document; and

(c) "Omission" is the failure to submit part or all of the information or documentation required in the Tender Document.

29. Nonmaterial Nonconformities

29.1 Provided that a Tender is substantially responsive, the Employer may waive any nonconformities in the Tender.

29.2 Provided that a Tender is substantially responsive, the Employer may request that the Tenderer submit the necessary information or documentation, within a reasonable period of time, to rectify nonmaterial nonconformities or omissions in the Tender related to documentation requirements. Requesting information or documentation on such nonconformities or omissions shall not be related to any aspect of the price of the Tender. Failure of the Tenderer to comply with the request may result in the rejection of its Tender.

29.3 Provided that a Tender is substantially responsive, the Employer shall rectify quantifiable nonmaterial nonconformities related to the Tender Price. To this effect, the Tender Price shall be adjusted, for comparison purposes only, to reflect the price of a missing or non-conforming item or component in the manner specified in the **TDS**.

G. Evaluation of Technical Parts of Tenders

30. Evaluation of Technical Parts

30.1 In evaluating the Technical Parts of each Tender, the Employer shall use the criteria and methodologies listed in this ITT and Section III, Evaluation and Qualification Criteria. No other evaluation criteria or methodologies shall be permitted.

30.2 If specified in the **TDS**, the Employer's evaluation will be carried out by applying rated criteria that take into account technical factors, in addition to cost factors. An Evaluated Tender Score will be calculated for each responsive Tender using the formula specified in Section III, Evaluation and Qualification Criteria. The scores to be given to technical factors and sub-factors are specified in the **TDS**. The weights to be given to the cost and the total technical score are specified in the **TDS**.

31. Determination of Responsiveness

31.1 The Employer's determination of a Tender's responsiveness is to be based on the contents of the Tender itself, as defined in ITT 11.

31.2 A substantially responsive Tender is one that meets the requirements of the Tender Document without material deviation, reservation, or omission. A material deviation, reservation, or omission is one that:

(a) if accepted, would:

(i) affect in any substantial way the scope, quality, or performance of the Works specified in the Contract; or

(ii) limit in any substantial way, inconsistent with the Tender Document, the Employer's rights or the Tenderer's obligations under the proposed Contract; or

(b) if rectified, would unfairly affect the competitive position of other Tenderers presenting substantially responsive Tenders.

31.3 The Employer shall examine the technical aspects of the Tender submitted in accordance with ITT 16, in particular, to confirm that all requirements of Section VII, Employer's Requirements have been met without any material deviation, reservation or omission.

31.4 If a Tender is not substantially responsive to the requirements of the Tender Document, it shall be rejected by the Employer and may not subsequently be made responsive by correction of the material deviation, reservation, or omission.

32. Qualification of the Tenderers

32.1 The Employer shall determine to its satisfaction whether the eligible Tenderers that have submitted substantially responsive Tender - Technical Parts meet the qualifying criteria specified in Section III, Evaluation and Qualification Criteria.

32.2 The determination shall be based upon an examination of the documentary evidence of the Tenderer's qualifications submitted by the Tenderer, pursuant to ITT 17. The determination shall not take into consideration the qualifications of other firms such as the Tenderer's subsidiaries, parent entities, affiliates, subcontractors

(other than Specialized Subcontractors if permitted in ITT 33.3), or any other firm(s) different from the Tenderer.

32.3 If a Tenderer does not meet the qualifying criteria specified in Section III, Evaluation and Qualification Criteria, its Tender shall be rejected by the Employer and may not subsequently be made responsive by correction of the material deviation, reservation, or omission.

32.4 Only Tenders that are both substantially responsive to the Tender Document, and meet all Qualification Criteria shall have their envelopes marked "FINANCIAL PART" opened at the second public opening.

33. Subcontractors

33.1 Unless otherwise stated in the **TDS**, the Employer does not intend to execute any specific elements of the Works by subcontractors selected in advance by the Employer.

33.2 Tenderers may propose subcontracting up to the percentage of total value of contracts or the volume of works as specified in the **TDS**. Subcontractors proposed by the Tenderer shall be fully qualified for their parts of the Works.

33.3 The subcontractor's qualifications shall not be used by the Tenderer to qualify for the Works unless their specialized parts of the Works were previously designated by the Employer in the **TDS** as can be met by subcontractors referred to hereafter as 'Specialized Subcontractors', in which case, the qualifications of the Specialized Subcontractors proposed by the Tenderer may be added to the qualifications of the Tenderer.

H. Public Opening of Financial Parts of Tenders

34. Public Opening of Financial Parts

34.1 Following the completion of the evaluation of the Technical Parts of the Tenders, and the Bank has issued its no objection (if applicable), the Employer shall notify in writing those Tenderers whose Tenders were considered non-responsive to the Tender Document or failed to meet the Qualification Criteria, advising them of the following information:

(a) the grounds on which their Technical Part of Tender failed to meet the requirements of the Tender Document;

(b) their envelopes marked "FINANCIAL PART" will be returned to them unopened after the completion of the selection process and the signing of the Contract; and

(c) notify them of the date, time and location of the public opening of the envelopes marked "FINANCIAL PART".

34.2 The Employer shall, simultaneously, notify in writing those Tenderers whose Tenders - Technical Parts have been evaluated as substantially responsive to the Tender Document and met all Qualifying Criteria, advising them of the following information:

(a) their Tender has been evaluated as substantially responsive to the Tender Document and met the Qualification Criteria;

(b) When rated criteria are used, the evaluated technical scores;

(c) their envelope marked "FINANCIAL PART" will be opened at the public opening of the Financial Parts; and

(d) notify them of the date, time and location of the second public opening of the envelopes marked "FINANCIAL PART" as specified in the **TDS**.

34.3 The opening date should allow Tenderers sufficient time to make arrangements for attending the opening. The Financial Part of the Tender shall be opened publicly in the presence of Tenderers' designated representatives and anyone who chooses to attend.

34.4 At this public opening the Financial Parts will be opened by the Employer in the presence of Tenderers, or their designated representatives and anyone else who chooses to attend. Tenderers who met the Qualification Criteria and whose Tenders were evaluated as substantially responsive will have their envelopes marked "FINANCIAL PART" opened at the second public opening. Each of these envelopes marked "FINANCIAL PART" shall be inspected to confirm that they have remained sealed and unopened. These envelopes shall then be opened by the Employer. The Employer shall read out the names of each Tenderer, and the total Tender prices, per lot (contract) if applicable, including any discounts and Alternative Tender - Financial Part, and any other details as the Employer may consider appropriate.

34.5 Only envelopes of Financial Part of Tenders, Financial Parts of Alternative Tenders and discounts that are opened and read out at tender opening shall be considered further for evaluation. The Letter of Tender – Financial Part and the Priced Bill of Quantities are to be initialed by representatives of the Employer attending the tender opening in the manner specified in the **TDS**.

34.6 The Employer shall neither discuss the merits of any Tender nor reject any envelopes marked "FINANCIAL PART".

34.7 The Employer shall prepare a record of the Financial Part of the Tender opening that shall include, as a minimum:

(a) the name of the Tenderer whose Financial Part was opened;

(b) the Tender price, per lot (contract) if applicable, including any discounts; and

(c) if applicable, any Alternative Tender – Financial Part.

34.8 The Tenderers whose envelopes marked "FINANCIAL PART" have been opened or their representatives who are present shall be requested to sign the record. The omission of a Tenderer's signature on the record shall not invalidate the contents and effect of the record. A copy of the record shall be distributed to all Tenderers.

I. Evaluation of Financial Parts of Tenders

35. Evaluation of Financial Parts

35.1 To evaluate the Financial Part, the Employer shall consider the following:

(a) the Tender price, excluding Provisional Sums and the provision, if any, for contingencies in the Price Schedule, but including Daywork items, where priced competitively;

(b) price adjustment for correction of arithmetic errors in accordance with ITT 36.1;

(c) price adjustment due to discounts offered in accordance with ITT 14.4;

(d) converting the amount resulting from applying (a) to (c) above, if relevant, to a single currency in accordance with ITT 37;

(e) price adjustment due to quantifiable nonmaterial nonconformities in accordance with ITT 29.3; and

(f) the additional evaluation factors are specified in the **TDS** and Section III, Evaluation and Qualification Criteria.

35.2 The estimated effect of the price adjustment provisions of the Conditions of Contract, applied over the period of execution of the Contract, shall not be taken into account in Tender evaluation.

35.3 If this Tender Document allows Tenderers to quote separate prices for different lots (contracts), the methodology to determine the lowest evaluated cost of the contract combinations, including any discounts offered in the Letter of Tender – Financial Part, is specified in Section III, Evaluation and Qualification Criteria. If, however, rated criteria are used in accordance with ITT 30.2, discounts on

condition of award of more than one contract shall not be used for Tender evaluation purpose.

36. Correction of Arithmetical Errors

36.1 If Tenders have been invited on single responsibility basis in terms of ITT 14, the Tenderer is deemed to have included all prices in the quoted lump sum Tender Price. Arithmetical corrections shall therefore not be made, except that where there is a discrepancy between the amount in words and the amount in figures, the amount in words shall prevail.

36.2 If Tenders have been invited to include any part of the Works to be paid according to quantity supplied or work done in terms of ITT 14, the Employer shall correct arithmetical errors only for the price for such part of the Works on the following basis:

(a) where there are errors between the total of the amounts given under the column for the price breakdown and the amount given under the Total Price, the former shall prevail and the latter will be corrected accordingly; and

(b) if there is a discrepancy between words and figures, the amount in words shall prevail, unless the amount expressed in words is related to an arithmetic error, in which case the amount in figures shall prevail subject to (a) above.

36.3 Tenderers shall be requested to accept correction of arithmetical errors. Failure to accept the correction in accordance with ITT 36.1, shall result in the rejection of the Tender.

37. Conversion to Single Currency

37.1 For evaluation and comparison purposes, the currency(ies) of the Tender shall be converted into a single currency as specified in the **TDS**.

38. Provision for Development of Domestic Industry

38.1 Unless otherwise specified in the **TDS**, provision for development of domestic industry (such as a margin of preference for domestic Tenderers[1]) shall not apply.

39. Comparison of Tenders

39.1 The Employer shall compare the evaluated costs of all substantially responsive Tenders established in accordance with ITT 35.1 to determine the Tender that has the lowest evaluated cost.

39.2 If ITT 30.2 is applicable, the Employer shall evaluate the technical score and financial score of each tender and determine the Tender

[1]An individual firm is considered a domestic Tenderer for purposes of the margin of preference if it is registered in the country of the Employer, has more than 50 percent ownership by nationals of the country of the Employer, and if it does not subcontract more than 10 percent of the contract price, excluding provisional sums, to foreign contractors. JVs are considered as domestic Tenderers and eligible for domestic preference only if the individual member firms are registered in the country of the Employer or have more than 50 percent ownership by nationals of the country of the Employer, and the JV shall be registered in the country of the Employer. The JV shall not subcontract more than 10 percent of the contract price, excluding provisional sums, to foreign firms. JVs between foreign and national firms will not be eligible for domestic preference.

with the highest combined technical and financial score in accordance with TDS ITT 30.2.

40. Abnormally Low-Priced Tenders

40.1 An Abnormally Low-Priced Tender is one where the Tender price, in combination with other elements of the Tender, appears so low that it raises material concerns as to the capability of the Tenderer in regard to the Tenderer's ability to perform the Contract for the offered Tender Price.

40.2 In the event of identification of a potentially Abnormally Low-Priced Tender, the Employer shall seek written clarifications from the Tenderer, including detailed price analyses of its Tender price in relation to the subject matter of the contract, scope, proposed methodology, schedule, allocation of risks and responsibilities and any other requirements of the Tender Document.

40.3 After examining the clarifications given and the detailed price analyses presented by the Tenderer, the Employer may as appropriate:

(a) accept the Tender, if the evidence provided satisfactorily accounts for the low tender price, in which case the Tender is not considered abnormally low; or

(b) accept the Tender, but require that the amount of the Performance Security be increased at the expense of the Tenderer to a level sufficient to protect the Employer against financial loss. The amount of the Performance Security shall generally be not more than 20% of the Contract Price; or

(c) reject the Tender, if the evidence provided does not satisfactorily account for the low tender price and make a similar determination for the next ranked Tender, if required.

41. Unbalanced or Front-Loaded Tenders

41.1 If the Tender that is evaluated as the Most Advantageous Tender is, in the Employer's opinion, seriously unbalanced or front loaded, the Employer may require the Tenderer to provide written clarifications. Clarifications may include detailed price analyses to demonstrate the consistency of the Tender prices with the scope of works, proposed methodology, schedule and any other requirements of the Tender Document.

41.2 After the evaluation of the information and detailed price analyses presented by the Tenderer, the Employer may as appropriate:

(a) accept the Tender; or

(b) accept the Tender, but require that the total amount of the Performance Security be increased at the expense of the Tenderer to a level not exceeding 20% of the Contract Price; or

(c) reject the Tender and make a similar determination for the next ranked Tender.

42. Most Advantageous Tender

42.1 The Employer shall determine the Most Advantageous Tender. The Most Advantageous Tender is the Tender of the Tenderer that meets the Qualification Criteria and whose Tender has been determined to be substantially responsive to the Tender Documents and:

(a) when rated criteria are used, is the tender with the highest combined technical and financial score; or

(b) when rated criteria are not used, is the tender with the lowest evaluated cost.

43. Employer's Right to Accept Any Tender, and to Reject Any or All Tenders

43.1 The Employer reserves the right to accept or reject any Tender and to annul the Tendering process and reject all Tenders at any time prior to Contract Award, without thereby incurring any liability to Tenderers. In case of annulment, all Tenders submitted and specifically, Tender securities, shall be promptly returned to the Tenderers.

44. Standstill Period

44.1 The Contract shall not be awarded earlier than the expiry of the Standstill Period. The Standstill Period shall be ten (10) Business Days unless extended in accordance with ITT 48. The Standstill Period commences the day after the date the Employer has transmitted to each Tenderer the Notification of Intention to Award the Contract. Where only one Tender is submitted, or if this contract is in response to an emergency situation recognized by the Bank, the Standstill Period shall not apply.

45. Notification of Intention to Award

45.1 The Employer shall send to each Tenderer the Notification of Intention to Award the Contract to the successful Tenderer. The Notification of Intention to Award shall contain, at a minimum, the following information:

(a) the name and address of the Tenderer submitting the successful Tender;

(b) the Contract price of the successful Tender;

(c) the names of all Tenderers who submitted Tenders, and their Tender prices as readout, and as evaluated, and when rated criteria are used, the evaluated technical and financial scores, and the combined total scores;

(d) a statement of the reason(s) the Tender (of the unsuccessful Tenderer to whom the notification is addressed) was unsuccessful, unless the price or score information in (c) above already reveals the reason;

(e) the expiry date of the Standstill Period; and

(f) instructions on how to request a debriefing and/or submit a complaint during the standstill period.

J. Award of Contract

46. Award Criteria

46.1 Subject to ITT 43, the Employer shall award the Contract to the successful Tenderer. This is the Tenderer whose Tender has been determined to be the Most Advantageous Tender.

47. Notification of Award

47.1 Prior to the expiry of the Tender Validity Period and upon expiry of the Standstill Period specified in ITT 43.1 or any extension thereof, and, upon satisfactorily addressing any complaint that has been filed within the Standstill Period, the Employer shall notify the successful Tenderer, in writing, that its Tender has been accepted. The notification of award (hereinafter and in the Conditions of Contract and Contract Forms called the "Letter of Acceptance") shall specify the sum that the Employer will pay the Contractor in consideration of the execution of the Contract (hereinafter and in the Conditions of Contract and Contract Forms called "the Contract Price").

47.2 Within ten (10) Business Days after the date of transmission of the Letter of Acceptance, the Employer shall publish the Contract Award Notice which shall contain, at a minimum, the following information:

(a) name and address of the Employer;

(b) name and reference number of the contract being awarded, and the procurement method used;

(c) names of all Tenderers that submitted Tenders, and their Tender prices as read out at Tender opening, and as evaluated, and when rated criteria are used, the evaluated tender scores;

(d) names of all Tenderers whose Tenders were rejected either as nonresponsive or as not meeting qualification criteria, or were not evaluated, with the reasons therefor;

(e) the name of the successful Tenderer, the final total contract price, the contract duration and a summary of its scope; and

(f) successful Tenderer's Beneficial Ownership Disclosure Form, if specified in TDS ITT 49.1.

47.3 The Contract Award Notice shall be published on the Employer's website with free access if available, or in at least one newspaper of national circulation in the Employer's Country, or in the official

gazette. The Employer shall also publish the contract award notice in UNDB online and AIIB website.

47.4 Until a formal Contract is prepared and executed, the Letter of Acceptance shall constitute a binding Contract.

48. Debriefing by the Employer

48.1 On receipt of the Employer's Notification of Intention to Award referred to in ITT 44.1, an unsuccessful Tenderer has three (3) Business Days to make a written request to the Employer for a debriefing. The Employer shall provide a debriefing to all unsuccessful Tenderers whose request is received within this deadline.

48.2 Where a request for debriefing is received within the deadline, the Employer shall provide a debriefing within five (5) Business Days, unless the Employer decides, for justifiable reasons, to provide the debriefing outside this timeframe. In that case, the standstill period shall automatically be extended until five (5) Business Days after such debriefing is provided. If more than one debriefing is so delayed, the standstill period shall not end earlier than five (5) Business Days after the last debriefing takes place. The Employer shall promptly inform, by the quickest means available, all Tenderers of the extended standstill period.

48.3 Where a request for debriefing is received by the Employer later than the three (3)-Business Day deadline, the Employer should provide the debriefing as soon as practicable, and normally no later than fifteen (15) Business Days from the date of publication of Contract Award Notice. Requests for debriefing received outside the three (3)-day deadline shall not lead to extension of the standstill period.

48.4 Debriefings of unsuccessful Tenderers may be done in writing or verbally. The Tenderer shall bear its own costs of attending such a debriefing meeting.

49. Signing of Contract

49.1 The Employer shall send to the successful Tenderer the Letter of Acceptance including the Contract Agreement, and, if specified in the **TDS**, a request to submit the Beneficial Ownership Disclosure Form providing additional information on its beneficial ownership. The Beneficial Ownership Disclosure Form, if so requested, shall be submitted within eight (8) Business Days of receiving this request.

49.2 The successful Tenderer shall sign, date and return to the Employer, the Contract Agreement within twenty-eight (28) days of its receipt.

50. Performance Security

50.1 Within twenty-eight (28) days of the receipt of the Letter of Acceptance from the Employer, the successful Tenderer shall furnish the Performance Security in accordance with the General Conditions of Contract, subject to ITT 40.3 (b) and ITT 41.2 (b), using for that

purpose the Performance Security Form included in Section X, Contract Forms, or another form acceptable to the Employer.

50.2 Failure of the successful Tenderer to submit the above-mentioned Performance Security or sign the Contract shall constitute sufficient grounds for the annulment of the award and forfeiture of the Tender Security. In that event the Employer may award the Contract to the Tenderer offering the next Most Advantageous Tender.

51. Procurement Related Complaint

51.1 The procedures for making a Procurement-related Complaint are as specified in the **TDS**.

Section II - Tender Data Sheet (TDS)

The following specific data for the Works to be procured shall complement, supplement, or amend the provisions in the Instructions to Tenderers (ITT). Whenever there is a conflict, the provisions herein shall prevail over those in ITT.

A. General	
ITT 1.1	The reference number of the SPN/Tender is: **HORC/HRIDC/C-23/2022** The Employer is*:* **Haryana Orbital Rail Corporation Limited (HORCL)** The name of the Tender is: **Contract Package C-23: Design and Construction of Civil Works (Earthwork, Bridges, Station Buildings, Retaining Walls and other miscellaneous Works) from km 29.68 to km 49.70 & from km 55.60 to km 61.50 and its connectivities to IR network from New Patli to Patli station & New Patli to Sultanpur station including modifications/civil works at Sultanpur Station in connection with laying of New BG Double Railway line of HORC project.** The number and identification of lots (contracts) comprising this Tender is: **Contract Package (C-23)**
ITT 1.2	Add new sub-paragraphs (f) and (g) after sub-paragraph (e) as follows: (f) "Joint Venture" shall be replaced with "Joint Venture or Consortium" (g) "JV" shall be replaced with "JV or Consortium"
ITT 1.2(a)	**Electronic – Procurement System** The Employer shall use the following electronic-procurement system to manage this Tendering process: **E-procurement portal of Govt. of Haryana (https://etenders.hry.nic.in)**

ITT 1.3	**Add new sub-clause ITT 1.3** **Instructions for Online Tender Submission:** The Tenderers are required to submit soft copies of their Tenders electronically on the e-procurement portal of Government of Haryana i.e. https://etenders.hry.nic.in, using valid Digital Signature Certificates. The instructions given below are meant to assist the Tenderers in registering on the e-procurement Portal, prepare their Tenders in accordance with the requirements and submitting their Tenders online on the e-procurement Portal. **Registration:** i) Tenderers are required to enroll on the above-mentioned e-Procurement portal by clicking on the link "Online Bidder Enrollment" on the Portal which is free of charge. ii) As part of the enrolment process, the Tenderers will be required to choose a unique username and assign a password for their accounts. iii) Tenderers are advised to register their valid email address and mobile numbers as part of the registration process. These would be used for any communication from the e-procurement Portal. **A. Obtaining a Digital Certificate:** i. The Tenders submitted online should be encrypted and signed electronically with a Digital Certificate to establish the identity of the Tenderer online. These Digital Certificates are issued by an Approved Certifying Authority, by the Controller of Certifying Authorities, Government of India. ii. A Digital Certificate is issued upon receipt of mandatory identity (i.e. Applicant's PAN Card) and Address proofs and verification form duly attested by the Bank Manager / Postmaster / Gazetted Officer. Only upon the receipt of the required documents, a digital certificate can be issued. For more details please visit the website – https://etenders.hry.nic.in iii. The Tenderers may obtain Class-II or III digital signature certificate from any Certifying Authority or Sub-certifying Authority authorized by the Controller of Certifying Authorities or may obtain information, application format and documents required for the issue of digital certificate. iv. The Tenderer must ensure that he/she comply by the online available important guidelines at the portal https://etenders.hry.nic.in for Digital Signature Certificate (DSC) including the e-Token carrying DSCs.

	For any queries related to e-tendering process (registration, online e-bid submission/withdrawal, uploading of documents), Tenderer may contact the below representative of NIC: **Ms. Manju Aggarwal** **Technical Director,** **Scientist-E, NIC.** **Panchkula.** **E - mail:** a.manju@nic.in **Help Desk:** 0172 – 584257, 94170-69017. v. Tender for a particular tender must be submitted online using the digital certificate (Encryption & Signing), which is used to encrypt and sign the data during the stage of Tender preparation. In case, during the process of a particular tender, the user loses his digital certificate (due to virus attack, hardware problem, operating system or any other problem) he will not be able to submit the Tender online. Hence, the users are advised **to keep a backup of the certificate** and also keep the copies at safe place under proper security (for its use in case of emergencies). vi. In case of online tendering, if the digital certificate issued to the authorized user of a firm is used for signing and submitting a Tender, it will be considered equivalent to a no-objection certificate/power of attorney/lawful authorization to that User. The firm has to authorize a specific individual through an authorization certificate signed by all partners to use the digital certificate as per Indian Information Technology Act 2000. Unless the certificates are revoked, it will be assumed to represent adequate authority of the user to Tender on behalf of the firm in the department tenders as per Information Technology Act 2000. The digital signature of this authorized user will be binding on the firm. vii. In case of any change in the authorization, it shall be the responsibility of management/ partners of the firm to inform the certifying authority about the change and to obtain the digital signatures of the new person/ user on behalf of the firm/ company. The procedure for application of a digital certificate however will remain the same for the new user. viii. The same procedure holds true for the authorized users in a private/Public limited company. In this case, the authorization certificate will have to be signed by the directors of the company. **B. Opening of an Electronic Payment Account:**

	For purchasing the tender documents online, Tenderers are required to pay the tender documents fee online using the electronic payment gateway service through their Debit Cards & Internet Banking accounts. For online payments guidelines, please refer to the Home page under tab "Guidelines for hassle free Bid Submission" of the e-procurement Portal of Government of Haryana, https://etenders.hry.nic.in **C. Pre-requisites for online Tendering:** In order to operate on the electronic tender management system, a user's machine is required to be set up. A help file on system setup/Pre-requisite can be obtained from National Informatics Center or downloaded from the home page of the website - https://etenders.hry.nic.in the link for downloading required java applet & DC setup are also available on the Home page of the e-procurement Portal. **D. Online Viewing of Specific Procurement Notice (SPN):** The Tenderers can view the SPN and the time schedule (Key Dates) through the single portal e-procurement system on the Home Page at https://etenders.hry.nic.in **E. Downloading of Tender Documents:** The tender documents can be downloaded free of cost from the e-procurement portal https://etenders.hry.nic.in **F. Key Dates:** The Tenderers are strictly advised to follow dates and times as indicated in the online Specific Procurement Notice. The date and time shall be binding on all Tenderers. All online activities are time tracked and the system enforces time locks that ensure that no activity or transaction can take place outside the start and end dates and the time of the stage as defined in the online Specific Procurement Notice. **G. Online Payment of E-Service Fee:** The online payment for eE-Service Fee in INR shall be made using the secure electronic payment gateway by Tenderers online directly through Debit Cards & Internet Banking accounts. The secure electronic payments gateway is an online interface between Contractors and Debit card/online payment authorization networks.

	H. Offline Payment of Tender Security For submission of the Tender Security in the form of BG (Tender Security offline Payment), System will direct Tenderer to the EMD details page (EMD Payment offline). Following Steps are to be followed: **Step 1:** Select 'Yes' option where system asks "Are you submitting EMD through BG/ST or Exempted from EMD payment". **Step2:** Select 'Percentage" option to choose EMD exemption type and insert 100% as exemption. **Step 3:** Tenderer must upload scanned copy of Bank Guarantee as EMD exemption document on e-Procurement Portal. After uploading the document, Tenderer must sign the document digitally. **Step 4:** After confirming the details of payment, Tenderer must Select option "Confirm to pay" **Step 5:** Tenderer must enter the details of BG as EMD fee detail on EMD offline payment page **Note:** Option of Exemption from payment of EMD mentioned in the module of e-Procurement portal is only for exemption of online payment of Tender Security to the Tenderers who wish to submit Tender Security in the form of Bank Guarantee. **I. Preparation & Submission of online Applications/Tenders:** i. Detailed Tender documents may be downloaded from e-procurement website (https://etenders.hry.nic.in) from **11.11.2022 (17:00 Hrs. IST) to *20.01.2023* (15:00 Hrs IST.)** and tender mandatorily be submitted online following the instruction appearing on the screen. ii. **Scan copy of Documents to be submitted/uploaded for Technical Part under online PQQ/ Technical Envelope:** All documents shall be prepared and scanned in file formats PDF /JPEG/MS WORD format such that file size does not exceed 10 MB) and uploaded during the on-line submission of PQQ or Technical Envelope. **iii. FINANCIAL PART shall be submitted mandatorily online under Commercial Envelope and original not to be submitted manually** ***NOTE:*** ***(A) Tenderers participating in online tenders shall check the validity of his/her Digital Signature Certificate before participating in the online Tenders at the portal*** https://etenders.hry.nic.in**.**

	(B) ***For help manual, please refer to the 'Home Page' of the*** **e-procurement** ***website at*** https://etenders.hry.nic.in
ITT 2.1	The Recipient is: **Haryana Orbital Rail Corporation Limited (HORCL) through Government of Haryana** The Bank Loan amount: **USD 400 million** The name of the Project is: **Haryana Orbital Rail Corridor (HORC)**
ITT 4.1	Maximum number of members in the JV shall be: **Three (03)**
ITT 4.1	**Add the following after the last sentence of Clause 4.1** Highest shareholding member in the JV/Consortium shall be the Lead member of JV/Consortium. Minimum percentage share of each JV member shall be as specified in Sub-Clause 3.1.6 of Section III, EQC. No change in constitution or percentage share shall be permitted at any stage after the Tender submission, failing which the Tenderer shall be treated as non-responsive. Authorized Representative of JV/Consortium shall be from Lead Member of JV/Consortium.
ITT 4.4	**Add the following after the last sentence of Clause 4.4** In the event that the Contract is awarded to a foreign Tenderer or to a JV/Consortium having foreign lead Member, such foreign Tenderer/foreign lead Member shall be required to set up a project office in India in accordance with applicable laws in India, and shall be required to submit a proof of having opened a project office in India along with statutory approvals, if any, prior to submitting any interim payment certificate in accordance with the Contract, failing which no payment shall be made to the Contractor by the Employer (in accordance with the Contract) until such requirement has been complied with by the foreign Contractor. The aforesaid condition of establishing a project office in India shall not be applicable in case the selected Tenderer is a joint venture between an Indian entity and a foreign entity where Indian Member is lead Member.
ITT 4.5	A list of debarred firms and individuals is available on the Bank's external website: https://www.aiib.org/debarment/
ITT 6.3	**Replace ITT 6.3 with the following:** The complete tender document can be viewed/ downloaded by the Tenderer from e-procurement portal of Govt. of Haryana https://etenders.hry.nic.in. The Employer is not responsible for the completeness of the Tender Document and their addenda, if they were not obtained directly from e-procurement portal of Govt. of Haryana https://etenders.hry.nic.in .
B. Contents of Tender Document	

ITT 7.1	For **Clarification of Tender purposes** only, the Employer's address is: **Attention:** Chief Project Manager **Street address:** Haryana Rail Infrastructure Development Corporation Limited (HRIDC), Plot no.143, Railtel Tower, Sector-44 **Floor:** 5th floor **City:** Gurugram **ZIP code:** 122003 **Country:** India **Telephone:** +91 9311478893 **E-mail:** horc.etendering@gmail.com
ITT 7.2	**Add the following at the end of Para 7.2:** *The Tenderer must obtain for themselves information related to site conditions, traffic, location, surroundings, climate, hydrology, meteorological conditions, weather data, availability of power, water, other utilities cumulative for construction, access and approach roads to the Site, handling and storage of materials, Waste disposal, applicable laws and regulations and any other matter considered relevant and necessary by them required for submitting their Tender and performance of all of its obligations in accordance with the requirements of Tender Documents.* No Site visit will be arranged by the Employer.
ITT 7.4	**Replace the entire Sub-Clause 7.4 with the following:** A Pre-Tender meeting will take place through online Video conferencing (VC) as well as offline in the Conference room of HRIDC office, Plot No 143, Railtel Tower, Sector-44, Gurugram, Haryana-122003 at the following date and time. The purpose of the meeting will be to clarify issues and to answer questions on any matter that may be raised at that stage. **Date: 08.12.2022** **Time: 11.00 hrs. IST** The prospective Tenderers who wish to join the Pre-Tender meeting through VC shall send a request (giving details of the Company, its address, and the name, designation and email of the person attending the VC) through email along with an editable soft copy (MS Word) of the queries raised by them on the email id (i.e.horc.etendering@gmail.com) so that a link for Video Conferencing can be sent by HRIDC. The Tenderers should use the following format for any Pre-Tender queries:

	<table><tr><th>Query No.</th><th>Reference to Tender Document (Clause/ Para No. & Page No.)</th><th>Brief Description of Clause/ Para No.</th><th>Query Raised</th></tr><tr><td>1.</td><td></td><td></td><td></td></tr><tr><td>2.</td><td></td><td></td><td></td></tr><tr><td>3.</td><td></td><td></td><td></td></tr><tr><td>4.</td><td></td><td></td><td></td></tr><tr><td>5.</td><td></td><td></td><td></td></tr><tr><td>etc.</td><td></td><td></td><td></td></tr></table> HRIDC will allow maximum of one email Id for one company to participate in the VC. Any request for VC received after the given date and time for sending the link for VC may not be entertained by HRIDC. Prospective Tenderers will be able to join the VC through the link provided to them on their Email ID.
ITT 7.5	**Replace ITT 7.5 with the following:** The Tenderer is requested to submit any questions in writing, to reach the Employer not later than 2 days before the Pre-Tender Meeting.
ITT 7.6	**Replace ITT 7.6 with the following:** Minutes of the Pre-Tender Meeting, including the text of the questions raised, without identifying the source, and the responses given, together with any responses prepared after the meeting will be uploaded on e-Procurement portal, https://etenders.hry.nic.in. Any modification to the Tender Document that may in the sole discretion of the Employer become necessary as a result of the pre-Tender meeting shall be made by the Employer exclusively through the use of an Addendum pursuant to ITT 8.
ITT 8.2	**Replace ITT 8.2 with the following:** Any addendum issued shall be part of the Tender Documents and shall be uploaded on e-Procurement portal, https://etenders.hry.nic.in. The onus is on the Tenderers to visit the e-Tendering portal to see the addenda published by the Employer.
C. Preparation of Tenders	
ITT 10.1	The language of the Tender is: **English**

	All correspondence exchange shall be in **English** language. **Add the following at the end of Sub-Clause ITT 10.1** In case the Certificates/ documents other than Power of Attorney are in foreign language, the translation of the same shall be submitted in English language. The translation of Certificates / documents in foreign language shall be done by the licensed translator. Tenderer must submit copy of license issued by the competent authority in their country of origin.
ITT 11.1	**Replace ITT 11.1 with the following:** The Tenderer shall submit their tender online on e-procurement portal https://etenders.hry.nic.in as mentioned in para ITT 21. The Tender shall comprise two parts submitted simultaneously, one called the Technical Part containing the documents listed in ITT 11.2 and the other the Financial Part containing the documents listed in ITT 11.3**.** The Tenderer shall upload only the above mentioned documents in its submission on e-procurement portal and is not required to upload Part 1, Part 2 and Part 3 of the Tender document issued by the Employer. The master copy of Tender Document published on e-Procurement portal shall be available with HRIDC which shall be final and binding.
ITT 11.2	**Replace the entire Sub-Clause 11.2 with the following:** The Tenderer shall submit all the documents in its Technical Part as per the Checklist CL (A. Technical Part) given in Section III: Evaluation and Qualification Criteria.
ITT 11.3	**Replace the entire Sub-Clause 11.3 with the following** The Tenderer shall submit all the documents in its Financial Part as per the Checklist CL (B. Financial Part) given in Section III: Evaluation and Qualification Criteria
ITT 13.1	Alternative Tenders **shall not be** considered.
ITT 13.2	Alternative times for completion **shall not be** permitted.
ITT 13.4	Alternative technical solutions **shall not** be permitted**.**
ITT 14.2	**Replace ITT 14.2 with the following: -** The Tenderer shall quote the total lump sum price "single responsibility basis" for Schedule 'A' in the prescribed place of Price Schedule in MS-Excel file. The Tenderer shall quote single percentage (%) Excess (+) or Less (-) on the estimated amount for Schedule 'B', Schedule 'C' and Schedule 'D' in the prescribed place of Price Schedule in MS-Excel file.

ITT 14.4	**Replace ITT 14.4 with the following: -** As there is no lot in this Contract Package, no discounts shall be quoted by the Tenderers.
ITT 15.1	The currency(ies) of the Tender and the payment currency(ies) shall be as described below: The prices shall be quoted by the Tenderer in the Price Schedule in Indian Rupees (**INR)** only. A Tenderer expecting to incur expenditures in other currencies for inputs to the Works supplied from outside the Employer's Country (referred to as "the foreign currency requirements") shall indicate in the Appendix A to Financial Part - Table B, Section IV-Tender Forms the percentage(s) of the Tender Price (excluding Provisional Sums), needed by the Tenderer for the payment of such foreign currency requirements, limited to United States Dollar (USD), European Euro (EUR) and Japanese Yen (JPY).
ITT 18.1	The Tender validity period shall be 180 days after the Tender submission deadline date.
ITT 19.1	The Tenderer shall furnish a Tender Security for an amount of **INR 10,000,000.00 (INR Ten Million only) or USD 121, 000.00 (USD One Hundred Twenty One Thousand Only).**
ITT 19.2	Not Applicable
ITT 19.3	**Replace the ITT 19.3 with the following:** The amount for Tender Security specified in ITT 19.1 above can be paid online by eligible Tenderers on e-procurement Portal in INR in favour of Haryana Rail Infrastructure Development Corporation Limited using the electronic payment gateway service or Tender Security can be submitted in the form of unconditional and irrevocable Bank Guarantee in INR or USD from the specified banks using the Tender Security Form included in Section IV, Tender Forms. The Bank Guarantee shall be issued from: (i) a scheduled bank (excluding co-operative banks) in India, or (ii) a Foreign Bank having arrangement with a nationalized bank or scheduled banks (excluding co-operative banks) in India; The scheduled bank issuing the bank guarantee shall be on "Structure Financial Messaging System (SFMS)" platform. A separate advice of the Bank Guarantee shall invariably be sent by the issuing bank to the Employer's Bank through SFMS and only after receipt of the same by the Employer's Bank, the bank guarantee shall become operative and acceptable to the Employer. Further, the bank guarantee in original form along with a copy of "MT760COV (in case of bank guarantee message)/ MT767COV (in case of bank guarantee amendment message) Report" sent

	by the concerned issuing bank sealed in an envelope shall be submitted to the Employer within ten (10) days of deadline of submission of Tender. The Issuing Bank shall send the SFMS to: Beneficiary: Haryana Rail Infrastructure Development Corporation Limited Bank Name: *State Bank of India* Branch: *HNI Branch, Chandigarh* IFSC Code: *SBIN0018249* The Tender Security shall be valid for twenty-eight (28) days beyond the original validity period of the Tender, or beyond any period of extension if requested under ITT 18.2. In case the Tenderer has opted for Tender Security in the form of an unconditional Bank guarantee, the Tenderer shall upload the scanned copy of Bank Guarantee with the Tender. The original Bank Guarantee shall be delivered either by Registered Post/Speed Post/Courier or by hand within ten (10) days of deadline of submission of Tender at the address given below: **Chief Project Manager,** Haryana Rail Infrastructure Development Corporation Limited, Plot No 143, 5th Floor, Railtel Tower, Sector-44, Gurugram, Haryana-122003 Non submission of scanned copy of Bank Guarantee with the Tender on e-Procurement portal and/or no submission of original Bank Guarantee within the specified period shall lead to summary rejection of Tender. The details of the Original Bank Guarantee should match with the details available in the scanned copy and the data entered during Tender submission time, failing which the Tender shall be rejected. **Notes:** ***1.*** *Original copy of BG received in such a manner will be sent to the concerned Bank for its verification and only after its confirmation from the Bank, BG shall be acceptable by the Employer and Tender shall be evaluated.* **2.** Option of Exemption from payment of EMD mentioned in the module of e-Procurement portal is only for exemption of online payment of Tender Security to the Tenderers who wish to submit Tender Security in the form of Bank Guarantee.

ITT 20.1	**Replace ITT 20.1 with the following:** The Technical Part (comprising of documents specified in ITT 11.2) and Financial Part (comprising of documents specified in ITT 11.3) shall be submitted online on e-procurement portal of Government of Haryana (**https://etenders.hry.nic.in)** only in accordance with the requirements of the Tender Documents.
ITT 20.3	The written confirmation of authorization to sign on behalf of the Tenderer shall consist of: (a) In case of Private/Public Companies, a Power of Attorney from the Director of the Company who has been authorized by the Board of Directors through resolution to sign on behalf of the Company. Copy of Board Resolution shall also be submitted. In case of Foreign Members, Power of Attorney(s) and Board Resolution confirming authority on the persons issuing the Power of Attorney for such actions shall be submitted duly notarized by the notary public of country of origin and should be either stamped by Indian Embassy/High Commission or Member Countries of Hague convention may submit these document with "Apostille" stamp. (b) In case of Proprietory Tenderers, Power of Attorney by the Proprietor. (c) In case of Partnership firms, Power of Attorney duly signed by all the Partners. (d) In case of Limited Liability Partnership (LLP) firms, a Power of Attorney issued by the LLP in favour of the individual to sign the tender on behalf of the LLP and create liability against the LLP. (e) In case of Joint Venture/Consortium, Power of Attorney duly signed by authorized representative of individual Member in favour of the Lead Member and Authorized representative of JV/Consortium. (f) The mode of execution of the Power of Attorney should be in accordance with the procedure, if any, laid down by the applicable law and the charter documents of the executant(s) and when it is so required the same should be under common seal affixed in accordance with the required procedure.
D. Submission of Tenders	
ITT 21	**Replace ITT 21 with the following:** 21.1 Tenderers shall upload their tender submission online on e-procurement portal (i.e. https://etenders.hry.nic.in) within the stipulated date and time as mentioned in ITT 22.1. The Tenderer shall ensure that they retain a copy of the receipt/ acknowledgement of their Tender

	submission which is generated by the system upon successful submission of Tender online. 21.2 Tenders sent telegraphically or through any other means of transmission except as mentioned above shall be treated as invalid and shall stand rejected. 21.3 No details about Financial Part shall be submitted/ disclosed directly or indirectly in the Technical Part failing which the employer has the right to reject the Tender.
ITT 22.1	**Replace ITT 22.1 with the following:** The Tender submission is through the e-procurement portal only (i.e. https://etenders.hry.nic.in) as specified in ITT 21.1 The Tenderer shall submit its Tender before expiry of the date and time for tender submission as specified herein. **The start date for Tender submission is:** Date: **05*.01.2023*** Time: **11.00 hrs. IST** **The deadline for Tender submission is:** Date: ***20.01.2023*** Time: **15.00 hrs. IST**
ITT 23.1	**Replace ITT 23.1 with the following:** Submission of Tenders shall be closed on e-procurement portal on the date & time of submission as prescribed in ITT 22.1 after which no tender can be uploaded.
ITT 24	**Replace ITT 24 with the following:** 24.1 The Tenderer may modify, substitute or withdraw its e-Tender after submission prior to the deadline for submission of Tenders. For modification of e-Tender, Tenderer has to detach its old Tender from e-procurement portal (https://etenders.hry.nic.in) and upload/ resubmit digitally signed modified tender. For withdrawal of tender, Tenderer has to click on withdrawal icon at e- procurement portal and can withdraw its e-tender. Before withdrawal of a tender, it may specifically be noted that after withdrawal of a tender for any reason, Tenderer cannot re-submit e-tender again.

	24.2 No Tender may be withdrawn, substituted, or modified in the interval between the deadline for submission of Tenders and the expiration of the period of Tender validity specified by the Tenderer on the Letter of Tender or any extension thereof.
E. Public Opening of Technical Parts of Tenders	
ITT 25	**Replace ITT 25 with the following:** 25.1 The Employer shall conduct the electronic opening of Technical Part on e-procurement portal on the date, time and place as specified below: **Street Address:** Haryana Rail Infrastructure Development Corporation Limited (HRIDC), Plot no.143, Railtel Tower, Sector-44 **Floor/ Room number:** 5th floor **City:** Gurugram **Zip code:** 122003 **Country:** INDIA Date: ***20.01.2023*** Time: **1530 hrs IST** The opening of the Technical Part and subsequent details can be viewed by the tenderers by logging on the e-procurement portal. Alternatively, any Tenderer who wish to attend the Technical Part opening can be present during the opening. The Tenderer's representatives who are present shall be requested to mark their attendance on the format available with the Employer. 25.2 The Financial Part submitted online on e-procurement portal will remain unopened in the e-procurement portal until the date and time of opening of Financial Part. The date and time of the opening of the Financial Part will be notified to all the Tenderers on e-procurement portal whose tender is found to be substantially responsive and qualified in technical evaluation as specified in ITT 34.2. 25.3 At the time of opening of Technical Part, the following shall be read out and recorded: (a) the name of the Tenderer; (b) the presence of a Tender Security; and

	(c) any other details as the Employer may consider appropriate. Only Technical Part read out and recorded at Tender opening shall be considered for evaluation. 25.4 The Employer shall prepare a record of the opening of Technical Part that shall include, as a minimum, the name of the Tenderer and the presence or absence of Tender Security. The Tenderers' representatives who are present shall be requested to sign the record available with the HRIDC. The omission of a Tenderer's signature on the record shall not invalidate the contents and effect of the record. 25.5 At the tender opening the Employer shall neither discuss the merits of any Tender nor reject any Tender.
F. Evaluation of Tenders – General Provisions	
ITT 27	**Replace ITT 27 with the following:** 27.1 To assist in the examination, evaluation and comparison of the Tenders, the Employer may, at its discretion, ask any Tenderer for a clarification of its Tender in accordance with ITT Clause 29. Any clarification submitted by a Tenderer that is not in response to a request by the Employer shall not be considered. The Employer's request for clarification and the response shall be in writing and delivered to concerned Tenderers (by courier or e-mail through PDF attachment). The due date and time to respond to these queries will also be communicated. No change in the prices or substance of the tender shall be sought, offered, or permitted, except to confirm the correction of errors discovered by the Employer in the evaluation of the Financial Part, in accordance with ITT Clause 35. 27.2 If a Tenderer does not provide clarifications of its Tender by the date and time set in the Employer's request for clarification, their Tender shall be evaluated as per the available information in the submitted Tender.
ITT 29.3	Not Applicable
G. Evaluation of Technical Parts of Tenders	
ITT 30.2	Not Applicable

ITT 32.4	**Replace ITT 32.4 with the following:** Only Tenders that are both substantially responsive to the Tender Document, and meet all Qualification Criteria, shall be notified on e-procurement portal for the public opening of "FINANCIAL PART".
ITT 33.1	Subcontractor is permitted for the activity specified in ITT 33.3.
ITT 33.2	Maximum allowable accumulated value of work to be subcontracted (as a percentage of the Accepted Contract Amount)- 30%
ITT 33.3	Subcontractor is permitted for fabrication, assembly & launching of Open Web Girders (OWG)
	H. Public Opening of Financial Parts of Tenders
ITT 34	**Replace ITT 34 with the following:** 34.1 Following the completion of the evaluation of the Technical Parts of the Tenders, and the Bank has issued its no objection (if applicable), the Employer shall notify in writing those Tenderers whose Tenders were considered non-responsive to the Tender Document or failed to meet the Qualification Criteria, advising them of the following information: (a) the grounds on which their Technical Part of Tender failed to meet the requirements of the Tender Document; (b) their "FINANCIAL PART" shall remain unopened on the e-procurement portal; (c) notify them of the date, time and location of the public opening of "FINANCIAL PART" on the e-procurement portal; 34.2 The Employer shall, simultaneously, notify in writing those Tenderers whose Tenders - Technical Parts have been evaluated as substantially responsive to the Tender Document and met all Qualifying Criteria, advising them of the following information: (a) their Tender has been evaluated as substantially responsive to the Tender Document and met the Qualification Criteria; (b) their "FINANCIAL PART" on e-procurement portal will be opened at the public opening of the Financial Parts; and (c) notify them of the date, time and location of the public opening of the "FINANCIAL PART" as specified below: i. The Employer shall publish a notice of the public opening of the Financial Parts on e-procurement portal.

	ii. Any interested party who wishes to attend this public opening may contact: **For the attention:** Chief Project Manager **Employer:** Haryana Rail Infrastructure Development Corporation Limited **Email address:** horc.etendering@gmail.com 34.3 The "FINANCIAL PART" of Tenderers who met the Qualification Criteria and whose Tenders were evaluated as substantially responsive, will be opened on e-procurement portal. The Employer shall read out the names of each Tenderer, and the total Tender prices, per lot (contract) if applicable, including any discounts and any other details as the Employer may consider appropriate. 34.4 The Employer shall neither discuss with Tenderer's representative present, if any, the merits of any Tender nor reject any "FINANCIAL PART". 34.5 The Employer shall prepare a record of the Financial Part of the Tender opening that shall include, as a minimum: (a) the name of the Tenderer whose Financial Part was opened; (b) the Tender price, per lot (contract) if applicable, including any discounts; and (c) if applicable, any Alternative Tender – Financial Part. 34.6 The Tenderer's representatives who are present at the time of opening of Financial Part shall be requested to sign the record. The omission of a Tenderer's signature on the record shall not invalidate the contents and effect of the record. A copy of the record (i.e. summary of rates quoted) can be viewed by all eligible Tenderers after opening of the Financial Part.
I. Evaluation of Financial Parts of Tenders	
ITT 37.1	The currency that shall be used for tender evaluation and comparison purposes is **Indian Rupees (INR) only.**
ITT 38.1	Provisions for development of domestic industry (such as a margin of domestic preference shall not apply.
J. Award of Contract	
ITT 47.1	**Add the following to ITT 47.1**

	The Accepted Contract Amount shall be in **INR** only. However, the payments will be made in currencies as quoted by the Tenderer in Appendix A, Table B, Section IV-Tender Forms.
ITT 49.1	The successful Tenderer shall submit the Beneficial Ownership Disclosure Form.
ITT 51.1	The procedures for making a Procurement-related Complaint are detailed in the Bank's Procurement Instructions for Recipients (Annex IV). A Tenderer may make a Complaint in writing, to: **For the attention:** Chief Project Manager **Employer**: Haryana Rail Infrastructure Development Corporation Limited **Email address***: horc.etendering@gmail.com*

Section III. Evaluation and Qualification Criteria

TABLE OF CONTENTS

1. General Provisions

1.1 Evaluation Sequence

(a) Tenders will be evaluated through the following four stages:

(i) Stage 1: Evaluation of Administrative Requirements

(ii) Stage 2: Evaluation of Compliance with the Qualification Requirements

(iii) Stage 3: Technical Evaluation

(iv) Stage 4: Financial Evaluation

1.2 Clarification from Tenderers

(a) The Engineer may request clarification(s) of any Tender in accordance with the provisions of the Tender Documents (Part 1, Section-I: Instructions to Tenderers, Clause 27 and Clause 29).

(b) If clarification is required, the Engineer will send written (Courier/email with PDF attachment) request(s) to the Authorized Representative for clarification(s), specifying the deadline for receipt of reply.

(c) Replies to the above request(s) shall be sent by Tenderer through Courier/e-mail with PDF attachments and the same shall be solely to clarify and/or elaborate the item(s) already included in the submitted Tenders for the purpose of evaluation in accordance with ITT 27.1 and ITT 29.

1.3 Tender Forms

(a) Tenderers should note that the information required to be inserted into the Tender Forms shall be comprehensive and detailed. The technical information shall be furnished in line with the requirements of Part 1, Part 2 and Part 3 of the Tender Documents.

(b) All Forms contained in the Tender Documents must be fully and properly completed and all the forms must be returned duly signed by Authorised Representative of the Tenderer, as they will be reviewed exactly as submitted and errors or omissions may count against the Tenderer.

(c) Any Tenderer who is found to have intentionally submitted false or inaccurate statements/information shall be disqualified from the Tendering process.

2. Stages of Evaluation

2.1 Stage 1: Evaluation of Administrative Requirements

A. General

(a) The Stage 1 Evaluation will consist of checking the Tenders to confirm whether they are substantially responsive to the administrative requirements of the Tender Documents.

(b) The following administrative items will be checked:

(i) Whether the Tender submission is in accordance with ITT 11.2;

(ii) Whether the Power of Attorney (POA) for the Tender signatory is in the correct form [Ref. ITT 20.3 and ITT 20.4]. If during technical evaluation stage, POA submitted by the Tenderer is not found in the correct format, Employer will send written (Courier/email with PDF attachment) request to the Authorized Representative for rectification of POA in accordance with format prescribed in Section IV, Tender Forms, specifying the deadline for receipt of Power of Attorney in correct form. If a tenderer does not provide the Power of Attorney in correct form within the stated date and time set in the Employer's request for correction of Power of Attorney, its Tender is liable to be rejected.

2.2 Stage 2: Evaluation of Compliance with the Qualification Requirements

A. General

Tenders will be reviewed to ascertain whether the Tender complies with all of the minimum requirements as stipulated in the Sub-Clause C. Qualification Criteria.

B. Check Items

The following requirements of the Instruction to Tenderers, Clauses 4, 11 & 17 will be checked to ensure compliance to the requirements of criteria given below:

(a) Eligibility

(i) Nationality: Form ELI-1.1(a), ELI-1.1(b), and Form ELI-1.2
(ii) Conflict Interest: Letter of Tender-Technical Part
(iii) Bank Eligibility: Letter of Tender -Technical Part
(iv) State-owned Enterprise or Institution of the Recipient country: Form ELI-1.1(a), ELI-1.1(b), and Form ELI-1.2, Letter of Tender -Technical Part
(v) United Nations resolution or Recipient's country law: Letter of Tender-Technical Part

(b) Historical Contract Non-Performance and Litigation

(i) History of Non-Performing Contracts: Form CON-1
(ii) Suspension Based on Execution of Tender- Securing Declaration by the Employer: Letter of Tender-Technical Part
(iii) Pending Litigation: Form CON-1
(iv) Declaration: Environmental, Social, Health, and Safety (ESHS) past performance: Form CON-2

(c) Financial Situation

(i) Financial Situation and Performance: Form FIN-3.3.1
(ii) Average Annual Construction Turnover: Form FIN-3.3.2

(d) Financial Resources

(i) Financial Resources: Form FIN-3.3.3
(ii) Bid Capacity: Form FIN-3.3.4

(e) Experience

(i) General Construction Experience: Form EXP-3.4.1
(ii) Specific Construction and Contract Management Experience: Form EXP-3.4.2(a)

3. Qualification Criteria

If the Tenderer fails to comply with any item of Qualification Criteria given below, the Tenderer shall be disqualified.

No.	Subject	Requirement	Single Entity	Joint Venture (existing or intended)			Submission Requirements
				All Members Combined	Each Member	Lead Member	
3.1 Eligibility							
3.1.1	**Nationality**	Nationality in accordance with ITT 4.4	Must meet requirement	Must meet requirement	Must meet requirement	Must meet requirement	Forms ELI – 1.1 (a), ELI – 1.1 (b) and ELI-1.2 with attachments
3.1.2	**Conflict of Interest**	No conflicts of interest in accordance with ITT 4.2	Must meet requirement	Must meet requirement	Must meet requirement	Must meet requirement	Letter of Tender-Technical Part
3.1.3	**Bank Eligibility**	Not having been declared ineligible by the Bank, as described in ITT 4.5.	Must meet requirement	Must meet requirement	Must meet requirement	Must meet requirement	Letter of Tender-Technical Part
3.1.4	**State-owned Enterprise or Institution of the Recipient country**	Meets conditions of ITT 4.6	Must meet requirement	Must meet requirement	Must meet requirement	Must meet requirement	Letter of Tender-Technical Part and Form ELI – 1.1 (a), ELI – 1.1 (b) and

No.	Subject	Requirement	Single Entity	Joint Venture (existing or intended)			Submission Requirements
				All Members Combined	Each Member	Lead Member	
							ELI-1.2 with attachments
3.1.5	**United Nations resolution or Recipient's country law**	Not having been excluded as a result of prohibition in the Recipient's country laws or official regulations against commercial relations with the Tenderer's country, or by an act of compliance with UN Security Council resolution, both in accordance with ITT 4.8 and Section V.	Must meet requirement	Must meet requirement	Must meet requirement	Must meet requirement	Letter of Tender-Technical Part
3.1.6	**Share of JV members**	The share of JV members shall not be less than the specified percentage	N/A	100%	30%	34%	Form ELI-1.3
3.2 Historical Contract Non-Performance							

No.	Subject	Requirement	Single Entity	Joint Venture (existing or intended)			Submission Requirements
				All Members Combined	Each Member	Lead Member	
3.2.1	**History of Non-Performing Contracts**	Non-performance of a contract[2] did not occur as a result of contractor default since 1st April 2017 till 28 days prior to deadline of Tender submission.	Must meet requirement	Must meet requirement	Must meet requirement[3]	Must meet requirement	Form CON-1
3.2.2	**Suspension Based on Execution of Tender-Securing Declaration by the Employer**	Not under suspension based on-execution of a Tender/Proposal Securing Declaration pursuant to ITT 4.7 and ITT 19.9	Must meet requirement	Must meet requirement	Must meet requirement	Must meet requirement	Letter of Tender – Technical Part
3.2.3	**Pending Litigation**	Tenderer's financial position and prospective long-term profitability still sound according to criteria established in 3.3.1 (iii) below and assuming that all pending litigation will	Must meet requirement	N/A	Must meet requirement	Must meet requirement	Form CON-1

[2] Nonperformance, as decided by the Employer, shall include all contracts terminated by the Employer where (a) nonperformance was not challenged by the contractor, including through referral to the dispute resolution mechanism under the respective contract, and (b) contracts that were so challenged but fully settled against the contractor. Nonperformance shall not include contracts where Employer's decision was overruled by the dispute resolution mechanism. Nonperformance must be based on all information on fully settled disputes or litigation, i.e., dispute or litigation that has been resolved in accordance with the dispute resolution mechanism under the respective contract and where all appeal instances available to the Tenderer have been exhausted.

[3] This requirement also applies to contracts executed by the Tenderer as JV member.

No.	Subject	Requirement	Single Entity	Joint Venture (existing or intended)			Submission Requirements
				All Members Combined	Each Member	Lead Member	
		be resolved against the Tenderer					
3.2.4	**Litigation History**	Not Applicable					
3.2.5	**Declaration: Environmental, Social, Health, and Safety (ESHS) past performance**	Declare any civil work contracts that have been suspended or terminated and/or performance security called by an employer for reasons related to the non-compliance of any environmental, or social, or health, or safety requirements or safeguard in the past five years [4] preceding 28 days prior to deadline of Tender submission	Must make the declaration	N/A	Must make the declaration	Must make the declaration	Form CON-2 ESHS Performance Declaration
3.3 Financial Situation and Performance							
3.3.1	**Financial Capabilities**	i) The Tenderer shall demonstrate that it has access to, or has available,	Must meet requirement	Must meet requirement	Must meet at least 30% *[Thirty*	Must meet at least 40% *[Forty*	Form FIN-3.3.3 (Sources of Finance for

[4] The Employer may use this information to seek further information or clarifications in carrying out its due diligence.

No.	Subject	Requirement	Single Entity	Joint Venture (existing or intended)			Submission Requirements
				All Members Combined	Each Member	Lead Member	
		liquid assets, unencumbered real assets, lines of credit, and other financial means (independent of any contractual advance payment) sufficient to meet the construction cash flow requirements estimated as **INR *580 million (USD 07 million)*** for the subject contract **(i.e. C-23).**			*percentage]* of requirement	*percentage]* of requirement	the subject Contract)
		(ii) The Tenderer shall also demonstrate, to the satisfaction of the Employer, that it has adequate **Bid capacity** for the works currently in progress and future contract commitments. The **available Bid capacity** should be equal to or more **than INR 8680 million (USD *105* million).** The available Bid capacity will be	Must meet requirement	Must meet requirement	Must meet at least 30% *[Thirty percentage]* of requirement	Must meet at least 40% *[Forty percentage]* of the requirement	Form FIN – 3.3.2 & Form FIN- 3.3.4

No.	Subject	Requirement	Single Entity	Joint Venture (existing or intended)			Submission Requirements
				All Members Combined	Each Member	Lead Member	
		calculated as per item no. 1 of Form FIN- 3.3.4.					
		(iii) The Tenderer must demonstrate the current soundness of its financial position and indicate its prospective long-term profitability. a) Average Net-Worth (Total Assets – Total Liabilities)* during the last three (03) financial years should be **positive** and the Net-worth during the last financial year must be positive. *Note: Amount corresponding to all pending litigations, considering that these will be resolved against the Tenderer (as per Form CON-1 item 2), will be subtracted from the average Net Worth calculated above.	Must meet requirement	Must meet requirement	Must meet requirement	Must meet requirement	Form FIN-3.3.1

No.	Subject	Requirement	Single Entity	Joint Venture (existing or intended)			Submission Requirements
				All Members Combined	Each Member	Lead Member	
3.3.2	**Average Annual Construction Turnover**	Minimum average annual construction turnover of **INR *5210* million (USD *63* million),** calculated as total certified payments received for contracts in progress and/or completed within the last three financial years divided by three	Must meet requirement	Must meet requirement	Must meet 30% *[Thirty percentage]* of the requirement	Must meet 40% *[Forty percentage]* of the requirement	Form FIN-3.3.2
3.4 Experience							
3.4.1	**General Construction Experience**	Experience under construction contracts in the role of Prime contractor, JV member or Management Contractor or a sub-contractor starting 1st April 2015 till 28 days prior to deadline of Tender submission.	Must meet requirement	N/A	Must meet requirement	Must meet requirement	Form EXP-3.4.1

No.	Subject	Requirement	Single Entity	Joint Venture (existing or intended)			Submission Requirements
				All Members Combined	Each Member	Lead Member	
3.4.2 (a)	Specific Construction & Contract Management Experience	Participation, as a Prime contractor, Joint venture [5] member or Management Contractor [6] or Sub-Contractor[7] in at least (i) one "similar work"* of value of **INR *5200* million (USD *63* million** or more. The above contract must involve minimum **1.8 million cum** earthwork[8]	Must meet requirement	Must meet requirement	Must have the experience of executing at least one "similar work" of value **INR 2600 million (USD 31 million)** or more involving minimum **1.00 million cum** of earthwork *or* bridges of	Must have the experience of executing at least one "similar work" of value **INR 2600 million (USD 31 million)** or more involving minimum **1.00 million cum** of earthwork *or* bridges of	

[5] Value of completed work done by a Member in an earlier JV shall be reckoned only to the extent of the concerned member's share in that JV for purpose of satisfying his/her experience criteria mentioned in 3.4.2(a).

[6] A management contractor is a firm which takes on the role of contract management as a "general" contractor of sort could do. It does not normally perform directly the work(s) associated with the Contract. Rather, it manages the work of other Contractors/Sub-Contractors while bearing full responsibility for quality, and timely performance of the contract. If the Tenderer or any of the JV/Consortium member submits experience certificate as a Management Contractor, then the documents issued by the Employer (owner of the work) in support of his being appointed as Management Contractor shall only be considered for evaluation and qualification purpose. In case the Tenderer fails to submit such document(s) issued by the Employer (owner of the work), the offer of the Tenderer shall be summarily rejected.

[7] If a tenderer has successfully completed a work as Sub-Contractor, the work experience certificate issued only by the Employer (owner of the work) for such work to Sub-Contractor shall be considered for the purpose of fulfillment of credentials. Tenders submitted without this documentary proof shall be summarily rejected.

For example: Entity **'A'** is the owner of the work and awards a contract for execution of work to Contractor **'X'**. Thereafter, Contractor **'X'** sublets part of the work to Sub-Contractor **'Y'**. In this case, experience certificate of Sub-Contractor **'Y'** issued only by Entity **'A'** shall be considered for the purpose of evaluation of the Tender. Experience certificate issued by Contractor **'X'** to Sub-Contractor **'Y'** shall not be considered and the offer submitted based on such certificate shall be summarily rejected.

[8] Earthwork in formation/cutting, Blanketing, GSB/WMM in "Railway Projects"[11] or road projects will be considered as part of Earthwork.

No.	Subject	Requirement	Single Entity	Joint Venture (existing or intended)			Submission Requirements
				All Members Combined	Each Member	Lead Member	
		and execution of bridges of minimum *cumulative* length[9] **630 m** **OR** (ii) two "similar works"* each of value of **INR 3500 million (USD 42 million)** or more. *Both the above contracts combined together* must involve minimum **2.4 million cum** earthwork and execution of bridges of minimum *cumulative* length **840 m.** **OR** (iii) three "similar works"* each of value of **INR 2600 million (USD 31million)** or more.			minimum **350 m** *cumulative* length that has been successfully or substantially completed since 1st April 2015 till 28 days prior to deadline of Tender submission.	minimum **350 m** *cumulative* length that has been successfully or substantially completed since 1st April 2015 till 28 days prior to deadline of Tender submission.	

[9] Evaluation of length of spans for multitrack/ multilanes bridges shall be done as under:

(a) In case of Railway bridges/Metro viaduct, accommodating multiple tracks, the length of span for each track shall be taken into consideration. In case of Road bridges accommodating multilanes, the credit for length of one span shall be given for every two lanes.

(b) The credit for multiple tracks/multilanes (exceeding two lanes) shall be given only if the number of tracks or number of lanes is specifically mentioned in the certificate of the Employer.

No.	Subject	Requirement	Single Entity	Joint Venture (existing or intended)			Submission Requirements
				All Members Combined	Each Member	Lead Member	
		All the above three contracts combined together must involve minimum **3.0 million cum** earthwork and execution of bridges of minimum *cumulative* length **1050 m.** The Contracts mentioned in (i) or (ii) or (iii) above must have been successfully completed or substantially completed [10] since 1st April 2015 till 28 days prior to deadline of Tender submission and that are similar to the proposed works. *"Similar work" *shall be "Railway Projects" [11] or road projects involving earthwork in formation or bridge works or both.*					

[10] Substantial completion shall be based on 80% or more of the original value of works completed under the contract.
[11] "Railway Projects" includes projects of Railway/ Metro Rail/ RRTS/High Speed Rail

Notes:

1. Exchange Rate for Qualification Criteria

Wherever a Form in Section IV, Tender Forms, requires a Tenderer to state a monetary amount, Tenderers shall indicate the INR equivalent as indicated in the respective form using the rate of exchange determined as follows:

(i) For construction turnover or financial data required for each year – Exchange rate prevailing on the last day of the respective financial year.

(ii) Value of single contract - Exchange rate prevailing on the date of the Contract Award i.e. the date of issue of Letter of Acceptance.

(iii) Exchange rates shall be taken from reference rate published by the Reserve Bank of India (RBI) on its website https://www.rbi.org.in. In case the exchange rate of particular currency on given date is not available on RBI web site, it will be as per the web site https://www.fbil.org.in of Financial Benchmark India Private Limited (FBIL). Any error in determining the exchange rates may be corrected by the Employer. In the case, where a Tenderer is required to convert a monetary amount from a currency other than those currencies for which the RBI/FBIL reference rate is not published, the INR equivalent shall be worked out using the rate of exchange as published by the central bank of the country issuing the said currency. In case the exchange rate of that currency is not directly available in INR on the website of the central bank of the country issuing the said currency then the currency will be first converted to USD as per that web site and then converted from USD to INR as Per RBI or FBIL reference rates.

2. Value of completed work done by a Member in an earlier JV shall be reckoned only to the extent of the concerned member's share in that JV for purpose of satisfying his/her experience criteria mentioned in 3.4.2(a).

3. For past experience of a firm in earlier JV for specified activity in sub clause 3.4.2 (a) credit shall be given for execution of that quantity of the specified activity executed by the firm as part of a JV, duly certified by the Employer. If the Employer's Certificate does not indicate the quantity of specified activity executed by each member, in such a case credit for quantity of specified activity shall be given as per following provisions in order of priority:

(i) As per details given in JV agreement forming part of the relevant Contract Agreement.

(ii) If JV agreement does not provide such details, then credit shall be given in proportion of the percentage share of the firm in that JV mentioned in the Employer's Certificate/ JV Agreement.

4. In case a JV quoting for the Tender has executed similar work specified in 3.4.2(a) with the same constitution of JV, the requirement specified to be met under Sub-Clause 3.4.2(a) and Sub-Clause 3.4.2(b) shall be considered to have been met treating the JV as a single entity for this purpose.

5. *For Sub-Clause 3.3.2, Average Annual Construction Turnover, the Tenderer should submit actual construction turnover figures for the specified financial years. For Evaluation purposes the figures of previous years shall be updated @ 5% per year compounded annually based on Rupee value to bring them to the level of the last Financial Year specified in Sub-Clause 3.3.2. If the figure for turnover in an individual year is in a currency other than INR, then the same shall first be converted to INR based on the exchange rates derived as mentioned in Note 1 above and then the figures in INR shall be updated.*

6. *For Sub-Clause 3.4.2 (a) Specific Construction & Contract Management Experience, the Tenderer should submit actual Value of Work completed/ substantially completed. Value of Work for Evaluation purposes shall be updated @ 5% per year compounded annually based on Rupee value to bring them to the price level of date of deadline for submission of Tenders. Updated value shall be calculated as per formula given below:-*

$P=Qx\ [1.05]N/365$

Where

P = updated value of work on deadline for submission of Tenders.

Q = value of work on the date of completion/substantial completion as indicated in the Employer's certificate.

N = Number of days between date of completion and deadline for submission of Tenders.

4. Stage 3: Technical Evaluation

A. Procedure for Technical Evaluation

(a) The Stage 3 Evaluation will consist of checking the technical aspects of the Tenders to confirm whether they substantially conform to the requirements of the Tender Documents.

(b) In order to determine whether the Tender substantially conforms to the technical requirements of the Tender Documents, the technical proposal shall broadly cover the following items in relevant Forms:

S. No.	Technical Evaluation Items	Relevant Forms
1	Site Organization	Form TP-1, Technical Proposal, Section IV Tender Forms
2	Outline Method Statement	Form TP-2, Technical Proposal, Section IV Tender Form
3	Works Execution Programme	Form TP-3, Technical Proposal, Section IV Tender Form

(c) It is expected that the Tenderer visits the site and is fully of aware of all the work requirements under this Tender and then prepares the Technical Part.

(d) If any of the Technical Evaluation items mentioned in above Table is not submitted by the Tenderer, his offer shall be considered nonresponsive.

All Tenders which are found substantially responsive after Stage 3 evaluation will proceed to the next stage.

5. STAGE 4: Financial Evaluation

The activities in this Stage 4 will be in two (2) parts.

A. Evaluation of Compliance and Responsiveness

(a) Under this Stage the following items will be checked:

(i) Whether the Letter of Tender-Financial Part is compliant (i.e. does not include any alteration to the basic terms and does not constitute an alternative offer).

(ii) Whether Financial Part has not been altered and is correctly completed and signed.

B. Detailed Financial Evaluation

(a) After passing the above requirements, the Tender will then proceed for Financial Part evaluation in accordance with ITT 35.

(b) In principle, the lowest evaluated Tender resulting from 'A' above will move to next stage as per ITT "J. Award of Contract", described in ITT Clauses 46 to 50.

Checklist-CL

Checklist of submission of Documents/Forms online, duly filled

(Reference to TDS-ITT 11.2 & 11.3, Section II, Part 1)

A. TECHNICAL PART

S. No.	Requirement of Tender Document	Ref. Clause of Tender documents	Tenderer's Name:	
			Whether information submitted (Yes/No/N.A.)	Ref. Pg No. in the Technical Submittal
1.	Letter of Tender-Technical Part	ITT 11.2 (a) and Section IV		
2.	Technical Part signed by authorized representative of Single Entity/Joint Venture/Consortium	ITT 20.3		
3.	Tender Security- Online Receipt or Scanned copy of Bank Guarantee	ITT 19.1, ITT 19.3 and Appendix E of Section IV		
4.	Form ELI – 1.1: (a) Tenderer Information Form (Single Entity)	ITT 17.1 and Appendix D of Section IV		
5.	Form ELI – 1.1: (b) Tenderer Information Form (JV/Consortium)	ITT 17.1 and Appendix D of Section IV		
6.	Form ELI – 1.2: Tenderer's JV Member Information Form	ITT 17.1 and Appendix D of Section IV		
7.	Form ELI – 1.3: Joint Venture/Consortium Agreement	ITT 17.1 and Appendix D of Section IV		
8.	Form ELI-1.4: Power of Attorney (POA) for Submitting Tender	ITT 20.3 and Appendix D of Section IV		
9.	Board Resolution in case of a Public/Private limited company/LLP	TDS ITT 20.3		
10.	Incorporation Certificate and Memorandum and Articles of Association (MOA & AOA) (in case of Private/Public Limited Company)	Note (iii) (d) of Form ELI 1.4		
11.	Incorporation Certificate and Limited Liability Membership Agreement in case of Limited Liability Membership firms.	Note (iii) (e) of Form ELI 1.4		
12.	Proprietorship Affidavit (in case the Tenderer is Proprietorship Tenderer)	Note (iii) (a) of Form ELI 1.4		
13.	Partnership Deed (in case the Tenderer is Partnership Firm)	Note (iii) (b) of Form ELI 1.4		
14.	Form ELI-1.5: Power of Attorney (POA) for Authorized Signatory of Joint venture (JV) Members	ITT 20.4		
15.	Form ELI-1.6: Power of Attorney to Lead Member and Authorised	ITT 20.4		

S. No.	Requirement of Tender Document	Ref. Clause of Tender documents	Tenderer's Name:	
			Whether information submitted (Yes/No/N.A.)	Ref. Pg No. in the Technical Submittal
	Representative of Joint venture (JV)			
16.	In case of foreign tenderer, the Notarised POA/MOU/JV Agreement is notarised in the country of origin and stamped by Indian Embassy/ High Commission or Member Countries of Hague convention submitted these documents with "Apostille" stamp	Note (i) of Form ELI 1.4		
17.	Form CON - 1: Historical Contract Non-Performance, Pending Litigation and Litigation History	ITT 17.2 and Appendix D of Section IV		
18.	Form CON - 2: Environmental, Social, Health, and Safety Performance Declaration	ITT 17.2 and Appendix D of Section IV		
19.	Form FIN – 3.3.1: Financial Situation and Performance	ITT 17.2 and Appendix D of Section IV		
20.	Form FIN – 3.3.2: Average Annual Construction Turnover	ITT 17.2 and Appendix D of Section IV		
21.	Form FIN – 3.3.3: Financial Resources	ITT 17.2 and Appendix D of Section IV		
22.	Form FIN - 3.3.4: Bid Capacity	ITT 17.2 and Appendix D of Section IV		
23.	Form EXP – 3.4.1: General Construction Experience	ITT 17.2 and Appendix D of Section IV		
24.	Form EXP – 3.4.2(a): Specific Construction and Contract Management Experience	ITT 17.2 and Appendix D of Section IV		
25.	Form TP-1: Site Organization	ITT 16.1 and Appendix A of Section IV		
26.	Form TP-2: Outline Method Statement	ITT 16.1 and Appendix A of Section IV		
27.	Form TP-3: Work Execution Programme	ITT 16.1 and Appendix A of Section IV		
28.	Undertaking for compliance to Employer's Requirement & Specification by Tenderer	FORM UT-1 of Section IV		
29.	Undertaking for Downloaded Tender Document	Form UT-2 of Section IV		
30.	In case of Certificate/documents translated in English from Foreign Language, copy of license of licensed translator issued by the competent authority in their country of origin	ITT 10.1 of Section II		

S. No.	Requirement of Tender Document	Ref. Clause of Tender documents	Tenderer's Name:	
			Whether information submitted (Yes/No/N.A.)	Ref. Pg No. in the Technical Submittal

Note:

(i) **The check list is indicative and not exhaustive. The Tenderer must go through the complete tender documents and submit the required documents accordingly.**

(ii) **If any of the above form or criteria is not applicable to the Tenderer, then they can simply indicate N.A. against the relevant column**

(iii) **All Tender Forms contained in the Tender Documents must be fully and properly completed and all the forms must be returned signed by Authorized Representative of the Tenderer.**

B. FINANCIAL PART

The Financial Part is provided in the Tender Documents in the form of MS-EXCEL file and PDF file. The Contract Price for the Works shall be quoted in the MS-EXCEL file provided in the e-procurement portal. The Tenderer shall download the MS-EXCEL file and after quoting their Contract Price, upload the same along with other PDF documents of Financial Part mentioned in (a) below on e-procurement portal. The quoted Contract Price shall not be offered/quoted elsewhere in the Technical Part submission/ Tender submission. These prices shall include all costs associated with the contract including GST. The Tenderer shall complete the Financial Part in accordance with the instructions given in the Financial Part. Following information are required to be submitted by Tenderers in their Financial Part**:**

(a) In PDF File

1. Letter of Tender – Financial Part
2. Appendix A to Financial part: Schedule of Adjustment Data
   Table A: Foreign Currency (FC)
   Table B: Summery of Payment Currencies
3. Appendix B to Financial Part: Price Schedules
   Contract Price comprises of the following Schedules:

Schedule	Description
A	Lump Sum component of Works
B	Retaining Wall, Bridges & other civil Works
C	General Electricals Services
D	Item rate for miscellaneous works

(b) In MS-Excel File

Price Schedule for quoting Price for the Works against each Schedule.

I hereby confirm that:

(i) I have checked the above list with our submittal. I am also aware that if our tender is not containing the above documents, the Employer has the right to reject our tender.

a. All the pages of tender submission are properly indexed and numbered.

Seal:
Date:
(Signature of Authorized representative of Tenderer)

Section IV - Tender Forms

Table of Forms

Letter of Tender – Technical Part

INSTRUCTIONS TO TENDERERS: DELETE THIS BOX ONCE YOU HAVE COMPLETED THE DOCUMENT

The Tenderer must prepare this Letter of Tender on stationery with its letterhead clearly showing the Tenderer's complete name and business address.

Note: All italicized text is to help Tenderers in preparing this form.

Date of this Tender submission: [*insert date (as day, month and year) of Tender submission*]

Tender No.: HORC/HRIDC/C-23/2022

To:

Chief Project Manager,
Haryana Rail Infrastructure Development Corporation Limited (HRIDC),
Plot no.143, 5th floor,
Railtel Tower, Sector-44
Gurugram – 122003
Tel: +91 9311478893

We, the undersigned, hereby submit our Tender, in two parts sealed separately, namely: (a) the Technical Part; and (b) the Financial Part.

In submitting our Tender, we declare that:

(a) **No Reservations:** We have examined and have no reservations to the Tender Document, including Addenda issued in accordance with ITT 8;

(b) **Eligibility:** We meet the eligibility requirements and have no conflict of interest in accordance with ITT 4;

(c) **Tender-Securing Declaration:** We have not been suspended nor declared ineligible by the Employer based on execution of a Tender-Securing or Proposal-Securing Declaration in the Employer's Country in accordance with ITT 4.7;

(d) **Conformity:** We offer to execute in conformity with the Tender Document and in accordance with the implementation and completion specified in the construction schedule, the following Works: *[insert a brief description of the Works];*

_____;

(e) **Tender Validity Period**: Our Tender shall be valid for the period specified in TDS 18.1 (as amended, if applicable) from the date fixed for the Tender submission deadline specified in TDS 22.1 (as amended, if applicable), and it shall remain binding upon us and may be accepted at any time before the expiration of that period;

(f) **Performance Security** If our Tender is accepted, we commit to obtain a Performance Security in accordance with the Tender Document;

(g) **One Tender Per Tenderer:** We are not participating, as a Tenderer, either individually or as a Joint Venture member, in more than one Tender in this tendering process, and meet the requirements of ITT 4.3;

(h) **Suspension and Debarment**: We, along with any of our subcontractors, suppliers, consultants, manufacturers, or service providers for any part of the contract, are not subject to, and not controlled by any entity or individual that is subject to, a temporary suspension or a debarment or any ineligibility imposed or recognized by the Bank. Further, we are not ineligible under the Employer's Country laws or official regulations or pursuant to a decision of the United Nations Security Council;

(i) **State-Owned Enterprise or Institution:** [*select the appropriate option and delete the other*] [*We are not a state-owned enterprise or institution*] / [*We are a state-owned enterprise or institution but meet the requirements of ITT 4.6*];

(j) **Binding Contract:** We understand that this Tender, together with your written acceptance thereof included in your Letter of Acceptance, shall constitute a binding contract between us, until a formal contract is prepared and executed;

(k) **Employer Not Bound to Accept**: We understand that you are not bound to accept the lowest evaluated cost Tender, the Most Advantageous Tender or any other Tender that you may receive;

(l) **Prohibited Practice**: We hereby certify that we have taken steps to ensure that no person acting for us or on our behalf engages in any type of Prohibited Practice; and

(m) **Inspection and Audit**: We agree to permit the Bank or its representative to inspect our accounts and records and other documents relating to the tender submission and to have them audited by auditors appointed by the Bank.

(n) We declare and certify that we have not made any misleading or false representation in the forms, statements and attachments in proof of the qualification requirements.

(o) We declare that the information and documents submitted along with the tender by us are correct and we are fully responsible for the correctness of the information and documents, submitted by us.

(p) [*select the appropriate option and delete* whichever *is not applicable*] [We declare and certify that financial data as per the balance sheets for last three financial years including that for the latest concluded financial year are being submitted] **OR** [We declare and

certify that balance sheet for the latest concluded financial year has not been finalized till date and that is why we are furnishing financial data for last three financial years ignoring the latest concluded financial year.]

Name of the Tenderer: * [*insert complete name of the Tenderer*]

Name of the person duly authorized to sign the Tender on behalf of the Tenderer: **[*insert complete name of person duly authorized to sign the Tender*]

Title of the person signing the Tender: [*insert complete title of the person signing the Tender*]

Signature of the person named above: [*insert signature of person whose name and capacity are shown above*]

Date signed [*insert date of signing*] **day of** [*insert month*], [*insert year*]

*****: In the case of the Tender submitted by joint venture specify the name of the Joint Venture as Tenderer

**: Person signing the Tender shall have the power of attorney given by the Tenderer. The power of attorney shall be attached with the Letter of Tender.

Appendix A to Technical Part: Technical Proposal

[Ref. ITT Sub-Clause 16.1, Clause 4 of Section III, Evaluation and Qualification Criteria (EQC)]

1. Site Organization

2. Outline Method Statement

3. Work Execution Programme

Form TP-1

Site Organization

(To be submitted by the Tenderer)

Form TP-2

Outline Method Statement

(To be submitted by the Tenderer)

Form TP-3

Work Execution Programme

(To be submitted by the Tenderer)

Appendix B to Technical Part: Equipment

Form EQU: Equipment

DELETED

Appendix C to Technical Part: Key Personnel

Form PER-1

DELETED

Form PER-2:

DELETED

Appendix D to Technical Part: Tenderer's Qualification

To establish its qualifications to perform the contract in accordance with Section III, Evaluation and Qualification Criteria the Tenderer shall provide the information requested in the corresponding Information Sheets included hereunder.

Form ELI-1.1 (a)

Tenderer Information Form (Single Entity)

[Ref. ITT Sub-Clause 17.1]

Date: _____
Tender No. and title: _____
Page_____of _____pages

Tenderer's name
Tenderer's actual or intended country of registration: *[indicate country of Constitution]*
Tenderer's actual or intended year of incorporation:
Tenderer's legal address [in country of registration]:
Tenderer's authorized representative information Name: _____ Address: _____ Mobile number: _____ Telephone/Fax numbers: _____ E-mail address: _____
Attached are copies of original documents of ☐ Articles of Incorporation (or equivalent documents of constitution or association), and/or documents of registration of the legal entity named above, in accordance with ITT 4.4 ☐ In case of state-owned enterprise or institution, in accordance with ITT 4.6, documents establishing: • Operation on a commercial basis; • Financial and managerial autonomy; • Day-to-day management not controlled by the government; and • Not under the supervision of the Employer or its procuring agency.

Tenderer's Authorized Representative

Signature: ……..
Date: ……..……..
Company stamp: ……..…..

Form ELI-1.1 (b)

Tenderer Information Form (JV/Consortium)

[Ref. ITT Sub-Clause 17.1]

Date: _____
Tender No. and title: _____
Page_____of _____pages

Tenderer's JV name
Name of each member: of JV/Consortium
Tenderer's actual or intended country of registration: *[indicate country of Constitution]*
Tenderer's actual or intended year of incorporation:
Tenderer's legal address [in country of registration]:
*Tenderer's authorized representative information Name: _____ Address: _____ Mobile number: _____ Telephone/Fax numbers: _____ E-mail address: _____
Attached are copies of original documents of ☐ In case of intended JV, letter of intent to form JV or JV agreement, in accordance with ITT 4.1

Tenderer's Authorized Representative

Signature: ……..

Date: ……..……..

Company stamp: ……..…..

Note:

1. *Tenderer's Authorized Representative shall be from Lead Member of JV/Consortium.

Form ELI-1.2

Tenderer's JV Member Information Form

[Ref. ITT Sub-Clause 17.1]
(To be completed for each member of Tenderer's JV)

Date: _____
TENDER No. and title: _____
Page _____ of _____ pages

Tenderer's JV name:
JV member's name:
JV member's country of registration:
JV member's year of constitution:
JV member's legal address in country of constitution:
JV member's authorized representative information Name: _____ Address: _____ Mobile: _____ Telephone/Fax numbers: _____ E-mail address: _____
Attached are copies of original documents of ☐ Articles of Incorporation (or equivalent documents of constitution or association), and/or registration documents of the legal entity named above, in accordance with ITT 4.4. ☐ In case of a state-owned enterprise or institution, documents establishing operation on a commercial basis; financial and managerial autonomy; day-to-day management not controlled by the government; and not under the supervision of the Employer or its procuring agency, in accordance with ITT 4.6.

Tenderer's Authorized Representative

Signature: ……..

Date: ……..……..

Company stamp: ……..…..

Form ELI-1.3

Joint Venture/Consortium Agreement

[Ref. ITT Sub-Clause 4.1 and ITT Sub-Clause11.5]

The Members of the Joint Venture/Consortium shall provide Joint Venture/Consortium Agreement for Joint Venture Participation in the name of M/s……of which includes at least the followings: -

(i) M/s …….. having its registered office at …… (hereinafter referred to as ……) acting as the Lead Member of the first part;

And

(ii) M/s ……having its registered office at ……. (hereinafter referred to as `…….') in the capacity of a Joint Member of the other part;

And

(iii) M/s ……having its registered office at ……. (hereinafter referred to as `…….') in the capacity of a Joint Member of the other part.

The expressions of (i) ,…….. (ii) …….. (iii) …… (names of JV/Consortium Members) shall wherever the context admits, mean and include their respective legal representatives, successors-in-interest and assigns and shall collectively be referred to as " the Parties" and individually as " the Party"

WHEREAS:

Haryana Orbital Rail Corporation Ltd. [hereinafter referred to as "Employer"] has invited tenders for …… *"[Insert name of work]……"*

NOW, THEREFORE, THE PARTIES AGREE AS FOLLOWS:

1. The following documents shall be deemed to form and be read and construed as an integral part of this JV agreement.
   i) Specific Procurement Notice, ii) Tender document, iii) Any Addendum/ Corrigendum issued by Haryana Rail Infrastructure Development Corporation Ltd.
   iv) The Tender submitted on our behalf jointly by the Lead Member/ authorised representative.
2. The `Parties' have studied the documents and have agreed to participate in submitting a tender jointly in the name of----------.
3. M/s ……shall be the lead Member of the JV/ Consortium for all intents and purpose and shall represent the Joint Venture/Consortium in its dealing with the Employer. For the purpose of submission of tenders, the parties agree to nominate …….. as the Lead Member duly authorized to sign and submit all documents and subsequent clarifications, if any, to the Employer. However, M/s …… shall not

submit any such tenders, clarifications or commitments before securing the written clearance of the other Member which shall be expeditiously given by M/s……..……. and M/s……. to M/s…….

4. The 'Parties' have resolved that the distribution of share and responsibilities between the JV/Consortium Members is as under:-

    a) Lead Member Name…….and share ……..% ;
    b) Joint Venture /Consortium Member Name…….and share ……..% ;
    c) Joint Venture /Consortium Member Name…….and share ……..% ;

5. JOINT AND SEVERAL RESPONSIBILITIES

The Parties undertake that they shall be jointly and severally liable to the Employer in the discharge of all the obligations and liabilities as per the contract with the Employer and for the performance of contract awarded to their JV/Consortium

6. ASSIGNMENT AND THIRD PARTIES

The parties shall co-operate throughout the entire period of this Joint Venture Agreement on the basis of exclusivity and neither of the Parties shall make arrangement or enter into agreement either directly or indirectly with any other party or group of parties on matters relating to the Project except with prior written consent of the other party and the Employer.

7. EXECUTIVE AUTHORITY

The said Joint Venture/ Consortium through its authorized representative shall receive instructions from the Employer. The management structure for the project shall be prepared by mutual consultations to enable completion of project to quality requirements within permitted cost and time.

8. PROPOSAL SUBMISSION

Each Party shall bear its own cost and expenses for preparation and submission of the tender *and all costs until conclusion of a contract with the Employer for the Project. Common expenses shall be shared by all the parties in the ratio of their actual participation.*

9. INDEMNITY

Each party hereby agrees to indemnify the other party against its respective parts in case of breach/default of the respective party of the contract works of any liabilities sustained by the Joint Venture/ Consortium.

10. For the execution of the respective portions of works, the parties shall make their own arrangements to bring the required finance, plants and equipment, materials, manpower and other resources.

11. DOCUMENTS & CONFIDENTIALITY

Each Party shall maintain in confidence and not use for any purpose related to the Project all commercial and technical information received or generated in the course of preparation and submission of the tender.

12. ARBITRATION

Any dispute, controversy or claim arising out of or relating to this Joint Venture agreement shall be settled in the first instance amicably between the parties. If an amicable settlement cannot be reached as above, it will be settled by arbitration in accordance with the Indian Arbitration and Conciliation Act 1996 or any amendments thereof. The venue of the arbitration shall be _____.

13. VALIDITY

This Joint Venture agreement shall remain in force till the occurrence of the earliest of any of the following, unless by mutual consent, the Parties agree in writing to extend the validity for a further period.

a. The Tender submitted by the Joint Venture/ Consortium is declared unsuccessful, or
b. Cancellation/ shelving of the Project by the Employer for any reasons prior to award of work
c. Execution of detailed JV /Consortium agreement by the parties, setting out detailed terms after award of work by the Employer.

14. This Joint Venture agreement is drawn in ….. number of copies with equal legal strength and status. One copy is held by M/s …… and the other by M/s. ..... and M/s. ..... and a copy submitted with the tender.

15. This Joint Venture agreement shall be construed under the laws of India.

16. NOTICES BETWEEN JV/CONSORTIUM MEMBERS

Notices shall be given in writing by fax confirmed by registered mail or commercial courier to the following fax numbers and addresses:

Lead Member.	Other Member	Other Member
……..	……	……
……	……	……
(Name & Address)	(Name & Address)	(Name & Address)

IN WITNESS WHEREOF THE PARTIES, have executed this MOU the day, month and year first before written

M/s……	M/s……	M/s……
……..……	……	……
(Seal)	(Seal)	(Seal)

Witness

1……..(Name & Address)

2…….. (Name & Address)

Form ELI-1.4

[Ref. ITT Sub-Clause 20.3]

Power of Attorney (POA) for Submitting Tender

(For Single Entity/Sole Tenderer only)

(To be executed on non-judicial stamp paper of the appropriate value in accordance with relevant stamp Act. The stamp paper to be in the name of the company who is issuing the Power of Attorney)

Know all men by these presents, we…..…….. (name and address of the registered office) do hereby constitute, appoint and authorise Mr/Ms…….. (name and residential address) who is presently employed with us and holding the position of ……..as our attorney, to do in our name and on our behalf, all such acts, deeds and things necessary in connection with or incidental to our tender for the work of **C-23:** Design and Construction of Civil Works (Earthwork, Bridges, Station Buildings, Retaining Walls and other miscellaneous Works) from km 29.68to km 49.70 & from km 55.60 to km 61.50 and its connectivities to IR network from New Patli to Patli station & New Patli to Sultanpur station including modifications/civil works at Sultanpur Station in connection with laying of New BG Double Railway line of HORC project, including signing and submission of all documents and providing information/ responses to Haryana Rail Infrastructure Development Corporation Ltd (HRIDC), representing us in all matters before HRIDC, and generally dealing with HRIDC in all matters in connection with our tender for the said project.

We hereby agree to ratify all acts, deeds and things lawfully done by our said attorney pursuant to this Power of Attorney and that all acts, deeds and things done by our aforesaid attorney shall and shall always be deemed to have been done by us.

……. (Signature)
(Name, Title and address) of the **Person Accepting the POA.**

……. (Signature)
(Name, Title and address) of the **Person issuing the POA**

Notes:

i. The tenderer should submit the notarised Power of Attorney. In case of Foreign Members, Power of Attorney(s) and Board Resolution confirming authority on the persons issuing the Power of Attorney for such actions shall be submitted duly notarized by the notary public of country of origin and should be either stamped by Indian Embassy/High Commission or Member Countries of Hague convention may submit these document with "Apostille" stamp. Also, in case the documents are in foreign language the translation of the same shall be authenticated by Embassy/High Commission.

ii. The mode of execution of the Power of Attorney should be in accordance with the procedure, if any, laid down by the applicable law and the charter documents of the executant(s) and when it is so required the same should be under common seal affixed in accordance with the required procedure.

iii. The tenderer should submit following additional document in support of the POA as case to case basis:

a) Proprietorship Affidavit in case of Proprietary Tenderer.
b) Partnership Deed in case of Partnership Firms.
c) Board Resolution in case of a Public/Private limited company/LLP.
d) Incorporation Certificate and Memorandum & Article of Association in case of a Public/Private limited company.
e) Incorporation Certificate and Limited Liability Membership Agreement in case of Limited Liability Membership firms.

Form ELI-1.5

Power of Attorney (POA) for Authorized Signatory of Joint Venture (JV)/ Consortium Members

[Ref. ITT Sub-Clause 20.4]

(To be submitted by Tenderer' each JV member)

POWER OF ATTORNEY*

(*To be executed on non-judicial stamp paper of the appropriate value in accordance with relevant stamp Act. The stamp paper to be in the name of the company who is issuing the Power of Attorney*)

Know all men by these presents, we…..…….. do hereby constitute, appoint and authorise Mr/Ms. …….. who is presently employed with us and holding the position of ……..as our attorney, to do in our name and on our behalf, all such acts, deeds and things necessary in connection with or incidental to our tender for the work of **C-23**: Design and Construction of Civil Works (Earthwork, Bridges, Station Buildings, Retaining Walls and other miscellaneous Works) from km 29.68to km 49.70 & from km 55.60 to km 61.50 and its connectivities to IR network from New Patli to Patli station & New Patli to Sultanpur station including modifications/civil works at Sultanpur Station in connection with laying of New BG Double Railway line of HORC project, including signing and submission of all documents, withdrawal, substitution and modification of tender and providing information/ responses to Haryana Rail Infrastructure Development Corporation Ltd, representing us in all matters, dealing with Haryana Rail Infrastructure Development Corporation Ltd. in all matters in connection with our tender for the said project.

We hereby agree to ratify all acts, deeds and things lawfully done by our said attorney pursuant to this Power of Attorney and that all acts, deeds and things done by our aforesaid attorney shall and shall always be deemed to have been done by us.

Dated this the …… day of ……. 20..

(Signature of authorised Signatory in token of **Acceptance of POA**

……

(Signature and Name in Block letters of Signatory)

Seal of Company

Witness

Witness 1:	Witness 2:
Name:	Name:
Address:	Address:
Occupation:	Occupation:

**Notes:*

i) To be executed by all the Members individually, in case of a Joint Venture/Consortium.

ii) The mode of execution of the Power of Attorney should be in accordance with the procedure, if any, laid down by the applicable law and the charter documents of the executant(s) and when it is so required the same should be under common seal affixed in accordance with the required procedure.

Form ELI-1.6

Power of Attorney to Lead Member and Authorized Representative of Joint Venture (JV)/ Consortium
[Ref. ITT Sub-Clause 20.4]

(To be executed on non-judicial stamp paper of the appropriate value in accordance with relevant stamp Act. The stamp paper to be in the name of the company who is issuing the Power of Attorney)

POWER OF ATTORNEY[1]

Whereas Haryana Rail Infrastructure Development Corporation Ltd. has invited Tenders for the work of ……

Whereas, the Members of the Joint Venture/Consortium comprising

1. M/s. …,

2. M/s. …,

and

3. M/s. ……,

are interested in submission of tender for the work of "**C-23:** Design and Construction of Civil Works (Earthwork, Bridges, Station Buildings, Retaining Walls and other miscellaneous Works) from km 29.68 to km 49.70 & from km 55.60 to km 61.50 and its connectivities to IR network from New Patli to Patli station & New Patli to Sultanpur station including modifications/civil works at Sultanpur Station in connection with laying of New BG Double Railway line of HORC project in accordance with the terms and conditions contained in the tender documents.

Whereas, it is necessary for the Members of the Joint Venture to designate one of them as the Lead Member as the authorized representative, with all necessary power and authority to do, for and on behalf of the Joint Venture/ Consortium, all acts, deeds and things as may be necessary in connection with the Joint Venture's tender for the project.

NOW THIS POWER OF ATTORNEY WITNESSETH THAT:

We, M/s. …… (Lead Member), M/s_____ and M/s_____ hereby designate M/s. ……, being one of the Members of the Joint Venture, as the Lead Member of the Joint Venture and designate Mr/Ms. _____ being authorized representative of the Joint Venture, to do on behalf of the Joint Venture, all or any of the acts, deeds or things necessary or incidental to the Joint Venture's tender for the contract, including

submission of tender, withdrawal, substitution and modification of tender, participating in conferences, responding to queries, submission of information/ documents and generally to represent the Joint Venture in all its dealings with the Employer or any other Government Agency or any person, in connection with the contract for the said work until culmination of the process of tendering till the contract agreement is entered into with the Haryana Orbital Rail Corporation Limited and thereafter till the expiry of the contract agreement.

We hereby agree to ratify all acts, deeds and things lawfully done by Lead Member, our said attorney, pursuant to this power of attorney and that all acts deeds and things done by our aforesaid attorney shall and shall always be deemed to have been done by us/ Joint Venture.

Dated this the …… Day of …….. 20..…….

(Signature) (Signature) (Signature)

…… …… ……..

(Name in Block letters of all Executants with Seal of Company)

……. (Signature)

(Name, Title and address) of the **Person Accepting the POA**

Witness 1:	Witness 2:
Name:	Name:
Address:	Address:
Occupation:	Occupation:

Notes:

1. To be executed by all the Authorized POA holders of each Members of the JV/Consortium.
2. The mode of execution of the Power of Attorney should be in accordance with the procedure, if any, laid down by the applicable law and the charter documents of the executant(s) and when it is so required the same should be under common seal affixed in accordance with the required procedure.
3. Authorized Representative of Tenderer's JV shall be from Lead Member of JV/Consortium.

Form CON-1

Historical Contract Non-Performance, Pending Litigation and Litigation History

[Ref. ITT Sub-Clause 17.2 and Section III, Evaluation and Qualification Criteria, Sub-Clause 3.2.1 and Sub-Clause 3.2.3]

[*The following table shall be filled in for the Tenderer or in case of JV/Consortium , each member of a Joint Venture/Consortium]*

Tender No.: HORC/HRIDC/C-23 /2022

Tenderer's Name: _____

JV Member's Name_____

Page _____of _____pages

1. Non-Performed Contracts in accordance with Section III, Evaluation and Qualification Criteria			
Description			YES/NO
(i) Whether Contract(s) Non-Performance occurred as a result of Contractor's default since 1st April 2017 specified in Section III, Evaluation and Qualification Criteria, requirement 3.2.1			
(ii) If answer to (i) above is YES, then following details to be submitted:			
Year	**Non-performed portion of contract**	**Contract Identification**	**Total Contract Amount (current value, currency, exchange rate and INR equivalent)**
[insert year]	*[insert amount and percentage]*	Contract Identification: *[indicate complete contract name/ number, and any other identification]* Name of Employer: *[insert full name]* Address of Employer: *[insert street/city/country]* Reason(s) for nonperformance: *[indicate main reason(s)]*	*[insert amount]*

2. Pending Litigation, in accordance with Section III, Evaluation and Qualification Criteria	
Description	YES/NO
(i) Whether any litigation is still pending against the Contractor in accordance with Section III, Evaluation and Qualification Criteria, Sub-Clause 3.2.3.	

(ii) If answer to (i) above is YES, then following details to be submitted:

Year of dispute	Amount in dispute (currency)	Contract Identification	Total Contract Amount (currency), INR Equivalent (exchange rate)
		Contract Identification: _____ Name of Employer: _____ Address of Employer: _____ Matter in dispute: _____ Party who initiated the dispute: ____ Status of dispute: _____	
		Contract Identification: Name of Employer: Address of Employer: Matter in dispute: Party who initiated the dispute: Status of dispute:	

3. Litigation History in accordance with Section III, Evaluation and Qualification Criteria **(Not Applicable)**

Tenderer's Authorized Representative

Signature: ……..
Date: ……..
Company stamp: ……..

Chartered Accountant/Company Auditor/Statutory Auditor

Certified that the information furnished above is correct as per the audited balance sheets of the entity.

Signature: ……..
Name: ……..
Position: ……..
Date: ……

Form CON-2

Environmental, Social, Health, and Safety Performance Declaration

[Ref. ITT Sub-Clause 17.2 and Section III, Evaluation and Qualification Criteria, Sub-Clause 3.2.5]

[The following table shall be filled in for the Tenderer or in case of JV/Consortium, each member of a Joint Venture/Consortium]

Tender No.: HORC/HRIDC/C-23 /2022

Tenderer's Name: _____

JV Member's Name_____

Page _____of _____pages

<table>
<tr><td colspan="4">Environmental, Social, Health, and Safety Performance Declaration in accordance with Sub-Clause 3.2.5, Section III, Qualification Criteria and Requirements</td></tr>
<tr><td colspan="3">Description</td><td>YES/NO</td></tr>
<tr><td colspan="3">(i) Declaration of suspension or termination of contract:
Whether contract(s) has/have been suspended or terminated and/or Performance Security called by an employer(s) for reasons related to Environmental, Social, Health, or Safety (ESHS) performance since the date specified in Section III, Qualification Criteria, and Requirements, Sub-Clause 3.2.5.</td><td></td></tr>
<tr><td colspan="4">(ii) If answer to (i) above is YES, then following details to be submitted:</td></tr>
<tr><td colspan="4">a. Details of Contract(s) suspended/terminated by an employer(s) for reasons related to ESHS performance</td></tr>
<tr><td>Year</td><td>Suspended or terminated portion of contract</td><td>Contract Identification</td><td>Total Contract Amount (current value, currency, exchange rate and INR equivalent)</td></tr>
<tr><td>[insert year]</td><td>[insert amount and percentage]</td><td>Contract Identification: [indicate complete contract name/ number, and any other identification]
Name of Employer: [insert full name]
Address of Employer: [insert street/city/country]
Reason(s) for suspension or termination: [indicate main reason(s)]</td><td>[insert amount]</td></tr>
</table>

[insert year]	*[insert amount and percentage]*	Contract Identification: *[indicate complete contract name/ number, and any other identification]* Name of Employer: *[insert full name]* Address of Employer: *[insert street/city/country]* Reason(s) for suspension or termination: *[indicate main reason(s)]*	*[insert amount]*
...	...	*[list all applicable contracts]*	...
b. **Details of Contract(s) in which Performance Security called by an employer(s) for reasons related to ESHS performance**			
Year		Contract Identification	Total Contract Amount (current value, currency, exchange rate and INR equivalent)
[insert year]		Contract Identification: *[indicate complete contract name/ number, and any other identification]* Name of Employer: *[insert full name]* Address of Employer: *[insert street/city/country]* Reason(s) for calling of performance security: *[indicate main reason(s)]*	*[insert amount]*

Tenderer's Authorized Representative

Signature: ……..
Date: ……..
Company stamp: ……..

Form FIN-3.3.1:

Financial Situation and Performance

[Ref. ITT Sub-Clause 17.2 and Section III, Evaluation and Qualification Criteria, Sub-Clause 3.3.1 (iii)]

[The following table shall be filled in for the Tenderer or in case of JV/Consortium, each member of a Joint Venture/Consortium]

Tender No.: HORC/HRIDC/C-23 /2022

Tenderer's Name: _____

JV Member's Name_____

Page _____of _____pages

Financial data *(All amounts in Millions)*

Type of Financial information in (currency)	**Historic information for last three Financial Years, (amount in currency, currency, exchange rate*, INR equivalent)**		
	Year 1: 2019-20	**Year 2:2020-21**	**Year 3:2021-22**
	Statement of Financial Position (Information from Balance Sheet)		
Total Assets (TA)			
Total Liabilities (TL)			
Total Equity/Net Worth (NW) = TA-TL			
Current Assets (CA)			
Current Liabilities (CL)			
Working Capital (WC)			
Total Revenue (TR)			
Profits Before Taxes (PBT)			

*Refer to Notes: Exchange Rate for Qualification Criteria, Section III, EQC.

Notes:

(i) In case, the Financial Year is the same as the Calendar Year, the financial data for the year 2019, 2020 and 2021 shall be furnished.

(ii) The Tenderer is not required to submit any document as documentary evidence along with the Tender Documents. All information furnished in this Form shall be certified by a Chartered Accountant/Company Auditor/Statutory Auditor.

(iii) The Form duly certified by a Chartered Accountant/Company Auditor/Statutory Auditor shall also be signed by Tenderer's Authorized representative.

(iv) The above documents shall reflect the financial situation of the legal entity or entities comprising the Tenderer and not the Tenderer's parent companies, subsidiaries, or affiliates.

(v) In the event that the audited accounts for the latest concluded Financial Year are not available, the Tenderer shall furnish information pertaining to the last three financial years after ignoring the latest concluded financial year. In case, the Tenderer submits audited financial information for the last four or more years, only the figures for the latest three years shall be considered for evaluation.

(vi) In case audited balance sheet of the last financial year is not available with the tenderer, he will declare the same vide item (p) prescribed in the Letter of Tender-Technical Part.

(vii) ***If the value of Net Worth is not submitted for any of the last three years, the Tender shall be considered nonresponsive and shall be summarily rejected****.*

Tenderer's Authorized Representative

Signature: ……..

Date: ……..……..

Company stamp: ……..…..

Chartered Accountant/Company Auditor/Statutory Auditor

Certified that the information furnished above is correct as per the audited balance sheets of the entity.

Signature: ……..

Name:

Position:

Date:

Company:

Company stamp:

Membership No:

Address:

Contact No:

Email ID:

Form FIN-3.3.2:

Average Annual Construction Turnover

[Ref. ITT Sub-Clause 17.2, Section III, Evaluation and Qualification Criteria, Sub-Clause 3.3.1 (ii) and Sub-Clause 3.3.2]

[The following table shall be filled in for the Tenderer or in case of JV/Consortium, each member of a Joint Venture/Consortium]

Tender No.: HORC/HRIDC/C-23 /2022

Tenderer's Name: _____

*JV Member's Name*_____
Page _____of _____pages

(All amounts in Millions)

Annual Turnover Data for the Last Three (03) Financial Years (Construction Only)			
Year	**Amount Currency**	***Exchange Rate**	**INR Equivalent**
2019-20	*[insert amount and indicate currency]*		
2020-21			
2021-22			

* See Section III, Evaluation and Qualification Criteria, Sub-Clause 3.3.2.

Notes:

(i) *In case, the Financial Year is the same as the Calendar Year, the turnover for the year 2019, 2020 and 2021 shall be furnished.*

(ii) *The Average Annual Construction Turnover shall be calculated by adding the turnover amount of last three financial years divided by three.*

(iii) *The Tenderer is not required to submit any document as documentary evidence along with the Tender Documents. All information furnished in this Form shall be certified by a Chartered Accountant/Company Auditor/Statutory Auditor.*

(iv) *The Form duly certified by a Chartered Accountant/Company Auditor/Statutory Auditor shall also be signed by Tenderer's Authorized representative.*

(v) *The above documents shall reflect the financial situation of the legal entity or entities comprising the Tenderer and not the Tenderer's parent companies, subsidiaries, or affiliates.*

(vi) *In the event that the audited accounts for the latest concluded Financial Year are not available, the Tenderer shall furnish information pertaining to the last three financial years after ignoring the latest concluded financial year. In case, the Tenderer submits audited financial information for the last four or more years, only the figures for the latest three years shall be considered for evaluation.*

(vii) In case audited balance sheet of the last financial year is not available with the tenderer, he will declare the same vide item (p) prescribed in the Letter of Tender-Technical Part..

(viii) If the value of Annual construction Turnover is not submitted for any of the last three years prescribed in Financial Data, the Tender shall be evaluated by considering "NIL" Turnover for that year(s).

Tenderer's Authorized Representative

Signature: ……..

Date: ……..……..

Company stamp: ……..…..

Chartered Accountant/Company Auditor/Statutory Auditor

Certified that the information furnished above is correct as per the audited balance sheets of the entity.

Signature: ……..

Name:

Position:

Date:

Company:

Company stamp:

Membership No:

Address:

Contact No:

Email ID:

Form FIN-3.3.3:

Sources of Finance for the Subject Contract

[Ref. ITT Sub-Clause 17.2 and Section III, Evaluation and Qualification Criteria, Sub-Clause 3.3.1 (i)]

[The following table shall be filled in for the Tenderer or in case of JV/Consortium, each member of a Joint Venture/Consortium]

Tender No.: HORC/HRIDC/C-23 /2022

Tenderer's Name: _____

JV Member's Name_____
Page _____of _____pages

A. Tenderer should specify proposed sources of financing, such as liquid assets, unencumbered real assets, lines of credit, and other financial means, net of current contract commitments, available to meet the total construction cash flow demands of the subject contract **i.e. Package C-23.**

(*All amounts in Millions*)

No.	Source of financing	Amount (INR equivalent)
1		
2		
3		
	Total Sources of Finance for the subject Contract	

(i) The Tenderer is not required to submit any document as documentary evidence along with the Tender Documents. All information furnished in this Form shall be certified by a Chartered Accountant/Company Auditor/Statutory Auditor.

(ii) The Form duly certified by a Chartered Accountant/Company Auditor/Statutory Auditor shall also be signed by Tenderer's Authorized representative.

(iii) The above documents shall reflect the financial situation of the legal entity or entities comprising the Tenderer and not the Tenderer's parent companies, subsidiaries, or affiliates.

Tenderer's Authorized Representative

Signature: ……..

Date: ……..

Company stamp: ……..…..

Chartered Accountant/Company Auditor/Statutory Auditor

Certified that the information furnished above is correct.

Signature: ……..

Name:

Position:

Date:

Company:

Company stamp:

Membership No:

Address:

Contact No:

Email ID:

Form FIN-3.3.4:

Bid Capacity

[Ref. ITT Sub-Clause 17.2, Section III, Evaluation and Qualification Criteria, Sub-Clause 3.3.1 (ii)]

[The following table shall be filled in for the Tenderer or in case of JV/Consortium, each member of a Joint Venture/Consortium]

Tender No.: HORC/HRIDC/C-23 /2022

Tenderer's Name: _____
JV Member's Name_____
Page _____of _____pages

1.0 Bid Capacity:

The available bid capacity shall be calculated as under:
Available Bid Capacity = [A x N x 2] – 0.33xNxB
Where,

A = Maximum value of construction works executed and payment received in any one of the previous three financial years, taking into account the completed as well as works in progress.

N= Number of years prescribed for completion of work for which Tender has been invited **(i.e *2.5* years)**.

B = Existing commitments and balance amount of ongoing works with tenderer and also the works which are awarded to tenderer but yet not started upto the date of inviting the Tender.

Note:

(a) The Tenderer(s) shall furnish the details of :

(i) Maximum value of construction works executed and payment received in any one of the previous three financial years for calculating **'A'**, and

(ii) Existing commitments and balance amount of ongoing works with tenderer and also the works which are awarded to tenderer but yet not started upto the date of inviting the Tender for calculating **'B'**. The details shall be submitted in the prescribed proforma given under **2.0 below.** In case of no works in hand, a 'NIL' statement should be furnished.

The submitted details for (i) and (ii) above should be duly verified by Chartered Accountant.

(b) In case if a tenderer is JV, the Tenderer(s) must furnish the details of:

(i) Maximum value of construction works executed and payment received in any one of the previous three financial years by each member of JV for calculating **'A'**, and

(ii) Existing commitments and balance amount of ongoing works with each member of JV either in individual capacity or as a member of other JV and also the works which are awarded to each member of JV either in individual capacity or as a member of other JV but yet not started upto the date of inviting the Tender for calculating **'B'**. The details shall be submitted by each member of JV in the prescribed proforma given under **2.0 below.** In case of no works in hand, a 'NIL' statement should be furnished.

.

The submitted details for (i) and (ii) above should be duly verified by Chartered Accountant.

(c) Value of a completed work/work in progress/work awarded but yet not started for a Member in an earlier JV/Consortium shall be reckoned only to the extent of the concerned member's share in that JV/Consortium for the purpose of satisfying his/her compliance to the above mentioned Bid Capacity in the Tender under consideration.

(d) For assessing the combined Bid capacity of JV/Consortium, the arithmetic sum of individual "Bid Capacity" of all the members shall be taken.

(e) In case, the Tenderer/s failed to submit the above statement along with offer, their/his offer shall be considered as incomplete and will be rejected summarily.

(f) The Available Bid Capacity of Tenderer shall be assessed based on the details submitted by the Tenderer. In case, the available bid capacity is less than that prescribed in Sub-Clause 3.3.1 (ii), Section III, EQC , then the offer shall not be considered even if the Tenderer has been found eligible in other eligibility criteria/tender requirement.

2.0 Tenderer should provide information on their current commitments on all contract that have been awarded, or for which a letter of intent or acceptance has been received, or for contracts approaching completion, but for which an unqualified, full completion certificate is yet to be issued.

Current Contract Commitments /Works in Progress

(All amounts in INR)

S. No.	Name and Brief particulars of contract (Clearly indicate the part of the work assigned to the applicant)	Contract No. & Date	Name of client with telephone number	Contract Value in INR Equivalent (Give only the value of work assigned to the applicant)	Stipulated Period of completion	Value of balance work yet to be done in INR equivalent upto the date of inviting the Tender
(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**
Total value of balance work yet to be done in INR equivalent upto the date of inviting the Tender						**B=**

Notes:

(i) Where a work is undertaken by a JV/Consortium, only that portion of the contract which is undertaken by the concerned applicant/member should be indicated and the remaining done by the other members of the JV/Consortium be excluded.

(ii) *The Tenderer is not required to submit any document as documentary evidence along with the Tender Documents.* ***All information furnished in this Form shall be certified by a Chartered Accountant/Company Auditor/Statutory Auditor.***

(iii) The above documents shall reflect the financial situation of the legal entity or entities comprising the Tenderer and not the Tenderer's parent companies, subsidiaries, or affiliates.

"Certified that current commitments on all the contracts that have been awarded or for which a letter of intent or acceptance has been received or for the works in progress or the works approaching completion, value of outstanding work has been indicated in the above table correctly. It is further certified that if later on the Employer discovers that information provided in the table is incorrect then the Employer will treat our Tender invalid and it will be liable for rejection"

3.0 Calculation of Available Bid Capacity

Description	**Value**
A= Maximum value of construction works executed and payment received in any one of the previous three financial years, taking into account the completed as well as works in progress ***as per Form FIN 3.3.2*** (in INR Equivalent)	

Description	**Value**
N= Number of years prescribed for completion of work for which Tender has been invited (in years)	***2.5***
B= Existing commitments and balance amount of ongoing works with tenderer and also the works which are awarded to tenderer but yet not started upto the date of inviting the Tender (in INR Equivalent)	
Bid Capacity (in INR Equivalent) = [A x N x 2] – 0.33xNxB	

Tenderer's Authorized Representative

Signature: ……..

Date: ……..……..

Company stamp: ……..…..

Chartered Accountant/Company Auditor/Statutory Auditor

Certified that the information furnished above is correct.

Signature: ……..

Name:

Position:

Date:

Company:

Company stamp:

Membership No:

Address:

Contact No:

Email ID:

Form EXP-3.4.1

General Construction Experience

[Ref. ITT Sub-Clause 17.2 and Section III, Evaluation and Qualification Criteria, Sub-Clause 3.4.1]

[The following table shall be filled in for the Tenderer or in case of JV/Consortium, each member of a Joint Venture/Consortium]

Tender No.: HORC/HRIDC/C-23 /2022

Tenderer's Name: _____

JV Member's Name_____
Page _____of _____pages

Details of Works executed under construction contracts in the role of Prime Contractor or a JV member or *Management Contractor* or a sub-contractor, starting 1st April 2015 till 28 days prior to deadline of Tender submission.

Starting Year	Ending Year	Contract Identification	Role of Tenderer [insert "Prime Contractor (single entity or JV member)" or *Management Contractor* or "Subcontractor"]
		Contract name: _____ Brief Description of the Works performed by the Tenderer: _____ Amount of contract: _____ Name of Employer: _____ Address: _____	
		Contract name: _____ Brief Description of the Works performed by the Tenderer: _____ Amount of contract: _____ Name of Employer: _____ Address: _____	
		Contract name: _____ Brief Description of the Works performed by the	

		Tenderer: _____ Amount of contract: _____ Name of Employer: _____ Address: _____	

Tenderer's Authorized Representative

Signature: ……..

Date: ……..

Company stamp: ……..

Form EXP-3.4.2(a)

Specific Construction and Contract Management Experience

[Ref. ITT Sub-Clause 17.2 and Section III, Evaluation and Qualification Criteria, Sub-Clause 3.4.2 (a)]

[The following table shall be filled in for the Tenderer or in case of JV/Consortium, each member of a Joint Venture/Consortium]

Tender No.: HORC/HRIDC/C-23 /2022

Tenderer's Name: _____

JV Member's Name_____
Page _____of _____pages

Similar Contract No.	**Information**		
Contract Identification			
Award date			
Completion date			
Role in Contract as Prime Contractor or Member in JV or *Management Contractor* or Sub-Contractor	*[insert the role in Contract]*		
Total Contract Amount	*[insert Contract amount(s) and currency(ies)]*		INR [insert *exchange rate and total Contract amount in INR equivalent]
If member in a JV or sub-contractor, specify participation in total Contract amount	*[insert Percentage participation]*	*[insert amount(s) and currency) of participation]*	*INR [insert exchange rate(i) and amount of participation in INR equivalent]*
Employer's Name:			
Address: Mobile: Telephone/fax number E-mail:			
Description of the similarity in accordance with Sub-Clause 3.4.2(a) of Section III:			
1. Amount			

2. (i) Quantity of Earthwork in Rail/Road projects formation. (in Cum) (ii) Total executed length of bridge works (in m)	

**Refer to Notes: Exchange Rate for Qualification Criteria, Section III, EQC.*

Tenderer's Authorized Representative

Signature: ……..

Date: ……..

Company stamp: ……..

Notes:

(i) Value of completed work done by a Member in an earlier JV shall be reckoned only to the extent of the concerned member's share in that JV for purpose of satisfying his/her experience criteria mentioned in 3.4.2(a).

(ii) The Tenderer shall submit copy of certificates issued by the Employer as documentary proof clearly indicating the similarity of the work as per Sub-Clause 3.4.2 (a), actual completion cost, actual completion date. Tenders submitted without this documentary proof shall not be evaluated.

(iii)In case Tenderer submits work experience certificate issued by other than Govt. / Public Sector undertakings, the Tenderer shall also submit along with work experience certificate, the relevant copy of work order, bill of quantities, bill wise details of payment received duly certified by Chartered Accountant, TDS certificates for all payments received and copy of final/last bill paid by company in support of above work experience certificate.

(iv) If a tenderer has successfully completed a work as subcontractor, the work experience certificate issued for such work to subcontractor by the Employer (owner of the work) shall only be considered for the purpose of fulfillment of credentials.

FORM UT-1

Undertaking for compliance to Employer's Requirements & Specification by Tenderer

1. We understand that our Technical Proposal are for assessment of eligibility requirements and the same have no bearing on our Financial Part. We undertake that the work will be executed as per provision of tender specifications/ drawings/ design basis report despite contrary provisions, if any, in our submission and nothing extra will be claimed on this account.

2. We hereby confirm that we will comply all the design requirement and codal provisions as specified in Tender documents and also confirm that due to any change in design/construction /methodology during the execution of work, nothing extra shall be claimed by us.

3. We understand that some of the parameters have been assumed or taken from Geo-Technical report for design purpose. The Geo-Technical report is for general information only. We hereby confirm that all the design/ methodologies shall be based on the detailed soil investigation to be carried out by us after award of work for which nothing extra shall be claimed by us.

We hereby undertake that in case of any deviation in Technical Proposal with respect to the Tender documents & Tender drawings, the conditions as mentioned in the Tender documents shall prevail.

Signature of authorized signatory of Tenderer with Seal

Form UT-2

Undertaking for Downloaded Tender Document

I/We hereby declare that, I/we have downloaded the Tender documents/addendum/corrigendum/ clarifications along with the set of enclosures hosted on e-procurement portal as mentioned in tender document. I/We verified the content of the document from the website and there is no addition, no deletion or no alteration to the content of the tender document. In case of any discrepancy noticed at any stage i.e. evaluation of tenders, execution of work or final payment of the contract, the master copy of Tender Documents available with HRIDC shall be final and binding upon me/us.

Signature of Authorized Signatory of Tenderer with Seal

Appendix E to Technical Part: Tender Security

The amount for Tender Security in INR will only be paid online by eligible Tenderers on e-procurement Portal of Government of Haryana.

OR

Tender Security can be submitted in the form of unconditional and irrevocable Bank Guarantee[1] in INR or USD from the banks specified in Sub-Clause ITT 19.3, Section II- TDS using the Tender Security Form given below:

[1] Refer Sub-Clause ITT 1.3 H and Sub-Clause 19.3, Section II, TDS for submission of the Tender Security in the form of BG. Option of Exemption from payment of EMD mentioned in the module of e-Procurement portal is only for exemption of online payment of Tender Security to the Tenderers who wish to submit Tender Security in the form of Bank Guarantee.

Tender Security
Form of Demand Guarantee

Beneficiary:

Chief Project Manager,
Haryana Rail Infrastructure Development Corporation Limited,
Plot No 143, 5th Floor, Railtel Tower,
Sector-44, Gurugram, Haryana-122003

Tender No: HORC/HRIDC/C-4/2022

Date: _____*[Insert date of issue]*

TENDER SECURITY GUARANTEE No.: _____

Guarantor: *[Insert name and address of place of issue, unless indicated in the letterhead]*

We have been informed that _____ (hereinafter called "the Applicant") has submitted or will submit to the Beneficiary its Tender (hereinafter called "the Tender") for the execution of **"C-23:** Design and Construction of Civil Works (Earthwork, Bridges, Station Buildings, Retaining Walls and other miscellaneous Works) from km 29.68 to km 49.70 & from km 55.60 to km 61.50 and its connectivities to IR network from New Patli to Patli station & New Patli to Sultanpur station including modifications/civil works at Sultanpur Station in connection with laying of New BG Double Railway line of HORC project."

Furthermore, we understand that, according to the Beneficiary's conditions, Tenders must be supported by a Tender guarantee.

At the request of the Applicant, we, as Guarantor, hereby irrevocably undertake to pay the Beneficiary any sum or sums not exceeding in total an amount of _____ (_____) upon receipt by us of the Beneficiary's complying demand, supported by the Beneficiary's statement, whether in the demand itself or a separate signed document accompanying or identifying the demand, stating that either the Applicant:

(a) has withdrawn its Tender during the period of Tender validity set forth in the Applicant's Letter of Tender ("the Tender Validity Period"), or any extension thereto provided by the Applicant; or

(b) having been notified of the acceptance of its Tender by the Beneficiary during the Tender Validity Period or any extension thereto provided by the Applicant, (i) has failed to execute the contract agreement, or (ii) has failed to furnish the Performance Security in accordance with the Instructions to Tenderers ("ITT") of the Beneficiary's Tender Document.

This guarantee will expire: (a) if the Applicant is the successful Tenderer, upon our receipt of copies of the contract agreement signed by the Applicant and the Performance Security issued to the Beneficiary in relation to such contract agreement; or (b) if the Applicant is not the successful Tenderer, upon the earlier of (i) our receipt of a copy of the Beneficiary's notification to the Applicant of the results of the Tendering process; or (ii) twenty-eight days after the end of the Tender Validity Period.

Consequently, any demand for payment under this guarantee must be received by us at the office indicated above on or before that date.

This guarantee is subject to the Uniform Rules for Demand Guarantees (URDG) 2010 Revision, ICC Publication No. 758.

_____

[signature(s)]

Form of Tender-Securing Declaration

DELETED

Letter of Tender – Financial Part

INSTRUCTIONS TO TENDERERS: DELETE THIS BOX ONCE YOU HAVE COMPLETED THE DOCUMENT

The Tenderer must prepare this Letter of Tender on stationery with its letterhead clearly showing the Tenderer's complete name and business address.

Note: All italicized text is to help Tenderers in preparing this form.

Date of this Tender submission: [*insert date (as day, month and year) of Tender submission*]
Tender No.: [*insert tender reference number*]
Alternative No.: [*insert reference number if this is a Tender for an alternative*]

To: **[*insert complete name of Employer*]**

We, the undersigned, hereby submit the second part of our Tender, the Tender Price and Price Schedule. This accompanies the Letter of Tender – Technical Part.

In submitting our Tender, we declare that:

(a) **Tender Validity Period**: Our Tender shall be valid for the period specified in TDS 18.1 (as amended, if applicable) from the date fixed for the Tender submission deadline specified in TDS 22.1 (as amended, if applicable), and it shall remain binding upon us and may be accepted at any time before the expiration of that period;

(b) ****Tender Price:** The total price of our Tender including Provisional Sum is: [*insert the total price of the Tender in words and figures in INR*];

(c) **Commissions, Gratuities, Fees:** We have paid, or will pay the following commissions, gratuities, or fees with respect to the Tendering process or execution of the Contract: *[insert complete name of each Recipient, its full address, the reason for which each commission or gratuity was paid and the amount and currency of each such commission or gratuity]*

Name of Recipient	Address	Reason	Amount

(If none has been paid or is to be paid, indicate "none.")

Name of the Tenderer: [*insert complete name of the Tenderer*]

Name of the person duly authorized to sign the Tender on behalf of the Tenderer: *[*insert complete name of person duly authorized to sign the Tender*]

Title of the person signing the Tender: [*insert complete title of the person signing the Tender*]

Signature of the person named above: [*insert signature of person whose name and capacity are shown above*]

Date signed [*insert date of signing*] **day of** [*insert month*], [*insert year*]

*: Person signing the Tender shall have the power of attorney given by the Tenderer. The power of attorney shall be attached with the Letter of Tender.

** The total price of Tender including Provisional Sums quoted in this Letter of Tender-Financial Part shall be same as given in Worksheet BOQ3 (Price Schedule –Summary Sheet) of MS-Excel File which includes cost of Schedule 'A" plus Schedule 'B' plus Schedule 'C' plus Schedule 'D' and plus Provisional Sum.

Appendix A to Financial Part: Schedule of Adjustment Data

1. Price adjustment

1.1 The amounts payable to the Contractor for Works shall be adjusted in accordance with the provisions of this Clause 1.0, Sub-Clause 13.7 of GCC and Sub-Clause 13.7, Specific Provision, Part B, Section IX-PCC.

1.2 The Contract Price shall be adjusted for increase or decrease in rates and prices of labour, materials, fuel and lubricants, equipment, Machinery, Plant and other Materials or inputs in accordance with the principles, procedures and formulae specified below:

a) Base month for the purpose of Price Adjustment shall be the month in which the Tender is opened for Civil Works and General Electrical Services Works. The 1st Quarter will start from Base month;

b) For Schedule-A, Price adjustment shall be applied on completion of the specified stage of the respective item of work.

c) Adjustment for each item of work/stage shall be made separately;

d) The following expressions and meanings are assigned to the value of the work done for Civil works:

EW = Value of work done for the completion of a stage under the Cost Centre 'CE' of Price Schedule 'A' ;

BR = Value of work done for the completion of a stage under the Cost Centre 'CB' of Price Schedule 'A';

STN = Value of work done for the completion of a stage under Cost Centre CS of Price Schedule 'A';

CW = Value of work done under Price Schedule 'B';

MISC = Value of work done under Price Schedule 'D';

The following expressions and meanings are assigned to the Cost Centre of Price Schedule 'A':

Cost Centre	Description of Cost Centre
1	**2**
CE	Earthwork and blanketing
CB	Bridges
CS	Station

e) Price adjustment for change in costs of civil works shall be paid in accordance with the following formula:

i) VEW= 0.85 EW x [PLB x (LBi – LBo)/LBo + PF x (Fi –Fo)/Fo + PMACH x (MACHi – MACHo)/MACHo + POTH x (OTHi - OTHo)/OTHo];

ii) VBR = 0.85 BR x [PLB x (LBi – LBo)/LBo + PC x (Ci – Co)/Co + PS x (Si – So)/So + PF x (Fi – Fo)/Fo + PMACH x (MACHi – MACHo)/MACHo + POTH x (OTHi - OTHo)/OTHo];

iii) VSTN = 0.85 STN x [PLB x (LBi – LBo)/LBo + PC x (Ci – Co)/Co + PS x(Si – So)/So + PF x (Fi – Fo)/Fo + PMACH x ((MACHi – MACHo)/MACHo + POTH x (OTHi - OTHo)/OTHo];

iv) VCW = 0.85 RW x [PLB x (LBi – LBo)/LBo + PC x (Ci – Co)/Co + PS x (Si – So)/So + PF x (Fi – Fo)/Fo + PMACH x (MACHi – MACHo)/MACHo + POTH x (OTHi - OTHo)/OTHo];

v) VMISC= 0.85 MISC x [PLB x (LBi – LBo)/LBo + PF x (Fi –Fo)/Fo + PMACH x (MACHi – MACHo)/MACHo + POTH x (OTHi - OTHo)/OTHo];

Where

VEW = Increase or decrease in the cost under the Cost Centre 'CE' of Price Schedule 'A' during the period under consideration due to changes in the rates for relevant components as specified in sub-paragraph (f);

VBR = Increase or decrease in the cost of Cost Centre 'CB' of Price Schedule 'A' during the period under consideration due to changes in the rates for relevant components as specified in sub-paragraph (f);

VSTN = Increase or decrease in the cost of Cost Centre 'CS' of Price Schedule 'A' during the period under consideration due to changes in the rates for relevant components as specified in sub-paragraph (f);

VCW = Increase or decrease in the cost of work done under Price Schedule 'B' during the period under consideration due to changes in the rates for relevant components as specified in sub-paragraph (f);

VMISC = Increase or decrease in the cost of work done under Price Schedule 'C' during the period under consideration due to changes in the rates for relevant components as specified in sub-paragraph (f);

PC, PF, PLB, PMACH, POTH and PS are the percentages of cement, fuel and lubricants, labour, Plant Machinery and tools, other materials, and steel/ steel components (including strands and steel cables), respectively for the relevant item as specified in sub-paragraph (f);

Co = The wholesale price index as published by the Ministry of Commerce and Industry, Government of India (hereinafter called "WPI") for sub-group Cement, Lime & Plaster for the Base Month;

Ci = The WPI for sub-group Cement, Lime & Plaster for the average price index of the 3 months of the quarter under consideration;

Fo = The wholesale price index as published by the Ministry of Commerce and Industry, Government of India (hereinafter called "WPI") for group Fuel & Power for the Base Month;

Fi = The WPI for group Fuel & Power for the average price index of the 3 months of the quarter under consideration

LBo = The consumer price index for industrial workers – All India, published by Labour Bureau, Ministry of Labour, Government of India, (hereinafter called "CPI") for the Base Month;

LBi = The CPI for industrial workers – All India for the average price index of the 3 months of the quarter under consideration;

MACHo = The wholesale price index as published by the Ministry of Commerce and Industry, Government of India (hereinafter called "WPI") for category- k "Manufacturing of Machinery for Mining, quarrying and construction' under (R) Manufacturing of Machinery and Equipment for the Base Month;

MACHi = The WPI for category- k "Manufacturing of Machinery for Mining, quarrying and construction' under (R) Manufacturing of Machinery and Equipment for the average price index of the 3 months of the quarter under consideration;

OTHo = The wholesale price index as published by the Ministry of Commerce and Industry, Government of India (hereinafter called "WPI") for all commodities for the Base Month;

OTHi = The WPI for all commodities for the average price index of the 3 months of the quarter under consideration;

So = Average Rate of RINL for Rebar 8 mm (coil) as published for Ludhiana Branch on their website for the Base Month;

Si = Average rate of RINL for Rebar 8 mm (coil) as published for Ludhiana Branch on their website for the 3 months of the quarter under consideration;

If only one rate is published for the 3 months of the quarter under consideration, the published rate for that quarter shall be considered for the quarter under consideration.

If no rate is published by RINL for Rebar 8mm (coil) for the 3 months of the quarter under consideration, the value of Si and So will be taken as under:

"So": Wholesale Price Index for 'MS Bright Bars' individual commodity of group item (d) Mild Steel- Long products under (N) MANUFACTURE OF BASIC METALS, published by Office of Economic Adviser, Government of India, Ministry of Commerce & Industry Department of Industrial Policy & Promotion (DIIP) for the Base Month;

"Si": Average Wholesale Price Index for 'MS Bright Bars' individual commodity of group item (d) Mild Steel- Long products under (N) MANUFACTURE OF BASIC METAL, published by Office of Economic Adviser, Government of India, Ministry of Commerce & Industry Department of Industrial Policy & Promotion (DIIP) for the 3 months of the quarter under consideration;

f) The following percentages shall govern the price adjustment of the Contract Price for costs of civil works:

Component	EW (Cost Centre CE of Price Schedule 'A')	BR (Cost Centre CB of Price Schedule 'A')	STN (Cost Centre CS of Price Schedule 'A')	CW (Price Schedule 'B')	MISC (Price Schedule 'D')
(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Cement (PC)	-	20%	15%	20%	-
Fuel and lubricants (PF)	30%	20%	15%	20%	30%
Labour (PLB)	20%	10%	25%	10%	20%
Machinery and Plants (PMACH)	40%	15%	05%	15%	40%
Other Materials (POTH)	10%	10%	20%	10%	10%
Steel (PS)	-	25%	20%	25%	-
Total	100%	100%	100%	100%	100%

g) The following expressions and meanings are assigned to the value of the work done for Various General Electrical Services works:

i) **ELEGWK** = Value of work done for General Electrical Services under Price Schedule 'C';

h) Price adjustment for changes in cost for various General Electrical Services works shall be paid in accordance with the following formula:

i) **VELEGWK** = 0.85 ELEGWK x [PLB x (LBi – LBo)/LBo + POTH x (OTHi – OTHo)/OTHo]

Where: -

VELEGWK = Increase or decrease in the cost of work done under Price Schedule 'C' of '**General Electrical Services works'** with complete accessories during the period under consideration due to changes in the rates for relevant components as specified in sub-paragraph (i);

PLB and POTH are the percentages of Labor and, All Other Commodities respectively for the relevant item as specified in sub-paragraph (i);

LBo = The consumer price index for industrial workers – All India, published by Labour Bureau, Ministry of Labour, Government of India, (hereinafter called "CPI") for the Base month;

LBi = The CPI for industrial workers – All India for the average price index of the 3 months of the quarter under consideration

OTHo = The wholesale price index as published by the Ministry of Commerce and Industry, Government of India (hereinafter called "WPI") for "All commodities" for the Base month;

OTHi = The WPI for all commodities for the average price index of the 3 months of the quarter under consideration;

i) The following percentages shall govern the price adjustment of the Contract Price for Various General Electrical Services works:

Component	**General Electrical**
Labour (PLB)	20%
All other commodities (POTH)	80 %
Total	100.00%

Table A. Foreign Currency (FC)

Not applicable as Tenderers are required to quote rates and prices only in INR.

Table B. Summary of Payment Currencies

For ……. [insert name of Works]

Name of Payment Currency	A Amount of Currency	B Rate of Exchange (local currency per unit of foreign)	C Local Currency Equivalent C = A x B	D Percentage of Net Tender Price (NTP) 100xC / NTP
For Schedule 'A'				
Local currency (INR)		**1.00**		
USD ($)				
EUR (€)				
JPY (¥)				
Schedule 'B'		**1.00**		
Schedule 'C'		**1.00**		
Schedule 'D'		**1.00**		
Net Tender Price				**100.00**
Provisional Sums Expressed in Local Currency (INR) in million	100,000,000.00	**1.00**	100,000,000.00	**Not Applicable**
TOTAL TENDER PRICE (including provisional sum)				

Note: *The Tenderer is required to propose and submit the schedules given in tables above as part of the Tender. The rates of exchange shall be the reference rate twenty-eight (28) days prior to the deadline for submission of Tenders published by the Reserve Bank of India (RBI) on its website https://www.rbi.org.in . In case the exchange rate of particular currency on given date is not available on RBI web site, it will be as per the web site https://www.fbil.org.in of Financial Benchmark India Private Limited (FBIL).*

Appendix B to Financial Part: Price Schedules

1 Preamble

1.1. The Price Schedules shall be read in conjunction with the Instructions to Tenderers, the General Conditions, the Particular Conditions and the Employer's Requirements (*General, Functional, Design (Civil), Construction (Civil), Outline Design Specifications (ODS)- Civil, Outline Construction Specifications (OCS)-Civil, General Electrical Services, Tender Drawings and Documents*) and the Addenda (if any).

1.2. **Schedule 'A'** comprises scope of work to be executed under lump sum contract as detailed in Part 2- Employers' Requirements of Tender Document. *Cost of Schedule 'A' also includes cost of tree cutting for entire package C-23 as per Sub-Clause 10.14 of Appendix 10, Section VII-9: Appendices, Part 2 -Employer's Requirements of Tender Documents.* The Tenderer has to quote a single lump sum amount against Schedule 'A'. Payment to the Contractor will be made in accordance with payment stages/Milestones defined for each Cost Centre detailed in Clause 5.0 below unless otherwise specified in the Contract.

1.3. **Schedule 'B' -**Retaining Wall, Bridges and other civil works:

Schedule 'B' comprises *of four parts i.e. Schedule B1, B2, B3 and B4. Schedule 'B1' comprises items based on NWR USSOR-2019. Schedule B2 comprises items based on NR USSOR-2010 mainly for building works. Schedule B3 comprises items based on DSR 2021. Schedule B4 contains Non-Schedule items. Cost of design and drawings of all the temporary works, temporary road diversion is deemed to be included in the rates quoted for the relevant item of Schedule 'B' unless otherwise specified in the Contract.* The Tenderer has to quote the percentage Excess (+) or Less (-) over the total Estimated amount of Schedule 'B' *(which is shown as "Estimated Rate" against Schedule 'B' in BOQ2 of MS excel file on e- procurement portal).* The payment against this Schedule 'B' will be made on the basis of quantities executed, measured and certified. Under this Schedule, the Contractor is required to carry out all works of retaining walls, bridges and other civil works, which are not covered in Schedule 'A', as per site requirements and as per the direction of the Engineer.

1.4. **Schedule 'C'** comprises of percentage rate for "General Electrical Services works". The Tenderer has to quote the percentage Excess (+) or Less (-) over the total Estimated amount of Schedule 'C' *(which is shown as "Estimated Rate" against Schedule 'C' in BOQ2 of MS excel file on e procurement portal). The quoted rate includes the cost of design and drawings of relevant systems and items as specified in the Contract Documents.* The payment against this Schedule 'C' will be made on the basis of quantities executed, measured and certified. Under this Schedule, the Contractor is required to carry out all works of General Electrical Services works, which are not covered in Schedule 'A' or Schedule 'B', as per site requirements and as per the direction of the Engineer.

1.5. **Schedule 'D'** comprises "Item rates for miscellaneous works". Under this Schedule, the Contractor has to undertake items or works not covered in Schedule ´A' or Schedule ´B' or

Schedule ´C'. Execution of items under this Schedule shall be carried out only after specific instructions of the Engineer. This Schedule consists of items for Civil works. The work has to be carried out as per Schedule of items given in this Schedule 'D'. This Schedule contains only Rate and Unit of items of the works. The basis of payment will be the actual quantities of work ordered and carried out, as measured by the Contractor and verified by the Engineer and valued at the rates and prices quoted in the Price Schedules. The Tenderer has to quote the percentage (%) Excess (+) or Less (-) *over the total Estimated Cost of Schedule 'D' (which is shown as "Estimated Rate" against Schedule 'D' in BOQ2 of MS excel file on e procurement portal)* for items to be executed against this head.

1.6. The Schedules may not generally give a full description of the works to be performed and the plant or equipment to be supplied under each item. Tenderers shall be deemed to have read the Employer's Requirements and the other sections of the Tender Documents and reviewed the Drawings to ascertain the full scope of the requirements included in each item prior to filling the rates and prices.

1.7. The price quoted in the Price Schedules for Schedule 'A', Schedule 'B' Schedule 'C' and Schedule 'D' are for complete and finished items of the work in all respects. The Price quoted in the Price Schedules shall, except otherwise specifically provided, shall include all design, include all necessary survey work, plants , tools, machinery, Contractor's equipment, labour, compliance of labour laws, supervision, materials, transportation, handling, loading & unloading, storage, sampling, testing, fuel, oil, consumables, electric power, water, all leads & lifts, dewatering, all temporary works including temporary accesses, staging, form works and false works, stacking, provision and maintenance of all temporary works area, construction of temporary store and buildings, fencing, barricading, lighting, drainage arrangements, erection & maintenance of inspection facilities above and below ground such as brick, concrete and steel etc., reinstatement, remedy of any defects during the Defects Notification Period, safety measures for workmen and road users, preparation of design and drawings pertaining to permanent and temporary works, & *temporary diversion works, temporary road widening,* traffic diversion works, mobilisation and demobilisation, establishment and overhead charges, labour camps, insurance cost for labour and works, contractor's profit, all taxes including Goods and Service Tax (GST), insurance, royalties, duties, cess, octroi, other levies and other charges together with all general risks, liabilities and obligations set out or implied in the Contract.

The price and rates quoted by Tenderer shall be deemed to have included GST at the rate of 18% as notified by 47th GST Council on 29th June 2022 ***and Item 18.5 of Circular No. 177/09/2022-TRU dated 03rd August 2022 issued by Ministry of Finance, Government of India.***

1.8. The whole cost of complying with the provisions of the Contract shall be included in the items provided in the Price Schedules, and where no items are provided, the cost shall be deemed to be distributed among the rates and prices entered for the related items of the Work.

1.9.To the extent acceptable to the Employer for the purpose of making payments or partial payments, valuing variations or evaluating claims, or for such other purposes as the Engineer may reasonably require, the Contractor may provide the Engineer with a breakdown of any composite or lump sum items included in the Schedules.

1.10.The Provisional Sums included and so designated in the Price Schedules shall be expended in whole or in part at the direction and discretion of the Engineer. The Provisional Sum shall be used to cover the Employer's share of the DAAB members' fees and expenses, in accordance with Clause 21. No prior instruction of the Engineer shall be required with respect to the work of the DAAB in accordance with Sub-Clause 13.4 of Part B-Specific Provisions - Particular Conditions of Contract. The Contractor shall submit the DAAB members' invoices and satisfactory evidence of having paid 100% of such invoices as part of the substantiation of those statements submitted under Sub-Clause 14.3. in accordance with Sub-Clauses 13.4 of the General Conditions.

1.11.The prices shall be quoted against Schedule 'A', Schedule 'B', Schedule 'C' and Schedule 'D' in the Price Schedule (Excel Workbook) uploaded on the e-Procurement portal.

1.12.The prices quoted shall be comprehensive and must include for complying in all respects with the Price Schedules, Instruction to Tenderers, the General Conditions, the Particular Conditions, Employer's Requirements, Specifications and Drawings and for all matters and things necessary for the proper construction, completion, and making good of any defect in part or of the whole of the Works.

1.13.No claims for additional payment shall be allowed for any error or misunderstanding by the Contractor of the work involved.

1.14.*The rates quoted by the Tenderer are for design and construction of the Works as per approved Alignment Plan & L-Section , approved GADs of bridges and approved drawings of other structures as per Scope of the Works.*

2 Variations in Price Schedule 'A', Schedule 'B' Schedule 'C' and Schedule 'D'

2.1 Variations in Price Schedules shall be dealt in accordance with Sub Clause 13.3.1 of Part B-Specific Provisions, Section IX- Particular Conditions of Contract.

2.2 The through Chainages mentioned in the Scope of the Works/Tender Drawings can undergo some minor corrections, without any impact on the overall length/Scope of the Works.

3 Measurement and Payment

3.1 The measurement shall be made as per Price Schedules i.e. Schedule 'A'. Schedule 'B' Schedule 'C' and Schedule 'D' and other relevant provisions of the Contract such as Employer's Requirements and the Drawings.

3.2 If during execution of the Contract, it is decided by the Employer/Engineer that one or more items of Work/Milestone of a Cost Centre in a particular Price Schedule is not required to be

executed, the proportionate amount against that particular Item of Work/Milestones shall not be paid. The Engineer's decision in this regard shall be final.

3.3 The Payment shall be made as per Clause 14 [Contract Price and Payment] of the General Conditions and Particular Conditions.

3.4 The Employer shall make interim payments to the Contractor in accordance with the provisions of Sub-Clause 14.6 [Issue of Interim Payment Certificates] of the General Conditions and Particular Conditions, as certified by the Engineer on the basis of the progress achieved for the items of works/stages/Milestones of the works.

3.5 The Contractor shall base its claim for interim payment in accordance with Sub-Clause 14.3 [Application for Interim Payment] of the General Conditions and Particular Conditions for each stage for various items of work on the basis of actual progress of work executed (i.e. Milestones achieved) till the end of the month for which the payment is claimed in relation to the Contractor's total executed quantity, supported with documents and updated programme in accordance with the Employer's Requirements.

3.6 The Employer may carry out necessary tests, either directly or through an independent agency, of the Works done by the Contractor for which payment has been accepted and certified by the Engineer. The payment shall depend upon the outcome of such tests.

3.7 Format for the Contractor's application for payment shall be agreed between the Engineer and the Contractor.

3.8 All necessary supplementary details to support progress claims, including all certified Request for Inspection in hard bound copy, shall be included with application for payment. Sketches, drawings, approvals, calculations, test reports etc. shall accompany an application for payment to be substantiated and certified by the Engineer and submitted to the Employer.

3.9 Even if no work is executed during the month, or the Contractor does not choose to issue an application for payment, a 'NIL' application shall be submitted.

3.10 For the purposes of payment, the Contractor shall submit to the Engineer a detailed Price Schedule indicating a further breakdown for each stage of payment contained in the Price Schedules within forty-two (42) days after the receipt of the Letter of Acceptance. Such cost breakdowns shall be subject to approval of the Engineer who shall review and evaluate with comments and/or issue approval within twenty-eight (28) days of receipt of same. The Contractor shall resubmit the cost breakdown structure corresponding to the Engineer's comments for review, if required.

3.11 The Engineer is not obliged to issue an Interim Payment Certificate until such breakdown structure of payment schedule has been submitted and accepted by the Engineer.

4 Methodology for Claiming Payment

4.1 The Contractor shall prepare his monthly application for payment in the agreed format in two hard copies and one soft copy. This shall be accompanied by supplementary details in accordance with Sub-Clause 14.3 [Application for Interim Payment Certificates] of the

General Conditions. All hard copies shall bear the original signatures of the Contractor's Representative and be submitted to the Engineer.

4.2 If these are found in order, in accordance with Sub-Clause 14.6 [Issue of Interim Payment Certificates] of the General Conditions, then the Engineer shall forward two certified copies of the application along with certified supplementary details to the Employer, with his recommendation for payment; otherwise, all documents shall be returned to the Contractor for rectification and resubmission.

***5* Price Schedule**

5.1 Schedule "A'- Breakup of Lump Sum cost of Works under various Sub-Heads shall be as follows:

Sub-Head	Description	Percentage of the quoted lump sum cost of Schedule 'A'	No. of Cost Centre	Total Cost of each Sub-Head
1	**2**	**3**	**4**	**5**
C	Civil works	100	4	C= 1xLS*

*LS = Total lump sum accepted cost of Works for Schedule 'A'

5.2 Apportionment of Contract Price for payments under various Cost Centre for Sub-Head 'C'- Civil Works

Cost Centre	Description of Cost Centre	Percentage of Cost Centre 'C'	Total Cost of Cost Centre	Total Cost of Sub-Head 'C'
1	**2**	**3**	**4**	**5**
CD	Design and As Built Drawing & Documents	*01.00%*	CD= *0.01*x 'C'	100% of SCH 'A'
CE	Earthwork and blanketing	*51.00%*	CE=*0.51*x 'C'	
CB	Bridges	*41.00%*	CE=*0.41*x 'C'	
CS	Station	*07.00%*	CE=*0.07*x 'C'	
	Total	100%		

Note: Value of 'C' shall be as defined in Sub-Clause 5.1 above.

The percentage figures as filled in column (3) for the apportionment of the Contract Price for completion of the Works corresponding to the various Sub-Heads and Cost Centres are fixed and payment will be released for different Cost centre as per above percentage break-up of Contract Price.

5.2.1 Stages of Payment i.e. Milestones of Cost Centre 'CD'- Design and As Built Drawing & Documents

Cost Centre			CD- Design and As Built Drawing & Documents	
Weightage of Cost Centre 'CD', (Y)			1%	
Sub Cost Centre	Item of Work		Milestone	Weightage (X)
	No.	Description		
1	2	3	4	5
CD1- Design	**CD1.1**	**Preliminary design**	Preliminary Design	7%
	CD1.2	**Formation**	Definitive design & Good for Construction Drawings (GFC)	7%
	CD1.3	**Minor Bridges**		
	CD1.3.1		Preparation & approval of GADs	10%
	CD1.3.2		Definitive Design	8%
	CD1.3.3		Good For Construction (GFC)	10%
	CD1.4	**Major Bridges**		
	CD1.4.1		Preparation & approval of GADs	6%
	CD1.4.2		Definitive Design	7%
	CD1.4.3		Good For Construction (GFC)	8%
	CD1.5	**Retaining Walls**		
	CD1.5.1		Definitive Design	3.5%
	CD1.5.2		Good For Construction (GFC)	3.5%
	CD1.6	**Stations**		
	CD1.6.1		Preparation & approval of Architectural Drawings	4%
	CD1.6.2		Definitive Design	3%
	CD1.6.3		Combined Services Drawings & MEP Drawings	5%
	CD1.6.4		Good For Construction (GFC) Drawings	3%
CD2- As Built Drawing & Documents	CD 2.1	As Built Drawings	Submission of As Built Drawings	10%
	CD 2.2	As Built Documents	Submission of As Built Documents	5%
			Total	**100%**

Note:

1. The value of each Milestones will be total lump sum accepted cost of Works for Schedule 'A' (LS) multiplied by X * Y. For example, the value of Milestone CD 1.3.2 will be equal to LS*X*Y= LSx0.08x0.01.
2. Adjustment to Contract Price pursuant to GCC 13.7 shall **NOT** be applicable to the payments of Works executed under this Cost Centre.
3. All minor bridges shall have equal weightage. Payment of each stage/Milestones shall be made on pro rata basis on completion of a stage for a bridge.
4. All major bridges shall have equal weightage. Payment of each stage/Milestones shall be made on pro rata basis on completion of a stage for a bridge.
5. All stations shall have equal weightage. Payment of each stage/Milestones shall be made on pro rata basis on completion of a stage for a station.
6. Payment will be made on Completion of each Milestones as per weightage given in this Cost Centre
7. *The Cost of Milestones include cost of design of the formation, Bridges, retaining wall, Structure, included in Schedule 'A' and Schedule 'B' as mentioned in Section VII-2, Employer's Requirements.*

5.2.2 Stages of Payment i.e. Milestones of Cost Centre 'CE'- Earthwork and Blanketing

Cost Centre			**CE-Earthwork and Blanketing**	
Weightage of Cost Centre 'CE', (Y)			**51.0%**	
Sub-Cost Centre	**Item of Work**		**Milestone**	**Weightage (X)**
	No.	**Description**		
1	2	3	4	5
CE.1- Earthwork	CE.1.1	Earthwork in formation from Ch 55600 to 56000 for double main line track.		
	CE.1.1.1		Earthwork in embankment / cutting including compaction.	2.16%
	CE.1.1.2		On cutting of extra width & dressing of slopes in profile, compaction, *providing vegetative cover including coir netting (where specified) and* drainage arrangement complete in all respects.	0.3%
	CE.1.1.3		On completion of maintenance *of slopes, drainage system & vegetative cover* for a period of 12 months *and after ensuring that vegetative cover* is properly rooted .	0.1%
	CE.1.2	Earthwork in formation from Ch 56000 to 57000 for double main line track.		
	CE.1.2.1		Earthwork in embankment/ cutting including compaction.	7.0%
	CE.1.2.2		On cutting of extra width & dressing of slopes in profile, compaction, *providing vegetative cover including coir netting (where specified) and* drainage arrangement complete in all respects.	0.7%
	CE.1.2.3		On completion of maintenance *of slopes, drainage system & vegetative cover* for a period of 12 months *and after ensuring that vegetative cover* is properly rooted .	0.18%

Cost Centre			CE-Earthwork and Blanketing	
Weightage of Cost Centre 'CE', (Y)			51.0%	
Sub-Cost Centre	Item of Work		Milestone	Weightage (X)
	No.	Description		
1	2	3	4	5
	CE.1.3	Earthwork in formation from Ch 57000 to 58000 for main line, loop line, connecting lines & platform area in New Patli station yard.		
	CE.1.3.1		Earthwork in embankment / cutting including compaction.	6.14%
	CE.1.3.2		On cutting of extra width & dressing of slopes in profile, compaction, *providing vegetative cover including coir netting (where specified) and* drainage arrangement complete in all respects.	0.4%
	CE.1.3.3		On completion of maintenance *of slopes, drainage system & vegetative cover* for a period of 12 months *and after ensuring that vegetative cover* is properly rooted .	0.2%
	CE.1.4	Earthwork in formation from Ch 58000 to 58700 in New Patli yard for main, loop & connecting lines and platform area		
	CE.1.4.1		Earthwork in embankment / cutting including compaction.	5.05%
	CE.1.4.2		On cutting of extra width & dressing of slopes in profile, compaction, *providing vegetative cover including coir netting (where specified) and* drainage arrangement complete in all respects.	0.3%
	CE.1.4.3		On completion of maintenance *of slopes, drainage system & vegetative cover* for a period of 12	0.15%

Cost Centre			CE-Earthwork and Blanketing	
Weightage of Cost Centre 'CE', (Y)			51.0%	
Sub-Cost Centre	Item of Work		Milestone	Weightage (X)
	No.	Description		
1	2	3	4	5
			months *and after ensuring that vegetative cover* is properly rooted .	
	CE.1.5	Earthwork in formation from Ch 58700 to 60000 for double main line & connecting line track.		
	CE.1.5.1		Earthwork in embankment / cutting including compaction.	4.21%
	CE.1.5.2		On cutting of extra width & dressing of slopes in profile, compaction, *providing vegetative cover including coir netting (where specified) and* drainage arrangement complete in all respects.	0.3%
	CE.1.5.3		On completion of maintenance *of slopes, drainage system & vegetative cover* for a period of 12 months *and after ensuring that vegetative cover* is properly rooted .	0.15%
	CE.1.6	Earthwork in formation from Ch 60000 to 61000 for double main line track.		
	CE.1.6.1		Earthwork in embankment / cutting including compaction.	3.21%
	CE.1.6.2		On cutting of extra width & dressing of slopes in profile, compaction, *providing vegetative cover including coir netting (where specified) and* drainage arrangement complete in all respects.	0.3%
	CE.1.6.3		On completion of maintenance *of slopes, drainage system & vegetative cover* for a period of 12	0.1%

Cost Centre			CE-Earthwork and Blanketing	
Weightage of Cost Centre 'CE', (Y)			51.0%	
Sub-Cost Centre	Item of Work		Milestone	Weightage (X)
	No.	Description		
1	2	3	4	5
			months *and after ensuring that vegetative cover* is properly rooted .	
	CE.1.7	Earthwork in formation from Ch 61000 to 61500 for doble main line track.		
	CE.1.7.1		Earthwork in embankment / cutting including compaction.	1.67%
	CE.1.7.2		On cutting of extra width & dressing of slopes in profile, compaction, *providing vegetative cover including coir netting (where specified) and* drainage arrangement complete in all respects.	0.25%
	CE.1.7.3		On completion of maintenance *of slopes, drainage system & vegetative cover* for a period of 12 months *and after ensuring that vegetative cover* is properly rooted .	0.1%
	CE.1.8	Earthwork in formation from Ch 29600 to 30000 for double main line track.		
	CE.1.8.1		Earthwork in embankment / cutting including compaction.	0.5%
	CE.1.8.2		On cutting of extra width & dressing of slopes in profile, compaction, *providing vegetative cover including coir netting (where specified) and* drainage arrangement complete in all respects.	0.36%
	CE.1.8.3		On completion of maintenance *of slopes, drainage system & vegetative cover* for a period of 12 months *and after ensuring that vegetative cover* is properly rooted .	0.09%

Cost Centre			**CE-Earthwork and Blanketing**	
Weightage of Cost Centre 'CE', (Y)			**51.0%**	
Sub-Cost Centre	**Item of Work**		**Milestone**	**Weightage (X)**
	No.	**Description**		
1	2	3	4	5
	CE.1.9	Earthwork in formation from Ch 30000 to 31000 for double main line track.		
	CE.1.9.1		Earthwork in embankment / cutting including compaction.	0.4%
	CE.1.9.2		On cutting of extra width & dressing of slopes in profile, compaction, *providing vegetative cover including coir netting (where specified) and* drainage arrangement complete in all respects.	0.65%
	CE.1.9.3		On completion of maintenance *of slopes, drainage system & vegetative cover* for a period of 12 months *and after ensuring that vegetative cover* is properly rooted .	0.13%
	CE.1.10	Earthwork in formation from Ch 31000 to 32000 for double main line track.		
	CE.1.10.1		Earthwork in embankment / cutting including compaction.	0.04%
	CE.1.10.2		On cutting of extra width & dressing of slopes in profile, compaction, *providing vegetative cover including coir netting (where specified) and* drainage arrangement complete in all respects.	0%
	CE.1.10.3		On completion of maintenance *of slopes, drainage system & vegetative cover* for a period of 12 months *and after ensuring that vegetative cover* is properly rooted .	0%
	CE.1.11	Earthwork in formation from Ch 32000 to 33000 for		

Cost Centre			CE-Earthwork and Blanketing	
Weightage of Cost Centre 'CE', (Y)			51.0%	
Sub-Cost Centre	Item of Work		Milestone	Weightage (X)
	No.	Description		
1	2	3	4	5
		main line, loop lines, including platform area in Dhulawat station yard.		
	CE.1.11.1		Earthwork in embankment / cutting including compaction.	0.9%
	CE.1.11.2		On cutting of extra width & dressing of slopes in profile, compaction, *providing vegetative cover including coir netting (where specified) and* drainage arrangement complete in all respects.	0.05%
	CE.1.11.3		On completion of maintenance *of slopes, drainage system & vegetative cover* for a period of 12 months *and after ensuring that vegetative cover* is properly rooted .	0.1%
	CE.1.12	Earthwork in formation from Ch 33000 to 34000 for main line, loop lines, including platform area in Dhulawat station yard.		
	CE.1.12.1		Earthwork in embankment / cutting including compaction.	1.62%
	CE.1.12.2		On cutting of extra width & dressing of slopes in profile, compaction, *providing vegetative cover including coir netting (where specified) and* drainage arrangement complete in all respects.	0.2%
	CE.1.12.3		On completion of maintenance *of slopes, drainage system & vegetative cover* for a period of 12 months *and after ensuring that vegetative cover* is properly rooted .	0.1%

Cost Centre			CE-Earthwork and Blanketing	
Weightage of Cost Centre 'CE', (Y)			51.0%	
Sub-Cost Centre	Item of Work		Milestone	Weightage (X)
	No.	Description		
1	2	3	4	5
	CE.1.13	Earthwork in formation from Ch 34000 to 35000 for main line track.		
	CE.1.13.1		Earthwork in embankment / cutting including compaction.	1.16%
	CE.1.13.2		On cutting of extra width & dressing of slopes in profile, compaction, *providing vegetative cover including coir netting (where specified) and* drainage arrangement complete in all respects.	0.15%
	CE.1.13.3		On completion of maintenance *of slopes, drainage system & vegetative cover* for a period of 12 months *and after ensuring that vegetative cover* is properly rooted .	0.1%
	CE.1.14	Earthwork in formation from Ch 35000 to 36000 for main line track.		
	CE.1.14.1		Earthwork in embankment / cutting including compaction.	0.75%
	CE.1.14.2		On cutting of extra width & dressing of slopes in profile, compaction, *providing vegetative cover including coir netting (where specified) and* drainage arrangement complete in all respects.	0.1%
	CE.1.14.3		On completion of maintenance *of slopes, drainage system & vegetative cover* for a period of 12 months *and after ensuring that vegetative cover* is properly rooted .	0.1%
	CE.1.15	Earthwork in formation from Ch		

Cost Centre			CE-Earthwork and Blanketing	
Weightage of Cost Centre 'CE', (Y)			51.0%	
Sub-Cost Centre	Item of Work		Milestone	Weightage (X)
	No.	Description		
1	2	3	4	5
		36000 to 37000 for main line track.		
	CE.1.15.1		Earthwork in embankment / cutting including compaction.	1.36%
	CE.1.15.2		On cutting of extra width & dressing of slopes in profile, compaction, *providing vegetative cover including coir netting (where specified) and* drainage arrangement complete in all respects.	0.15%
	CE.1.15.3		On completion of maintenance *of slopes, drainage system & vegetative cover* for a period of 12 months *and after ensuring that vegetative cover* is properly rooted .	0.1%
	CE.1.16	Earthwork in formation from Ch 37000 to 38000 for main line track.		
	CE.1.16.1		Earthwork in embankment / cutting including compaction.	1.39%
	CE.1.16.2		On cutting of extra width & dressing of slopes in profile, compaction, *providing vegetative cover including coir netting (where specified) and* drainage arrangement complete in all respects.	0.15%
	CE.1.16.3		On completion of maintenance *of slopes, drainage system & vegetative cover* for a period of 12 months *and after ensuring that vegetative cover* is properly rooted .	0.1%

Cost Centre			**CE-Earthwork and Blanketing**	
Weightage of Cost Centre 'CE', (Y)			**51.0%**	
Sub-Cost Centre	**Item of Work**		**Milestone**	**Weightage (X)**
	No.	**Description**		
1	2	3	4	5
	CE.1.17	Earthwork in formation from Ch 38000 to 39000 for main line track.		
	CE.1.17.1		Earthwork in embankment / cutting including compaction.	1.2%
	CE.1.17.2		On cutting of extra width & dressing of slopes in profile, compaction, *providing vegetative cover including coir netting (where specified) and* drainage arrangement complete in all respects.	0.14%
	CE.1.17.3		On completion of maintenance *of slopes, drainage system & vegetative cover* for a period of 12 months *and after ensuring that vegetative cover* is properly rooted .	0.1%
	CE.1.18	Earthwork in formation from Ch 39000 to 40000 for main line track.		
	CE.1.18.1		Earthwork in embankment / cutting including compaction.	0.87%
	CE.1.18.2		On cutting of extra width & dressing of slopes in profile, compaction, *providing vegetative cover including coir netting (where specified) and* drainage arrangement complete in all respects.	0.1%
	CE.1.18.3		On completion of maintenance *of slopes, drainage system & vegetative cover* for a period of 12 months *and after ensuring that vegetative cover* is properly rooted .	0.1%

Cost Centre			CE-Earthwork and Blanketing	
Weightage of Cost Centre 'CE', (Y)			51.0%	
Sub-Cost Centre	Item of Work		Milestone	Weightage (X)
	No.	Description		
1	2	3	4	5
	CE.1.19	Earthwork in formation from Ch 40000 to 41000 for main line track.		
	CE.1.19.1		Earthwork in embankment / cutting including compaction.	0.92%
	CE.1.19.2		On cutting of extra width & dressing of slopes in profile, compaction, *providing vegetative cover including coir netting (where specified) and* drainage arrangement complete in all respects.	0.1%
	CE.1.19.3		On completion of maintenance *of slopes, drainage system & vegetative cover* for a period of 12 months *and after ensuring that vegetative cover* is properly rooted .	0.1%
	CE.1.20	Earthwork in formation from Ch 41000 to 42000 for main line track.		
	CE.1.20.1		Earthwork in embankment / cutting including compaction.	1.24%
	CE.1.20.2		On cutting of extra width & dressing of slopes in profile, compaction, *providing vegetative cover including coir netting (where specified) and* drainage arrangement complete in all respects.	0.15%
	CE.1.20.3		On completion of maintenance *of slopes, drainage system & vegetative cover* for a period of 12 months *and after ensuring that vegetative cover* is properly rooted .	0.1%
	CE.1.21	Earthwork in formation from Ch		

Cost Centre			CE-Earthwork and Blanketing	
Weightage of Cost Centre 'CE', (Y)			51.0%	
Sub-Cost Centre	Item of Work		Milestone	Weightage (X)
	No.	Description		
1	2	3	4	5
		42000 to 43000 for main line including platform area in Chandla Dungerwas station.		
	CE.1.21.1		Earthwork in embankment / cutting including compaction.	1.95%
	CE.1.21.2		On cutting of extra width & dressing of slopes in profile, compaction, *providing vegetative cover including coir netting (where specified) and* drainage arrangement complete in all respects.	0.4%
	CE.1.21.3		On completion of maintenance *of slopes, drainage system & vegetative cover* for a period of 12 months *and after ensuring that vegetative cover* is properly rooted .	0.1%
	CE.1.22	Earthwork in formation from Ch 43000 to 44000 for main line track.		
	CE.1.22.1		Earthwork in embankment / cutting including compaction.	2.15%
	CE.1.22.2		On cutting of extra width & dressing of slopes in profile, compaction, *providing vegetative cover including coir netting (where specified) and* drainage arrangement complete in all respects.	0.4%
	CE.1.22.3		On completion of maintenance *of slopes, drainage system & vegetative cover* for a period of 12 months *and after ensuring that vegetative cover* is properly rooted .	0.15%

Cost Centre			CE-Earthwork and Blanketing	
Weightage of Cost Centre 'CE', (Y)			51.0%	
Sub-Cost Centre	Item of Work		Milestone	Weightage (X)
	No.	Description		
1	2	3	4	5
	CE.1.23	Earthwork in formation from Ch 44000 to 45000 for main line track.		
	CE.1.23.1		Earthwork in embankment / cutting including compaction.	4.94%
	CE.1.23.2		On cutting of extra width & dressing of slopes in profile, compaction, *providing vegetative cover including coir netting (where specified) and* drainage arrangement complete in all respects.	0.4%
	CE.1.23.3		On completion of maintenance *of slopes, drainage system & vegetative cover* for a period of 12 months *and after ensuring that vegetative cover* is properly rooted .	0.15%
	CE.1.24	Earthwork in formation from Ch 45000 to 46000 for main line track.		
	CE.1.24.1		Earthwork in embankment / cutting including compaction.	1.6%
	CE.1.24.2		On cutting of extra width & dressing of slopes in profile, compaction, *providing vegetative cover including coir netting (where specified) and* drainage arrangement complete in all respects.	0.3%
	CE.1.24.3		On completion of maintenance *of slopes, drainage system & vegetative cover* for a period of 12 months *and after ensuring that vegetative cover* is properly rooted .	0.1%

Cost Centre			CE-Earthwork and Blanketing	
Weightage of Cost Centre 'CE', (Y)			51.0%	
Sub-Cost Centre	Item of Work		Milestone	Weightage (X)
	No.	Description		
1	2	3	4	5
	CE.1.25	Earthwork in formation from Ch 46000 to 47000 for main line including platform area in Panchgaon station.		
	CE.1.25.1		Earthwork in embankment / cutting including compaction.	6.42%
	CE.1.25.2		On cutting of extra width & dressing of slopes in profile, compaction, *providing vegetative cover including coir netting (where specified) and* drainage arrangement complete in all respects.	0.55%
	CE.1.25.3		On completion of maintenance *of slopes, drainage system & vegetative cover* for a period of 12 months *and after ensuring that vegetative cover* is properly rooted .	0.2%
	CE.1.26	Earthwork in formation from Ch 47000 to 48000 for main line track.		
	CE.1.26.1		Earthwork in embankment / cutting including compaction.	4.31%
	CE.1.26.2		On cutting of extra width & dressing of slopes in profile, compaction, *providing vegetative cover including coir netting (where specified) and* drainage arrangement complete in all respects.	0.45%
	CE.1.26.3		On completion of maintenance *of slopes, drainage system & vegetative cover* for a period of 12 months *and after ensuring that vegetative cover* is properly rooted .	0.15%

Cost Centre			**CE-Earthwork and Blanketing**	
Weightage of Cost Centre 'CE', (Y)			**51.0%**	
Sub-Cost Centre	**Item of Work**		**Milestone**	**Weightage (X)**
	No.	**Description**		
1	2	3	4	5
	CE.1.27	Earthwork in formation from Ch 48000 to 49000 for main line track.		
	CE.1.27.1		Earthwork in embankment / cutting including compaction.	1.47%
	CE.1.27.2		On cutting of extra width & dressing of slopes in profile, compaction, *providing vegetative cover including coir netting (where specified) and* drainage arrangement complete in all respects.	0.2%
	CE.1.27.3		On completion of maintenance *of slopes, drainage system & vegetative cover* for a period of 12 months *and after ensuring that vegetative cover* is properly rooted .	0.1%
	CE.1.28	Earthwork in formation from Ch 49000 to 49700 for main line track.		
	CE.1.28.1		Earthwork in embankment / cutting including compaction.	0.2%
	CE.1.28.2		On cutting of extra width & dressing of slopes in profile, compaction, *providing vegetative cover including coir netting (where specified) and* drainage arrangement complete in all respects.	0.04%
	CE.1.28.3		On completion of maintenance *of slopes, drainage system & vegetative cover* for a period of 12 months *and after ensuring that vegetative cover* is properly rooted .	0.03%

Cost Centre			**CE-Earthwork and Blanketing**	
Weightage of Cost Centre 'CE', (Y)			**51.0%**	
Sub-Cost Centre	**Item of Work**		**Milestone**	**Weightage (X)**
	No.	**Description**		
1	2	3	4	5
	CE.1.29	Earthwork in formation from Ch 0614 to 1000 for New Patli - Patli connecting line		
	CE.1.29.1		Earthwork in embankment / cutting including compaction.	0.34%
	CE.1.29.2		On cutting of extra width & dressing of slopes in profile, compaction, *providing vegetative cover including coir netting (where specified) and* drainage arrangement complete in all respects.	0.15%
	CE.1.29.3		On completion of maintenance *of slopes, drainage system & vegetative cover* for a period of 12 months *and after ensuring that vegetative cover* is properly rooted .	0.05%
	CE.1.30	Earthwork in formation from Ch 1000 to 2000 for New Patli - Patli connecting line.		
	CE.1.30.1		Earthwork in embankment / cutting including compaction.	1.15%
	CE.1.30.2		On cutting of extra width & dressing of slopes in profile, compaction, *providing vegetative cover including coir netting (where specified) and* drainage arrangement complete in all respects.	0.2%
	CE.1.30.3		On completion of maintenance *of slopes, drainage system & vegetative cover* for a period of 12 months *and after ensuring that vegetative cover* is properly rooted .	0.1%
	CE.1.31	Earthwork in formation from Ch 2000 to Ch 2700 for		

Cost Centre			CE-Earthwork and Blanketing	
Weightage of Cost Centre 'CE', (Y)			51.0%	
Sub-Cost Centre	Item of Work		Milestone	Weightage (X)
	No.	Description		
1	2	3	4	5
		New Patli-Patli connecting line		
	CE.1.31.1		Earthwork in embankment / cutting including compaction.	0.15%
	CE.1.31.2		On cutting of extra width & dressing of slopes in profile, compaction, *providing vegetative cover including coir netting (where specified) and* drainage arrangement complete in all respects.	0.02%
	CE.1.31.3		On completion of maintenance *of slopes, drainage system & vegetative cover* for a period of 12 months *and after ensuring that vegetative cover* is properly rooted .	0.0%
	CE.1.32	Earthwork in formation from Ch 0703 to 2000 for New Patli-Sultanpur connecting line		
	CE.1.32.1		Earthwork in embankment / cutting including compaction.	1.52%
	CE.1.32.2		On cutting of extra width & dressing of slopes in profile, compaction, *providing vegetative cover including coir netting (where specified) and* drainage arrangement complete in all respects.	0.2%
	CE.1.32.3		On completion of maintenance *of slopes, drainage system & vegetative cover* for a period of 12 months *and after ensuring that vegetative cover* is properly rooted .	0.1%
	CE.1.33	Earthwork in formation from Ch 2000 to 3000 for		

Cost Centre			CE-Earthwork and Blanketing	
Weightage of Cost Centre 'CE', (Y)			51.0%	
Sub-Cost Centre	Item of Work		Milestone	Weightage (X)
	No.	Description		
1	2	3	4	5
		New Patli-Sultanpur connecting line		
	CE.1.33.1		Earthwork in embankment / cutting including compaction.	0.98%
	CE.1.33.2		On cutting of extra width & dressing of slopes in profile, compaction, *providing vegetative cover including coir netting (where specified) and* drainage arrangement complete in all respects.	0.1%
	CE.1.33.3		On completion of maintenance *of slopes, drainage system & vegetative cover* for a period of 12 months *and after ensuring that vegetative cover* is properly rooted .	0.1%
	CE.1.34	Earthwork in formation from Ch 3000 to 4190 for New Patli-Sultanpur connecting line and Sultanpur station yard (Km 0861 towards Garhi Harsaru side & Km 0530 towards Badsa side & Km 0689 towards Farukhnagar side)		
	CE.1.34.1		Earthwork in embankment / cutting including compaction.	0.3%
	CE.1.34.2		On cutting of extra width & dressing of slopes in profile, compaction, *providing vegetative cover including coir netting (where specified) and* drainage arrangement complete in all respects.	0.06%

Cost Centre			CE-Earthwork and Blanketing	
Weightage of Cost Centre 'CE', (Y)			51.0%	
Sub-Cost Centre	Item of Work		Milestone	Weightage (X)
	No.	Description		
1	2	3	4	5
	CE.1.34.3		On completion of maintenance *of slopes, drainage system & vegetative cover* for a period of 12 months *and after ensuring that vegetative cover* is properly rooted .	0.06%
CE.2-Blanketing	**CE.2.1**	Blanketing from Ch 55600 to 56000 for double main line track.	Blanketing on subgrade/ prepared subgrade as per design profile including compaction complete in all respects.	0.27%
	CE.2.2	Blanketing from Ch 56000 to 57000 for double main line track.	Blanketing on subgrade/ prepared subgrade as per design profile including compaction complete in all respects.	0.57%
	CE.2.3	Blanketing from Ch 57000 to 58000 for main line, loop lines & connecting lines in New Patli station yard.	Blanketing on subgrade/ prepared subgrade as per design profile including compaction complete in all respects.	1.03%
	CE.2.4	Blanketing from Ch 58000 to 58700 for main line, loop lines & connecting lines in New Patli station yard.	Blanketing on subgrade/ prepared subgrade as per design profile including compaction complete in all respects.	0.88%
	CE.2.5	Blanketing from Ch 58700 to 60000 for main line & connecting line.	Blanketing on subgrade/ prepared subgrade as per design profile including compaction complete in all respects.	1.2%
	CE.2.6	Blanketing from Ch 60000 to 61000 for double main line track	Blanketing on subgrade/ prepared subgrade as per design profile including compaction complete in all respects.	0.56%
	CE.2.7	Blanketing from Ch 61000 to 61500 for double main line track.	Blanketing on subgrade/ prepared subgrade as per design profile including compaction complete in all respects.	0.29%
	CE.2.8	Blanketing from Ch 29600 to 30000 for	Blanketing on subgrade/ prepared subgrade as per design profile	0.27%

Cost Centre			CE-Earthwork and Blanketing	
Weightage of Cost Centre 'CE', (Y)			51.0%	
Sub-Cost Centre	Item of Work		Milestone	Weightage (X)
	No.	Description		
1	2	3	4	5
		double main line track.	including compaction complete in all respects.	
	CE.2.9	Blanketing from Ch 30000 to 31000 for double main line track.	Blanketing on subgrade/ prepared subgrade as per design profile including compaction complete in all respects.	0.56%
	CE.2.10	Blanketing from Ch 31000 to 32000 for double main line track.	Blanketing on subgrade/ prepared subgrade as per design profile including compaction complete in all respects.	0.6%
	CE.2.11	Blanketing from Ch 32000 to 33000 for main line & loop lines in Dhulawat station yard.	Blanketing on subgrade/ prepared subgrade as per design profile including compaction complete in all respects.	0.81%
	CE.2.12	Blanketing from Ch 33000 to 34000 for main line & loop lines in Dhulawat station yard.	Blanketing on subgrade/ prepared subgrade as per design profile including compaction complete in all respects.	0.69%
	CE.2.13	Blanketing from Ch 34000 to 35000 for main line track.	Blanketing on subgrade/ prepared subgrade as per design profile including compaction complete in all respects.	0.58%
	CE.2.14	Blanketing from Ch 35000 to 36000 for double main line track.	Blanketing on subgrade/ prepared subgrade as per design profile including compaction complete in all respects.	0.56%
	CE.2.15	Blanketing from Ch 36000 to 37000 for double main line track.	Blanketing on subgrade/ prepared subgrade as per design profile including compaction complete in all respects.	0.56%
	CE.2.16	Blanketing from Ch 37000 to 38000 for double main line track.	Blanketing on subgrade/ prepared subgrade as per design profile including compaction complete in all respects.	0.56%
	CE.2.17	Blanketing from Ch 38000 to 39000 for	Blanketing on subgrade/ prepared subgrade as per design profile	0.56%

Cost Centre			CE-Earthwork and Blanketing	
Weightage of Cost Centre 'CE', (Y)			51.0%	
Sub-Cost Centre	Item of Work		Milestone	Weightage (X)
	No.	Description		
1	2	3	4	5
		double main line track.	including compaction complete in all respects.	
	CE.2.18	Blanketing from Ch 39000 to 40000 for double main line track.	Blanketing on subgrade/ prepared subgrade as per design profile including compaction complete in all respects.	0.57%
	CE.2.19	Blanketing from Ch 40000 to 41000 for double main line track.	Blanketing on subgrade/ prepared subgrade as per design profile including compaction complete in all respects.	0.57%
	CE.2.20	Blanketing from Ch 41000 to 42000 for double main line track.	Blanketing on subgrade/ prepared subgrade as per design profile including compaction complete in all respects.	0.56%
	CE.2.21	Blanketing from Ch 42000 to 43000 for double main line track.	Blanketing on subgrade/ prepared subgrade as per design profile including compaction complete in all respects.	0.48%
	CE.2.22	Blanketing from Ch 43000 to 4400 for double main line track.	Blanketing on subgrade/ prepared subgrade as per design profile including compaction complete in all respects.	0.57%
	CE.2.23	Blanketing from Ch 44000 to 45000 for double main line track.	Blanketing on subgrade/ prepared subgrade as per design profile including compaction complete in all respects.	0.57%
	CE.2.24	Blanketing from Ch 45000 to 46000 for double main line track.	Blanketing on subgrade/ prepared subgrade as per design profile including compaction complete in all respects.	0.62%
	CE.2.25	Blanketing from Ch 46000 to 47000 for double main line track.	Blanketing on subgrade/ prepared subgrade as per design profile including compaction complete in all respects.	0.49%
	CE.2.26	Blanketing from Ch 47000 to 48000 for double main line track.	Blanketing on subgrade/ prepared subgrade as per design profile including compaction complete in all respects.	0.57%

Cost Centre			CE-Earthwork and Blanketing	
Weightage of Cost Centre 'CE', (Y)			51.0%	
Sub-Cost Centre	Item of Work		Milestone	Weightage (X)
	No.	Description		
1	2	3	4	5
	CE.2.27	Blanketing from Ch 48000 to 49000 for double main line track.	Blanketing on subgrade/ prepared subgrade as per design profile including compaction complete in all respects.	0.51%
	CE.2.28	Blanketing from Ch 49000 to 49700 for double main line track.	Blanketing on subgrade/ prepared subgrade as per design profile including compaction complete in all respects.	0.45%
	CE.2.29	Blanketing from Ch 0614 to 1000 for New Patli - Patli connecting line	Blanketing on subgrade/ prepared subgrade as per design profile including compaction complete in all respects.	0.06%
	CE.2.30	Blanketing from Ch 1000 to 2000 for New Patli - Patli connecting line.	Blanketing on subgrade/ prepared subgrade as per design profile including compaction complete in all respects.	0.36%
	CE.2.31	Blanketing from Ch 2000 to Ch 2700 for New Patli-Patli connecting line	Blanketing on subgrade/ prepared subgrade as per design profile including compaction complete in all respects.	0.24%
	CE.2.32	Blanketing from Ch 0703 to 2000 for New Patli-Sultanpur connecting line	Blanketing on subgrade/ prepared subgrade as per design profile including compaction complete in all respects.	0.3%
	CE.2.33	Blanketing from Ch 2000 to 3000 for New Patli-Sultanpur connecting line	Blanketing on subgrade/ prepared subgrade as per design profile including compaction complete in all respects.	0.35%
	CE.2.34	Blanketing from Ch 3000 to 4119 for New Patli-Sultanpur connecting line and in Sultanpur Station yard (Km 0861 towards Garhi Harsaru side & Km 0530 towards Badsa side& Km 0689	Blanketing on subgrade/ prepared subgrade as per design profile including compaction complete in all respects.	1.00%

Cost Centre			CE-Earthwork and Blanketing	
Weightage of Cost Centre 'CE', (Y)			51.0%	
Sub-Cost Centre	Item of Work		Milestone	Weightage (X)
	No.	Description		
1	2	3	4	5
		towards Farukhnagar side)		
			Total	100%

Notes:

1. *The value of each Milestones will be total lump sum accepted cost of Works for Schedule 'A' (LS) multiplied by X * Y. For example, the value of Milestone CE1.1.1 will be equal to LS*X*Y= LSx0.0216 x 0.51.*
2. Adjustment to Contract Price pursuant to GCC 13.7 shall be applicable to the payments of Works executed under this Sub Heads / Price Schedule.
3. Payment will be made on Completion of each Milestones as per weightage given in this schedule.
4. *If owing to site conditions or any other reasons, locations of retaining walls are changed or new retaining walls are constructed or retaining walls are eliminated & normal bank is provided, the variation caused in quantity of earthwork in embankment on this account shall be payable/ recoverable under Item no. NS-1 of Schedule 'B4'.*

5.2.3 Milestones of Cost Centre 'CB'- for Bridges

Cost Centre			CB- Bridges	
Weightage of Cost Centre 'CB', (Y)			41%	
Sub-cost Centre	Item of Work		Milestone	Weightage (X)
	No.	Description		
1	2	3	4	5
CB1- Minor Bridges	CB1.1	Construction of minor bridge No. Nil between Ch 55600 to 56000 for main line track.		0%
	CB.1.2	Construction of minor bridge Nos. 137,138, 139 & 140 between Ch 56000 to 57000 for main line track.	On completion of bridge works in all respects	7.34%
	CB1.3	Construction of minor bridge No. 141, 141A,142, 143 & 144 between Ch 57000 to 58000 for main line and New Patli - Patli connecting line.	On completion of bridge works in all respects	9.85%
	CB1.4	Construction of minor bridge No. 145 & 146 between ch 58000 to 58700 in New Patli yard.	On completion of bridge works in all respects	2.58%
	CB.1.5	Construction of minor bridge No. 148 between ch 58700 to 60000 for main & New Patli-Sultanpur connecting lines.	On completion of bridge works in all respects	1.20%
	CB.1.6	Construction of minor bridge No. 149 & 149A between Ch 60000 to 61000 for main line.	On completion of bridge works in all respects	1.35%
	CB1.7	Construction of minor bridge No. 154 between Ch 61000 to 61500 for main line track.	On completion of bridge works in all respects	0.36%
	CB1.8	Construction of minor bridge No. Nil between ch 29600 to 30000 for main line track.	-	0%
	CB1.9	Construction of minor bridge No. Nil between Ch 30000 to 31000 for main line track.	-	0%
	CB1.10	Construction of minor bridge No. 77 between Ch 31000 to 32000 for main line track.	On completion of bridge works in all respects	1.64%
	CB1.11	Construction of minor bridge No. 78 between Ch 32000 to 33000 for main line, loop line & platform.	On completion of bridge works in all respects	0.33%

Cost Centre			CB- Bridges	
Weightage of Cost Centre 'CB', (Y)			41%	
Sub-cost Centre	Item of Work		Milestone	Weightage
	No.	Description		
1	2	3	4	5
	CB1.12	Construction of minor bridge No. 80, 81, 82 & 83 between ch 33000 to 34000 for main line, loop line & platform.	On completion of bridge works in all respects	2.25%
	CB1.13	Construction of minor bridge No. Nil between Ch 34000 to 35000 for main line track.	-	0%
	CB1.14	Construction of minor bridge No. 87 & 88 between Ch 35000 to 36000 for main line track.	On completion of bridge works in all respects	3.23%
	CB1.15	Construction of minor bridge No. Nil between Ch 36000 to 37000 for main line track.	-	0%
	CB1.16	Construction of minor bridge No. 90 & 91 between Ch 37000 to 38000 for main line track.	On completion of bridge works in all respects	0.99%
	CB1.17	Construction of minor bridge No. Nil between Ch 38000 to 39000 for main line track.	-	0%
	CB1.18	Construction of minor bridge No. 94 between Ch 39000 to 40000 for main line track.	On completion of bridge works in all respects	0.68%
	CB1.19	Construction of minor bridge No. 96 & 97 between Ch 40000 to 41000 for main line track.	On completion of bridge works in all respects	0.55%
	CB1.20	Construction of minor bridge No. 98, 99 & 100 between Ch 41000 to 42000 for main line track.	On completion of bridge works in all respects	0.92%
	CB1.21	Construction of minor bridge No. 102 & 103 between Ch 42000 to 43000 for main line track.	On completion of bridge works in all respects	0.79%
	CB1.22	Construction of minor bridge No. 106 between ch 43000 to 44000 for main line track.	On completion of bridge works in all respects	0.62%
	CB1.23	Construction of minor bridge No. 108, 109 & 110 between	On completion of bridge works in all respects	2.22%

Cost Centre			CB- Bridges	
Weightage of Cost Centre 'CB', (Y)			41%	
Sub-cost Centre	Item of Work		Milestone	Weightage
	No.	Description		
1	2	3	4	5
		Ch 44000 to 45000 for main line track.		
	CB1.24	Construction of minor bridge No. Nil between Ch 45000 to 46000 for main line track.	-	0%
	CB1.25	Construction of minor bridge No. 114, 115 & 116 between Ch 46000 to 47000 for main line track.	On completion of bridge works in all respects	2.91%
	CB1.26	Construction of minor bridge No. 117, 118 & 119 between Ch 47000 to 48000 for main line track.	On completion of bridge works in all respects	0.78%
	CB1.27	Construction of minor bridge No. 120, 121, 122 & 124 between Ch 48000 to 49000 for main line track.	On completion of bridge works in all respects	2.02%
	CB1.28	Construction of minor bridge No. 125 & 126 between Ch 49000 to 49700 for main line track.	On completion of bridge works in all respects	3.04%
	CB1.29	Construction of minor bridge No. Nil between Ch 0614 to 1000 for New Patli to Patli connecting line.	-	0%
	CB1.30	Construction of minor bridge No. 1, 2 & 3 between Ch 1000 to 2000 for New Patli to Patli connecting line.	On completion of bridge works in all respects	1.63%
	CB1.31	Construction of minor bridge No. 4 & 5 between Ch 2000 to 2700 for New Patli to Patli connecting line	On completion of bridge works in all respects	1.63%
	CB1.32	Construction of minor bridge No. 2 between Ch 0703 to 2000 for New Patli to Sultanpur connecting line	On completion of bridge works in all respects	0.21%
	CB1.33	Construction of minor bridge Nos. 4 & 5 between Ch 2000 to 3000 for New Patli to Sultanpur connecting line	On completion of bridge works in all respects	0.83%

Cost Centre			CB- Bridges	
Weightage of Cost Centre 'CB', (Y)			41%	
Sub-cost Centre	Item of Work		Milestone	Weightage
	No.	Description		
1	2	3	4	5
	CB1.34	Construction of minor bridge No. Nil between Ch 3000 to 4119 for New Patli-Sultanpur connecting line and in Sultanpur Station yard (Km 0861 towards Garhi Harsaru side & Km 0530 towards Badsa side& Km 0689 towards Farukhnagar side)	-	0%
CB.2-Major Bridges	CB.2.1	Foundation	On completion of the foundation work including pile caps/ well caps and foundations for wing and return walls, and testing.	13.0%
	CB.2.2	Substructure	On Completion of Abutment/Piers including Abutment/Pier Cap without bearings.	
	CB.2.2.1		Pier/Abutment	3%
	CB.2.2.2		Pier/Abutment cap	1%
	CB.2.2.3		Completion of the wing walls, return walls in all respects	4%
	CB.2.3	Superstructure		
	CB.2.3.1		On completion of superstructure including launching in position.	18.5%
	CB.2.3.2		On fixing of bearings in position true to line & level and placement of superstructure on bearings including grouting of holding down bolts complete.	1.5%
	CB.2.4	Installation of Track on OWG	On completion of installation of track on H-beam sleepers including fixing of guard rails, gang pathway complete and supply of 10% spare fittings.	1.0%
	CB.2.5	Miscellaneous works		

Cost Centre			CB- Bridges	
Weightage of Cost Centre 'CB', (Y)			41%	
Sub-cost Centre	Item of Work		Milestone	Weightage
	No.	Description		
1	2	3	4	5
	CB.2.5.1		On completion of Trolley refuge, Pathway on the sides, Inspection arrangement including access ladder etc.as per approved drawings and Employer's requirement,	2.0%
	CB.2.5.2		On completion of balance works as per drawing like- Protection works including Toe wall, Pitching, inspection steps, Bridge plaque, Bridge board, painting of HFL, Height Gauge, drainage arrangement in RUBs, and Testing on completion, if any, complete in all respect and fit for use.	6.05%.
			Total	**100%**

Notes:

1. *The value of each Milestones will be total lump sum accepted cost of Works for Schedule 'A' (LS) multiplied by X * Y. For example, the value of Milestone CB1.2 will be equal to LS*X*Y= LSx*0.0734 x 0.41.
2. Adjustment to Contract Price pursuant to GCC 13.7 shall be applicable to the payments of Works executed under this Sub Head / Price Schedule.
3. Payment will be made on Completion of each Milestones as per weightage given in this schedule.
4. CB2.2-Major Bridges:
   (i) For the purpose of stage payment/Milestones, cost of a bridge shall be taken in proportion to its linear length measured along the alignment to the total linear length of all major bridges.
   (ii) Payment of each stage/Milestones for a bridge will be made on completion of the relevant stage as per the weightage given in this schedule in proportion to the cost of the bridge.
5. Stages CB.2.1 to CB.2.2 will further be subdivided into the number of piers + 2 abutments, as applicable as per approved drawing by the Engineer, and Milestones for completed work for each pier and abutment shall be made as per the requirement of the stages stated above.

6. For steel Open Web Girder (OWG) and Composite girders payment against Cost centre CB.2.3.1 shall be released as per following schedule-

   (i) Receipt of material at approved location: 40%

   (ii) Fabrication of girder and transportation to site: 25%

   (iii)Erection/launching and completion of all other balance works: 35%,

and for PSC girder/slabs payment against sub cost centre 2.3.1 shall be released as per following schedule-

   (i) On casting of PSC girder/slabs: 50%

   (ii) On first stage prestressing: 20%

   (iii) On completion in all respect: 30%

7. *The Cost of Milestones include cost of all temporary works and temporary diversion of roads wherever required, for all bridges included in Schedule 'A' section VII-2, Employer's Requirements.*

8. *The Cost of Milestones include cost of all permanent roads diversion and regrading of roads, wherever required, for all bridges included in Schedule 'A' except for Br. No 150 & 153 which shall be paid under Schedule 'B'.*

5.2.4 Stages of Payment i.e. Milestones of Cost Centre 'CS'- Stations

Cost Centre			**'CS'- Stations**	
Weightage of Cost Centre 'CS', (Y)			**7.0%**	
Sub-Cost Centre	**Item of Work**		**Milestone**	**Weightage (X)**
	No.	**Description**		
1	2	3	4	5
CS.1- Sultanpur Station	**CS.1.1**	**Station building and service buildings**	*Construction of station buildings and S&T huts complete in all respects.*	3.0%
	CS.1.2	**Platform & *Passenger amenities***		
	CS.1.2.1		Dismantling of existing platform and construction of new platform including earthwork in filling above formation level and *cast-in-situ platform face wall* as per the Employer's requirements.	4.0%
	CS.1.2.2		Surfacing of platform, Precast *coping, tactile tiles, fencing at end platform etc.*	2.0%
	CS.1.2.3		PF shelters, Mini PF shelters.	0.9%
	CS.1.2.4		*Passenger amenities*	0.9%
	CS.1.3	**Subway**	*No work of Subway included in Schedule 'A'*	0%
	CS.1.4	**Water Supply System**	*Water supply works including bore well, pump house, underground & overhead water storage tanks, water supply distribution system*	1.2%
	CS.1.5	***Drainage, Sewerage and rainwater harvesting system***	On completion of drainage, s*ewerage and rainwater harvesting system.*	1.0%
	CS.1.6	**Miscellaneous works**	On completion of *station name boards at station building and platform, platform number boards* and other incidental works in station area.	0.7%
	CS.2.1	**Service buildings**		

Cost Centre			'CS'- Stations	
Weightage of Cost Centre 'CS', (Y)			7.0%	
Sub-Cost Centre	Item of Work		Milestone	Weightage (X)
	No.	Description		
1	2	3	4	5
CS.2 New Patli Station	CS.2.1.1		Construction of *S&T service building and S&T huts* complete in all respects.	5.25%
	CS.2.2	**Platform &** *Passenger amenities*		
	CS.2.2.1		Construction of platforms including earthwork in filling above formation level and *cast-in-situ platform face wall* as per the Employer's requirements.	3.0%
	CS.2.2.2		Surfacing of platforms, Precast *coping, tactile tiles, fencing at end platform etc*.	4.0%
	CS.2.2.3		PF shelters, Mini PF shelters.	1.5%
	CS.2.2.4		*Passenger amenities*	1.1%
	CS2.3	**Subway (Bridge No. 144A)**		
	CS2.*3.1*		On completion of barrel of RCC box.	4.2%
	CS2.3.2		On completion of stairs to platforms including shed and lift wells.	1.7%
	CS2.3.3		On completion of subway including flooring, dado, water proofing, drainage complete in all respects.	1.0%
	CS.2.4	**Water Supply System**	On completion of *water supply works including bore well, pump house, underground & overhead water storage tanks, water supply distribution system*	2.0%
	CS.2.5	***Drainage, Sewerage and rainwater harvesting system***	On completion of drainage, s*ewerage and rainwater harvesting system.*	2.5%
	CS.2.6	**Miscellaneous works**	On completion of *station name boards at station building and platforms, platform number boards* and other incidental works in station area.	0.89%
CS.3- Panchgaon Station	**CS.3.1**	**Station building and service buildings**	*No work of Station building and service buildings included in Schedule 'A'*	0%

Cost Centre			'CS'- Stations	
Weightage of Cost Centre 'CS', (Y)			7.0%	
Sub-Cost Centre	Item of Work		Milestone	Weightage (X)
	No.	Description		
1	2	3	4	5
	CS.3.2	**Platform & *Passenger amenities***		
	CS.3.2.1		Construction of platforms including earthwork in filling above formation level and *cast-in-situ platform face wall* as per the Employer's requirements.	2.5%
	CS.3.2.2		Surfacing of platforms, Precast *coping, tactile tiles, fencing at end platform etc.*	3.0%
	CS.3.2.3		PF shelters, Mini PF shelters.	1.20%
	CS.3.2.4		*Passenger amenities*	0.75%
	CS.3.3	**Subway (Bridge No. 113)**		
	CS3.*3.1*		On completion of barrel of RCC box.	2.90%
	CS3.3.2		On completion of covered stairs and ramps to platforms.	2.25%
	CS3.3.3		On completion of subway including flooring, dado, water proofing, drainage complete in all respects.	1.0%
	CS.3.4	**Water Supply System**	On completion of *water supply works including bore well, pump house, underground & overhead water storage tanks, water supply distribution system*	1.0%
	CS.3.5	***Drainage, Sewerage and rainwater harvesting system***	On completion of drainage, s*ewerage and rainwater harvesting system.*	1.40%
	CS.3.6	**Miscellaneous works**	On completion of *station name boards at station building and platforms, platform number boards* and other incidental works in station area.	0.85%
CS.4 Chandla Dungerwas station	**CS.4.1**	**Station building & Service buildings**	*No Work of Station building & Service building in Schedule 'A'.*	0.00%
	CS.4.2	**Platform &** *Passenger amenities*		

Cost Centre			'CS'- Stations	
Weightage of Cost Centre 'CS', (Y)			7.0%	
Sub-Cost Centre	Item of Work		Milestone	Weightage (X)
	No.	Description		
1	2	3	4	5
	CS.4.2.1		Construction of platforms including earthwork in filling above formation level and *cast-in-situ platform face wall* as per the Employer's requirements.	2.5%
	CS.4.2.2		Surfacing of platforms, Precast *coping, tactile tiles, fencing at end platform etc.*	3.0%
	CS.4.2.3		PF shelters, Mini PF shelters.	0.50%
	CS.4.2.4		*Passenger amenities*	0.75%
	CS4.3	**Subway (Bridge No. 104)**		
	CS4.*3.1*		On completion of barrel of RCC box.	2.90%
	CS4.3.2		On completion of covered stairs and ramps to platforms.	2.25%
	CS4.3.3		On completion of subway including flooring, dado, water proofing drainage complete in all respects.	1.0%
	CS.4.4	**Water Supply System**	On completion of *water supply works including bore well, pump house, underground & overhead water storage tanks, water supply distribution system*	1.0%
	CS.4.5	***Drainage, Sewerage and rainwater harvesting system***	On completion of drainage, s*ewerage and rain water harvesting system.*	1.20%
	CS.4.6	**Miscellaneous works**	On completion of *station name boards at station building and platforms, platform number boards* and other incidental works in station area.	0.70%
CS.5 Dhulawat Station	**CS.5.1**	**Station building & Service Buildings**		
	CS.5.1.1		Construction of Station Building *and S&T huts* complete in all respects.	5.25%
	CS.5.2	**Platform &** *Passenger amenities*		

Cost Centre			'CS'- Stations	
Weightage of Cost Centre 'CS', (Y)			7.0%	
Sub-Cost Centre	Item of Work		Milestone	Weightage (X)
	No.	Description		
1	2	3	4	5
	CS.5.2.1		Construction of platforms including earthwork in filling above formation level and *cast-in-situ platform face wall* as per the Employer's requirements.	2.8%
	CS.5.2.2		Surfacing of platforms, Precast *coping, tactile tiles, fencing at end platform etc.*	4.20%
	CS.5.2.3		PF shelters, Mini PF shelters.	1.5%
	CS.5.2.4		*Passenger amenities*	1.0%
	CS5.3	**Subway (Bridge No. 79)**		
	CS5.*3.1*		On completion of barrel of RCC box.	4.2%
	CS5.3.2		On completion of stairs and ramps to platforms including shed.	1.7%
	CS5.3.3		On completion of subway including flooring, dado, water proofing, drainage complete in all respects.	1.0%
	CS.5.4	**Water Supply System**	On completion of *water supply works including bore well, pump house, underground & overhead water storage tanks, water supply distribution system*	1.26%
	CS.5.5	***Drainage, Sewerage and rainwater harvesting system***	On completion of drainage, s*ewerage and rain water harvesting system.*	2.75%
	CS.5.6	**Miscellaneous works**	On completion of *station name boards at station building and platforms, platform number boards* and other incidental works in railway station area.	0.85%
			Total	**100%**

Notes:

1. The value of each Milestones will be total lump sum accepted cost of Works for Schedule 'A' (LS) multiplied by X * Y. For example, the value of Milestone CS1.1–will be equal to LS*X*Y= LSx 0.003 x 0.07
2. Adjustment to Contract Price pursuant to GCC 13.7 shall be applicable to the payments of Works executed under this Sub Head / Price Schedule.

3. Station Building- Unit of measurement is plinth area in square meters. For the buildings having more than one storey, the total area shall be found out by adding the area of each storey. Unit cost shall be determined on pro rata basis with respect to the total area of all stations and service buildings.
   - 50% Payment shall be paid after completion of structural works i.e beam, columns & slab in case of framed structure or walls & slabs in case of other buildings and
   - 30% Payment shall be paid after completion of finishing and
   - 20% Payment on final completion of works in all respects ready for use.

4. Platform- Unit of measurement is *area measured in square meter*. Unit cost shall be determined on pro rata basis with respect to the total area of all *platforms at the* station.

5. Payment will be made on Completion of each Milestones as per weightage given in this schedule.

6. Variation in 'Station *building*':
   In case of variation in the plinth area of any station *and service building* on either side i.e. increase or decrease with respect to the area shown in the Tender Drawings, the total value of station as mentioned in respective Sub-Cost Centres as applicable will get modified accordingly on pro rata basis of *plinth* area.

6 Schedule 'B': Retaining Wall, Bridges & other civil works

Schedule 'B' Retaining Wall, Bridges & other civil works							
S. No	Item No.	Description of Item	Quantity	Unit	USSOR/ DSR Rate in INR	Estimated Rate including GST@18% in INR	Estimated Amount in INR
Schedule B1:- NWR-USSOR 2019 BASED ITEMS (From S. No. 1 to 39)							
Chapter 1-Earthwork							
1	**011010**	Earthwork in cutting (classified) in formation, trolley refuges, side drains, level crossing approaches, platforms, catch water drains, diversion of nallah & finishing to required dimension and slopes to obtain a neat appearance to standard profile inclusive of all labour, machine & materials and removing & leading all cut spoils either to make spoil dumps beyond 10m from cutting edge or for filling in embankment with leads within 2 km on either side of cutting edge, lifts, ascent, descent, loading, unloading, all taxes / royalty, clearance of site and all incidental charges, bailing & pumping out water, if required, etc. complete as per directions of the Engineer-in-Charge. The work is to be executed as per latest / updated edition of "Guidelines for Earthwork in Railway Projects" issued by RDSO, Lucknow. Cut trees shall be property of HRIDC and to be deposited in the Employers' godown unless specified otherwise in the Special Conditions of Contract. {Note - (i) All usable earth arising from cut spoils shall be led into bank formation and Unusable spoils shall be dumped / stacked (ii) All hard rock /and					

Schedule 'B' Retaining Wall, Bridges & other civil works							
S. No	Item No.	Description of Item	Quantity	Unit	USSOR/ DSR Rate in INR	Estimated Rate including GST@18% in INR	Estimated Amount in INR
		boulders not fit for filling will be stacked by the contractor and will be property of HRIDC.}					
1a	**011011**	In all conditions and classifications of soil except rock	10,000	Cum	152.47	**172.32**	**17,23,200.00**
1b	**011012**	Soft rock not requiring blasting in all conditions	500	Cum	347.68	**392.94**	**1,96,470.00**
2	**012040**	Extra for mechanical compaction of soil in embankment with contractor's rollers of suitable capacity, type and size to achieve specified density as per specification, testing as per IS codes including cost of water, T&P, consumable and all labour as a complete job. The work is to be executed as per Latest edition of "Guidelines for Earthwork in Railway Projects" issued by RDSO, Lucknow.	5,000	Cum	17.23	**19.47**	**97,350.00**
3	**013100**	Providing and removing barricading with the help of portable fencing along running track where work is to be done in close vicinity of track. Fencing shall consist of self supporting steel angles of size 50mm x 50mm x 6mm, 1.5m long provided with hooks etc. and embedded in CC 1:2:4 block of size 0.23m x 0.23m x 0.23m placed at c/c distance of 2m along track. 12mm dia rods in three horizontal layers shall be tack welded with angle posts. {Note : Released material will be property of the contractor after completion of work. Cost of cement to be paid separately}					

Schedule 'B' Retaining Wall, Bridges & other civil works							
S. No	Item No.	Description of Item	Quantity	Unit	USSOR/ DSR Rate in INR	Estimated Rate including GST@18% in INR	Estimated Amount in INR
3a	**013101**	With provision of one 50mm wide retro-reflective tape in horizontal direction, duly secured/tight with vertical posts	3,000	Meter	225.23	**254.55**	**7,63,650.00**
3b	**013102**	With provision of painting verticals & horizontals with red luminous paints / strips of 30cm each with a gap of 30 cm	700	Meter	110.43	**124.80**	**87,360.00**
4	**013130**	Shoring with 'Z' section MS sheet piles side by side in all kinds of soil mechanically or manually as per approved drawing with contractor's own arrangement complete in all respects and removal of sheet piles after completion of the work as directed by engineer in-charge. {Note - Payment will be made as per actual driven length of pile}	400	Sqm	868.29	**981.32**	**3,92,528.00**
Chapter 2-Bridge Work Substructure							
5	**022010**	Earthwork in excavation by mechanical means (Hydraulic Excavator)/Manual Means for foundations and floors of the bridges, retaining walls etc. including setting out, dressing of sides, ramming of bottom, getting out the excavated material, back filling in layers with approved material and consolidation of the layers by ramming and watering etc. including all lift, disposal of surplus soil upto a lead of 300m, all types of shoring and strutting with all labour and material complete as per drawing and technical specification as directed by Engineer.					

Schedule 'B' Retaining Wall, Bridges & other civil works							
S. No	Item No.	Description of Item	Quantity	Unit	USSOR/ DSR Rate in INR	Estimated Rate including GST@18% in INR	Estimated Amount in INR
		Note: This item will be used for excavation work in connection with other miscellaneous works also like side drains, foundation for OHE masts and other miscellaneous structures in connection with Gauge Conversion, Doubling, New lines.					
5a	**022011**	All kinds of soils	60,013	Cum	195.57	**221.03**	**1,32, 64,673.39**
6	**022040**	Providing and laying in position machine batched, machine mixed and machine vibrated Design Mix Cement Concrete of specified grade **(M-20** Cast in-Situ) using 20mm graded crushed stone aggregate and coarse sand of approved quality in RCC raft foundation & Pile cap including finishing, using Admixtures in approved proportions (as per IS:9103), to modify workability & other properties without impairing strength and durability complete as per specifications and direction of the Engineer in charge. Payment for cement, reinforcement and shuttering shall be paid extra. **Note-**Cement concrete in levelling coarses, drainage and other miscellaneous works shall be paid under this item.	13,809	Cum	2,840.33	**3,210.06**	**4,43,27,718.54**
7	**022070**	Providing and fixing Weep Holes in Abutments, Wing walls and Return walls etc. of new bridges with 110mm dia UPVC pipe (IS :13592) Type A ISI marked with all contractor's men, material,	20,000	Rmt	242.28	**282.92**	**56,58,400.00**

Schedule 'B' Retaining Wall, Bridges & other civil works							
S. No	Item No.	Description of Item	Quantity	Unit	USSOR/ DSR Rate in INR	Estimated Rate including GST@18% in INR	Estimated Amount in INR
		transportation, all taxes as per specifications and as directed by Engineer-in-Charge.					
8	**022100**	Providing, fabricating and installing permanent casing pipe for bored piles for all diameters with specified thickness of steel plate including all labour, materials, pumping and bailing out water wherever required, complete as per technical specifications as directed by Engineer in charge. This will include the weight of plate only and no cognizance will be given for the fittings, i.e. rivets and welding etc	52	MT	86,647.55	**97,926.63**	**50,92,184.76**
9	**022120**	Conducting load testing of a single pile upto following capacity in accordance with IS:2911 (Part IV) including installation of loading platform and preparation of pile head or construction of test cap and dismantling of test cap after test etc. with all labour, material, tool & plants, equipment, machinery, etc. complete as per drawing and specification, as directed by the Engineer					
9a	**022123**	Initial load test above 100 ton capacity upto 250 ton capacity pile	2	Each	92,300.97	**1,04,315.97**	**2,08,631.94**
9b	**022124**	Extra for every increase of 50 ton in pile capacity or part thereof over 250 ton	52	Each	9,087.94	**10,270.94**	**5,34,088.88**
9c	**022127**	Routine Load Test above 100 ton capacity upto 250 ton capacity pile	8	Each	62,036.82	**70,112.28**	**5,60,898.24**

Schedule 'B' Retaining Wall, Bridges & other civil works							
S. No	Item No.	Description of Item	Quantity	Unit	USSOR/ DSR Rate in INR	Estimated Rate including GST@18% in INR	Estimated Amount in INR
10	**022130**	Lateral load testing of single pile in accordance with "IS Code of practice IS:2911 (Part-IV) for determining safe allowable lateral load of pile" with all labour, material, tool & plants, equipment, machinery, etc complete as per drawing and specification as directed by the Engineer					
10a	**022131**	Piles with lateral load capacity of upto 50 ton	8	Each	23,066.05	**26,068.60**	**2,08,548.80**
11	**022140**	Pulse Echo Test (PET) for integrity testing of piles with contractor's men, materials and machines. The rate includes cost of Inspection of site, preparation of pile head and any other unforeseen cost required for the test, submission of reports in triplicate as per satisfaction of the Engineer in Charge at site.	100	Each	3,291.33	**3,719.77**	**3,71,977.00**
12	**025020**	Providing and applying two coats of coal tar or bitumen confirming to IS:3117– latest version on the top and sides of RCC box/slabs @ 1.70 kg/sqm after cleaning the surface with all labour and materials complete job as directed by the Engineer	38,257	Sqm	155.67	**175.93**	**67,30,554.01**
13	**025030**	centering and shuttering including strutting, propping etc. and removal of form for :					
13a	**025031**	All types of bridge sub-structures, e.g. pier, abutment, wing wall, retaining wall, RCC box type foundations, Abutment cap, Pier Cap, Inspection Platform & Pedestal over Pier cap, Fender wall, Diaphragm wall etc. upto 5m above ground level	1,97,164	Sqm	671.94	**759.41**	**14,97,28,313.20**

Schedule 'B' Retaining Wall, Bridges & other civil works							
S. No	Item No.	Description of Item	Quantity	Unit	USSOR/ DSR Rate in INR	Estimated Rate including GST@18% in INR	Estimated Amount in INR
13b	**025032**	All types of bridge super-structures, e.g. slabs, I-girders, T-girders, Box girders etc. upto 5m above ground level	8,352	Sqm	874.49	**988.32**	**82,54,448.64**
13c	**025033**	Extra for additional height over item no. 025031 & 025032 wherever required with adequate bracing, propping etc. over initial height of 5 metres for every additional height of 1 metre or part thereof	14,020	Sqm	110.17	**124.51**	**17,45,630.20**
14	**025060**	Supply and using Cement at Worksite					
14a	**025062**	Ordinary Portland Cement 53 grade	1,500	MT	7,398.80	**9,019.52**	**1,35,29,280.00**
14b	**025063**	Pozzolana Portland Cement	4,035	MT	6,905.10	**7,657.41**	**3,08,97,649.35**
15	**025070**	Steel reinforcement for R.C.C. work including straightening, cutting, bending, placing in position and binding all complete	-				
15a	**025072**	Thermo-Mechanically Treated bars of grade Fe-500D or more.	75,49,462	Kg	78.01	**87.70**	**66,20,87,817.40**
Chapter 3- Bridge Work Super Structure -RCC							
16	**031020**	Providing and laying in position machine batched, machine mixed and machine vibrated Design Mix Cement Concrete of specified grade using 20mm graded crushed stone aggregate and coarse sand of approved quality for the Precast Prestressed (Post tensioned) concrete girder/Box (spans upto 30.5m) in contactor's casting yard, including finishing, using	37	Cum	2,840.33	**3,210.06**	**1,18,772.22**

Schedule 'B' Retaining Wall, Bridges & other civil works							
S. No	Item No.	Description of Item	Quantity	Unit	USSOR/ DSR Rate in INR	Estimated Rate including GST@18% in INR	Estimated Amount in INR
		Admixtures in approved proportions (as per IS:9103), to modify workability & other properties without impairing strength and durability, complete as per drawings, specifications and direction of the Engineer. Payment for Shuttering, Cement, reinforcement, HTS cables, anchorage cones, stressing of cables and grouting of the ducts will be done extra. Launching of girder/slab in position is not included in this item.					
16a	**031021**	Deduct from 0310220 for casting of Slab in place of Girder/Box	-37	Cum	42.48	**48.01**	**-1,776.37**
17	**031040**	Providing, fabricating & fixing in position to exact design profiles, prestressing H.T.S. cables of all classification made from Low Relaxation strands conforming to IS:14268– latest version in Prestressed (Post tensioned) Concrete girders/slabs etc. including supplying, cutting, making into cables with necessary spacers, colour coding, protecting with water soluble oil at all time, anchoring of cables, supplying and placing spiral corrugated type galvanized metal steel ducts sheathing made up of Cold Rolled Cold Annealed (CRCA) mild steel conforming to IS:513 of required diameter/ thickness, vent pipe, placing, bending, routing, fixing, stressing & grouting of cable ducts with cement grout, Anchorage sets in required number with provision for future prestressing if any	2	MT	1,79,099.63	**2,02,413.39**	**4,04,826.78**

Schedule 'B' Retaining Wall, Bridges & other civil works							
S. No	Item No.	Description of Item	Quantity	Unit	USSOR/ DSR Rate in INR	Estimated Rate including GST@18% in INR	Estimated Amount in INR
		including all lead and lift with contractor's own materials, labour, equipments etc. complete as per drawings & specifications. Rate also includes covering anchorage pads with epoxy mortar of approved quality to avoid corrosion. Cement for grouting to be paid separately. Payment shall be made in terms of weight of HTS cables as per drawing.					
18	**031090**	Design, manufacturing, supplying and fixing in position elastomeric bearing true to line and level conforming to IS:3400, IS:226, BS-5400 under prestressed concrete girders/ Steel Girders, for Precast as well as cast-in-situ girders as per approved drawing. The rate shall include cost of load test of one no. bearing from Railway approved firms and all fixing materials, equipments, machineries, labour, taxes, loading, unloading, leading, lifting etc. complete. Rates include getting the drawing approved from Railway and cost of inspection during manufacturing from railway approved organization. Notes: 1. The rate is for finished item complete and paid only after fixing in position below the girder. 2. The volume shall be given in the drawing and no deduction shall be made for inserted	37,56,245	Cu.Cm.	1.61	**1.82**	**68,36,365.90**

Schedule 'B' Retaining Wall, Bridges & other civil works							
S. No	Item No.	Description of Item	Quantity	Unit	USSOR/ DSR Rate in INR	Estimated Rate including GST@18% in INR	Estimated Amount in INR
19	**031140**	Providing and fixing in position GI Drainage Spouts of required length with Grating in RCC slab and filling bitumen along kerb as shown in drawing with contractor's pipes, bitumen, tools, equipment, lead, lifts etc. complete as per specifications and as directed by Engineer in-charge					
19a	**031142**	100mm dia. Drainage Spouts	882	Meter	1,202.50	**1,359.03**	**11,98,664.46**
Chapter 4- Bridge Work Super Structure -Steel							
20	**041010**	Supplying, fabrication, assembling of all types of steel girders of specified spans with structural steel conforming to Quality "B0" Grade Designation E250 conforming to IS:2062, erection / slewing / end launching of steel girders with cranes or any other approved launching methods as per site conditions (not requiring traffic block) on sub-structure including provision of trolley refuges etc., complete as per approved QAP and drawings conforming to IRS-B1-2001 and other relevant codes and specifications. Note: 1. Detailed fabrication and erection drawings & launching methodology will be prepared by the contractor and got approved from Railway. 2. The item includes fabrication of all types of battens, bracings, ties, stiffeners, packing, diaphragms, shop rivets / welding, T&F bolts, drifts, SAW, templates,					

Schedule 'B' Retaining Wall, Bridges & other civil works							
S. No	Item No.	Description of Item	Quantity	Unit	USSOR/ DSR Rate in INR	Estimated Rate including GST@18% in INR	Estimated Amount in INR
		jigs, fixtures, accessories, transporting various components from fabrication shop to site including loading & unloading, assembly of girders with drifts/bolts, field riveting /welding /HSFG Bolting, assembling of temporary support for side slewing, raising of girders to the bed block level, providing sliding arrangements and slewing the girder in position, lowering of girder on bearings and bed plates with all temporary arrangements or any other method of launching complete. 3. The bearing sets to be provided with the girders will be paid separately as per relevant item. 4. Payment for addition in weight for rivets / welds shall be made as per clause 45 of IRS B-1-2001. 5. In case of composite work (welding and HSFG bolts), addition in weight shall be 1% for					
20a	**041013**	Open Web Girder above 45.7m clear Span	1,593	MT	1,68,004.82	**1,89,874.34**	**30,24,69,823.62**

Schedule 'B' Retaining Wall, Bridges & other civil works							
S. No	Item No.	Description of Item	Quantity	Unit	USSOR/ DSR Rate in INR	Estimated Rate including GST@18% in INR	Estimated Amount in INR
21	**041020**	Supplying, fabrication, assembling of all types of steel Composite girders of specified spans with structural steel conforming to Quality "B0" Grade Designation E250 conforming to IS:2062, erection / slewing / end launching of steel girders with cranes or any other approved launching methods as per site conditions on sub-structure including provision of stud bolts / shear connectors, complete as per approved QAP and drawings conforming to IRS-B1-2001 and other relevant codes and specifications. Note:1. Detailed fabrication and erection drawings & launching methodology will be prepared by thecontractor and got approved from Railway. 2. Rate includes fabrication of all types of battens, bracings, ties, stiffeners, packing, diaphragms, shop rivets / welding, T&F bolts, drifts, SAW, templates, jigs, fixtures, accessories, transporting various components from fabrication shop to site including loading & unloading, assembly of girders with drifts/bolts, field riveting /welding /HSFG Bolting, assembling of temporary supportfor side slewing, raising of girders to the bed block level, providing sliding arrangements and slewing the girder in position, lowering of girder on bearings and bed plates with all temporary arrangements or any other method of launching complete. 3. The bearing sets to be provided with the					

Schedule 'B' Retaining Wall, Bridges & other civil works							
S. No	Item No.	Description of Item	Quantity	Unit	USSOR/ DSR Rate in INR	Estimated Rate including GST@18% in INR	Estimated Amount in INR
		girders will be paid separately as per relevant item. 4. Payment for addition in weight for rivets / welds shall be made as per clause 45 of IRS B-1- 2001. 5. In case of composite work (welding and HSFG bolts), addition in weight shall be 1% for					
21a	**041021**	Composite steel girder of span length up to 36.0m	1,364	MT	1,23,733.20	**1,39,839.80**	**19,07,41,487.20**
22	**041030**	Supplying and fixing HSFG bolts of any dia and any length with suitable nuts including DTI washers conforming to IRS-B1-2001 for bridges and steel structures with contractors labour, tools and plants and lead and lift etc., complete.	62,106	Kg	305.32	**345.06**	**2,14,30,296.36**
23	**041050**	Metalizing of steel work of girders with sprayed aluminium after surface preparation by Sand/grit blasting, followed by one coat of etch primer (IS:5666) & one coat of Zinc Chrome primer (IS:104)and two coats of aluminium paint (IS:2339) with all labour, T&P and material as a complete job duly conforming to all relevant specifications and process given under Clause 39 of IRS-B1-2001 Note: Nominal Thickness of Aluminium coating shall be 150 microns. DFT of Zinc chrome primer shall be	27,931	Sqm	905.47	**1,023.34**	**2,85,82,909.54**

Schedule 'B' Retaining Wall, Bridges & other civil works							
S. No	Item No.	Description of Item	Quantity	Unit	USSOR/ DSR Rate in INR	Estimated Rate including GST@18% in INR	Estimated Amount in INR
		25-30 microns and DFT of each coat of Aluminium paint shall be 12-14 microns.					
24	**041060**	Providing and fixing railing used in rows for footpath or anti-crash barrier railing with B class G.I. pipe 65/50 mm nominal dia including cost of M.S. angle and channels in vertical posts, welding / bolting, priming painting with one coat ready mix Zinc Chromate conforming to IS:104 with DFT of 25-30Microns, followed by one coat of Zinc Chrome red oxide conforming to IS:2074 with DFT of 25 Microns with all material, labour, T&P as a complete job.	40,090	Kg	96.09	**108.60**	**43,53,774.00**
25	**041080**	Providing and fixing various size HTS holding down bolts conforming to IS:1364 in concrete column or in other structures with proper nuts, bolts, washers/plates, grouting of holes with all material, labour, T&P as a complete job. Note: Cement used in grouting will be paid separately under relevant item.	334	Kg	149.66	**169.14**	**56,492.76**

Schedule 'B' Retaining Wall, Bridges & other civil works							
S. No	Item No.	Description of Item	Quantity	Unit	USSOR/ DSR Rate in INR	Estimated Rate including GST@18% in INR	Estimated Amount in INR
26	**041180**	Design, supply and fixing 300MT capacity Spherical Bearing in position true to line and level consisting of set of concave and convex mating steel backing plate with a low friction sliding interface, flat sliding elements ,guides and restraining rings; with all components conforming to approved drawing and technical specifications & Bridge Code including grouting of holes for anchor bolts and underside of baseplate with approved non-shrink epoxy grout with all material, labour, T&P as a complete job. Note: Sliding surface with PTFE or UHMWPE low friction thermoplastic material and steel for backing plate of Mild steel in accordance to IS:2062 grade-B. Cast steel in accordance with IS 1030 Grade 280-520W. Stain less steel in accordance with AISI 304/316.Low friction thermo -plastic sliding PTFE material either pure polytetrafluroethalyne (PTFE) Or Ultra High Molecular weight Polythylene (UHMWPE). Austanitic steel is of stainless steel for the sliding interface shall be in accordance with AISI 316L or O2 Cr17 NI12 of IS-6911. The thickness of the stain less steel sheet shall be 3mm minimum. The stainless steel sheet shall be attached to its backing plate either by screwing/riveting or by continuous fillet weld. Hard chromium plated surface shall be entire curved surface of the convex steel plate mating					

Schedule 'B' Retaining Wall, Bridges & other civil works							
S. No	Item No.	Description of Item	Quantity	Unit	USSOR/ DSR Rate in INR	Estimated Rate including GST@18% in INR	Estimated Amount in INR
		with hard chromium plated concave sliding surface. The thickness of the hard chromium plating shall be at least 100 microns and the final surface roughness of the plated surface shall not exceed 3 microns. Bearing manufacturer shall give the guarantee for satisfactory performance of bearing for period specified					
26a	**041181**	Spherical Fixed Bearing	4	Each	1,16,994.18	**1,32,223.55**	**5,28,894.20**
26b	**041182**	Spherical Free Float Bearing	4	Each	1,27,739.32	**1,44,367.40**	**5,77,469.60**
26c	**041183**	Spherical Slide Guide (L) Bearing	4	Each	1,28,212.55	**1,44,902.23**	**5,79,608.92**
26d	**041184**	Spherical Slide Guide (T) Bearing	4	Each	1,27,962.01	**1,44,619.08**	**5,78,476.32**
27	**041240**	Surface preparation for painting of bridge plate/composite girders and other steel structures where the finishing coat shows signs of deterioration; but primer coat of paint is sufficiently in good condition and there are no signs of rusting etc. Surface shall be cleaned free from oil grease, scaling and other foreign matters without disturbing the primer coat {Rate includes cost of labour, consumables, tools & plants, scaffolding, jhoola, ladder etc.}	5,000	Sqm	25.53	**28.85**	**1,44,250.00**

Schedule 'B' Retaining Wall, Bridges & other civil works							
S. No	Item No.	Description of Item	Quantity	Unit	USSOR/ DSR Rate in INR	Estimated Rate including GST@18% in INR	Estimated Amount in INR
28	**041260**	Painting cleaned bridge plate/composite girders including all scaffolding, shuttering and strutting along with provision of Jhoola/hanging scaffolding ladders etc. where required					
28a	**041261**	With one coat ready mix Zinc Chromate conforming to IS:104 with DFT of 25-30 Microns followed by one coat of Zinc Chromate red oxide conforming to IS:2074 DFT of 25 Microns	5,000	Sqm	96.30	**108.84**	**5,44,200.00**
29	**041330**	Launching & fixing in specified Bridge location all types of Steel Plate girders / PSC girders / Slabs including loading/unloading and transport to the site of launching with a lead of five kilometres & lifting to any height as per site requirement, provision of approaches for leading, cleaning of bed block and minor repairs to bed block with epoxy if required, as directed by Engineer in charge with all labour, tools and plant, equipment etc., complete					
29a	**041331**	PSC girders / slabs	94	MT	6,346.14	**7,172.23**	**6,74,189.62**
30	**041390**	Supplying fabricating and erecting welded and/or bolted and/or riveted steel work in built up sections, trusses and framed work, staging, racks etc. for Steel Structures other than bridge girders, using RSJ, tees, angles and channels/flats, plates, gussets, round or square bars, cleats, bolts etc., with contractors own steel including cutting, bending, straightening,	475	MT	86,019.71	**97,217.07**	**4,61,78,108.25**

Schedule 'B' Retaining Wall, Bridges & other civil works							
S. No	Item No.	Description of Item	Quantity	Unit	USSOR/ DSR Rate in INR	Estimated Rate including GST@18% in INR	Estimated Amount in INR
		drilling, riveting, hoisting, fixing, erecting, welding, bolting etc., with Providing stiffeners wherever required as per approved drawing including applying a priming coat of a approved steel primer with all contractor's materials, labour, tools & plants, lead & lift including crossing of tracks if required etc., complete as per specification and as directed by Engineer-in-charge.					
Chapter 5- Bridge Works- Misc.							
31	**051120**	Stenciling of Girders with black / blue lettering over yellow background with ready mix paint w.r.t. details of executed inspection, greasing and painting, other details as directed by Engineer in charge	3,550	Each	41.09	**46.44**	**1,64,862.00**
32	**051170**	Providing and laying of filter media consisting of granular materials of GW, GP, SW groups as per IS:1498 (latest) in required profile behind boulder filling of abutments, wing walls / return walls etc. above bed level with all labour and material complete job as per drawing and technical specification of RDSO Guidelines.	1,25,900	Cum	2,658.72	**2,190.33**	**27,57,62,547.00**
33	**052220**	Painting the HFL mark and Danger level mark, year of HFL on bridge abutments and piers with ready mixed paint as per standard in two coats over one coat of primer with all materials, labour, tools, scaffolding, all lead and lift etc. including writing complete	3,550	Each	283.91	**320.87**	**11,39,088.50**

Schedule 'B' Retaining Wall, Bridges & other civil works							
S. No	Item No.	Description of Item	Quantity	Unit	USSOR/ DSR Rate in INR	Estimated Rate including GST@18% in INR	Estimated Amount in INR
34	**052230**	Providing cast in situ bridge number plaques as per Railway drawing in cement concrete 1:2:4 mix using 20mm hard stone aggregate embedded in 30mm notch in Bridge parapet coping duly engraving the letter and figures and an arrow indicating the direction of flow and finishing the top exposed surface with cement mortar 1:3, painting letters and figures with two coats of black enamel paint on two coats of white background with all labour, tools, cement, paint etc. with all leads and lifts.	6	Each	801.69	**906.05**	**5,436.30**
35	**052240**	Providing cast in-situ plaques for bridge foundations details of size 45cmx45cmx5cm in cement concrete 1:2:4 mix using 20mm hard stone aggregate embedded in 30mm deep notch over abutment & piers, engraving the letters & figures with CM 1:3 and finished smooth including painting letters and figures with 2 coats of black enamel and plaque with white enamel with all labour, tools, cement, paint, curing etc. as a complete job.	21	Each	1,049.88	**1,186.54**	**24,917.34**
36	**052250**	Providing & laying non pressure NP-4 Class RCC pipe with collars, jointing with 1:2 cement and ordinary sand mortar including testing of joints, but excluding earthwork with all labour and material as a complete job. Cement for mortar will be paid separately. (Pipes of 600mm dia and above will be laid using crane/hydra).					

Schedule 'B' Retaining Wall, Bridges & other civil works							
S. No	Item No.	Description of Item	Quantity	Unit	USSOR/ DSR Rate in INR	Estimated Rate including GST@18% in INR	Estimated Amount in INR
36a	**052252**	450mm dia.	282	Meter	2,609.92	**2,949.66**	**8,31,804.12**
37	**052260**	Supplying, spreading and filling coarse sand (no cohesive materials to be used) of approved quality including watering and ramming in foundation, plinth, behind the abutment, wing wall, retaining wall in layers not exceeding 150mm thick including its compaction as per direction of Engineer-incharge. The rate includes all lead, lift, ascent, descent, crossing of Railway line etc. complete with contractor's labour, materials, tools and plant.	2,921	Cum	2,194.63	**2,480.31**	**72,44,985.51**
Chapter 19- Bridge Related Activities							
38	**191260**	Supplying & fixing MS chequered plates 6 to 8mm thick between guard rails on unballasted deck bridge for gang pathway, overlapping at regular intervals of 2m to 2.5m with rail screws or bolts duly drilling holes in chequered plate, as directed [Note : Overlapping of chequered plates shall not fall in between sleepers]	26,000	Kg	80.87	**91.69**	**23,83,940.00**
39	**191310**	Fabrication, supplying and fixing 600mm x 450mm Bridge Board made from 16 SWG MS Sheet duly welded or rivited to back support of two 600mm long horizontal angles of size 25mm x 25mm x 3mm & two 2.5 metre long vertical support of MS Angle of size 50mm x 50mm x 5mm, welded /rivited to board. Vertical supports shall have split ends for proper	12	Each	2,571.26	**2,905.97**	**34,871.64**

Schedule 'B' Retaining Wall, Bridges & other civil works							
S. No	Item No.	Description of Item	Quantity	Unit	USSOR/ DSR Rate in INR	Estimated Rate including GST@18% in INR	Estimated Amount in INR
		fixing in ground. Vertical supports of board shall be embedded in ground in M 20 Cement Concrete blocks of size 300mm x300mm x 300mm, complete job including painting & writing of subject matter on bridge board, as directed by Engineer – In charge {Note : Excavation & concrete work will be paid separately}					
Schedule B2:- USSOR 2010 BASED ITEMS(For Building Works)- (From S. No. 40 to 124)							
Chapter -1 : Earth Work							
40	**012050**	Supplying and filling sand in plinth and under floors including watering, ramming, consolidating and dressing complete	45	cum	725.00	**1,158.13**	**52,115.85**
Chapter -2: Carriage of materials							
41	**021150**	Leading miscellaneous materials such as iron work, rails, fittings & fastenings, pipes, wooden logs, stones over pitching stone size, RCC/PCC beams/slabs etc. and all similar articles (each individual article or bundle being not more than 3.5m long in the longest direction) including all loading, unloading and stacking, lead over 500m and upto 10 km. Note: Lead under this item is payable when the same exceeds 500m.	80	MT	177.74	**271.85**	**21,748.00**
41a	**021151**	Additional lead for every subsequent km or part thereof, over 10 km and upto 100 km over item no. 021150	400	MT/Km	8.02	**12.27**	**4,908.00**

Schedule 'B' Retaining Wall, Bridges & other civil works							
S. No	Item No.	Description of Item	Quantity	Unit	USSOR/ DSR Rate in INR	Estimated Rate including GST@18% in INR	Estimated Amount in INR
Chapter -3: Plain Concrete except item no. 033060 to 033064							
42	**031010**	Providing and laying in position cement concrete of specified proportion excluding cost of cement, centering and shuttering - All works upto Plinth level :					
42a	**031012**	1:3:6 (1 cement : 3 sand : 6 graded stone aggregate 40mm nominal size)	425	Cum	1,882.49	**4,203.39**	**17,86,440.75**
43	**031060**	Centering and shuttering including strutting, propping etc. and removal of form work for :					
43a	**031061**	Foundations, footings, bases of columns	46	Sqm	121.03	**270.25**	**12,431.50**
43b	**031063**	Columns, pillars, posts and struts & miscellaneous parts	40	Sqm	240.45	**536.90**	**21,476.00**
44	**032050**	Providing and laying cement concrete 1:2:4 in damp-proof course (1 cement : 2 sand : 4 graded stone aggregate 12.5mm nominal size - excluding the cost of cement and including providing, fixing and removal of forms:.					
44a	**032053**	50mm thick (20 mm coarse aggregate instead of 12.5mm)	16	Sqm	155.36	**346.90**	**5,550.40**
Chapter -4 : Reinforced cement concrete (except item no. 045016)							

Schedule 'B' Retaining Wall, Bridges & other civil works							
S. No	Item No.	Description of Item	Quantity	Unit	USSOR/ DSR Rate in INR	Estimated Rate including GST@18% in INR	Estimated Amount in INR
45	**041010**	Providing and laying in position M-20 Grade concrete for reinforced concrete structural elements, but excluding cost of centering, shuttering, reinforcement and Admixtures in recommended proportion (as per IS:9103) to accelerate, retard setting of concrete, improve workability without impairing strength and durability as per direction of Engineer in charge					
45a	**041011**	All work upto plinth level, including raft foundation of washable aprons, HS tank, pile cap, footings of FOB, and Platform shelter etc.	338	cum	2,422.38	**5,263.83**	**17,79,174.54**
45b	**041012**	All work in buildings above plinth level upto floor two level.	447	cum	2,645.23	**5,748.08**	**25,69,391.76**
46	**042010**	Centering and shuttering including strutting, propping etc. and removal of form for :					
46a	**042013**	Suspended floors, roofs, landings, balconies, FOB slabs, walkway slabs and access platform	838	Sqm	185.57	**403.24**	**3,37,915.12**
46b	**042014**	Lintels, beams, plinth beams, bed blocks, girders, bressumers and cantilevers	28	Sqm	163.20	**354.63**	**9,929.64**
46c	**042015**	Columns, pillars, posts and struts	1,012	Sqm	240.50	**522.61**	**5,28,881.32**
47	**042020**	Centering and shuttering including strutting, propping etc. and removal of form for special shapes					
47a	**042029**	Weather shade, Chajjas, corbels etc. including edges	40	Sqm	331.42	**720.18**	**28,807.20**

Schedule 'B' Retaining Wall, Bridges & other civil works							
S. No	Item No.	Description of Item	Quantity	Unit	USSOR/ DSR Rate in INR	Estimated Rate including GST@18% in INR	Estimated Amount in INR
48	**042030**	Extra for additional height in centering, shuttering wherever required with adequate bracing, propping etc. including cost of de-shuttering and de-centering at all levels, over a height of 3.5m for every additional height of 1 metre or part thereof in suspended floors, roofs, landing, beams and balconies (plan area to be measured)	13,263	Sqm	74.40	**161.67**	**21,44,229.21**
49	**046010**	Extra for RCC work in superstructure above floor two level for every floor or part thereof	452	cum	280.18	**608.83**	**2,75,191.16**
50	**048100**	Keeping holes for holding down bolts in foundation blocks or bed blocks	100	Each	32.89	**71.47**	**7,147.00**
51	**048110**	Grouting of holding down bolts with cement mortar in foundation blocks or bed blocks	100	Each	31.69	**68.86**	**6,886.00**
Chapter -5 : Brick Work							
52	**051010**	Brick work with non-modular (FPS) bricks of class designation 7.5 in foundation and plinth in :					
52a	**051018**	Cement Mortar 1:6 (1cement : 6 coarse sand)	683	cum	2,218.87	**4,469.74**	**30,52,832.42**
53	**051040**	Extra over items 051010 & 051020 for brick work in superstructure beyond plinth level upto floor two level.	112	Cum	133.42	**268.76**	**30,101.12**
54	**051050**	Extra for brick work in superstructure beyond second floor level for every 3m or part thereof :	283	cum	264.82	**533.46**	**1,50,969.18**
Chapter -7 : Wood Work							

Schedule 'B' Retaining Wall, Bridges & other civil works							
S. No	Item No.	Description of Item	Quantity	Unit	USSOR/ DSR Rate in INR	Estimated Rate including GST@18% in INR	Estimated Amount in INR
55	**071010**	Providing wood work in frames of doors, windows, clerestory windows and other frames and trusses, wrought, framed and fixed in position:					
55a	**071013**	Hollock wood or locally available comparable species of country wood (to be listed by respective railway) - Kiln seasoned & chemically treated	3,727	Cudm	44.47	**72.99**	**2,72,033.73**
56	**072020**	Providing and fixing panelling/glazing or panelling & glazing in panelled/glazed or panelled & glazed shutters for doors, windows & clerestory windows (area of opening for panel inserts excluding portion inside grooves or rebates to be measured). Panelling/glazing for panelled/glazed or panelled & glazed shutters 25mm to 40mm thick					
56a	**072022**	Hollock wood or locally available comparable species of country wood (to be listed by respective railway). - Kiln seasoned & chemically treated - 15mm thick	124	Sqm	750.56	**1,231.98**	**1,52,765.52**
57	**072030**	Providing and fixing paneling and/or glazing in panelled and/or glazed shutters for doors, windows and clerestory windows (area of opening for panel inserts excluding portion inside grooves or rebates to be measured). Panelling/glazing for panelled/ glazed or panelled and glazed shutters 25mm to 40mm thick :					
57a	**072037**	Glazing with float glass panes 4mm thick (10kg/sqm)	40	Sqm	260.07	**426.88**	**17,075.20**

Schedule 'B' Retaining Wall, Bridges & other civil works							
S. No	Item No.	Description of Item	Quantity	Unit	USSOR/ DSR Rate in INR	Estimated Rate including GST@18% in INR	Estimated Amount in INR
58	**074230**	Providing and fixing M.S. grills of required pattern in frames of windows etc. with M.S. flats, square or round bars etc. all complete					
58a	**074232**	Fixed to opening / wooden frames with rawl plugs screws etc.	600	Kg	66.17	**108.61**	**65,166.00**
59	**074280**	Providing 40mmx5mm flat iron hold fast 40cm long including fixing to frame with 10mm diameter bolts, nuts and wooden plugs and embeddings in cement concrete block 30cmx10cmx15cm 1:3:6 mix (1 cement : 3 coarse sand : 6 graded stone aggregate-20mm nominal size)	90	Each	58.54	**96.09**	**8,648.10**
60	**076010**	Providing and fixing ISI:12817 marked stainless steel butt hinges with stainless steel screws etc. complete of size :					
60a	**076012**	100mmx58mmx1.9mm	80	Each	46.06	**75.60**	**6,048.00**
60b	**076013**	75mmx47mmx1.8mm	68	Each	25.63	**42.07**	**2,860.76**
61	**077090**	Providing and fixing bright finished brass 100mm mortice latch and lock with 6 levers and a pair of lever handles with necessary screws etc. complete (best make of approved quality)	101	Each	560.08	**919.32**	**92,851.32**
62	**077140**	Providing and fixing bright finished brass hanging type floor door stopper with necessary screws etc. complete	26	Each	69.75	**114.49**	**2,976.74**

Schedule 'B' Retaining Wall, Bridges & other civil works							
S. No	Item No.	Description of Item	Quantity	Unit	USSOR/ DSR Rate in INR	Estimated Rate including GST@18% in INR	Estimated Amount in INR
63	**077180**	Providing and fixing IS:3564 marked aluminium die cast body tubular type universal hydraulic door closer, hardwyn make (Classic Queen) or equivalent with necessary accessories and screws etc. complete	26	Each	669.45	**1,098.84**	**28,569.84**
64	**078020**	Providing and fixing aluminium sliding door bolts ISI marked anodised (anodic coating not less than grade AC 10 as per IS:1868) transparent or dyed to required colour or shade with nuts and screws etc. complete :					
64a	**078021**	300mmx16mm	34	Each	178.83	**293.53**	**9,980.02**
65	**078030**	Providing and fixing aluminium tower bolts ISI marked anodised (anodic coating not less than grade AC 10 as per IS:1868) transparent or dyed to required colour or shade with necessary screws etc. complete :					
65a	**078033**	200mmx10mm	34	Each	48.55	**79.69**	**2,709.46**
65b	**078035**	100mmx10mm	33	Each	29.60	**48.59**	**1,603.47**
66	**078060**	Providing and fixing aluminium handles ISI marked anodised (anodic coating not less than grade AC 10 as per IS:1868) transparent or dyed to required colour or shade with necessary screws etc. complete :					
66a	**078061**	125mm	58	Each	38.04	**62.44**	**3,621.52**
66b	**078062**	100mm	58	Each	33.96	**55.74**	**3,232.92**

Schedule 'B' Retaining Wall, Bridges & other civil works							
S. No	Item No.	Description of Item	Quantity	Unit	USSOR/ DSR Rate in INR	Estimated Rate including GST@18% in INR	Estimated Amount in INR
66c	**078063**	75mm	38	Each	30.14	**49.47**	**1,879.86**
Chapter -8 : Steel and Aluminium Work							
67	**081420**	Providing and fixing hand rail by welding etc. to steel ladders railing, balcony railing and staircase railing including applying a priming coat of approved steel primer					
67a	**081423**	G.I. pipes 40mm nominal bore (class B)	288	Kg	107.57	**178.55**	**51,422.40**
68	**082010**	Providing and fixing anodised aluminium work for doors, windows, ventilators and partitions with extruded built-up standard tubular and other sections of approved make conforming to IS:733 and IS:1285, anodised transparent or dyed to required shade according to IS:1868 (Minimum anodic coating of grade AC 15), fixed with rawl plugs and screws or with fixing clips, or with expansion hold fasteners including necessary filling up of gaps at junctions, at top, bottom and sides with required PVC/neoprene felt etc. Aluminium sections shall be smooth, rust free, straight, mitred and jointed mechanically wherever required including cleat angle. Aluminium snap beading for glazing/panelling, C.P. brass/stainless steel screws, all complete as per architectural drawings and directions of Engineer-in-charge. (Glazing & panelling to be paid for separately)					

Schedule 'B' Retaining Wall, Bridges & other civil works							
S. No	Item No.	Description of Item	Quantity	Unit	USSOR/ DSR Rate in INR	Estimated Rate including GST@18% in INR	Estimated Amount in INR
68a	**082011**	for Fixed portion	80	Kg	305.87	**507.70**	**40,616.00**
68b	**082012**	For openable/sliding portions and fixing hinges / pivots, PVC/neoprene gasket required and making provision for fixing of fittings. (Fittings shall be paid for separately)	80	Kg	317.67	**527.29**	**42,183.20**
Chapter -9 : Flooring, Paving & Dado							
69	**092010**	Cement concrete flooring 1:2:4 (1 cement : 2 coarse sand : 4 graded stone aggregate) finished with a floating coat of neat cement including cement slurry, but excluding the cost of nosing of steps etc. complete :					
69a	**092012**	40mm thick with 20mm nominal size stone aggregate	141	Sqm	120.99	**196.77**	**27,744.57**
70	**094070**	Providing and fixing 10mm thick heavy duty acid and/or alkali resistant factory made tiles conforming to Group V-RD series of approved make and colour using acid and/or alkali resisting mortar bedding and joints filled with acid and/or alkali resisting cement as per IS:4457 complete including cost of acid/alkali resistant cement					
70a	**094071**	In flooring on a bed of 10mm thick mortar 1:4 (1 appropriate cement : 4 coarse sand)	10	Sqm	1,252.14	**2,036.43**	**20,364.30**

Schedule 'B' Retaining Wall, Bridges & other civil works							
S. No	Item No.	Description of Item	Quantity	Unit	USSOR/ DSR Rate in INR	Estimated Rate including GST@18% in INR	Estimated Amount in INR
71	**095010**	Providing and fixing Ist quality ceramic tiles conforming to Group B-III (Ceramic Wall Tiles) of IS:15622 of manufacturers approved by railway in all colours, shades, and design as approved by the Engineer-in-Charge in skirting, risers of steps and dado over 12mm thick bed of cement mortar 1:3 (1 cement : 3 coarse sand) including pointing in white cement mixed with pigment of matching shade complete					
71a	**095011**	200x200 mm	175	Sqm	498.16	**810.19**	**1,41,783.25**
72	**095020**	Providing and fixing ceramic tiles conforming to IS:15622 of manufacturers approved by railway in all colours, shades, design and abrasion resistance class as approved by the Engineer-in-Charge in floors and landings over 20mm thick bed of cement mortar 1:4 (1 cement : 3 coarse sand) including pointing in white cement mixed with pigment of matching shade complete					
72a	**095024**	Providing and fixing ceramic tiles conforming to IS:15622 of manufacturers approved by railway in all colours, shades, design and abrasion resistance class as approved by the Engineer-in-Charge in floors and landings over 20mm thick bed of cement mortar 1:3 (1cement: 3coarse sand) including pointing in white cement mixed with pigment ofmatching shade	60	Sqm	754.29	**1,226.75**	**73,605.00**

Schedule 'B' Retaining Wall, Bridges & other civil works							
S. No	Item No.	Description of Item	Quantity	Unit	USSOR/ DSR Rate in INR	Estimated Rate including GST@18% in INR	Estimated Amount in INR
		complete: Of Group B-I-b of IS : 15622 (Ceramic Tiles) of size above 400x400mm					
72b	**095026**	Providing and fixing ceramic tiles conforming to IS:15622 of manufacturers approved by railway in all colours, shades, design and abrasion resistance class as approved by the Engineer-in-Charge in floors and landings over 20mm thick bed of cement mortar 1:3 (1cement: 3coarse sand) including pointing in white cement mixed with pigment of matching shade complete: Of Group B-I-a of IS : 15622 (Vitrified tiles) of size above 400x400mm upto 600x600 mm	487	Sqm	932.87	**1,517.18**	**7,38,866.66**
73	**096070**	40mm thick Kota stone slab flooring of size up to 60x60cm over 20mm (average) thick base of 1:4 cement mortar (1cement: 4coarse sand) and jointed with grey cement slurry mixed with pigment to match the shade of the slab including rubbing and polishing complete :					
73a	**096074**	40mm thick	174	Sqm	1,499.02	**2,437.94**	**4,24,201.56**
74	**096080**	Kota stone slabs 25mm thick in risers of steps, skirting, dado and pillars laid on 12mm (average) thick cement mortar 1:3 (1cement: 3coarse sand) and jointed with grey cement slurry mixed with pigment	166	Sqm	655.12	**1,065.46**	**1,76,866.36**

Schedule 'B' Retaining Wall, Bridges & other civil works							
S. No	Item No.	Description of Item	Quantity	Unit	USSOR/ DSR Rate in INR	Estimated Rate including GST@18% in INR	Estimated Amount in INR
		to match the shade of the slab, including rubbing and polishing complete					
75	**099080**	Polished stone tile work for wall lining (dado) over 12mm thick bed of cement mortar 1:3 including pointing in white cement with an admixture of pigment to match the stone shade with tiles of all size upto 300mm x 300mm					
75a	**099082**	8mm thick superior quality black granite tiles	188	Sqm	1,351.62	**2,198.22**	**4,13,265.36**
76	**099210**	Providing and fixing 10mm (± 0.2mm) thick heavy duty, full-body homogeneous, anti-algal, all weather resistant, exterior use Paving vitrified tiles of size upto 400mmx400mm in approved shade, colour & quality, having anti-skid matt finish surface with plain or projected texture. Tiles to be laid on 20mm average thick cement mortar bed of 1:4 (1 cement : 4 coarse sand) with all labour, material complete job	677	Sqm	670.49	**1,090.46**	**7,38,241.42**
Chapter -10 : Roof and Ceilings							
77	**106100**	Providing and fixing at all height false ceiling of 12.5mm thick tapered edge gypsum board conforming to IS:2095-Part I, including providing and fixing of frame work made of special sections power pressed from M.S. sheet and galvanised with zinc coating of grade 350 as per IS:277 and consisting of angle cleats of size 25mm x 1.6mm with flanges of 22mm and	295	Sqm	561.22	**916.49**	**2,70,364.55**

Schedule 'B' Retaining Wall, Bridges & other civil works							
S. No	Item No.	Description of Item	Quantity	Unit	USSOR/ DSR Rate in INR	Estimated Rate including GST@18% in INR	Estimated Amount in INR
		37mm at 1200mm centre to centre one flange fixed to the ceiling with stener 12.5mm dia x 40mm long with 6mm dia bolts to the angle hangers of 25mmx25mmx0.55mm of required length and other end of angle hanger being fixed with nut and bolts to G.I. channels 45mmx15mmx0.9mm running at the rate of 1200mm centre to centre to which the ceiling section 0.5mm thick bottom wedge of 80mm with tapered flanges of 26mm each having clips of 10.5mm at 450mm centre to centre shall be fixed in a direction perpendicular to G.I. channel with connecting clips made out of 2.64mm dia x 230mm long G.I. wire at every junction including fixing the gypsum board with ceiling section and perimeter channels 0.5mm thick 27mm high having flanges of 20mm and 30mm long, the perimeter of ceiling fixed to wall/partition with the help of rawl plugs at 450mm centre to centre with 25mm long drive-all screws @ 230mm interval including jointing and fixing to a flush finish of tapered and square edges of the gypsum board with recommended filler, paper tapes, finisher and two coats of primer suitable for gypsum board as per manufacturers specification and also including the cost of making openings for light fittings, grills, diffusers, cutouts made with frame of perimeter channels suitably fixed all complete as per drawing					

Schedule 'B' Retaining Wall, Bridges & other civil works							
S. No	Item No.	Description of Item	Quantity	Unit	USSOR/ DSR Rate in INR	Estimated Rate including GST@18% in INR	Estimated Amount in INR
		and specification and direction of the Engineer-in-Charge but excluding the cost of painting.					
78	**106110**	Providing 10mm thick Plaster of Paris (gypsum anhydrous) ceiling upto a height of 5m above floor level over 1st class kail or similar wood strips 25mmx6mm with 10mm gap in between and reinforced with rabbit wire mesh fixed to wooden frame (frame work to be paid separately)					
78a	**106111**	Flat surfaces	490	Sqm	562.62	**918.78**	**4,50,202.20**
79	**108190**	Providing and fixing unplasticised-PVC pipe clips of approved design to unplasticised-PVC rain water pipes by means of 50mmx50mmx50mm hard wood plugs, screwed with M.S. screws of required length including cutting brick work and fixing in cement mortar 1:4 (1 cement : 4 coarse sand) and making good the wall etc. complete					
79a	**108192**	110mm	6	Each	164.34	**268.37**	**1,610.22**
80	**108200**	Providing and fixing to the inlet mouth of rainwater pipe cast iron grating 15cm dia and weighing not less than 440 grams	6	Each	120.98	**197.56**	**1,185.36**
Chapter -11 : Finishing Masonary							

Schedule 'B' Retaining Wall, Bridges & other civil works							
S. No	Item No.	Description of Item	Quantity	Unit	USSOR/ DSR Rate in INR	Estimated Rate including GST@18% in INR	Estimated Amount in INR
81	**111040**	12 mm cement plaster of mix -					
81a	**111042**	1:6 (1 cement : 6 coarse sand)	833	Sqm	61.86	**108.04**	**89,997.32**
82	**111070**	12mm cement plaster finished with a floating coat of neat cement of mix -					
82a	**111072**	1:4 (1 cement : 4 fine sand)	11	Sqm	68.05	**118.85**	**1,307.35**
83	**111120**	18mm cement plaster in two coats under layer 12mm thick cement plaster 1:5 (1 cement : 5 coarse sand) and a top layer 6mm thick cement plaster 1:3 (1 cement : 3 coarse sand) finished rough with sponge/rubber pad	1,967	Sqm	92.68	**161.86**	**3,18,378.62**
84	**112040**	Providing and applying plaster of Paris putty of 2mm average thickness over plastered surface to prepare the surface even and smooth complete	2,589	Sqm	62.28	**108.77**	**2,81,605.53**
85	**115050**	Distempering two or more coats on new work with 1st quality acrylic washable distemper (ready mixed) of approved manufacturer and of required shade and colour complete as per manufacturer's specification	2,822	Sqm	30.45	**53.18**	**1,50,073.96**
86	**115110**	Finishing walls with water proofing cement paint of required shade two or more coats on new work applied @ 3.84 kg/10 sqm	1,294	Sqm	38.40	**67.06**	**86,775.64**
Chapter -12 : Painting, Polishing & Varnishing							
87	**121010**	Applying Priming Coat :					
87a	**121011**	With ready mixed pink or grey primer of approved brand and manufacture on woodwork (hard and soft wood)	363	Sqm	19.08	**35.81**	**12,999.03**

Schedule 'B' Retaining Wall, Bridges & other civil works							
S. No	Item No.	Description of Item	Quantity	Unit	USSOR/ DSR Rate in INR	Estimated Rate including GST@18% in INR	Estimated Amount in INR
87b	**121013**	With ready mixed red oxide zinc chromate primer of approved brand and manufacture on steel galvanized iron/steel works	474	Sqm	14.97	**28.09**	**13,314.66**
88	**121150**	Painting two coats (excluding priming coat) with chocolate, red, grey or buff ready mixed paint of approved quality on steel or wood work	286	Sqm	38.79	**72.80**	**20,820.80**
Chapter -13 : Water Supply							
89	**131150**	Providing and fixing medium grade G.I Pipes complete G.I fittings including trenching and refilling etc External work					
89a	**131151**	15mm dia nominal bore	72	Meter	128.42	**192.52**	**13,861.44**
89b	**131153**	25mm dia nominal bore	72	Meter	214.91	**322.18**	**23,196.96**
89c	**131156**	50mm dia nominal bore	232	Meter	384.78	**576.85**	**1,33,829.20**
89d	**131157**	65mm dia nominal bore	4	Meter	484.87	**726.90**	**2,907.60**
89e	**131158**	80mm dia nominal bore	4	Meter	629.12	**943.15**	**3,772.60**
90	**131160**	Making connection of medium grade G.I. distribution branch with G.I. main of following sizes by providing and fixing tee, including cutting and threading the pipe etc. complete					

Schedule 'B' Retaining Wall, Bridges & other civil works							
S. No	Item No.	Description of Item	Quantity	Unit	USSOR/ DSR Rate in INR	Estimated Rate including GST@18% in INR	Estimated Amount in INR
90a	**131161**	Making connection G.I. of size 25 to 40 mm	26	Each	208.98	**313.29**	**8,145.54**
90b	**131162**	Making connection G.I. of size 50 to 80 mm	68	Each	610.28	**914.91**	**62,213.88**
91	**132010**	Providing & fixing brass bib cock of approved quality					
91a	**132011**	15 mm nominal bore	21	Each	154.55	**231.69**	**4,865.49**
91b	**132013**	25mm nominal bore	10	Each	300.36	**450.29**	**4,502.90**
92	**132020**	Providing and fixing brass stop cock of approved quality					
92a	**132021**	15 mm nominal bore	23	Each	151.88	**227.69**	**5,236.87**
93	**136040**	Constructing masonry Chamber 120x120x100 cm, inside with 7.5 class designation brick work with FPS Bricks in cement mortar 1:4 (1 cement : 4 coarse sand) for sluice valve, with C.I. surface box 100mm top diameter, 160mm bottom diameter and 180mm deep (inside) with chained lid and RCC top slab 1:2:4 mix (1 cement : 2 coarse sand : 4 graded stone aggregate-20 mm nominal size) necessary excavation foundation concrete 1:5:10 (1 cement : 5 fine sand :10 graded stone aggregate 40mm nominal size) and inside plastering with cement mortar 1:3 (1 cement : 3 coarse sand) 12mm thick finished with a floating coat of neat cement complete as per standard design.	2	Each	5,887.89	**8,826.88**	**17,653.76**

Schedule 'B' Retaining Wall, Bridges & other civil works							
S. No	Item No.	Description of Item	Quantity	Unit	USSOR/ DSR Rate in INR	Estimated Rate including GST@18% in INR	Estimated Amount in INR
Chapter -14 : Drainage and sewerage							
94	**142010**	Providing and laying non-pressure NP2 class (light duty) R.C.C. pipes including bends etc with collars jointed with stiff mixture of cement mortar in the proportion of 1:2 (1 cement : 2 fine sand) including testing of joints etc. complete upto 800mm dia.					
94a	**142014**	300mm dia. R.C.C. pipe	20	Meter	721.21	**1,542.42**	**30,848.40**
Chapter -15 : Sanitary Installations							
95	**151010**	Providing and fixing water closet squatting pan (Indian type W.C. pan) with 100mm sand cast iron 'P' or 'S' trap, 10 litres low level white P.V.C. flushing cistern with manually controlled device (handle lever) conforming to IS:7231, with all fittings and fixtures complete including cutting and making good the walls and floors wherever required					
95a	**151011**	White Vitreous China Orissa pattern W.C. pan of size 580mmx440mm with integral type foot rests	3	Each	3,057.59	**4,439.91**	**13,319.73**
96	**151020**	Providing and fixing white vitreous china pedestal type water closet (European type W.C. pan) with seat and lid, 10 litres low level white, P.V.C. flushing cistern with manually controlled device (handle lever) conforming to IS:7231, with all fittings and fixtures complete including cutting and making good the walls and floors wherever required					

Schedule 'B' Retaining Wall, Bridges & other civil works							
S. No	Item No.	Description of Item	Quantity	Unit	USSOR/ DSR Rate in INR	Estimated Rate including GST@18% in INR	Estimated Amount in INR
96a	**151021**	W.C. pan with ISI marked white solid plastic seat and lid	11	Each	2,856.65	**4,148.12**	**45,629.32**
97	**151040**	Providing and fixing white vitreous china flat back or wall corner type lipped front urinal basin of 430mmx260mmx350mm and 340mmx410mmx 265mm sizes respectively with automatic flushing cistern, with standard flush pipe and C.P. brass spreaders with brass					
97a	**151041**	One urinal basin with 5 litres white P.V.C. automatic flushing cistern	5	Each	2,377.03	**3,451.67**	**17,258.35**
98	**151050**	Providing and fixing white, vitreous china flat back half stall urinal of 580mmx380mmx350mm with white P.V.C. automatic flushing cistern, with fittings, standard size C.P. brass flush pipe, spreaders with unions and clamps (all in C.P. brass) with waste fitting as per IS:2556, C.I. trap with outlet grating and other coupling in C.P. brass including painting of fittings and cutting and making good the walls and floors, wherever required					
98a	**151051**	Single half stall urinal with 5 litres P.V.C. automatic flushing cistern	5	Each	3,798.11	**5,515.21**	**27,576.05**
99	**151070**	Providing and fixing wash basin with C.I./M.S. brackets, 15mm C.P. brass pillar taps, 32mm C.P. brass waste of standard pattern, including painting of fittings and brackets, cutting and making good the walls, wherever required :					

Schedule 'B' Retaining Wall, Bridges & other civil works							
S. No	Item No.	Description of Item	Quantity	Unit	USSOR/ DSR Rate in INR	Estimated Rate including GST@18% in INR	Estimated Amount in INR
99a	**151071**	White, vitreous china wash basin size 630mm x 450mm with a pair of 15mm C.P brass pillars.	15	Each	1,942.55	**2,820.77**	**42,311.55**
100	**152020**	Providing and fixing Stainless Steel AISI-304 (18/8) kitchen sink with drain board as per IS:13983 with C.I. brackets and stainless steel plug 40mm including painting of fittings and brackets, cutting and making good the walls, wherever required:					
100a	**152021**	510mmx1040mm bowl depth 250mm	2	Each	2,558.56	**3,715.27**	**7,430.54**
101	**152080**	Providing and fixing P.V.C. waste pipe for sink or wash basin including P.V.C. waste fittings complete					
101a	**152084**	Flexible pipe 40mm dia.	40	Each	92.92	**134.93**	**5,397.20**
102	**152110**	Providing and fixing 600x450 mm beveled edge mirror of superior glass (of approved quality) complete with 6 mm thick hard board ground fixed to wooden cleats with C.P. brass screws and washers complete.	9	Each	706.70	**1,026.19**	**9,235.71**
103	**152120**	Providing and fixing mirror of 5.5mm thickness of float Glass (of approved Quality) required shape and size with plastic moulded frame of approved make and shade with 6mm thick hard board backing					
103a	**152124**	Rectangular shape 1500mmx450mm (outer dimension)	6	Each	1,750.45	**2,541.82**	**15,250.92**
104	**153010**	Providing and fixing soil, waste and vent pipes					

Schedule 'B' Retaining Wall, Bridges & other civil works							
S. No	Item No.	Description of Item	Quantity	Unit	USSOR/ DSR Rate in INR	Estimated Rate including GST@18% in INR	Estimated Amount in INR
104a	**153012**	100mm dia. centrifugally cast (spun) iron S&S pipe as per IS:3989	56	Meter	599.73	**870.86**	**48,768.16**
105	**153300**	Providing and fixing PTMT liquid soap container 109 mm wide, 125 mm high and 112 mm distance from wall of standard shape with bracket of the same materials with snap fittings of approved quality and colour, weighing not less than 105 gms.	8	Each	185.84	**269.86**	**2,158.88**
106	**153410**	Providing and fixing Towel rail (C.P.) brass 15mm dia. x 600mm long having approx. weight 500 gm	11	Each	413.49	**600.43**	**6,604.73**
107	**154010**	Providing and fixing 110mm dia PVC soil, waste and vent pipes including jointing and cost of spun yarn and sand etc. complete	100	Meter	205.50	**298.41**	**29,841.00**
108	**154100**	Providing and fixing 110mm PVC Plain bend of the required degree with access door inclusive of 3mm thick bitumastic felt washer, bolts and nuts, complete, including jointing and cost of spun yarn and sand etc. complete	100	Each	77.54	**112.60**	**11,260.00**
109	**154130**	Providing and fixing 110mm PVC collar (loose socket) including jointing and cost of spun yarn and sand etc. complete	20	Each	73.17	**106.25**	**2,125.00**
110	**154140**	Providing and fixing 75mm PVC soil, waste and vent pipes including jointing and cost of spun yarn and sand etc. complete	60	Meter	128.17	**186.11**	**11,166.60**
111	**154150**	Providing and fixing brackets comprising of aluminium painted steel clips and cast iron base for 75mm PVC pipes including cost of screws etc. and	40	Each	52.17	**75.76**	**3,030.40**

Schedule 'B' Retaining Wall, Bridges & other civil works							
S. No	Item No.	Description of Item	Quantity	Unit	USSOR/ DSR Rate in INR	Estimated Rate including GST@18% in INR	Estimated Amount in INR
		drilling of holes and making good the walls, including cost of sand etc. complete					
112	**155060**	Supplying and fixing pipe as outlet or waste pipe to wash basins sink and bowl type urinals etc. complete including providing clamps to hold the pipe, making holes in masonry and making it good to original condition when not included in the item					
112a	**155063**	PVC 50 mm bore 1.7mm thick	12	Meter	109.06	**158.37**	**1,900.44**
113	**155070**	Supplying and fixing granite stone superior quality black 20mm to 25mm thick in masonry or concrete as a Purdah to urinal range etc. stone to be machine cut & well polished on all faces and the edges to be moulded by semi-circular rounding and polishing. NOTE : The following percentage is to be added / deducted in case of granites other than superior quality black : i) For superior quality Red like "RBI" red add 15% extra; ii) For pink coloured granite deduct 25%; iii) For gray coloured granite deduct 18%.	40	sqm	2,449.89	**3,557.47**	**1,42,298.80**
114	**155200**	Providing and fixing Flush valve (C.P.) 25mm with 25mm size control cock having approx. weight 2.75 kg conforming to IS:9758-1981	10	Each	1,529.70	**2,221.27**	**22,212.70**

Schedule 'B' Retaining Wall, Bridges & other civil works							
S. No	Item No.	Description of Item	Quantity	Unit	USSOR/ DSR Rate in INR	Estimated Rate including GST@18% in INR	Estimated Amount in INR
115	**156010**	Cutting chases in brick masonry walls for following diameter sand cast iron/centrifugally cast (spun) iron or any other types of pipes and making good the same with cement concrete 1:3:6 (1 cement : 3 coarse sand : 6 graded stone aggregate 12.5mm nominal size) including necessary plaster and pointing in cement mortar 1:4 (1 cement : 4 coarse sand)					
115a	**156011**	100mm dia.	108	Meter	129.28	**187.73**	**20,274.84**
115b	**156012**	75mm dia.	68	Meter	92.25	**133.96**	**9,109.28**
115c	**156013**	50mm dia.	48	Meter	58.94	**85.59**	**4,108.32**
Chapter -17 : Misc Building Works							
116	**171100**	Providing and fixing 16mm MS Fan clamps of standard shape and size in existing R.C.C. slab including cutting chase and making good with 1:2 C:S mortar and painting (two coats) exposed portion of the clamps complete	20	Each	123.05	**186.41**	**3,728.20**
117	**171690**	Providing & applying Pre-Construction Anti-Termite treatment to proposed structure, with application of Imidacloprid 30.5% SC @ o.075% concentration mixed with water in ratio of 1:475, as per detailed specifications given in Indian Railways Standard Specifications, so as to create a chemical barrier below and around the structure by an approved	38	Sqm	70.81	**107.27**	**4,076.26**

Schedule 'B' Retaining Wall, Bridges & other civil works							
S. No	Item No.	Description of Item	Quantity	Unit	USSOR/ DSR Rate in INR	Estimated Rate including GST@18% in INR	Estimated Amount in INR
		agency. (plinth area/basement floor area shall be considered for payment)					
Chapter -18 : Dismantling and Demolishing							
118	**181030**	Demolishing R.C.C. work including cutting and stacking of steel bars and disposal of unserviceable material within 50m lead. (Extra payment for scraping, cleaning and straightening of bars to be made separately)	340	cum	603.12	**1,026.92**	**3,49,152.80**
119	**182010**	Demolishing brick work including stacking of serviceable material and disposal of unserviceable material within 50m lead					
119a	**182013**	In cement mortar	260	cum	348.90	**594.06**	**1,54,455.60**
120	**182030**	Demolishing stone rubble masonry including stacking of serviceable material and disposal of unserviceable material within 50m lead					
120a	**182033**	In cement mortar	20	cum	416.29	**708.81**	**14,176.20**
121	**182040**	Dismantling dressed stone work, ashlar face stone work, marble work, including stacking of serviceable and disposal of unserviceable material within 50m lead					
121a	**182042**	In cement mortar	20	cum	486.91	**829.05**	**16,581.00**

Schedule 'B' Retaining Wall, Bridges & other civil works							
S. No	Item No.	Description of Item	Quantity	Unit	USSOR/ DSR Rate in INR	Estimated Rate including GST@18% in INR	Estimated Amount in INR
122	**185010**	Dismantling doors, windows and clerestory windows (steel or wood) shutter including chowkhats, architrave, holdfasts in CC or masonry etc. complete and stacking within 50m lead	8	Each	84.12	**143.23**	**1,145.84**
123	**186010**	Dismantling steel work in single sections including dismembering & stacking within 50m lead in					
123a	**186011**	Dismantling steel work in single sections including dismembering & stacking within 50m lead in R.S. joists./ Rails	10,240	Kg	0.57	**0.97**	**9,932.80**
123b	**186012**	Channels, angles, tees and flats/ rounds or any other rolled shape	10,912	Kg	0.41	**0.70**	**7,638.40**
Chapter -25 : Supply of Material							
124	**257050**	Polyethylene Vinyl Chloride water storage tank with cover and suitable locking arrangement	4,000	litre	5.75	**8.70**	**34,800.00**
Schedule B3:- DSR-2021 BASED ITEMS (from S. No. 125 to 152)							
125	**3.8**	1:3 (1 Cement : 3 coarse sand (zone-III)) cement sand levelling mortar. Item will be used as below precast item. Note:- cost of cement is included in the item.	220	Cum	5,024.15	**5,502.88**	**12,10,633.60**
126	**10.16**	Steel work in built up tubular (round, square or rectangular hollow tubes etc.) trusses etc., including cutting, hoisting, fixing in position and applying a priming coat of approved steel primer, including welding and bolted with special shaped washers etc. complete.					

Schedule 'B' Retaining Wall, Bridges & other civil works							
S. No	Item No.	Description of Item	Quantity	Unit	USSOR/ DSR Rate in INR	Estimated Rate including GST@18% in INR	Estimated Amount in INR
126a	**10.16.2**	Hot finished seamless type tubes	2,088	Kg	168.95	**185.05**	**3,86,384.40**
127	**11.20**	Chequerred precast cement concrete tiles 22 mm thick in footpath & courtyard, jointed with neat cement slurry mixed with pigment to match the shade of tiles, including rubbing and cleaning etc. complete, on 20 mm thick bed of cement mortar 1:4 (1 cement: 4 coarse sand).					
127a	**11.20.1**	Light shade pigment using white cement	500	Sqm	1,233.05	**1,350.54**	**6,75,270.00**
128	**16.30**	Providing and applying tack coat using hot straight run bitumen of grade VG - 10, including heating the bitumen, spraying the bitumen with mechanically operated spray unit fitted on bitumen boiler, cleaning and preparing the existing road surface as per specifications					
128a	**16.30.2**	On bituminous surface @ 0.50 Kg / sqm	9,750	Sqm	36.60	**40.09**	**3,90,877.50**
129	**16.33**	2.5 cm premix carpet surfacing with 2.25 cum and 1.12 cum of stone chippings of 13.2 mm and 11.2 mm size respectively per 100 sqm and 52 kg and 56 kg of hot bitumen per cum of stone chippings of 13.2 mm and 11.2 mm size respectively, including a tack coat with hot straight run bitumen, including consolidation with road roller of 6 to 9 tonne capacity etc. complete (tack coat to be paid for separately).					

Schedule 'B' Retaining Wall, Bridges & other civil works							
S. No	Item No.	Description of Item	Quantity	Unit	USSOR/ DSR Rate in INR	Estimated Rate including GST@18% in INR	Estimated Amount in INR
129a	**16.33.2**	With paving Asphalt grade VG - 30 with no solvent	9,750	Sqm	254.80	**279.08**	**27,21,030.00**
130	**16.55**	Providing and laying bituminous macadam using crushed stone aggregates of specified grading premixed with bituminous binder, transported to site by tippers, laid over a previously prepared surface with paver finisher equipped with electronic sensor to the required grade, level and alignment and rolling with smooth wheeled, vibratory and tandem rollers as per specifications to achieve the desired compaction and density, complete as per specifications and directions of Engineer-in-Charge.					
130a	**16.55.1**	50 to 100 mm average compacted thickness with bitumen of grade VG-30 @ 3.50% (percentage by weight of total mix) prepared in Batch Type Hot Mix Plant of 100-120 TPH capacity.	2,100	Cum	7,756.40	**8,495.47**	**1,78,40,487.00**
131	**16.69**	Providing and laying at or near ground level factory made **kerb stone** of M-25 grade cement concrete in position to the required line, level and curvature, jointed with cement mortar 1:3 (1 cement: 3 coarse sand), including making joints with or without grooves (thickness of joints except at sharp curve shall not to more than 5mm), including making drainage opening wherever required complete etc. as per direction of Engineer-in-charge (length of finished kerb edging shall be measured for payment). (Precast	72	Cum	8,613.55	**9,434.29**	**6,79,268.88**

Schedule 'B' Retaining Wall, Bridges & other civil works							
S. No	Item No.	Description of Item	Quantity	Unit	USSOR/ DSR Rate in INR	Estimated Rate including GST@18% in INR	Estimated Amount in INR
		C.C. kerb stone shall be approved by Engineer-in-charge).					
132	**16.75**	Providing and laying C.C. pavement of mix M-25 with ready mixed concrete from batching plant. The ready mixed concrete shall be laid and finished with screed board vibrator , vaccum dewatering process and finally finished by floating, brooming with wire brush etc. complete as per specifications and directions of Engineer-in-charge. Note:- Cement content considered in this item is @ 330 kg/cum. Excess/less cement used as per design mix is payable/ recoverable separately).	4,000	Cum	8,277.55	**9,066.28**	**3,62,65,120.00**
133	**16.78**	Construction of granular sub-base by providing close graded Material conforming to specifications, mixing in a mechanical mix plant at OMC, carriage of mixed material by tippers to work site, for all leads & lifts, spreading in uniform layers of specified thickness with motor grader on prepared surface and compacting with vibratory power roller to achieve the desired density, complete as per specifications and directions of Engineer-in-Charge.					

Schedule 'B' Retaining Wall, Bridges & other civil works							
S. No	Item No.	Description of Item	Quantity	Unit	USSOR/ DSR Rate in INR	Estimated Rate including GST@18% in INR	Estimated Amount in INR
133a	**16.78.2**	With material conforming to Grade-II (size range 53 mm to 0.075 mm) having CBR Value-25	11,500	Cum	2,775.65	**3,040.13**	**3,49,61,495.00**
134	**16.79**	Providing, laying, spreading and compacting graded stone aggregate (size range 53 mm to 0.075 mm) to wet mix macadam (WMM) specification including premixing the material with water at OMC in for all leads & lifts, laying in uniform layers with mechanical paver finisher in sub- base / base course on well prepared surface and compacting with vibratory roller of 8 to 10 tonne capacity to achieve the desired density, complete as per specifications and directions of Engineer-in-Charge.	4,500	Cum	2,803.65	**3,070.80**	**1,38,18,600.00**
135	**16.80**	Construction of dry lean cement concrete sub base over a prepared sub-grade with coarse and fine aggregate conforming to IS:383, the size of coarse aggregate not exceeding 25 mm, aggregate cement ratio not to exceed 15:1, aggregate gradation after blending to be as per specifications, cement content not to be less than 150 Kg/cum, optimum moisture content to be determined during trial length construction, concrete strength not to be less than 10 Mpa at 7 days, mixed in a batching plant, transported to site, for all leads & lifts, laid with a mechanical paver, compacting with 8-10 tonne vibratory roller, finishing and curing etc. complete as per direction of Engineer-in- charge	3,000	Cum	4,130.55	**4,524.13**	**1,35,72,390.00**

Schedule 'B' Retaining Wall, Bridges & other civil works							
S. No	Item No.	Description of Item	Quantity	Unit	USSOR/ DSR Rate in INR	Estimated Rate including GST@18% in INR	Estimated Amount in INR
136	**16.90**	Providing and laying tactile tile (for vision impaired persons as per standards) of size 300x300x9.8mm having with water absorption less than 0.5% and conforming to IS:15622 of approved make in all colours and shades in for outdoor floors such as footpath, court yard, multi modals location etc., laid on 20mm thick base of cement mortar 1:4 (1 cement : 4 coarse sand) in all shapes & patterns including grouting the joints with white cement mixed with matching pigments etc. complete as per direction of Engineer-in-Charge.	500	Sqm	1,719.00	**1,882.79**	**9,41,395.00**
137	**16.91**	Providing and laying factory made chamfered edge Cement **Concrete paver blocks** in footpath, parks, lawns, drive ways or light traffic parking etc, of required strength, thickness & size/ shape, made by table vibratory method using PU mould, laid in required colour & pattern over 50mm thick compacted bed of sand, compacting and proper embedding/laying of inter locking paver blocks into the sand bedding layer through vibratory compaction by using plate vibrator, filling the joints with sand and cutting of paver blocks as per required size and pattern, finishing and sweeping extra sand. complete all as per direction of Engineer-in-Charge.					
137a	**16.91.1**	60 mm thick C.C. paver block of M-30 grade with approved color design and pattern.	1,840	Sqm	932.35	**1,021.19**	**18,78,989.60**

Schedule 'B' Retaining Wall, Bridges & other civil works							
S. No	Item No.	Description of Item	Quantity	Unit	USSOR/ DSR Rate in INR	Estimated Rate including GST@18% in INR	Estimated Amount in INR
137b	**16.91.2**	80 mm thick C.C. paver block of M-30 grade with approved color design and pattern.	300	Sqm	1,011.20	**1,107.55**	**3,32,265.00**
138	**18.8**	Providing and fixing Chlorinated Polyvinyl Chloride (CPVC) pipes, having thermal stability for hot & cold water supply, including all CPVC plain & brass threaded fittings, i/c fixing the pipe with clamps at 1.00 m spacing. This includes jointing of pipes & fittings with one step CPVC solvent cement and the cost of cutting chases and making good the same including testing of joints complete as per direction of Engineer in Charge. Concealed work, including cutting chases and making good the walls etc					
138a	**18.8.1**	15 mm nominal dia Pipes	50	Meter	441.15	**483.18**	**24,159.00**
138b	**18.8.2**	20 mm nominal dia Pipes	50	Meter	513.75	**562.70**	**28,135.00**
138c	**18.8.3**	25 mm nominal dia Pipes	50	Meter	626.05	**685.70**	**34,285.00**
138d	**18.8.4**	32 mm nominal dia Pipes	50	Meter	712.75	**780.66**	**39,033.00**
139	**19.1**	Providing, laying and jointing glazed stoneware pipes class SP-1 with stiff mixture of cement mortar in the proportion of 1:1 (1 cement : 1 fine sand) including testing of joints etc. complete :					

Schedule 'B' Retaining Wall, Bridges & other civil works							
S. No	Item No.	Description of Item	Quantity	Unit	USSOR/ DSR Rate in INR	Estimated Rate including GST@18% in INR	Estimated Amount in INR
139a	**19.1.2**	150 mm diameter	53	Rmt	591.40	**647.75**	**34,330.75**
140	**20.2**	Boring, providing and installation bored cast-in-situ reinforced cement concrete piles of grade M-25 of specified diameter and length below the pile cap, to carry a safe working load not less than specified, excluding the cost of steel reinforcement but including the cost of boring with bentonite solution and temporary casing of appropriate length for setting out and removal of same and the length of the pile to be embedded in the pile cap etc. by percussion drilling using Direct mud circulation (DMC) or Bailer and chisel technique by tripod and mechanical Winch Machine all complete, including removal of excavated earth with all its lifts and leads (length of pile for payment shall be measured up to bottom of pile cap). **Note:** Truck Mounted rotary/TMR/Tubewell boring machine shall not be used .					
140a	**20.2.1**	450 mm dia piles	1,174	Meter	1,916.40	**2,099.00**	**24,64,226.00**
141	**23.1**	Boring/drilling bore well of required dia for casing/ strainer pipe, by suitable method prescribed in IS: 2800 (part I), including collecting samples from different strata, preparing and submitting strata chart/ bore log, including hire & running charges of all					

Schedule 'B' Retaining Wall, Bridges & other civil works							
S. No	Item No.	Description of Item	Quantity	Unit	USSOR/ DSR Rate in INR	Estimated Rate including GST@18% in INR	Estimated Amount in INR
		equipments, tools, plants & machineries required for the job, all complete as per direction of Engineer-in-charge, upto 90 metre depth below ground level.					
141a	**23.1.1**	All types of soil					
141aa	**23.1.1.1**	300 mm dia	400	Meter	592.05	**648.46**	**2,59,384.00**
142	**23.3**	Supplying, assembling, lowering and fixing in vertical position in bore well, unplasticized PVC medium well casing (CM) pipe of required dia, conforming to IS: 12818, including required hire and labour charges, fittings & accessories etc. all complete, for all depths, as per direction of Engineer -in-charge.					
142a	**23.3.2**	150 mm nominal size dia	400	Meter	668.50	**732.20**	**2,92,880.00**
143	**23.4**	Supplying, assembling, lowering and fixing in vertical position in bore well unplasticized PVC medium well screen (RMS) pipes with ribs, conforming to IS: 12818, including hire & labour charges, fittings & accessories etc. all complete, for all depths, as per direction of Engineer-in-charge.					
143a	**23.4.2**	150 mm nominal size dia	50	Meter	681.90	**746.87**	**37,343.50**
144	**23.8**	Gravel packing in tubewell construction in accordance with IS: 4097, including providing gravel	100	CUM	1,479.25	**1,620.20**	**1,62,020.00**

Schedule 'B' Retaining Wall, Bridges & other civil works							
S. No	Item No.	Description of Item	Quantity	Unit	USSOR/ DSR Rate in INR	Estimated Rate including GST@18% in INR	Estimated Amount in INR
		fine/ medium/ coarse, in required grading & sizes as per actual requirement, all complete as per direction of Engineer-in-charge.					
145	**23.9**	Providing and fixing factory made precast RCC perforated drain covers, having concrete of strength not less than M-25, of size 1000 x 450x50 mm, reinforced with 8 mm dia four nos longitudinal & 9 nos cross sectional T.M.T. hoop bars, including providing 50 mm dia perforations @ 100 to 125 mm c/c, including providing edge binding with M.S. flats of size 50 mm x 1.6 mm complete, all as per direction of Engineer-in-charge.	100	each	1,213.25	**1,328.85**	**1,32,885.00**
146	**23.11**	Supplying, assembling, lowering and fixing in vertical position in bore well, ERW (Electric Resistance Welded) FE 410 plain slotted (having slot of size 1.6/3.2 mm) mild steel threaded and socketed/ plain bevel ended pipe (type A) of required dia, conforming to IS: 8110, of reputed and approved make, having wall thickness not less than 5.40 mm, including painted with outside surface with two coats of anticorrosive bitumestic paint of approved brand and manufacture, including hire & labour charges, fittings & accessories, all complete, for all depths, as per direction of Engineer -in-charge.					
146a	**23.11.2**	150 mm nominal size dia	50	Meter	1,790.00	**1,960.56**	**98,028.00**

Schedule 'B' Retaining Wall, Bridges & other civil works							
S. No	Item No.	Description of Item	Quantity	Unit	USSOR/ DSR Rate in INR	Estimated Rate including GST@18% in INR	Estimated Amount in INR
147	**23.12**	Development of tube well in accordance with IS : 2800 (part I) and IS: 11189, to establish maximum rate of usable water yield without sand content (beyond permissible limit), with required capacity air compressor, running the compressor for required time till well is fully developed, measuring yield of well by "V" notch method or any other approved method, measuring static level & draw down etc. by step draw down method, collecting water samples & getting tested in approved SUB HEAD: 23- RAIN WATER HARVESTING & TUBEWELLS 2022 laboratory, i/c disinfection of tubewell, all complete, including hire & labour charges of air compressor, tools & accessories etc., all as per requirement and direction of Engineer-in-charge.	200	Hour	916.80	**1,004.16**	**2,00,832.00**
148	**23.13**	Providing and fixing suitable size threaded mild steel cap or spot welded plate to the top of bore well housing/ casing pipe, removable as per requirement, all complete for borewell of:					
148a	**23.13.2**	150 mm dia	4	each	210.75	**230.83**	**923.32**
149	**23.14**	Providing and fixing M.S. clamp of required dia to the top of casing/ housing pipe of tubewell as per IS: 2800 (part I), including necessary bolts & nuts of required size complete.					

Schedule 'B' Retaining Wall, Bridges & other civil works							
S. No	Item No.	Description of Item	Quantity	Unit	USSOR/ DSR Rate in INR	Estimated Rate including GST@18% in INR	Estimated Amount in INR
149a	**23.14.2**	150 mm clamp	4	each	1,609.25	**1,762.59**	**7,050.36**
150	**23.15**	Providing and fixing Bail plug/ Bottom plug of required dia to the bottom of pipe assembly of tubewell as per IS:2800 (part I).					
150a	**23.15.2**	150 mm dia	4	each	281.75	**308.60**	**1,234.40**
151	-	Items included in Delhi Schedule of Rate-(Horticulture & Landscaping) 2020		LS			**10,00,000.00**
152	-	Any Other Items related to DSR		LS			**1,00,00,000.00**
Schedule B4:- NS BASED ITEMS (From S. No. 153 to 174)							
153	**NS-1**	Earthwork in embankment for 32.5t axle load and as per RDSO specification No. RDSO/2020/GE:004 September 2020 "Comprehensive Guidelines and Specification for Railway Formation" with contractor's own earth from borrow areas including all lead, lift, ascent, descent, royalty, taxes, cess, compensation, crossing of nallahs /stream and other obstructions including mechanical compaction in layers with watering, handling, re-handling, dressing of banks to the final profile with all labour, material, tools, plant, machinery and equipment, taxes, cess etc. as a complete job in accordance with the specification and drawings.Note: 10% of payment shall be withheld till the slopes are dressed to the required profile and	1,04,400	Cum	-	**342.37**	**3,57,43,428.00**

Schedule 'B' Retaining Wall, Bridges & other civil works							
S. No	Item No.	Description of Item	Quantity	Unit	USSOR/ DSR Rate in INR	Estimated Rate including GST@18% in INR	Estimated Amount in INR
		compacted mechanically with vibratory rollers as per RDSO guidelines					
154	**NS-2**	Supplying and laying blanketing material produced through mechanical means using crushers and pug mill for 32.5 T axle load as per RDSO specification No. RDSO/2020/GE:004 September 2020 "Comprehensive Guidelines and Specification for Railway Formation" over the top of subgrade including all lead, lift, ascent, descent, royalty, taxes, cess, crossing of nallahs /stream and other obstructions including mechanical compaction in layers not exceeding 300 mm thick with vibratory rollers, watering, handling, re-handling and dressing of formation to the final profile with all labour, material, tools, plants, machinery and equipment, taxes, cess, etc. as a complete job in accordance with the specification and drawings. Note: 10% of payment shall be withheld till the slopes are dressed to the required profile and compacted mechanically with vibratory rollers as per RDSO guidelines.	522	Cum	-	**2,480.58**	**12,94,862.76**

Schedule 'B' Retaining Wall, Bridges & other civil works							
S. No	Item No.	Description of Item	Quantity	Unit	USSOR/ DSR Rate in INR	Estimated Rate including GST@18% in INR	Estimated Amount in INR
155	**NS-3**	Supplying and laying in position **M-35 RCC** as per approved design mix with admixtures and manufactured in fully automatic batching plant and transported to site of work in transit mixer for all lifts & leads, having continuous agitated mixer, pumping concrete from transit mixer to site of laying, compacting, finishing & curing, with all labour, material, tools, plants, machinery and equipment, taxes, cess etc., as a complete job ,but excluding supplying & fixing form work (centring & shuttering),in accordance with the specification and drawings. Note –(i) Cost of cement is included in the above item. (ii) Cost of Reinforcement steel is not included in the above item and will be paid separately under relevant item of Schedule B1. (iii) Cost of supplying & fixing form work (centring & shuttering) is not included in the above item (except pile cap & open foundation) and will be paid separately under relevant item of Schedule B1					
155a	**NS-3A**	In Pile caps, open foundation & RCC Box/Sub way, well steining, well cap	21,657	Cum	-	**8,327.88**	**18,03,56,897.16**
155b	**NS-3B**	In Piers, abutments, box	804	Cum	-	**8,673.84**	**69,73,767.36**

Schedule 'B' Retaining Wall, Bridges & other civil works							
S. No	Item No.	Description of Item	Quantity	Unit	USSOR/ DSR Rate in INR	Estimated Rate including GST@18% in INR	Estimated Amount in INR
155c	**NS-3C**	Abutment cap & Pier Cap, pedestals, approach slab, Deck slab	2,704	Cum	-	**9,020.24**	**2,43,90,728.96**
155d	**NS-3D**	Retaining walls, wing walls, return walls, drop walls, curtain walls, toe walls etc. of all heights	23,775	Cum	-	**8,449.01**	**20,08,75,212.75**
156	**NS-4**	Boring 1200 mm diameter piles using Hydraulic Rig in all kinds of strata including boulder studded soil, underground structure like channel, sewer manholes, old foundation or any other obstruction, irrespective of sub-soil water level in all conditions whether dry or under water, shoe and temporary casing pipe, if required, with contractor plant, machinery & equipment for pile boring, use of bentonite slurry including all operations, cleaning of bore holes, supplying and laying in-situ with tremie pipe M-35 RCC in piles as per approved design mix with admixtures and manufactured in fully automatic batching plant and transported to site of work in transit mixer for all lifts & leads, having continuous agitated mixer, pumping concrete from transit mixer to site of laying including supplying & fixing form work (centering & shuttering), compacting, finishing, curing, chipping off pile top to remove laitance concrete above cut off level, removal and disposal of surplus excavated earth/debris/muck outside ROW including all lead, lift, ascends, descends, loading,	2,000	RMT	-	**12,366.49**	**2,47,32,980.00**

Schedule 'B' Retaining Wall, Bridges & other civil works							
S. No	Item No.	Description of Item	Quantity	Unit	USSOR/ DSR Rate in INR	Estimated Rate including GST@18% in INR	Estimated Amount in INR
		unloading handling, re-handling, crossing of stream, nallahs, railway track, level crossing etc. with all labour, material, tools, plants, machinery and equipment, taxes, cess etc. as a complete job in accordance with the Specification and the Drawings. Note – i. Cost of cement is included in the above item. ii. Cost of Reinforcement steel is not included in the above item and will be paid separately under relevant item of schedule-B1. iii. Cost of temporary casing pipe is included in the above item. However, the cost of permanent casing pipe is not included in this item and shall be paid separately under relevant item of schedule B1, if required and approved by the Engineer.					
157	**NS-5**	Earthwork in filling with contractor's own earth of approved quality from borrow areas including all lead all lead, lift, ascent, descent, royalty, taxes, cess, compensation, crossing of nallahs /stream and other obstructions including mechanical compaction in layers with watering to 95% of MDD (as per IS 2720 part 8), handling, re-handling, dressing to the final profile with all labour, material, tools, plant, machinery and equipment, taxes, cess etc. as a complete job in accordance with the specification and drawings	20,000	Cum	-	**287.75**	**57,55,000.00**

Schedule 'B' Retaining Wall, Bridges & other civil works							
S. No	Item No.	Description of Item	Quantity	Unit	USSOR/ DSR Rate in INR	Estimated Rate including GST@18% in INR	Estimated Amount in INR
		Note:- This item will be used for earthwork in filling for other than railway embankment work.					
158	**NS-6**	Providing, fabricating & laying of colour coated galvalume(Proflex system roofing)material for self supported roofing system, material shall be of following specification, BMT 0.90mm to 1.00mm,APT 0.95mm tolerance +/- 0.02mm thick ,Width 605 mm or as decided by railway (Tolerance +/- 2mm),including supplying, loading ,transporting, uploading & stacking at site ,fabricating and laying with all contractors tools, plants, machineries materials and fixtures labours including all lead and lift and laps/wastage if any etc. complete. The colour of sheet will be decided by Engineer. The rate is also inclusive of designing of roofing system, proof checking and providing execution drawing. Fabrication and installation of self supported roofing.	3,000	Sqm	-	**2,513.24**	**75,39,720.00**

Schedule 'B' Retaining Wall, Bridges & other civil works							
S. No	Item No.	Description of Item	Quantity	Unit	USSOR/ DSR Rate in INR	Estimated Rate including GST@18% in INR	Estimated Amount in INR
159	**NS-7**	Providing and fixing stainless steel (Grade 304) railing made of Hollow tubes, channels, plates etc., including welding, grinding, buffing, polishing and making curvature (wherever required) and fitting the same with necessary stainless steel nuts and bolts complete, i/c fixing the railing with necessary accessories & stainless steel dash fasteners , stainless steel bolts etc., of required size, on the top of the floor or the side of waist slab with suitable arrangement as per approval of Engineer-in-charge, (for payment purpose only weight of stainless steel members shall be considered excluding fixing accessories such as nuts, bolts, fasteners etc.).	500	Kg	-	**696.80**	**3,48,400.00**
160	**NS-8**	supplying, fabricating, transportation and fixing galvanized H-Beam sleepers as per RDSO drawing RDSO/B/1636/4/R & RDSO/B/1636/5 with latest alteration and specifications thereto complete with all fittings and fixtures including the cost of all steel sections, all fittings and fixtures ,elastomeric pad, galvanized bolts, nuts, washer, split pin, fish plates 1m and 0.6m long along with fish bolts and nuts for60Kg running rail and 52Kg guard rail respectively, track fittings and fastenings (Zero Toe Load Fastening) for 60 kg running rail and 52 Kg guard rail as per RDSO drg -RDSO/T-8759 to RDSO/T8765. labour, lead, lift, plants and equipment including galvanized work of	508	Each	-	**29,601.96**	**1,50,37,795.68**

Schedule 'B' Retaining Wall, Bridges & other civil works							
S. No	Item No.	Description of Item	Quantity	Unit	USSOR/ DSR Rate in INR	Estimated Rate including GST@18% in INR	Estimated Amount in INR
		full steel components complete in all respects as per approved drawing and technical specifications & as per direction of Engineer on Open Web Girder (OWG) bridges. The rate is also inclusive of the cost of supply of approved quality of epoxy/adhesive and fixing of elastomeric pads with different components of steel sleepers & girder in accordance with approved drawings. The steel to be supplied by the contractor for fabrication of steel H-Beam sleepers shall conform to IS-2062-2006, Grade B0 only. The rate is alsoinclusive of inspection charges of components of sleepers including all fixtures & fastening, galvanization etc. from the reputed laboratory/organization. Elastomeric pad plate and other track fittings shall be procured from RDSO approved source.Note: Payment under this item shall be made in following manner;i. 75% of the rate shall be paid after fabrication, galvanization and transportation of H beam sleepers tothe site and submission of material test certificate of manufacturer and inspection certificate of theagency nominated by Engineer.ii. 15% of the rate shall be paid after supply of fittings to the site and submission of inspection certificateof the agency nominated by Engineer. iii. 10% of the rate will be paid after fixing H Beam sleepers to the girder in satisfactory manner. iv. In					

Schedule 'B' Retaining Wall, Bridges & other civil works							
S. No	Item No.	Description of Item	Quantity	Unit	USSOR/ DSR Rate in INR	Estimated Rate including GST@18% in INR	Estimated Amount in INR
		case fixing is not required, then balance payment will be released on handing over of the sleepers after making recovery @ Rs.850/- per sleeper.					
161	**NS-9**	Supplying, fabrication and fixing pathway on Open Web Girder bridges with hollow steel, rolled and chequred plate including welding / bolting, priming painting with one coat ready mix Zinc Chromate conforming to IS:104 with DFT of 25-30Microns, followed by one coat of Zinc Chrome red oxide conforming to IS:2074 with DFT of 25 Microns with all material, labour, T&P as a complete job as RDSO drawing No. CBS 0045	82	MT	-	**1,17,633.50**	**96,45,947.00**
162	**NS-10**	Casting, supplying and installation of Pre-cast cement concrete blocks of size **25X25 X20cm**. or of required size as directed by the Engineer for protective works at bridges & banks like pitching, toe wall, flooring, drains etc. using M20 design concrete mix with 20mm aggregate size including Contractor's shuttering, leading to bridge site from casting depot, including dressing and levelling of surface, providing gravel backing, laying & jointing blocks with cement mortar 1:3 with Contractor's labour and as directed by Engineer-in-charge (All labour and materials including cement by Contractor). Note:	3,300	Cum	-	**6,792.44**	**2,24,15,052.00**

Schedule 'B' Retaining Wall, Bridges & other civil works							
S. No	Item No.	Description of Item	Quantity	Unit	USSOR/ DSR Rate in INR	Estimated Rate including GST@18% in INR	Estimated Amount in INR
		i) Payment for gravel backing will be paid under item no. NS-11of this Schedule. ii) 60% Payment shall be made after casting of pre-cast concrete blocks and bringing at work site. The balance 40% will be made on completion of laying and finishing. iii) Measurement is based on quantity calculation of blocks used only (no of blocks x volume of one block).					
163	**NS-11**	Supplying and laying of 150mm thick well graded stones aggregate/gravel as base layer over the slopes of embankment with manual dressing with water compaction including the cost of supply of all material, labour, lead, lift, tools, plants, crossing of tracks etc. complete as per approved drawings and technical specifications.	2,100	Cum	-	**722.04**	**15,16,284.00**
164	**NS-12**	Providing Boulder Backing behind wing wall, return wall, retaining wall with hand packed boulders & cobbles not less than 15cm in any direction & not less than 15kg (except smaller boulders required for filling voids) including all lead, lift, labour & other incidental charges as complete work in all respect. Cost of boulder/cobbles is included in this item.	28,774	Cum	-	**1,494.09**	**4,29,90,945.66**

Schedule 'B' Retaining Wall, Bridges & other civil works							
S. No	Item No.	Description of Item	Quantity	Unit	USSOR/ DSR Rate in INR	Estimated Rate including GST@18% in INR	Estimated Amount in INR
165	**NS-13**	Providing and fixing of 75mm dia PVC pipe for weep holes in abutments, Wing Wall, Return Wall, Face wall, retaining wall etc. at suitable intervals as directed by the Engineer-in-charge.	8,100	Rmt	-	**244.86**	**19,83,366.00**
166	**NS-14**	Manufacturing, transportation (including loading & unloading) and installation in position (including joining and grouting) M-50 or higher grade precast reinforced cement concrete segmental retaining walls of specified height (height measured from founding level) as per the directions of the Engineer. Precast reinforced retaining walls shall be factory-made and steam cured in a controlled environment with weep holes and in-built inserts for handling/transportation. Dimensional tolerances shall be as per IS: 6408 (part 2) for PC Class 6. Note:- 1. This item includes cost of all the materials, labour, machinery, tools & plant etc. complete required for manufacture of precast segments except Steel Reinforcement which shall be paid separately under relevant item of schedule B1. 2. Boulder Backing and backfilling of filter media behind wall shall be paid separately under NS-12 of this schedule and relevant item of schedule B1.	3,000	Cum	-	**30,126.94**	**9,03,80,820.00**

Schedule 'B' Retaining Wall, Bridges & other civil works							
S. No	Item No.	Description of Item	Quantity	Unit	USSOR/ DSR Rate in INR	Estimated Rate including GST@18% in INR	Estimated Amount in INR
		3. Excavation of soil for foundation shall be paid separately under item (USSOR item No. 022010) of Schedule B1. 4. Before placing of wall segments, 20 mm thick stiff 1:3 cement mortar bedding layer shall be laid over a levelling course of 150 mm thick of M20 concrete. Payment for M20 concrete shall be made under relevant item (USSOR-2019 item 022040) of Schedule B1and for mortar under relevant item (DSR Item no. 3.8) of Schedule- B3. 5. 60% of the rate shall be paid on receipt of the precast retaining wall segments at site and balance 40% will be paid on fixing the same in position in satisfactory condition.					

Schedule 'B' Retaining Wall, Bridges & other civil works							
S. No	Item No.	Description of Item	Quantity	Unit	USSOR/ DSR Rate in INR	Estimated Rate including GST@18% in INR	Estimated Amount in INR
167	**NS-15**	Manufacturing, transportation (including loading & unloading) and installation in position (including joining and grouting) M-50 or higher grade precast reinforced cement concrete U-shaped drain with cover as per the directions of the Engineer. Precast reinforced U-shaped drain shall be factory-made, and steam cured in a controlled environment with inserts for handling/transportation. Dimensional tolerances shall be as per IS: 6408 (part 2) for PC Class 6.Note: -1. This item includes cost of all the materials, labour, machinery, tools & plant etc. complete required for manufacture of precast segments except Steel Reinforcement which shall be paid separately under relevant item of schedule B1.2. Excavation of soil for foundation shall be paid separately under item (USSOR item No. 022010) of Schedule B1. 3. Before placing wall segments, 20 mm thick stiff 1:3 cement mortar bedding layer shall be laid over a levelling course of 150 mm thick of M20 concrete. Payment for M20 concrete shall be made under relevant item (USSOR-2019 item 022040) of Schedule B1and for mortar under relevant item (DSR Item no. 3.8) of Schedule- B3.4. 60% of the rate shall be paid on receipt of the precast drain segments at site and balance 40% will be paid on fixing the same in position in satisfactory condition.	20	Cum	-	**30,126.94**	**6,02,538.80**

Schedule 'B' Retaining Wall, Bridges & other civil works							
S. No	Item No.	Description of Item	Quantity	Unit	USSOR/ DSR Rate in INR	Estimated Rate including GST@18% in INR	Estimated Amount in INR
168	**NS-16**	Linking of track on H- beam sleepers on Open Web Girder (OWG) bridges with 60 Kg running rail and 52 kg guard rail with track fittings/fastenings including leading of Running and guard rails from bridge approach and fixing of running rails & guard rails, bending of guard rails, notching, drilling of holes, cutting of rails etc., as directed and making track structure fit for sectional speed. (Rails will be supplied by Employer)	1,200	RTM	-	**1,388.64**	**16,66,368.00**
169	**NS-17**	Supplying and fixing M.S. Angles 100mmx 100 mmx 10mm size conforming to IS:2062 in expansion joint of Composite girder bridges including provision of 10mm dia dowel bar & 12mm dia anchor bolts at 150 mm centre to centre, and 250mm wide GI plate over the top of angles as per relevant RDSO standard drawing with all material, labour, T&P as a complete job.	275	Each	-	**6,568.82**	**18,06,425.50**
170	**NS-18**	Supply and fixing of Metallic Guided Bearing in position true to line and level as per RDSO drawing No. RDSO/B-11754/3R2 and IRC:83 pt. III-2018 including supply & grouting of anchor bolts with approved non-shrinking epoxy grout with all material, labour, T&P as a complete job.	4	Each	-	**53,000.00**	**2,12,000.00**

Schedule 'B' Retaining Wall, Bridges & other civil works							
S. No	Item No.	Description of Item	Quantity	Unit	USSOR/ DSR Rate in INR	Estimated Rate including GST@18% in INR	Estimated Amount in INR
171	**NS-19**	Supply, fabrication and erection of bed plate of approved sizes as per relevant RDSO drawing No. RDSO/B-11751/4R2, B-11753/5R1, B-11754/3R2 with UpToDate corrections, in exact position over bed block on pier/abutments by giving full and even bearing, setting them on the layer of free flow non-shrinkable grouting compound, scrapping or chipping of bed block, if required, fabrication and fixing of HD bolts of suitable sizes along with nuts, washers etc., drilling holes of required size, grouting of holes by epoxy mortar after fixing HD bolts with all labour, material, T & P as a complete job.					
171a	**NS-19a**	More than 12.2m and upto 18.3m clear span	11,200	Kg	-	**241.43**	**27,04,016.00**
171b	**NS-19b**	More than 18.3m and upto 30.5m clear span	52,800	Kg	-	**252.93**	**1,33,54,704.00**

Schedule 'B' Retaining Wall, Bridges & other civil works							
S. No	Item No.	Description of Item	Quantity	Unit	USSOR/ DSR Rate in INR	Estimated Rate including GST@18% in INR	Estimated Amount in INR
172	**NS-20**	Designing, Providing and erection of specified grade precast RCC Facia Panel of thickness 180 mm made with M-35 Grade Concrete Batching plant, Transit Mixer, Concrete Pump and Vibrator for retaining earth with all element and accessories including reinforcing element complete as per approval drawing and Section 3100 of MORT&H specification including all material labour machinery etc. (Scope of work including designing, getting approval, casting in yad, curing, storing, Transporting, lifting, placing in position, erection with all necessaries fasteners etc complete).The cost of cement & steel are included in this item & no separate payment shall be paid whatsoever. The rate also include cost for excavation, foundation, reinforcing element, fasteners, drainage layer, drain pipe, coping beam and other accessories for which nothing extra shall be paid. Mode of Payment: 1- Casting of RE Panel : 60% 2- Erection & fixing : 35 % 3- Final Bill: 5%	6,000	Sqm	-	**6,229.67**	**3,73,78,020.00**
173	**NS-21**	Providing Placing & Compacting to desired density approved backfill material in layers as per approved methodology including testing of reinforced fill portion in approaches between reinforced soil (RS) wall panels as per approved drawing as per Section	30,000	Cum	-	**381.91**	**1,14,57,300.00**

Schedule 'B' Retaining Wall, Bridges & other civil works							
S. No	Item No.	Description of Item	Quantity	Unit	USSOR/ DSR Rate in INR	Estimated Rate including GST@18% in INR	Estimated Amount in INR
		3103 of MORT&H Specification. The soil should be predominantly coarse grained, Not more than 10 % of particles should pass 75 micron sieve. The item shall be measured and paid for the finished volume of backfill and subgrade placed in position excluding the volume of filter media at base and behind the RS RE Wall					
174	**NS-22**	Providing & constructing of RCC Crash Barrier of M35 at the edge of road , approaches to bridge structures and medians, constructed with specified grade of concrete using batching plant , transit mixer, concrete pump and vibrator with 450 mm long at expansion joint filled with premolded asphalt filler board, keyed to the structure on which it is built and installed as per design and dimension in the approved drawing and at location directed by the engineer, all as specified as per Section 809 of MORT&H Specification including all material labour, scaffolding etc.	500	Cum	-	**7,342.91**	**36,71,455.00**
						Total Estimated Amount of Schedule 'B'	**2,74,48,66,582.33**

7 Schedule 'C': General Electrical Services

Schedule 'C' General Electrical Services					
S. No.	**ITEM Description**	**Item Qty**	**Unit**	**Unit Rate including GST @18% (INR)**	**Estimated Amount in INR**
1	Concealed/Surface conduit wiring system- Supply of material and wiring of LP/TP/FP/Ex. Fan point with 1.5sqmm PVC single core multistranded copper wire insulated concealed in stone/brick masonry wall in19/20 mm conduit with 1.5sqmm PVC wire insulated copper for earth wire 1-way/2-way switch 5/6A as required and good quality ceiling rose including connection(with modular switch, socket & ceiling rose) as per specification.	880	Numbers	289.94	255147.20
2	Supply and fixing 5/6A plug, modular 5-pin 230V including modular switch and with modular board and wiring with 2.5sqmm PVC CU cable as per specification.	480	Numbers	173.84	83443.20
3	Supply and fixing 15/16A plug, modular 5-pin 230V including modular switch and with modular board and wiring with 4 sqmm PVC CU cable as per specifications.	200	Numbers	192.3	38460.00
4	Supply and fixing 2 module modular switch board plate for fixing of modular switches -plug with sheet metal box of good quality and standard size, concealed fixing of GI /PVC as per specifications.	360	Numbers	74.73	26902.80
5	Supply and fixing 4 module modular switch board plate for fixing of modular switches -plug with sheet metal box of good quality and standard size, concealed fixing of *GI /PVC* as per specifications.	440	Numbers	103.29	45447.60

Schedule 'C' General Electrical Services					
S. No.	**ITEM Description**	**Item Qty**	**Unit**	**Unit Rate including GST @18% (INR)**	**Estimated Amount in INR**
6	Supply and fixing 8 module modular switch board plate for fixing of modular switches -plug with sheet metal box of good quality and standard size, concealed fixing of *GI /PVC* as per specification.	250	Numbers	178.02	44505.00
7	Supply and fixing 12 module modular switch board plate for fixing of modular switches -plug with sheet metal box of good quality and standard size, concealed fixing of *GI /PVC* as per specification.	180	Numbers	191.5	34462.80
8	Supply, laying, connection and commissioning of sub- main 2x2.5 Sqmm with PVC insulated single core copper conductor cable and same size PVC insulated copper conductor for earthing wire in 19/20 mm conduit as per site requirement etc. as per specifications.	11000	Metre	58.14	639540.00
9	Supply, laying, connection and commissioning of sub- main 2x4 Sqmm with PVC insulated single core copper conductor cable and same size (4 sqmm) PVC insulated copper conductor for earthing wire in 19/20 mm conduit as per site requirement and as per specification.	6000	Metre	97.16	582960.00
10	Supply, laying, connection and commissioning of sub- main 2x6 Sqmm with PVC insulated single core copper conductor cable and same size PVC insulated copper conductor for earthing wire in 19/20 mm conduit as per site requirement and as per specification	3000	Metre	98.40	295200.00
11	Supply, Installation, testing and commissioning of 1200/1400mm ceiling fans ISI marked, 5 star rated reputed make and as per specification.	250	Numbers	1042.98	260745.00

Schedule 'C' General Electrical Services					
S. No.	**ITEM Description**	**Item Qty**	**Unit**	**Unit Rate including GST @18% (INR)**	**Estimated Amount in INR**
12	Supply and fixing of ceiling fan regulator electronic type 5-step (modular type) as per specifications.	250	Numbers	282.16	70540.00
13	Supply of 4 Core 16 Sqmm XLPE Armoured Cable with Aluminium Conductor 650/1100 V grade confirming to IS 7098 (Part-1) 1988, 1.1 KV grade LT XLPE insulated armoured, aluminium conductor cable as per specification	12000	Meters	171.59	2059080.00
14	Supply of 4 Core, 35 Sqmm XLPE, Armoured Cable with Aluminium Conductor 650/1100 V grade confirming to IS 7098 (Part-1) 1988, 1.1 KV grade LT XLPE insulated armoured, aluminium conductor cable as per specification.	5000	Meters	295.2	1476000.00
15	Supply of 4 Core 50 Sqmm XLPE Armoured Cable with Aluminium Conductor 650/1100 V grade confirming to IS 7098 (Part-1)1988, 1.1 KV grade LT XLPE insulated armoured, aluminium conductor cable as per specification.	9500	Meters	393.60	3739200.00
16	Supply of 4 Core 70 Sqmm XLPE Armoured Cable with Aluminium Conductor 650/1100 V grade confirming to IS 7098 (Part-1) 1988, 1.1 KV grade LT XLPE insulated armoured, aluminium conductor cable as per specification.	1500	Meters	527.3	790890.00

Schedule 'C' General Electrical Services					
S. No.	**ITEM Description**	**Item Qty**	**Unit**	**Unit Rate including GST @18% (INR)**	**Estimated Amount in INR**
17	Supply of 4 Core 95 Sqmm XLPE Armoured Cable with Aluminium Conductor 650/1100 V grade confirming to IS 7098 (Part-1) 1988, 1.1 KV grade LT XLPE insulated armoured, aluminium conductor cable as per specification.	1500	Meters	664.2	996300.00
18	Supply of 4 Core 120 Sqmm XLPE Armoured Cable with Aluminium Conductor 650/1100 V grade confirming to IS 7098 (Part-1) 1988, 1.1 KV grade LT XLPE insulated armoured, aluminium conductor cable.	3000	Meters	818.0	2453850.00
19	Supply of 4 Core 185 Sqmm XLPE Armoured Cable with Aluminium Conductor 650/1100 V grade confirming to IS 7098 (Part-1) 1988, 1.1 KV grade LT XLPE insulated armoured, aluminium conductor cable as per specification.	1200	Meters	1243.53	1492236.00
20	Supply, fixing, installation and commissioning of 25 ltrs. fully automatic with auto cut off RO (Reverse osmosis) portable water purification system with inbuild storage tank similar to Aquaguard model no - AG 25 LPH RO S 8421 and as per specification.	5	Nos	22360.58	111802.90
21	Supply and laying of HDPE pipe conforming to IS 4984:1995, 75/80 mm dia wall thickness 3 mm PN-4 under the road/air, as per specification.	5500	Meters	71.26	391930.00

Schedule 'C' General Electrical Services					
S. No.	**ITEM Description**	**Item Qty**	**Unit**	**Unit Rate including GST @18% (INR)**	**Estimated Amount in INR**
22	Supply and laying of HDPE pipe conforming to IS 4984:1995, 50 mm dia wall thickness 3 mm PN-4 under the road/air, as per specification.	24000	Meters	72.89	1749360.00
23	Supply and laying of HDPE pipe dia 160mm (OD) under road/ground/ floor/railway track or as per site requirement already excavated trench. the material grade PE-80 and class of pipe should be PN-4 IS-4984/1995 wall thickness between 6.2mm to 7.1 mm as per specification.	2000	Meters	369	738780.00
24	Supply and fixing of 50mm dia G.I. pipe medium B class for cable laying as per specification	200	Meters	178.57	35714.00
25	Laying of LT/HT cables in Air/pipe/cable tray/trench etc. as per specification.	33700	Meters	16.24	547288.00
26	Excavation & Refilling of trench of size 0.5 mtr wide x 1.2 mtr deep as per specification. Trench work may be on kuchha/pacca land and all type of soil as per site requirement and without protective layer of brick. Surface of trench shall be made good in all respect and satisfaction of site engineer includes suitable protection of loop cable and as per specification.	28000	Meters	96.51	2702280.00
27	Supply, fixing & commissioning of 300 mm sweep ISI marked exhaust fan with louvre shutter as per specification.	80	Numbers	956.87	76549.60

Schedule 'C' General Electrical Services					
S. No.	**ITEM Description**	**Item Qty**	**Unit**	**Unit Rate including GST @18% (INR)**	**Estimated Amount in INR**
28	Supply and fixing of Double Door MCB, TPN DB 8 modules 4 row, neutral and earth link, with one no four pole MCB 40 amp, one no FP RCCB 40 amp 30 mA and twenty four no SP MCB 40/32/25/16/10/6amp. 'C' series. Breaking capacity not less than 10 kA. MCB, RCCB and DB should be as per technical specifications and of same make.	15	Numbers	13403.41	201051.15
29	Supply and fixing of Double Door MCB, DB SP 12 way (10+ 2 module),neutral and earth link, with one no DP MCB 40amp, one no DP RCCB 40 amp 30 mA and eight no SP MCB 32/25/16/10/6 amp. 'C'series. Breaking capacity not less than 10 kA. MCB, RCCB and DB should be as per technical specifications and of same make.	20	Numbers	6099.17	121983.40
30	Supply, fixing, testing and commissioning of 22 W Energy efficient LED tubular lamp four feet with its driver and Luminaire of CRCA steel sheet enclosure, IP-20 for indoor application, operating voltage (140-270)V, minimum 2000 Lumens, color temperature 6500ºK, CRI>65 as per specification.	580	Numbers	501.13	290655.40
31	Supply, Transportation, erection, testing, Installation & commissioning of self-contained drinking water cooler (150 litre) with all connected standard fitting, accessories etc and 5 kVA wall mounted IC controlled electronic auto voltage corrector with time delay relay. Supply and erection of earth electrode and connection to earthing system etc as required.	10	Numbers	66260.70	662607.00

Schedule 'C' General Electrical Services					
S. No.	**ITEM Description**	**Item Qty**	**Unit**	**Unit Rate including GST @18% (INR)**	**Estimated Amount in INR**
32	Supply & erection of 5 m high with single/ double arm model, hot dip galvanized steel octagonal pole with galvanized base plate of 200x200x12 mm, junction box with 6 Amp. MCB and GI stud terminals (for mounting inside the base compartment of pole), GI foundation bolt size 4x16mm dia. 600 mm in length including excavation and making foundation as per specification and drawing. It shall be galvanized internally and externally by single dipping methods. The pole and foundation shall be made as per specification.	250	Numbers	8081.77	2020442.50
33	Supply, fixing and commissioning of street light fitting accessories i.e GI pipe of suitable size.	50	Numbers	117.14	5857.00
34	Supply, Erection, testing & commissioning of 40 Watt LED Energy efficient LED based street light fitting with pressure die cast aluminium housing with driver & suitable fixing arrangement, IP-65 for outdoor application, operating voltage (140-270) V, System efficacy more than 100 lm/W, color temperature 6500K, CRI>65, and as per technical specification.	300	Numbers	3313.66	994098.00
35	Supply, fixing testing and commissioning of (OFF delay) modular digital timers for operation of platforms and circulating area street light, as per specification.	12	Numbers	4148.88	49786.56

Schedule 'C' General Electrical Services					
S. No.	**ITEM Description**	**Item Qty**	**Unit**	**Unit Rate including GST @18% (INR)**	**Estimated Amount in INR**
36	Supply, Fixing, testing and commissioning of *feeder pillar CRCA material powder coated with 7 tank process* of size 900x600x300 mm and bus bar capacity 200 Amp 3 phase and neutral with box as per specification.	15	Numbers	2940.55	44108.25
37	Supply, installation, Testing & Commissioning of rechargeable batten type Emergency light 60 LED 4 watt or higher with one hour minimum backup.	50	Numbers	2230.63	111531.50
38	Supply and preparation of all drawings in AutoCAD (Original + 5 copies) showing electrical installation being done through this contract for station as per specification.	5	Numbers	2802.78	14013.90
39	Supply, installation, testing and commissioning of Single sided LED signage board with pictogram/symbol (if any) as per specification.	*48*	*Square Mtr*	*16549.9*	794395.20
40	Supply, installation, testing and commissioning of double sided LED signage board with symbol as per specification.	*28*	*Square Mtr*	*20526.3*	574736.40
41	Supply and fixing of Rubber mat (ISI marked) nonstick type suitable for 11 kv AC size 2000x1000x25mm & as per specification.	30	Numbers	738.00	22140.00

Schedule 'C' General Electrical Services					
S. No.	**ITEM Description**	**Item Qty**	**Unit**	**Unit Rate including GST @18% (INR)**	**Estimated Amount in INR**
42	Supply, installation, testing and commissioning of LT heat shrinkable straight through joint with required accessories complete in all respect suitable for LT ,XLPE, 4 core cable as per site requirement and as per specification.	30	Numbers	1597.35	47920.50
43	Supply and erection of GI cable route marker of size not less than 200x150x3mm thick GI Plate. for HT / LT Electric underground cable as per Drawing and specification.	250	Numbers	329.64	82410.00
44	Dismantling of Rail/cable tray Pole & Over head line, EFT's, cable tray complete, as per specification.	30	Numbers	410.43	12312.90
45	Supply, installation, testing and commissioning earth electrode complete in all respect with perforated GI pipe medium "B" class (Blue) confirming to IS 1239 part-I length of 3 mtr, bore 50mm with all accessories like nut, bolt, reducer nipple, wire meshed funnel and CC finished chamber covered by CI/RCC frame etc. Digging pit and refilling it with charcoal and salt in successive layers and connection with 8 SWG GI wire and as per IS:3043 and drawing and testing of earth resistance as required.	220	Numbers	924.29	203343.80

Schedule 'C' General Electrical Services					
S. No.	**ITEM Description**	**Item Qty**	**Unit**	**Unit Rate including GST @18% (INR)**	**Estimated Amount in INR**
46	Design, manufacture, Supply, testing, erection and commissioning of indoor type LT PANEL, Medium voltage switch board front operated type will have digital ammeter, voltmeter, multifunction energy meter of reputed make on all the main and 3 phase. LED type indication lamps on all the mains, digital ammeter & 3 phase flush type mounted electronic energy meter counter display in every outgoing MCCB's copper bus bar and accessories as per specification with following features: (A) incoming 2x250 amp 4 pole MCCB's with change over provision with microprocessor release having integral overload, short circuit, earth fault and neutral protection and breaking capacity 60 KA (Ics=100%Icu). (B)outgoing 2x125 amps, 2x100 amps and 2x63 amp, 4 poles MCCB's with adjustable overload and adjustable short trip unit and breaking capacity 36KA (Ics=100%Icu). the panel is to be provided with over voltage protection with suitable relay. work includes formation for panel foundation and other civil work with suitable trench up to the satisfaction of the site engineer (as per technical specification). panel shall be manufactured from CPRI tested firm. All the material should be of reputed make and as per tech specification. General arrangement, single line diagram and technical detail (make & model no) of the equipment and electrical accessories.	5	Numbers	129429.62	647148.10

Schedule 'C' General Electrical Services					
S. No.	**ITEM Description**	**Item Qty**	**Unit**	**Unit Rate including GST @18% (INR)**	**Estimated Amount in INR**
47	Supply, erection, testing and commissioning of phase change over distribution board (phase selector box) size 610x450x190 mm fabricated from 1.6mm thick CRCA sheet with 7 tank process power coated with 01 no, 100 Amp FP MCCB at the incomer and 01 no, 100 amp SPN MCCB as outgoing and 01 no 63 amp phase selector switch with multi LED indication lamps & by pass arrangement as per specification.	5	Numbers	7944.16	39720.80
48	Supply and fixing of GI cable duct 40 x 60 mm (Approx.) slot greenish as per specification.	1000	Meters	73.82	73820.00
49	Supply and fixing of 4 pole MCCB 200 amp. 36 kA with enclosure and adjustable thermal, fix magnetic release complete. MCCB should be of reputed make and as per specification.	10	Numbers	12778.00	127780.00

Schedule 'C' General Electrical Services					
S. No.	**ITEM Description**	**Item Qty**	**Unit**	**Unit Rate including GST @18% (INR)**	**Estimated Amount in INR**
50	Laying of cable under the road/Railway track, recessing in platform /wall along with Railway Track. in laid HDPE /GI pipe as required 1.1 KV grade LT XLPE insulated armored, aluminium conductor cable including making chase & plastering after laying of cable/digging of cable trench, sand cushioning, protective covering with bricks of compressive strength 7.5/sqmm (minimum). Provision of cable route marker as per technical specification. including end terminations with Aluminium Crimping socket/lugs testing and commissioning of Various sizes. NOTE:- i) All cable connection shall be made with proper size of crimping socket /Glands by the contractor at his own cost and labour ii) Road/floor where cable is to be laid shall be made good as original by the firm at his own cost and to the satisfaction of Engineer.	800	Meters	39.80	31840.00
51	Supply and fixing of GI jali 1"x1" welded on GI angle as per specification.	1200	Kg	46.70	56040.00
52	Supply of submersible energy efficient pump set of 10 HP (3 star & above rated), 20 Stages, Head :120-160 Mtr, 415 V, AC complete with accessories at sight as per specification.	10	Numbers	50457.00	504570.00
53	Supply fixing, testing and commissioning of automatic control panel with star delta starter for 10 HP three- phase pump including connections and providing cable from main board to control panel and connection for water level controller (WLC) in bore well as per specification.	10	Numbers	14118.00	141180.00

Schedule 'C' General Electrical Services					
S. No.	**ITEM Description**	**Item Qty**	**Unit**	**Unit Rate including GST @18% (INR)**	**Estimated Amount in INR**
54	Lowering, testing and commissioning of submersible pump set of 10 HP with G.I. pipe, nuts, bolts, washer & rubber packing and copper flat cable & as per specification. Interface shall be made with Civil agency who will be making the bore hole.	10	Numbers	3435.00	34350.00
55	Supply, Installation, Testing and commissioning of mono-block submersible pump 2.0 HP complete in all respect as per specification.	6	Numbers	10901.79	65410.74
56	Supply & fixing of G.I. pipe 50 MM dia B class with flanges, sockets and welding as per IS 1239 as per specification.	800	Meters	167.38	133904.00
57	Supply and fixing pipe fitting bends, sockets, flanges, delivery valve, Non Return valve and supporting clamps (2 set). As per specification.	10	set	2996.86	29968.60
58	Supply, fixing, testing, commissioning of 3 core 6 Sq.mm. size PVC insulated PVC sheathed multi strand flat copper cable conductor. As per specification.	2000	Metre	57.80	115600.00
59	SITC of Submersible mono block pump (150 mm dia) 5 HP, 3.75KW (dia 150 mm), 20-25 mtrs. Head, discharge 700 LPM complete with all accessories and as per specification.	4	Numbers	16290.69	65162.76

Schedule 'C' General Electrical Services					
S. No.	**ITEM Description**	**Item Qty**	**Unit**	**Unit Rate including GST @18% (INR)**	**Estimated Amount in INR**
60	Supply, fixing, testing and commissioning of automatic control panel with DOL starter for 5 HP three-phase pump including connections and providing cable from main board to control & as per specification. Interface shall be made with Civil agency who will be making the bore hole.	4	Numbers	8287.09	33148.36
61	Lowering, testing and commissioning of horizontal monoblock submersible pump set. as per specification.	4	Numbers	1207.25	4829.00
62	Supply, installation, testing and commissioning of 32 Amp. DP MCB, 10 kA, 'C' curve with metal enclosure as per specification.	30	Numbers	1206.07	36182.10
63	Supply of material and wiring of shed with 1.5 sqmm single core multi-stranded copper wire PVC insulated in conduit 1.5mm thick 19mm size white colour shall be fixed with junction box TEE and 1.5mmsq PVC CU cable insulated multi stranded for earth wire and 5/6A, ceiling rose. The conduit shall be fixed with rawl plugs/ tied with 14 S.W.G. GI wire including connection. As per specification and satisfaction of Engineer.	450	Numbers	106.28	47826.00

Schedule 'C' General Electrical Services					
S. No.	**ITEM Description**	**Item Qty**	**Unit**	**Unit Rate including GST @18% (INR)**	**Estimated Amount in INR**
64	*Supply, installation, testing and commissioning of 125 KVA Capacity radiator cooled Silent DG Set with AMF panel and Complete with all accessories like- exhaust fan system, diesel engine with alternator capable of delivering continuous power output at 3 phase 4 wire 415 Volts AC Supply with control panel, electronic energy meter, digital Ammeter, Voltmeter, Power factor meter, Digital frequency meter, clustered LED Type indication light, cable glands, earthing terminal maintenance free battery set mounted on wooden frame and plank, Anti-Vibration pad and all other accessories equipment, protective device, Exhaust fan shall be installed as per latest CPCB norms as per specification.*	*1*	*Numbers*	*885000.00*	*885000.00*
65	Supply, installation, testing and commissioning of Cu Earthing with 600mmx600mmx3mm thick copper earth plate, as per IS 3043(latest version) to achieve earth resistance less than one ohm and salt, providing concrete enclosure and cast Iron(CI) cover plate with lifting arrangement, watering pipe etc. as required and as per specification.	10	Numbers	7424.0	74240.00
66	Supply and fixing 40mm x 5mm copper strip on surface or in recess or in 50mm dia G.I. pipe as required and as per specification.	50	Meters	1102.0	55100.00

Schedule 'C' General Electrical Services					
S. No.	**ITEM Description**	**Item Qty**	**Unit**	**Unit Rate including GST @18% (INR)**	**Estimated Amount in INR**
67	Supply, fixing, testing and commissioning of passenger Lift, gearless machine room less, single landing (GF & FF) Minimum load 13 persons, speed - 1 m/s to 1.5 m/s, Automatic doors with two sides opening, Microprocess based variable frequency, variable voltage drive controller with ARD etc. and all safety devices as required. (The cost excludes Civil and Electrical work) as per specification, with warranty period of 24 months from the date of commissioning of lift and 30 months from the date of supply, whichever is earlier.	3	Numbers	2580137.0	7740411.00
68	Supply, Fixing, testing & commissioning of 1.5 Ton heavy duty Split inverter type Air conditioner with including petty hardwares, gas charging along with the cost of refrigerant with LCD display cordless remote ,5 star rating suitable for 1 phase, 230 Volts & IC controlled electronic auto voltage corrector.	30	Numbers	46731.80	1401954.00
69	Supply and fixing of Metal Clad Plug Socket 20A single phase with 32A MCB including fixing and sheet metal enclosure box with one 20A plug top (Ray roll type) to be supplied with board as per spec as per specification,	30	Numbers	750.75	22522.50

Schedule 'C' General Electrical Services					
S. No.	**ITEM Description**	**Item Qty**	**Unit**	**Unit Rate including GST @18% (INR)**	**Estimated Amount in INR**
70	Supply and fixing of junction box size 390x305x170mm comprising of SMP/FRP material with rubber gasket, padlock arrangement, zinc passivated earth bolt, etc. similar to Sintex model no. GSJB 3525 or similar with 4 no. aluminium busbar cap 200 Amp., suitable for 415 volt supply requirement.	100	Numbers	1972.92	197292.00
71	Supply, Installation, testing and commissioning of 2 kVA, 240 volt AC, pure sine wave, online UPS cum inverter consisting of intelligent battery charging mechanism with adaptive battery charging and 150 AH , 24 Volt tubular battery (2 batteries of 12 V each connected in series) suitable for heavy duty application. with UPS cum inverter warranty of 24 months and for Battery - 36 months, as per specification.	10	Numbers	32864.78	328647.80
72	Supply, installation and commissioning and of Perforated Cable Tray of size 150x50 mm made out of GI sheet hot dip galvanized (85 microns) 1.6 mm thick with suitable fixing arrangement.	500	Meters	535.46	267730.00
73	Supply, Installation, testing & commissioning of control and distribution panel for colour light signalling for 10/25 kVA AT supply in 25 kV AC traction system as per RSDO technical specifications No. TI/SPC/PSI/CLS/ 0020 (12/02) With A&C slips No. 1 to 4 or latest, connections as required.	10	Numbers	77563.80	775638.0

Schedule 'C' General Electrical Services					
S. No.	**ITEM Description**	**Item Qty**	**Unit**	**Unit Rate including GST @18% (INR)**	**Estimated Amount in INR**
74	*New Connection/Load Augmentation complete in all respect for bringing Power supply HT/LT from DISCOM terminal to HORC HT/LT Panel and payment of all fees/charges to DISCOM as per specification.*	*300*	*KW*	*6000.0*	*1800000.0*
75	Supply, Installation, testing and commissioning of 16 M high mast shaft totally hot dip galvanized and suitable for wind velocity as per IS 875 part-3. The mast shaft shall be in two finished sections, it shall also include all accessories for 16M high mast including head frame, steel wire rope 6mm dia (7/19 construction) double drum winch galvanized lantern carriage arrangement suitable for 8 luminaries and its control gear boxes and lightning finial. The mast shall have integral power tool installed at its base compartment. The high-powered single- phase non-reversible power tool for electrical operation of raising and lowering of lantern carriage with its supporting stand, torque limiter and fixing chain. The mast shall have only one longitudinal seam weld per section along with Earthing with *GI flat.* As per specification.	4	Numbers	174988.3	699953.0
76	Design and casting of suitable foundation with M-20 concrete for the 16 mtr High Mast having the safe soil bearing capacity at site as *10T/sqm at 2 meter depth* including supply of foundation bolts manufactured from special steel along with *GI nuts, washers and anchor plates and templates.* As per specification.	4	Numbers	18811.0	75244.0

Schedule 'C' General Electrical Services					
S. No.	**ITEM Description**	**Item Qty**	**Unit**	**Unit Rate including GST @18% (INR)**	**Estimated Amount in INR**
77	Supply, fixing, testing and commissioning of LED type flood light luminaries wattage 200 Watt made up of pressure die cast housing and heat sink in aluminium extrusion with IP- 66 protection as per CEE/NR/121-Elect/PS/2018 (Rev-03) dt 28/06/18 & CEE/NR/121- Elect/PS/2019(Rev-04) dt 04 /11/19 or latest specification and as per site requirement. Guarantee five years from date of commissioning and as per specification.	32	Numbers	9220.0	295040.0
78	Supply, installation, testing and commissioning of LED Aviation light luminaries Model no. BGAV 302 LED of Bajaj or similar as per specification.	4	Numbers	8215.0	32860.0
79	Supply, installation, testing and commissioning of control panel housing suitable timer contactor circuit for automatic ON & OFF of the mast lights at a pre-set time, (16M) as per specification.	4	Numbers	8431.0	33724.0
80	*Supply, installation, testing and commissioning of 11/0.433kV ,250 kVA outdoor type CSS consisting of 2 LBS (Load break Switch) and 1 VCB at HT side (630 Amps., 20 kA), 250 kVA Dry type transformer and 400 Amps ACB at LT side including RMU and other associated items as per requirement & as per specification.*	*2*	*Numbers*	*1857800.0*	*3715600.0*
81	Supply, installation, testing and commissioning of automatic power factor correction control panel (APFC panel) with 100 KVAR shunt capacitors complete in all respect and as per specification.	1	Numbers	73731.4	73731.4
				Total Estimated Amount of Schedule 'C'	**4,86,55,175.76**

8 Schedule D: Item Rate for Miscellaneous Works

Schedule 'D' Item Rate for Miscellaneous Works					
S. No	**Item Reference DSR-21/USSOR-2019 (NWR)**	**Description of Item**	**Unit**	**DSR/USSOR Rate in INR**	**Estimated Rate including GST@18% in INR**
DSR-21 Items (From S. No. 1 to 2)					
1	19.35	Providing and laying Non Pressure NP-3 class (Medium duty) R.C.C. pipes including collars/spigot jointed with stiff mixture of cement mortar in the proportion of 1:2 (1 cement : 2 fine sand) including testing of joints etc. complete.			
I	19.35.1	450mm dia. RCC pipes	Metre	2385.5	2,612.84
II	19.35.2	600 mm dia RCC pipes.	Metre	3051.55	3,342.36
2	19.6	Providing and laying non-pressure NP2 class (light duty) R.C.C. pipes with collars jointed with stiff mixture of cement mortar in the proportion of 1:2 (1 cement : 2 fine sand) including testing of joints etc. complete :			
I	19.6.1	100 mm dia. R.C.C. pipe	Metre	447.25	489.87
II	19.6.2	150 mm dia. R.C.C. pipe	Metre	493.1	540.09
III	19.6.3	250 mm dia. R.C.C. pipe	Metre	811	888.29

Schedule 'D' Item Rate for Miscellaneous Works					
S. No	**Item Reference DSR-21/USSOR-2019 (NWR)**	**Description of Item**	**Unit**	**DSR/USSOR Rate in INR**	**Estimated Rate including GST@18% in INR**
USSOR-2019 (NWR) Items - (From S. No. 3 to 6)					
3	031110	Load testing of one or more spans of bridge as selected by the Engineer as per approved load test procedure following relevant IS/IRC/Railway codes with contractor's labour, deflection measuring instruments, loading materials, recoding and analyzing the load testing results including all lead & lift, etc. complete as required. The rates are all inclusive and will be paid after load test is finished and girder is cleared of the kentledges/loading material etc. The load shall be 1.25 times the stipulated design load.			
I	031111	For Span design load upto 100 MT	Each	85662.09	96,815.29
II	031112	Extra for every increase 1 MT or part thereof in the span design load capacity upto 800 MT	MT	845.81	955.93
4	021010	Exploratory drilling of boreholes down to required depth, drilling of 150mm dia. boreholes in all type of soils except hard rock & large boulders (boulder core more than 30cm) including refilling, reinstating surface and disposing off surplus material including use of mechanical rigs with power operated winches as well as percussion/chiselling tool for advancing through occasional seams of hard strata to be employed, where necessary in Dry area.			
I	021011	0m to 10m	Metre	1,213.51	1,371.48
II	021012	10m to 20m	Metre	1,296.46	1,465.22
III	021013	20m to 30m	Metre	1,431.59	1,617.94
IV	021014	30m to 40m	Metre	1,554.68	1,757.06

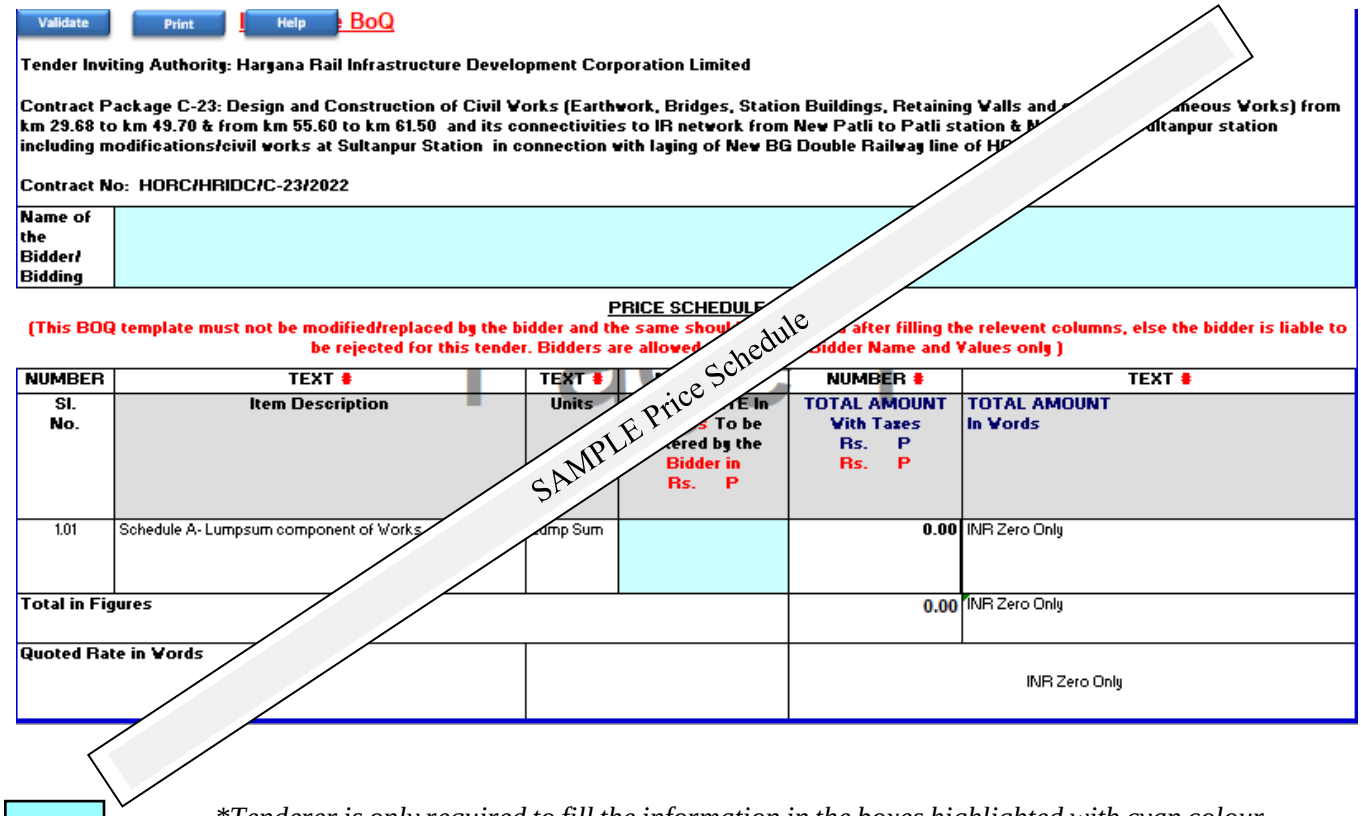
Schedule 'D' Item Rate for Miscellaneous Works					
S. No	**Item Reference DSR-21/USSOR-2019 (NWR)**	**Description of Item**	**Unit**	**DSR/USSOR Rate in INR**	**Estimated Rate including GST@18% in INR**
5	021050	Drilling of NX size borehole (75mm dia.) in all types of hard rock and collection of rock core samples from boreholes and preserving in boxes			
I	021051	0m to 10m	Metre	3,189.64	3,604.84
II	021052	10m to 20m	Metre	3,418.43	3,863.41
III	021053	20m to 30m	Metre	3,775.66	4,267.15
6	021060	Conducting in-situ full size Plate Load Test (PLT) at selected location as per IS:1888 including making loading arrangements & casting of RCC/cast in-situ concrete footing as per codal provisions including excavation and refilling of trial pit			
I	021062	Plate size 45cm x 45cm	Each	27,754.18	31,367.00
II	021063	Plate size 60cm x 60cm	Each	31,000.02	35,035.35
7	021080	Conducting SCPT for soil as per IS:4968	Each	47,313.49	53,472.38
8	021090	Conducting DCPT for soil as per IS:4968	Each	37,394.02	42,261.67
9	021110	Taking out 100mm dia. & 450mm long undisturbed samples of soil from bore holes, including provision of air tight containers for packing and, labelling incl. transporting the samples to laboratory. Piston sampler shall be used for extracting undisturbed samples where necessary. Samples shall be collected as per IS:2720.	Each	152.52	172.37

Schedule 'D' Item Rate for Miscellaneous Works					
S. No	**Item Reference DSR-21/USSOR-2019 (NWR)**	**Description of Item**	**Unit**	**DSR/USSOR Rate in INR**	**Estimated Rate including GST@18% in INR**
10	021120	Taking out 100mm dia. & 450mm long disturbed samples of soil from bore holes, including provision of air tight containers for packing, labelling and transporting the samples to laboratory. Samples shall be collected as per IS:2720.	Each	164.57	185.99
11	021130	Conducting standard penetration test as per IS:2131 at approximate1.5m intervals in bore holes, as directed by the Engineer in charge	Each	852.27	963.21
12	021150	Conducting laboratory Tests on collected soil samples as per relevant IS code			
I	021151	Moisture Content/Dry Density	Each	287.66	325.11
II	021152	Atterberg Limits	Each	586.02	662.30
III	021153	Specific Gravity	Each	631.51	713.71
IV	021154	Grain size analysis including Hydrometer analysis	Each	731.85	827.12
V	021155	Direct Shear Test	Each	2,140.70	2,419.36
VI	021156	Natural Density	Each	709.11	801.42
VII	021157	Consolidation Test	Each	6,886.37	7,782.78
VIII	021158	Unconfined Compression Test	Each	2,006.91	2,268.15
IX	021159	Tri-axial Test	Each	2,408.29	2,721.78

Total Estimated cost of Schedule 'D'- INR 2.00 Crore (INR 20 million).

Price Schedule

(Please refer Price Schedule uploaded on e-procurement portal)



Validate Print Help BoQ

Tender Inviting Authority: Haryana Rail Infrastructure Development Corporation Limited

Contract Package C-23: Design and Construction of Civil Works (Earthwork, Bridges, Station Buildings, Retaining Walls and ... ...aneous Works) from km 29.68 to km 49.70 & from km 55.60 to km 61.50 and its connectivities to IR network from New Patli to Patli station & N... ...ultanpur station including modifications/civil works at Sultanpur Station in connection with laying of New BG Double Railway line of HO...

Contract No: HORC/HRIDC/C-23/2022

Name of the Bidder/ Bidding	

PRICE SCHEDULE

(This BOQ template must not be modified/replaced by the bidder and the same shou... ...after filling the relevent columns, else the bidder is liable to be rejected for this tender. Bidders are allowed... ...idder Name and Values only)

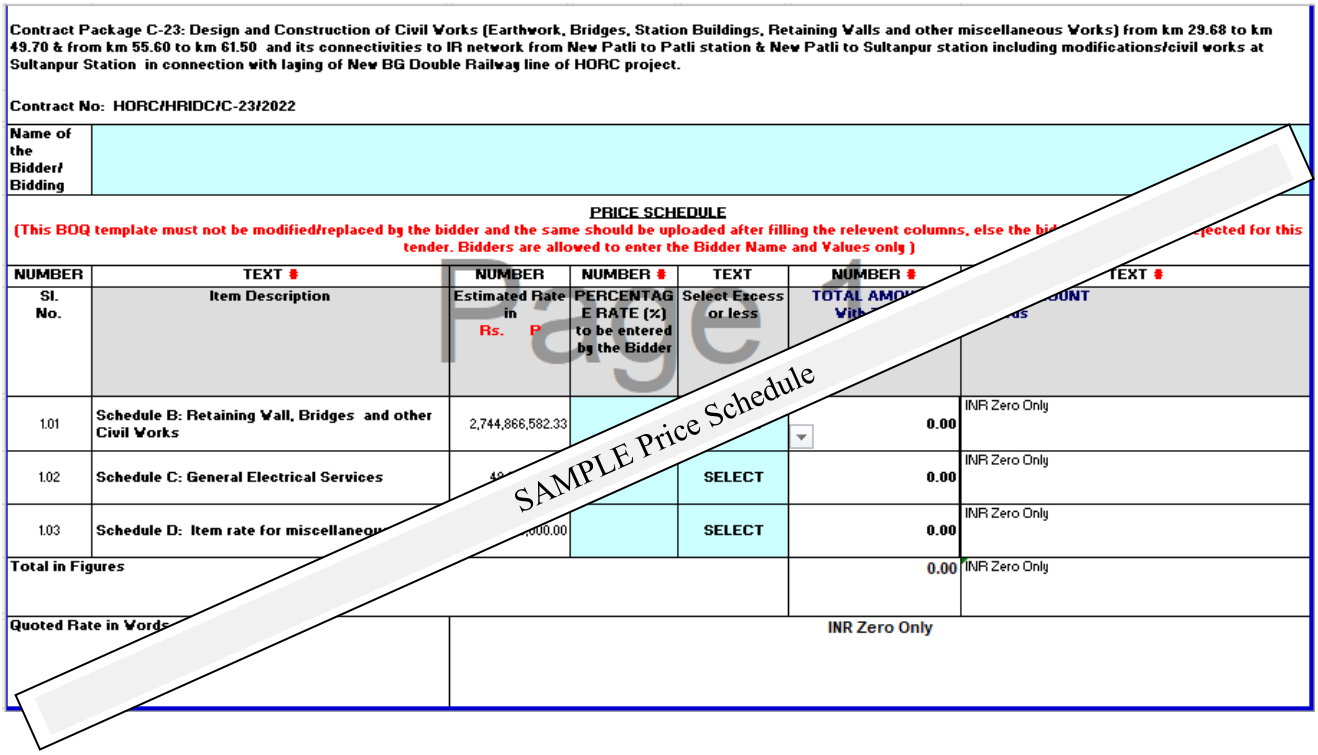
NUMBER	TEXT	TEXT		NUMBER	TEXT
Sl. No.	Item Description	Units	...TE In ...s To be ...ered by the Bidder in Rs. P	TOTAL AMOUNT With Taxes Rs. P Rs. P	TOTAL AMOUNT In Words
1.01	Schedule A- Lumpsum component of Works	...ump Sum		0.00	INR Zero Only
Total in Figures				0.00	INR Zero Only
Quoted Rate in Words					INR Zero Only

SAMPLE Price Schedule

**Tenderer is only required to fill the information in the boxes highlighted with cyan colour in Price Schedule (Excel sheet)*

Price Schedule

(Please refer Price Schedule uploaded on e-procurement portal)



Contract Package C-23: Design and Construction of Civil Works (Earthwork, Bridges, Station Buildings, Retaining Walls and other miscellaneous Works) from km 29.68 to km 49.70 & from km 55.60 to km 61.50 and its connectivities to IR network from New Patli to Patli station & New Patli to Sultanpur station including modifications/civil works at Sultanpur Station in connection with laying of New BG Double Railway line of HORC project.

Contract No: HORC/HRIDC/C-23/2022

Name of the Bidder/ Bidding	

PRICE SCHEDULE

(This BOQ template must not be modified/replaced by the bidder and the same should be uploaded after filling the relevent columns, else the bid ...jected for this tender. Bidders are allowed to enter the Bidder Name and Values only)

NUMBER	TEXT *	NUMBER	NUMBER *	TEXT	NUMBER *	TEXT *
Sl. No.	Item Description	Estimated Rate in Rs. P	PERCENTAGE RATE (%) to be entered by the Bidder	Select Excess or less	TOTAL AMO... With ...	...OUNT ...s
1.01	Schedule B: Retaining Wall, Bridges and other Civil Works	2,744,866,582.33			0.00	INR Zero Only
1.02	Schedule C: General Electrical Services	4...		SELECT	0.00	INR Zero Only
1.03	Schedule D: Item rate for miscellaneou...	...,000.00		SELECT	0.00	INR Zero Only
Total in Figures					0.00	INR Zero Only
Quoted Rate in Words		INR Zero Only				

Page 4
SAMPLE Price Schedule

**Tenderer is only required to fill the information in the boxes highlighted with cyan colour in Price Schedule (Excel sheet)*

Price Schedule

(Please refer Price Schedule uploaded on e-procurement portal)

Name of the Bidder/ Bidding			
PRICE SCHEDULE-SUMMARY SHEET (This BOQ template must not be modified/replaced by the bidder and the same should be uploaded after filling the relevent columns, else the bidder is liable to be rejected for this tender. Bidders are allowed to enter the Bidder Name and Values only)			
NUMBER	TEXT #	NUMBER #	TEXT #
Sl. No.	Item Description	TOTAL AMOUNT With Taxes Rs. P	TOTAL AMOUNT In Words Rs. P
1.01	Schedule A: Lumpsum component of Works	0.00	INR Zero Only
1.02	Schedule-B: Retaining Wall, Bridges and Other Civil Works	0.00	
1.03	Schedule-C: General Electrical Services		INR Zero Only
1.04	Schedule-D: Item rate for miscellaneous woks	0.00	INR Zero Only
1.05	Provisional Sum	100,000,000.00	INR Ten Crore Only
Total in Figures		100,000,000.00	INR Ten Crore Only
Quoted Rate in W		INR Ten Crore Only	

Page 1
SAMPLE Price Schedule

**Tenderer is only required to fill the information in the boxes highlighted with cyan colour in Price Schedule (Excel sheet)*

Section V - Eligible Countries

Eligibility for the Provision of Goods, Works and Non-Consulting Services in Bank-Financed Procurement

In reference to ITT 4.8 and 5.1, for the information of the Tenderers, at the present time, firms, goods and services from the following countries are excluded from this Tendering process:

Under ITT 4.8 (a) and 5.1: ***None***

Under ITT 4.8 (b) and 5.1: ***None***

Section VI - Prohibited Practices

1. The Bank requires that the Recipient (and all other beneficiaries of the Bank financing), as well as tenderers, suppliers, contractors, concessionaires and consultants under Bank-financed contracts for the Project, observe the highest standard of transparency and integrity during the procurement, execution and implementation of such contracts.

2. Definitions. In pursuance of this policy, the Bank defines the terms set forth below as Prohibited Practices:

   (a) "**coercive practice**" means impairing or harming, or threatening to impair or harm, directly or indirectly, any party or the property of a party to influence improperly the actions of a party;
   (b) "**collusive practice**" means an arrangement between two or more parties designed to achieve an improper purpose, including to influence improperly the actions of another party;
   (c) "**corrupt practice**" means the offering, giving, receiving or soliciting, directly or indirectly, of anything of value to influence improperly the actions of another party;
   (d) "**fraudulent practice**" means any act or omission, including a misrepresentation, that knowingly or recklessly misleads, or attempts to mislead, a party to obtain a financial or other benefit or to avoid an obligation.
   (e) "**misuse of resources**" means improper use of the Bank's resources, carried out either intentionally or through reckless disregard;
   (f) "**obstructive practice**" means any of the following practices: (i) deliberately destroying, falsifying, altering or concealing of evidence material to a Bank investigation; (ii) making false statements to investigators in order to materially impede a Bank investigation into allegations of a Prohibited Practice; (iii) failing to comply with requests to provide information, documents or records in connection with a Bank investigation; (iv) threatening, harassing or intimidating any party to prevent it from disclosing its knowledge of matters relevant to a Bank investigation or from pursuing the investigation; or (v) materially impeding the exercise of the Bank's contractual rights of audit or inspection or access to information; and
   (g) "**theft**" means the misappropriation of property belonging to another party.

3. Any occurrence, or suspected occurrence, of a Prohibited Practice in the procurement, award, or implementation of a Bank-financed contract is dealt with in accordance with the provisions of the Bank's Policy on Prohibited Practices. Suppliers, contractors, service providers and consultants selected pursuant to the provisions of Section II and concessionaires selected pursuant to paragraph 14.3 of the Bank's Procurement Instructions for Recipients, as well as the Recipient shall fully cooperate with the Bank (or a cofinancier undertaking an investigation pursuant to paragraph 6.1 of the Bank's Procurement Instructions for Recipients) in any investigation into an alleged Prohibited Practice to be carried out pursuant to the Policy on Prohibited Practices, and permit the Bank or its representative (including such co-financier) to

inspect such of their accounts and records as may be relevant for such investigation and to have such records and accounts audited by the auditors appointed by the Bank.

4. Provisions to this effect are included in the Legal Agreements and the procurement contracts with such entities.

5. If the Project is financed by a sovereign-backed loan, the Bank (or, where relevant, a co-financier having undertaken an investigation pursuant to paragraph 6.1 of the Bank's Procurement Instructions for Recipients):

   (a) may take any of the following additional actions in connection with a Prohibited Practice under the Project:

      (i) reject a proposal for award if it determines that the tenderer recommended for award, or any of its personnel, or its agents, or its sub-consultants, subcontractors, service providers, suppliers or their employees, has, directly or indirectly, engaged in a prohibited practice in competing for the contract in question; and

      (ii) cancel the undisbursed portion of the loan allocated to a contract (and require reimbursement of the disbursed portion of the loan allocated to the contract) if it determines at any time that representatives of the Recipient or of a recipient of any part of the proceeds of the loan engaged in a prohibited practice during the procurement, administration or implementation of the contract in question; and

   (b) requires that a clause be included in tender documents and in contracts financed by the Bank loan, requiring tenderers, suppliers and contractors, and their subcontractors, agents, personnel, consultants, service providers, or suppliers, to permit the Bank (and a co-financier undertaking an investigation pursuant to paragraph 6.1 of the Bank's Procurement Instructions for Recipients) to inspect all accounts, records, and other documents relating to the submission of tenders and contract performance, and to have them audited by auditors appointed by the Bank.

Final Tender Document for Works

(Two-Envelope Tendering Process Without Prequalification)

Procurement of:

Contract Package C-23: Design and Construction of Civil Works (Earthwork, Bridges, Station Buildings, Retaining Walls and other miscellaneous Works) from km 29.68 to km 49.70 & from km 55.60 to km 61.50 and its connectivities to IR network from New Patli to Patli station & New Patli to Sultanpur station including modifications/civil works at Sultanpur Station in connection with laying of New BG Double Railway line of HORC project.

Summary

Specific Procurement Notice (SPN)

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Section VII-1: General

EMPLOYER'S REQUIREMENTS – GENERAL

1 Project Profile and Background.

1.1 General

State of Haryana is strategically located bordering the National capital of Delhi. NCT, Delhi shares three fourth of its border with Haryana alone and remaining with Uttar Pradesh. The development of Haryana region, bordering Delhi is very important for balanced growth of NCR as it acts as buffer zone against rampant migration and other support infrastructure. At present on account of growth of Metro network in Delhi & NCR, there is radial movement of commuters to and from, Delhi being in centre. This "Hub and Spoke" traffic planning has resulted in rapid growth of Noida, Greater Noida, Faridabad and Gurugram. However, for hub and spoke concept to sustain it is necessary to link the ends of spoke by ring connectivity. There will be natural demand for commuter movement within these towns like Gurugram, Faridabad, Ballabhgarh, Palwal, Sohna, Manesar etc. Peripheral roads have been commissioned recently, linking these towns around Delhi but Rail link provides economical, sustainable, eco-friendly and bulk freight transport option. The peripheral Rail link will also help in growth of other cities within the same distance from Delhi like Sonipat, Panipat, and Rohtak. Western DFC originating from Dadri station is passing through Asaoti Station on Delhi- Mathura route, providing connectivity to Haryana Orbital Rail Corridor (HORC). This will also help in easing the pressure on the transport network of Delhi as some of the commuter traffic moving on the radials will get shifted to HORC. Apart from passenger traffic, substantial amount of freight traffic, which is entering the Delhi area of rail network but is not meant to be consumed in Delhi, will also get diverted via this corridor. Apart from this, there are major goods sheds in the heart of Delhi causing endless avoidable traffic jams. The goods sheds in west Delhi are Azadpur, Shakurbasti, Dayabasti, Sabzi Mandi which are located on prime commercial land and are black spots of the urban planning. Previously moving out commercial activity to other states had interstate taxation issues but now with GST in place, there is no reason of not shifting these activities to the peripheral region. In any case, if freight traffic movement through Delhi is restricted, then these goods sheds or alternatives will be serviced via the proposed HORC. Haryana Orbital Rail Corridor (HORC) from Palwal to Sonipat Via Sohna, Manesar, Kharkhoda and Harsana Kalan is to be constructed as an Electrified (1X25kV AC-50Hz) double line track, capable of operating at a maximum train speed of 160 kmph.

1.2 Forest and Environmental Clearance

It is mentioned that for railway projects no prior environmental clearance is required as per Environment Impact Assessment (EIA) Notification, 2006. Further, the Forest (Conservation) Act, 1980 is not applicable to the Project in terms of Ministry of Environment, Forest and Climate Change (MoEFCC's) OM No.11-37/2016 FC dated 10.03.2022. *However, a small portion of approximately 150m length between km 49.3 to km 49.45 of the Project falls in specified area of Aravalli plantation. The clearance for this area of Aravalli plantation is under process. This is likely to be obtained within 180 days of the Commencement Date. This being a small isolated patch will not effect the progress of work at any of the other locations and as such no claims on these grounds by the Contractor shall be accepted. The Contractor shall plan his works taking this aspect into consideration..*

2 DEFINITIONS AND INTERPRETATIONS

In addition to the words and expressions defined in the General Conditions of Contract, further following words and expressions shall have the meaning assigned to them except where the context otherwise requires:

- **"As-Built Drawings"** means those drawings produced by the Contractor and endorsed by its true records of construction of the Permanent Works and which have been given a consent from the Engineer.

- **"As-Built Documents"** mean the set of drawings and documents which are a true record of the construction of the Permanent Works prepared by the Contractor.

- **"CAD Standards"** means requirements for CAD, as specified in the Appendix 9 of Employer's Requirements.

- **"Charted Utilities"** mean identified Utilities listed in Employer's Requirements-Tender Drawings and Documents, which may be affected by the execution of the Works under the Contract.

- **"Cold Joint"** means a joint or discontinuity formed when a concrete surface hardens before the next batch is placed against it, characterised by poor bond unless necessary procedures are observed.

- **Combined Services Drawings" (CSD):** means drawings showing the locations, layouts and sizes of all services including those of other contractors co-ordinated so as to eliminate all clashes.

- **"Construction Phase":** has the meaning identified in the Employer's Requirements - General.

- **"Construction Reference Drawings":** means those drawings referred in the Employer's Requirements - Design in respect of which a Notice has been issued.

- **"Construction Reference Drawings Submission":** means the submission of Construction Reference Drawings representing elements of the Permanent Works and for which the Contractor seeks a Notice.

- **"Contract Spares"** means any Spare Parts recommended by the Contractor for the operation and maintenance of the Permanent Works following the Taking Over of the Works.

- **"Consumables"** means those parts that are not repairable and usually have a relatively short life span.

- **"Critical Path Method"** means a schedule network analysis technique used to determine the amount of scheduling flexibility (the amount of float) on

various logical network paths in the project schedule network, and to determine the minimum total project duration.

- **"Definitive Design Submission":** means the submission of documents which comprise the whole or parts of the proposed Definitive Design and for which the Contractor seeks a Notice.

- **"Design Criteria":** means the criteria defined in Employer's Requirements-Design and Outline Design Specifications.

- **"Design Manual":** means the manual to be prepared and submitted by The Contractor as part of the Definitive Design and as described in the Employer's Requirements - Design.

- **"DN Line"** means the down line of the HORC double line track route from Sonipat to Palwal.

- "**Final Design":** has the meaning identified in the Employer's Requirements – Design.

- **"Fixed Structure Gauge":** means the profile related to the designed normal co-ordinated axis of the track into which no part of any structures or fixed equipment may penetrate.

- **"Good For Construction Drawings (GFC)":** Construction Reference Drawings or Working Drawings which have received Notice from the Engineer, shall be endorsed as "Good For Construction Drawings" and will be issued to the Site. Execution of work shall be carried out only as per drawings which have been endorsed as GFC.

- **"Interface Management Plan"** means the plan for all interface issues that may arise during the design, construction, testing and commissioning of the Works, in consultation with the Interfacing Contractors/ Interfacing Parties and the Engineer.

- **"Independent Laboratory"** means a laboratory, submitted by the Contractor to the Engineer for approval, that is free from outside control and not subject to direct or indirect influence or authority of the Employer, the Engineer, or the Contractor

- **"Inspection and Test Plan"** means a document that states inspection and testing requirements and actions provisioned for the Works, related process, Plant, or Materials. It is used to control, check, monitor and record; testing procedures that are required for quality assurance and to achieve the agreed quality requirements for the Works.

- **"Installation Tests"** means the tests to be performed to verify the conformity of completion of an installation/assembly to the design documents approved by the Engineer prior to the start of Commissioning, and they must be successfully completed before the Tests on Completion.

- **"Interface Coordinator"** means the person who has the responsibility, and authority with substantial experience to resolve interface matters to the satisfaction of the Engineer and provide the necessary support team for the Interface Management System as specified in Appendix 5

- **"Interfacing Contractor"** means the Contractor engaged by the Employer or other agencies having an interface issue with the Contractor for the Works.

- **"Interfacing Parties"** comprises the interfacing contractors / consultants / service providers, who are engaged in part of the works, relevant authorities and public utility agency.

- **"Interface Table"** means the table that describes the relationships between the Contractor and Interfacing Contractors / Interfacing Parties and their roles and responsibilities is a key document.

- **"Kick-Off Meeting"** means the meeting held by the Engineer to formally notify all parties concerned under the Contract that the project has commenced and to ensure that every party has a common understanding of their role from the Commencement Date up until issuance of the Performance Certificate.

- **"Maintenance Manuals"** means the manuals providing detailed instructions for the maintenance of infrastructure and maintenance facilities.

- **"Method Statement"** means a document that states the way a particular work, task, or process along with various associated aspects such as quality, safety, environment protection, time and resources; are planned to be directly controlled by the Contractor or its Subcontractor.

- **"Monthly Progress Meeting"** means the meeting specified under Appendix 7 of the Employer's Requirements.

- **"Monthly Progress Report"** means the report that the Contractor shall prepare and submit to the Engineer.

- **"Nonconformity Report"** means a report documenting non-fulfilment of a requirement, with objective evidence, the location and time of occurrence or detection, and provision for its proper resolution by the concerned responsible.

- **"Notice":** means a Notice of No Objection.

- **"Notice of Objection"** means a category of Engineer's response, issued by the Engineer to the Contractor.

- **"Not Reviewed"** means a category of Engineer's response, issued by the Engineer to the Contractor .

- **"On-Site Laboratory"** means Contractor's own laboratory submitted by the Contractor to the Engineer for approval as specified in Appendix 12 of the Employer's Requirements.

- **"Operation and Maintenance Manuals (O&M Manuals)"** means the manual that will be indicating the provisions which are required for maintenance of various assets created under the Contract by the Employer under their operation phase.

- **"Priority Section"** means the section from Km 49.7 to Km 55.6 of HORC Main line and connectivity line from Manesar station on HORC and Patli station on Delhi-Rewari section of Indian Railway Network.

- **"Programme Analysis Report"** means the report submitted to the Engineer that shall, in narrative format, describe the basis and assumptions used to develop each programme.

- **"Project"** means the project named as "Haryana Orbital Rail Corridor (HORC)".

- **"Project Management Plan"** refers to the plan that will be established by the Contractor for the management of activities related to design, procurement, manufacture, execution/construction, delivery, installation, testing and commissioning.

- **"Project Management Information System"** means a document, information and communication technology system (platform) that is to be implemented by the Contractor so that the management of information between the Contractor, the Employer and the Engineer is efficient, reliable, and secure.

- **"Preliminary Design":** means the submission of documents which comprise the initial stage of the design phase.

- **"Indian Railway"** means the rail tracks of the Indian Railway or any other organization and any ancillary areas of Indian Railway such as the depots, sidings, stations, terminus, traction power stations, etc.

- "**Request for Inspection"** means the form used to give notice by the Contractor to the Engineer.

- **"Railway Representative"** means a person, or persons, nominated by the Employer / Engineer to liaise with the Contractor and the Engineer on matters affecting the operation of Indian Railway.

- **"Tender drawings and Documents"** means the drawings and documents prepared by the Employer for reference purposes only and included in the Tender Documents.

- **"Right of Way"** means the land area of the Project, either acquired by the Employer or for which the Employer has the permission of the Stakeholder to construct the embankment & bridges, etc. over their area.

- **"Environmental, Social, Health and Safety Management Plan"** means the plan in accordance with the requirements of Appendix 13 of the Employer's Requirements.

- "**Safety**" freedom from unacceptable risk of harm.

- **"Site Office"** means Site Office for Employer's/Engineer's Personnel constructed by the Contractor.

- **"Spare Parts"** means those parts which are generally repairable and have normally a service life of several years.

- **"Specification"** has the meaning identified in the Employer's Requirements - General.

- **"Station Yard"** is defined as the section between points at either end of the station which are located 50 m from the outermost points away from the station.

- **"Tertiary Control Points (TCP)"** means the benchmarks provided by the Employer, used to locate & confirm the Right of Way (ROW) and its co-ordinates including levels for the purpose of execution of works.

- **"Three Months Rolling Programme"** means the programme which the Contractor shall prepare and update monthly as per Appendix 6 of the Employer's Requirements.

- **"Three Weeks Rolling Programme"** means the programme which the Contractor shall prepare and update weekly as per Appendix 6 of the Employer's Requirements.

- **"Time Bar Chart",** known as "Gantt Chart" too is a type of bar chart which illustrates a project schedule. i.e. the start and finish dates of the activities and summary elements of a project

- **"Uncharted Utilities"** mean Utilities other than Charted Utilities which are identified during a survey conducted by the Contractor or encountered during excavation/ other works.

- **"UP Line"** means the up line of the HORC double line track route from Palwal to Sonipat.

- **"Utilities"** means the electricity, lighting, traffic control, telephone and/or communication cables, gas, water, sewage and drainage pipes, including all associated protection, supports, ancillary structures, fittings and equipment.

- **"Working Drawing"** means additional drawings developed by the Contractor as necessary to supplement the Construction Reference Drawings and to specify additional details and procedures for construction of the Works, such as shop drawings, fabrication drawings, erection drawings, Temporary Works drawings, bar bending schedules, bar reference drawings, embankment/cutting cross sections. All such drawings shall comply with the requirements of the Contract.

- **"Works Areas"** means the areas of the Site within the Right of Way and any additional areas which may be obtained by the Contractor and agreed by the Engineer as additional working area.

- **"Works Programme"** means the time-scaled and resource-loaded critical path network, updated from time to time in accordance with the General Conditions of Contract and Employer's Requirements, depicting activities, durations, sequences and interrelationships that represent the Contractor's work plan, work breakdown, schedule structure for constructing and completing the Works, distributed over the Time for Completion of the Contract.

- **Abbreviations**

AC	**:**	**Alternating Current**
ACB	**:**	**Air Circuit Breaker**
AIIB	**:**	**Asian Infrastructure Investment Bank**
ALARP	**:**	**As Low As Reasonably Practicable**
ASLI	**:**	**Automatic Safe Load Indicator**
BG	**:**	**Broad Gauge**
BIS	**:**	**Bureau Of Indian Standards**
BOCW	**:**	**Building Or Other Construction Work**
BS	**:**	**British Standards**
CAD	**:**	**Computer Aided Design**
CCTV	**:**	**Closed Circuit Television**
CP	**:**	**Contract Package**
CPCB	**:**	**Centre Pollution Control Board**
CPM	**:**	**Critical Path Method**

CRS	**:**	**Commissioner Of Railway Safety**
CSD	**:**	**Combined Service Drawings**
CV	**:**	**Curriculum Vitae**
DB	**:**	**Distribution Box**
DCN	**:**	**Design Change Notice**
DFC	**:**	**Dedicated Freight Corridor**
DFCCIL	**:**	**Dedicated Freight Corridor Corporation Of India Limited**
DG	**:**	**Diesel Generator**
DGPS	**:**	**Differential Global Positioning System**
DIN	**:**	**Deutsche Industrial Norms**
DL	**:**	**Double Line**
DNP	**:**	**Defect Notification Period**
DPR	**:**	**Daily Progress Report**
DT	**:**	**Down Time**
E&M	**:**	**Electrical & Mechanical**
EIA	**:**	**Environmental Impact Assessment**
ELCB	**:**	**Earth Leakage Circuit Breaker**
EMC	**:**	**Electro Magnetic Compatibility**
EMI	**:**	**Electro Magnetic Interference**
ESHS	**:**	**Environmental, Social, Health And Safety**
FAT	**:**	**Factory Acceptance Test(S)**
FCN	**:**	**Field Change Notice**
FFL	**:**	**Finished Floor Level**
FL	**:**	**Formation Level**
GAD	**:**	**General Arrangement Drawing**
GCC	**:**	**General Conditions Of Contract**

GE	**:**	**Geotechnical Engineering**
GFL	**:**	**Ground Floor Level**
GIS	**:**	**Geographical Information System**
GL	**:**	**Ground Level**
GNSS	**:**	**Global Navigation Satellite System**
GOI	**:**	**Government Of India**
GPS	**:**	**Global Positioning System**
GRC	**:**	**Grievance Redress Committee**
GRM	**:**	**Grievance Redress Mechanism**
HDPE	**:**	**High Density Polyethylene**
HFL	**:**	**Highest Flood Level**
HORC	**:**	**Haryana Orbital Rail Corridor**
HT	**:**	**High Tension**
HV	**:**	**High Voltage**
HVAC	**:**	**Heating, Ventilation And Air Conditioning**
Hz	**:**	**Hertz**
IC	**:**	**Integrated Circuit**
ID	**:**	**Identification**
IMD	**:**	**Integrated Maintenance Depot**
IMP	**:**	**Interface Management Plan**
INR	**:**	**Indian Rupee**
IP	**:**	**Point Of Intersection**
IPS	**:**	**Integrated Power Supply**
IR	**:**	**Indian Railways**
IRC	**:**	**Indian Road Congress**
IRS	**:**	**Indian Railway Standards**

IS	**:**	**Indian Standards**
ISO	**:**	**International Organization For Standardization**
IT	**:**	**Information Technology**
ITP	**:**	**Inspection And Test Plan**
Km	**:**	**Kilometre**
kV	**:**	**Kilo Volt**
LAN	**:**	**Local Area Network**
LCD	**:**	**Liquid Crystal Display**
LCX	**:**	**Leaky Coaxial Cable**
LED	**:**	**Light Emitting Diode**
LT	**:**	**Low Tension**
LV	**:**	**Low Voltage**
LWL	**:**	**Lowest Water Level**
MC	**:**	**Municipal Corporation**
MCB/LV	**:**	**Miniature Circuit Breaker / Low Voltage**
MCCB	**:**	**Moulded Case Circuit Breaker**
MDR	**:**	**Major District Roads**
MOR	**:**	**Ministry Of Railway**
MPR	**:**	**Monthly Progress Report**
MQR	**:**	**Monthly Quality Report**
MS	**:**	**Method Statement**
MSDS	**:**	**Material Safety Data Sheet**
MSL	**:**	**Mean Sea Level**
NABL	**:**	**National Accreditation Board For Testing And Calibration Laboratories**
NCR	**:**	**Nonconformity Report**
NFPA	**:**	**National Fire Protection Association**

NGO	**:**	**Non-Governmental Organization**
NH	**:**	**National Highway**
NHAI	**:**	**National Highway Authority Of India**
NOC	**:**	**No Objection Certificate**
NONO	**:**	**Notice Of No Objection**
NONOC	**:**	**Notice Of No Objection With Comments**
NOO	**:**	**Notice Of Objection**
NR	**:**	**Not Reviewed**
O&M	**:**	**Operation And Maintenance**
OCS	**:**	**Overhead Catenary System**
ODR	**:**	**Other District Roads**
OEM	**:**	**Original Equipment Manufacturer**
OFC	**:**	**Optical Fibre Cable**
OHE	**:**	**Over Head Electrification**
OHSAS	**:**	**Occupational Health And Safety Assessment Series**
OHTL	**:**	**Over Head Transmission Lines**
PCC	**:**	**Particular Conditions Of Contract**
PDF	**:**	**Portable Document Format**
PHA	**:**	**Preliminary Hazard Analysis**
PMIS	**:**	**Project Management Information System**
PPE	**:**	**Personal Protective Equipment**
PR	**:**	**Public Relation**
PS	**:**	**Particular Specifications**
PVC	**:**	**Polyvinyl Chloride**
PWD	**:**	**Public Works Department**
QA	**:**	**Quality Assurance**

RAMS	**:**	**Reliability, Availability, Maintainability And Safety**
RAP	**:**	**Resettlement Action Plan**
RCC	**:**	**Reinforced Cement Concrete**
RDSO	**:**	**Research Designs And Standards Organization**
RFI	**:**	**Request For Inspection**
RFO	**:**	**Rail Fly Over**
RINL	**:**	**Rashtriya Ispat Nigam Limited**
RL	**:**	***Reduced Level***
ROB	**:**	**Road Over Bridge**
ROW	**:**	**Right Of Way**
RUB	**:**	**Road Under Bridge**
S&T	**:**	**Signalling And Telecommunication**
SAIL	**:**	**Steel Authority Of India Limited**
SAT	**:**	**System Acceptance Test**
SCADA	**:**	**Supervisory Control And Data Acquisition**
SH	**:**	**State Highway**
SI	**:**	**International System Of Units**
SL	**:**	**Single Line**
SM	**:**	**Station Master**
SOD	**:**	**Schedule Of Dimensions**
SP	**:**	**Sectioning Post**
SRR	**:**	**Submission Review Request**
SSP	**:**	**Sub-Sectioning Post**
TSS	**:**	**Traction Substation**
UG	**:**	**Under Ground**

UPS	**:**	**Uninterrupted Power Supply**
USB	**:**	**Universal Serial Bus**
UTM	**:**	**Universal Transverse Mercator**
VN	**:**	**Variation Notice**
WGS84	**:**	**World Geodetic System 84**
WHO	**:**	**World Health Organization**
WQMP	**:**	**Works Quality Management Plan**

3 RELEVANT DOCUMENTS

The Design Criteria shall be read in conjunction with the General Conditions of Contract (GCC), the Particular Conditions of Contract (PCC), the Employer's Requirements, the drawings and any other document forming part of the Contract.

In case of conflict in Design Criteria in various Sub-Sections of Section VII, Employer's Requirement the order of precedence shall be as follows :

CIVIL

- Outline Design Specifications,
- Outline Construction Specification,
- Tender drawings,
- Employer's Requirements (Functional),
- Employer's Requirements (Design),
- Employer's Requirements (Construction),
- Employer's Requirements (General),
- Employer's Requirements (Appendices),
- Indian and other International Standards referenced herein,
- Indian and other International Standards.

All relevant RDSO Standards/drawings required by the Contractor for performance of its obligations under the Contract shall be obtained by the Contractor at their own cost from the office of RDSO. RDSO drawings can also be purchased online from RDSO website.

4 PHASES (DESIGN AND CONSTRUCTION)

a) The Contractor shall execute the Works in two phases, the Design Phase and the Construction Phase.

b) The Design Phase shall commence upon the date of Letter of Acceptance (LOA). This phase shall include the preparation and submission of:

i. the Preliminary Design,

ii. the Definitive Design;

iii. The Construction Reference Drawings.

iv. The Design Phase will be complete upon the issue of a Notice in respect of the comprehensive and complete Construction Reference Drawings Submission for the whole of the Permanent Works.

c) The requirements for the Preliminary Design, Definitive Design and Construction Reference Drawings are stated in Clause 2 of the Employer's Requirements -Design.

d) The Construction Phase for the whole or a part of the Permanent Works shall commence immediately upon the issue of a Notice by the Engineer/Employer in respect of the relevant Construction Reference Drawings Submission. Such Notice may be issued by the Engineer in respect of a Construction Reference Drawing Submission covering a major and distinctive part of the Permanent Works. However, construction shall not be commenced until the appropriate Working Drawings have been endorsed:

(a) by the Contractor as "Good for Construction"; and

(b) by the Engineer that he has no objections to the drawing.

The Construction Phase shall include the completion and submission of the Final Design and the preparation and submission of the As Built Drawings and other records as specified.

e) Notwithstanding Clause *4 (b) (iv)* above, for those elements identified under Clause *2.6* of the Employer's Requirements - Design, the Construction Phase may commence immediately upon the issue of the Notice in respect of the Definitive Design Submission in respect of each such element subject to availability of the site in accordance with agreed programme.

f) The Contractor shall furnish Contractor's Warranty in the format approved by the Employer given in Section X – Contract Forms.

5 SPECIFICATIONS

In accordance with the provisions of these Employer's Requirements (Section VII-1 to Section VII-9), the Contract Specification contained in the Contract shall be developed during the design stage and submitted as part of the Definitive Design Submission. When the Specification has received a Notice of No Objection from the Engineer, it shall become the Particular Specifications and shall take precedence over the other Specifications for construction purposes.

6 SPECIFICATIONS IN METRIC AND IMPERIAL UNITS

a) The Contract shall utilise the SI system of units. Codes and Standards in imperial units shall not be used unless the Engineer has given his consent.

b) Conversion between metric units and imperial units shall be in accordance with the relevant Indian Standards.

7 WORKS PROGRAMME

a) The Key Dates are defined in Appendix 2 to these Employer's Requirements.

b) The Contractor shall prepare and submit its Works Programme and three-month rolling programmes and the detailed requirements contained in Appendix 6 to these Employer's Requirements.

c) In compiling its Works Programme and in all subsequent updating and reporting, the Contractor shall make provision for the time required for co-

ordinating and completing the design, testing, commissioning and integrated testing of the Works, including, inter alia, design co-ordination periods during which the Contractor shall co-ordinate its design with those of Interfacing Contractors, the review procedures, determining and complying with the requirements of all Government Departments and all others whose consent, permissions, authority or licence is required prior to the execution of any work.

d) The Works Programme shall take full account of the Design Submission Programme.

8 MONITORING OF PROGRESS

a) Project Monitoring shall be done by Project Monitoring and Information System (PMIS). The contractor has to prepare Primavera P6 schedule as per the Programme Requirements provided in Appendix 6.

b) The Contractor shall submit to the Engineer three copies (along with an additional copy in digital format) of a Monthly Progress Report (MPR), as described in Appendix 7 to these Employer's Requirements, describing the progress and current status of the Works. The MPR shall address the matters set out in the Works Programme.

c) The MPR shall be submitted by the end of each calendar month. It shall account for all works actually performed in the current month.

d) The MPR shall be divided into two sections. The first section shall cover progress and current status relating to design and the second section shall cover progress and current status relating to construction.

e) A monthly meeting to monitor & review the progress of the project shall be convened by the Engineer. Contractor's site Representative & Designer Representative of Contractor and site representative of all Interfacing Contractors shall also attend the meeting. The Employer may also be present in the meeting.

f) The Engineer or Employer may also conduct progress review meetings and Interface meetings on weekly /bi-weekly intervals depending upon the requirements or urgency of works. In these review meetings Engineer may call Contractor's Supplier/Sub-Contractor/Designer etc. as per the requirements.

9 QUALITY ASSURANCE

The Contractor shall establish and maintain a Quality Assurance System in accordance with Appendix 11 to these Employer's Requirements for design and construction procedures and the interfaces between them. This Quality Assurance system shall be applied without prejudice to, or without in any way limiting, any Quality Assurance Systems that the Contractor already maintains.

10 IMPLEMENTATION OF SOFTWARE BASED BILLING & PROJECT MANAGEMENT SYSTEMS

The Contractor shall perform all billing processes through the software-based billing system as and when introduced by HORC *free of cost*. The Contractor shall also introduce appropriate Project Management Systems during the project execution phase.

11 CO-ORDINATION WITH INTERFACTING CONTRACTORS

11.1 General

a) The Contractor is responsible for detailed co-ordination of his design and construction activities with Interfacing Contractors. Such co-ordination responsibilities of the Contractor shall include the following:

i. To provide all information reasonably required by the Interfacing Contractors in a timely and professional manner to allow them to proceed with their design or construction activities, and specifically to meet their contractual obligations.

ii. To ensure that the Contractor's requirements are provided to all other Interfacing Contractors before the cut-off dates to be identified in the Interface Management Plan (IMP).

iii. To obtain from the Interfacing Contractors information reasonably required to enable the Contractor to meet the design submission dates as identified in Appendix 2.

iv. Where the execution of the work of the Interfacing Contractors depends upon the site management or information to be given by the Contractor, the Contractor shall provide to such Interfacing Contractors the services or correct and accurate information required to enable them to meet their own programme or construct their work.

v. To attend regular co-ordination meetings convened by the Engineer with the Interfacing Contractors. The Contractor shall conduct separate meetings with the Interfacing Contractors as necessary to clarify particular aspects of the interfacing requirements of the Works. The party who convenes the meeting shall prepare minutes recording all matters discussed and agreed at the meeting.

vi. To ensure that copies of all correspondence, drawings, meeting minutes, programmes, etc. relating to the Contractor's co-ordination with the Interfacing Contractors are issued to all concerned parties and the Engineer no later than two (2) calendar days from the date of such correspondence and meetings.

b) The Contractor, shall in carrying out his co-ordination responsibilities, raise in good time and provide sufficient information for the Engineer to decide on any disagreement between the Contractor and the Interfacing Contractors as to the extent of services or information required to pass between them. If such disagreement cannot be resolved by the Contractor despite having taken all reasonable efforts, then the decision of the Engineer shall be final and binding on the Contractor.

c) Where an Interfacing Contract is yet to be awarded the Contractor shall proceed with the co-ordination activities with the Engineer until such time when the Interfacing Contractor is available. The Contractor shall provide the Interfacing Contractor with all information necessary to enable the Interfacing Contractor to follow-on and proceed with their co-ordination.

d) The cut-off dates to be identified in the IMP are the latest dates. Any claim of additional costs by the Interfacing Contractors as a result of the Contractor's

failure in adhering to these dates shall be borne by the Contractor. The Contractor shall note that the information exchange is an iterative process requiring the exchange and update of information at the earliest opportunity and shall be carried out on a regular and progressive basis so that the process is completed for each design stage by the cut-off dates.

e) The Contractor shall co-ordinate with the Engineer on all matters relating to works that may affect the Operation & Maintenance of the already operational Section corridor of the of Employer in general. Such work shall be subject to the rules and regulations imposed by the Employer.

11.2 Design Interface

a) The dates shown in Employer's Requirements Appendix 2 are critical to the timely completion of the project. The Contractor shall commence design interface with the Interfacing Contractors as soon as he has been notified by the Engineer that such Interfacing Contract has been awarded. In the case of utility agencies and other statutory boards, interface shall commence as soon as it is practicable. Where no design interface date has been established whether because the Interfacing Contractor(s) have not been identified or for whatever reason, the Contractor shall liaise with such Interfacing Contractor/s as soon as they have been awarded.

b) The Contractor shall immediately upon award of the Contract gather all necessary information and develop his design to a level where meaningful interaction can take place as soon as the Interfacing Contracts are available. The Contractor shall submit together with each of his Design Submissions a joint statement from the Contractor and the relevant Interfacing Contractor confirming that design co-ordination has been completed and that they have jointly reviewed the appropriate document to ensure that a consistent design is being presented.

c) The design interface is an iterative process requiring regular exchange and update of interfacing information. The Contractor shall ensure that the information he requires from the Interfacing Contractors is made known at the outset of each design interface and vice versa so that the information can be provided in time for the Contractor and the Interfacing Contractors to complete their design to meet their various design submission stages.

11.3 Construction Interface

a) Construction interface will be necessary throughout the duration of the Works commencing from the time the Contractor mobilises to the Site to the completion of the Works. Construction interface will overlap design interface, involving cast-in and buried items such as pipes for electrical and mechanical services, supports, brackets, plinths, ducts, service buildings, openings, cableways, trenches etc. that are to be incorporated at the early stage of the construction up to provision of attendance during the testing and commissioning stage.

b) The Contractor shall ensure that there is no interference with the Works of the Interfacing Contractors and shall maintain close co-ordination with them to ensure that his work progresses in a smooth and orderly manner. The Contractor shall carry out and complete the Works, or any part thereof, in such order as may be agreed by the Engineer or in such revised order as may be

requested by the Engineer from time to time. The Contractor shall, unless otherwise provided, be liable for and shall indemnify the Employer against all costs, charges, expenses and the like resulting from failure of the Contractor to co-ordinate the Works as specified.

12 SURVEY AND SITE INVESTIGATIONS

a) The datum used for the Contract shall be Mean Sea Level Datum.

b) The Contractor shall carry out all further site investigations (such as detailed utility identification, detailed geo technical investigation) necessary for the design of the Permanent Works and to enable the determination of the methods of construction and the nature, extent and design of the Temporary Works.

c) The Contractor shall carry out geotechnical investigation using conventional method of boreholes and geo-physical methods for the entire alignment.

13 CLIMATIC CONDITIONS

a) The entire section of HORC with connecting IR Station is situated in the state of Haryana. During summer months the temperature can be as high as 45°C with a high level of humidity, nights can be relatively cool with temperatures dipping to 30°C. Torrential rains and high humidity accompany the monsoon in late June to early September. In the winter months temperatures can vary from a high of 21°C during day to a low of 2°C during night.

b) The information given above is only indicative. The contractor shall obtain detailed climatic data in respect of minimum & maximum temperatures, rain, relative humidity, sunshine, and wind velocity/pressure etc. from "India Meteorological Department publications" and the same shall be taken into account by the Contractor when designing any part of the Permanent Works. The Contractor shall ensure that due allowance is made for more severe local conditions when Permanent Works are required to operate, for example, with restricted ventilation that may lead to higher local ambient temperatures, and any other factors that may affect the operating environment in any way.

c) Unless specific figures are provided elsewhere, the Permanent Works will generally be required to function at its rated value with the values of ambient temperature and relative humidity appropriate to the location of the equipment within the classifications shown in Table given below. Certain parts of the Permanent Works may need to be rated for more or less onerous conditions as required by the PS.

d) The Contractor's attention is drawn to the more severe environmental conditions that may exist during the construction/installation period and shall take adequate measures to protect the Permanent works against any deleterious effects of such conditions during the time between installation and final completion of the project. Also, Air throughout the project will contain considerable moisture content, hence the permanent works shall be tropicalized and vermin proof.

14 PROJECT MANAGEMENT INFORMATION SYSTEM (PMIS)

The Contractor shall utilise an available PMIS such that all documents generated by the Contractor can be transmitted to the Engineer by electronic means (and vice versa) and that all documents generated by either party are electronically captured at the point of origin and can be reproduced later, electronically and in hard copy. A similar

link shall also be provided between the Engineer office at site and the Employer's Office by the Contractor. In case of non-availability, the Contractor may devise a PMIS of its own.

15 CONTRACTOR'S PROJECT ORGANISATION

a) The Contractor shall have a competent team of Managers, Engineers, Technical staff etc so as to complete the work satisfactory as per various requirements of the Contract.

b) The designations of the various project organisations team members shall be got approved by the Engineer before adoption so as to avoid any duplication of the designations with those of the Employer or the Engineer.

16 CONTRACTOR'S CERTIFICATE

The Contractor shall provide his registration details for GST Registration, EPF registration, ESI registration, Statutory Certificate, Certificate as per ESHS Manual etc. as required for the execution and completion of the Works.

Section VII: Employer's Requirements

Section VII-2: Functional

EMPLOYER'S REQUIREMENTS – FUNCTIONAL

Objective

The objective of the Contract is the design, construction, testing and commissioning of the permanent works by the Contractor (including without limitation, the design, construction and removal of the Temporary Works) and the rectification of defects appearing in Permanent Works in the manner and to the standards and within the time obligations, liabilities and risks which may be involved, the Contractor shall undertake the execution of the Works.

1. GENERAL

1.1 *The Works to be executed under Package C-23 is for design and construction of civil works and General electrical services work as per Employer's Requirements on 'Design Build' basis. All information available with the Employer has been furnished in Section VIII-Tender Drawings and Documents, Part 2, Employer's Requirements. The Works are to be designed by the Contractor. Any other site data and information required for design of the Works shall be collected (through tests or otherwise), arranged, produced by the Contractor at his own cost. No claim from the Contractor whatsoever shall be entertained on the ground of certain information not being furnished in the Contract.* The design and performance of the Permanent Works shall comply with the specific core requirements contained in these Employer's Requirements – Functional and Employer's Requirements- General Electrical Services.

1.2 The Permanent Works shall be designed and constructed to the highest standards available using proven up-to-date good Engineering practices. The Specification shall in any case not specify standards which, in the Engineer's opinion, are less than or inferior to those described in the Outline Design Specifications (ODS) and Outline Construction Specifications (OCS). Construction shall be carried out employing the procedures established by the Contractor as per approved quality assurance plan and Environmental, Social, Health and Safety (ESHS) Plan.

1.3 The Contractor shall be responsible for obtaining all necessary approvals from the relevant Public/Government/Local/Statutory or any agencies in the design and construction of the Works.

1.4 Employer's Requirements- Functional shall be read in conjunction with Employer's Requirements-Design, Construction, Outline Design specification (ODS), Outline Construction Specifications (OCS), General Electrical Services and other requirements of the Contract.

1.5 Jurisdictional Sketch of Civil works under C-23 package is given in Section VII-8, Tender Drawings and Documents, Part 2, Employer's Requirements.

2. SCOPE OF WORK

2.1 Scope under Lump Sum Price Schedule 'A'

The through Chainages mentioned in the Scope of the Works/Tender drawings can undergo some minor corrections, without any impact on the overall length/Scope of the Works. The Lumpsum Scope of Work in brief is given below but the scope also includes all other requirements stipulated in various parts/sections of the Contract Document including Appendices and Annexures.

2.1.1 Design of the Works

i. Schedule 'A'

a) Design and drawings of all items of the Works under Schedule 'A' shall be carried out by the Contractor and the payment for the same is included in Cost Centre 'CD' of Schedule 'A'.

b) Design and drawings of all the temporary works, temporary road diversion shall also be carried out by the Contractor and the payment for the same is included in Cost Centre 'CD' of Schedule 'A'.

ii. Schedule 'B'

a) Design and drawings of all items of the Works under Schedule 'B' shall be carried out by the Contractor and the payment for the same is included in Cost Centre 'CD' of Schedule 'A'.

b) Design and drawings of all the temporary works, temporary road diversion shall also be carried out by the Contractor and the cost for the same is deemed to be included in the rates quoted for the relevant item of Schedule 'B' unless otherwise specified in the Contract.

Payment matrix for design of bridges is given in **Annexure F-7.**

2.1.2 Design and construction of railway formation

The Contractor shall design and construct railway formation for 32.5 t axle load as per RDSO Specifications "Comprehensive Guidelines and specifications for Railway Formation-Specification No. RDSO/2020/GE: IRS-0004, Sept 2020" from Chainage 29680 m to Chainage 49700 m and from Chainage 55600 m to Chainage 61500 m for double track of Main line; from Chainage 614 m to Chainage 2700 m for connecting single line from New Patli to Patli; from Chainage 703 m to Chainage 4114 m for connecting single line from New Patli to Sultanpur; and at Sultanpur station from Chainage +689.546 m on Farukhnagar side and from Chainage +530.00 m on Badsa side to Chainage -861.218 m on Garhi Harsaru side as shown in Tender drawings and shall include earthwork in cutting/filling, subgrade, prepared subgrade and blanketing including mechanical compaction. The Contractor shall arrange borrow areas for earthwork in embankment at its own cost.

Excavated earth/rock from cutting shall be utilised for formation in embankment/structures in C-23 Package. Royalty for using the excavated earth/rock for construction of the Works shall be borne by the Contractor. Surplus/unsuitable excavated earth/rock shall be disposed off by the Contractor at his own cost.

2.1.3 Design and construction of slope protection works

The slope of embankment/cuttings shall be protected by vegetative cover comprising perenial turf forming grass in accordance with Section VII- 6 Outline Construction Specifications (OCS)-Civil . On embankments/cuttings higher/deeper than 4 m *vegetative cover* shall be provided using coir netting as per IS:15869, IS:15872 and IRC: 56.

After Taking Over the Works, the Contractor shall maintain slopes of embankment/cutting and vegetative cover for a period of one (01) year and shall make good any loss/damage to formation and vegetative cover due to rain cuts, pedestrian movement or any other reason.

2.1.4 Design and construction of drainage system on embankments/cuttings by providing precast RCC drains on berms, chute drains, sumps and RCC catch water drains & side drains in cuttings

The Contractor shall design and construct precast RCC longitudinal drains on berms of embankments/cuttings to collect surface runoff from the slope. Precast RCC chute drains shall be provided at approximately every 50 m for collecting water from drains on berms and discharging it safely away from toe in embankments or to side drain in cuttings as shown in the Tender drawings. RCC collecting chambers shall be provided at the junction of longitudinal berm drains and chutes.

In cuttings the Contractor shall design and construct following additional items:

a. Cast in-situ RCC catch water drains of adequate capacity to intercept and safely dispose of the surface runoff from adjoining areas from entering into the cutting.

b. Cast in-situ RCC side drain of adequate capacity on both sides near toe of cutting to safely carry the surface runoff from cutting slope and formation.

After Taking Over the Works, the Contractor shall maintain drainage system in embankment/cutting including sump, drain on berms, side drains, catch water drains, chutes etc. for a period of one (01) year and shall make good any damage to the drainage system due to rain cuts, pedestrian movement or any other reason.

2.1.5 Design and construction of minor bridges

The Contractor shall design and construct minor bridges (RUBs, canal and waterway bridges) including protection works on bridge approaches and height gauges at all RUBs as per Employer's Requirements. List of minor bridges is given in ***Annexure-F-1.*** *Approach road on both sides of RUBs shall be designed and constructed by the Contractor upto ROW of HORC for full clear width of RUB. Design and construction of permanent diversion at RUBs shall be carried out by the Contractor as shown in the Tender drawings. Payment matrix for various items incidental to bridges is given in* ***Annexure F-7.*** *Drainage and rain water harvesting system shall be designed and constructed at RUBs where road level in the RUB is located below natural ground level i.e. at Br No. 77 at Ch.31365, Br No.125 at Ch.49167.307 on main line and Br No.04 on New Patli to Patli connectivity at Ch.2518.489.*

2.1.6 Design and construction of major bridges

The Contractor shall design and construct major bridges (RUBs, canal and waterway bridges) including protection works on bridge approaches and height gauges at all RUBs as per Employer's Requirements. List of major bridges is given in ***Annexure- F-2****. Approach road on both sides of RUBs shall be designed and constructed by the Contractor upto ROW of HORC for full clear width of RUB. Design and construction of permanent diversion at RUBs shall be carried out by the Contractor as shown in the Tender drawings. Payment matrix for various items incidental to bridges is given in* ***Annexure F-7.***

For construction of Br No. 150 and 153, temporary diversions of existing roads will be required first. Then existing roads will be lowered by about 1.90 m at the site of the bridges and regraded to join the existing roads. Thereafter, Br Nos. 150 and 153 will be constructed.

2.1.7 Linking of track on Open Web Girders (OWG)

The Contractor shall supply H- beam sleepers & track fittings and link track on OWG bridges including providing and fixing guard rails and gang pathway as per list given in **Annexure F-2.** *The Contractor shall supply spare track fittings as per* ***Annexure F-8.***

Rails for linking of track shall be supplied free of cost by the Employer *at the stock yard of T-1 Contractor located at Manesar station yard. Rails for linking of track shall be provided in the length of 13/26 m. Rails shall be transported to the Site of OWG bridges by the Contractor.*

2.1.8 Design and construction of stations

The Contractor shall design and construct *four new stations namely Dhulawat, Chandla Dungerwas, Pachgaon & New Patli.In addition there is one existing halt station i.e. Sultanpur (on Garhi Harsaru- Farrukhnagar railway line) which is to be converted into a crossing station.*

i. New Patli station

New Patli is a crossing station with five tracks, one island platform and one end platform..There is a S&T service building on the platform which shall be designed and constructed as shown in Tender drawings.

ii. Dhulawat Station

This is a crossing station with five tracks, one island platform and one end platform. There is a station building at Dhulawat station which shall be designed for single storey as shown in Tender drawings.

iii. Chandla Dungerwas

This is a halt station having only two tracks and two platforms.

iv. Pachgaon

This is a halt station having only two tracks and two platforms.

v. Sultanpur

This is a halt station and will be converted into a crossing station. The sequence of working at Sultanpur station shall be as follows:

a) The Contractor shall dismantle the existing platform

b) The Contractor shall prepare formation for Line No.1 in Sultanpur yard and construct the New platform, station building, other structures and facilities as shown in the Tender drawing.

c) T-1 contractor shall slew/dismantle existing main line track to the prepared formation of line No.1.

d) The Contractor shall prepare formation for Line No.2

e) T-1 Contractor shall link the track for Line No.2

The items of works to be carried out at various stations are shown in ***Annexure F-3.*** *Tender drawings. One subway shall be constructed at Dhulawat, Chandla Dungerwas, Pachgaon & New Patli stations as shown in Tender drawings. The list of subways is*

*shown in **Annexure F-5**. The works at stations shall be carried out in accordance with Tender drawings, Outline Design Specifications (ODS) and Outline Construction Specifications(OCS).*

2.1.9 Design and construction of RCC hume pipe (NP-4) of 450 mm dia/precast RCC box (500mm x 500mm, clear opening) in the embankment at approximately 500m interval for crossing utilities in future.

2.1.10 Design of precast RCC longitudinal drain of required capacity with suitable slope and outfall at places where HORC embankment overlaps with KMP expressway embankment to safely cater the surface runoff from the slopes of HORC embankment and KMP expressway embankment. *Construction of precast RCC drain shall be paid under Schedule 'B'.*

2.1.11 Design of precast and cast in-situ retaining walls for retaining soil of formation along the alignment at locations given in ***Annexure F-4***. Construction of these retaining walls shall be paid under Schedule 'B'.

2.1.12 *Design of bridges including protection works as mentioned in **Annexure F-6** including design of drainage and rain water harvesting system for Br No.76 at Ch.31114. Construction of these bridges shall be paid under Schedule 'B'.*

2.1.13 *Design of station building at New Patli station which shall be designed for G+5 storeys with stilt parking but construction will be carried out only for G+1 with stilt parking. Construction of station building shall be paid under Schedule 'B'.*

2.1.14 *Design of Retaining wall/RE wall in station area as shown in Tender drawings.*

2.1.15 *Design of minor structures at stations like portico, ticket counter structure, approach roads to stations etc. shall also be carried out by the Contractor. Construction of above mentioned items shall be paid under Schedule 'B'*

2.1.16 *Design of permanent road diversion and regrading (raising and lowering) of roads at RUBs for Br. Nos. 73 & 112 of **Annexure F-6** and Br. Nos. 150 and 153 of **Annexure F-2.** Construction of these items shall be paid under Schedule 'B'.*

2.1.17 Traffic management along the work site including construction works required in connection with traffic management like road works, footpaths, drains and other services etc. and repair and maintenance of these construction works during construction period. Any road widening / diversion along with associated drainage system required to facilitate the movement of traffic and their repair & maintenance *shall also be carried out by the Contractor*. It also includes reinstatement of land/structure/*roads*/services etc. to original condition wherever road diversion has been made outside original road including reconstruction of structure demolished for traffic management. Materials and other specification related to traffic control devices shall conform to IRC standards.

2.1.18 Design and construction of one deep *bore well* of *15,000 litre/hr* yield with pump house and overhead gantry for lowering/taking out pumps at Dhulawat, Chandla Dungerwas, Pachgaon, New Patli and Sultanpur stations, providing GI/Mild Steel pipeline from tube well to underground water storage tank and from underground water storage tank to overhead water storage tank with all accessories.

2.1.19 Design and application of water proofing system in subway at four stations–i.e, Dhulawat, Chandla Dungerwas, Pachgaon and New Patli as per the Employer's Requirements.

2.1.20 The Contractor shall provide and maintain during progress of works barricading around the work area where vehicular or pedestrian traffic passes with all safety measures as shown in Tender drawings. The excavations near habitations/public movement areas and all works along the roads shall be provided with proper caution signs and marked with red lights, reflectors at night to avoid accidents near public places to ensure safety of public

2.1.21 Reinstatement/Restoration of roads and services with new material of similar specification as per codal requirement after completion of work for the area disturbed by the Contractor during construction activities. However, reinstatement of roads and its drainage system will be as per current standards being used by the roads/service owning agency for similar roads. Proper survey to be done before dismantling of any of the above services along with extensive photographs, videos & sample of these services by the Contractor & get it verified by the representative of Engineer so as to ascertain the extent of these existing services and its specification.

2.1.22 There is possibility of some of the items not getting mentioned in the above list of works. Tenderers are requested to go through the Tender drawings also in details as the works listed in Clause 2.1 above as well as indicated in the Tender drawings would be considered inclusive in the scope of work under lump sum quoted price except the items mentioned in Sub-Clause 2.2, 2.3 and 2.4 below unless specified otherwise in the Contract. Engineer's decision shall be final in this regard in case of dispute.

2.1.23 The work content against the lump sum component of the work i.e. Schedule 'A' shall also include, but not be limited to, the following:

a) Site clearance and dismantling of obstructions etc., before commencement of work as specified or as directed by the Engineer;

b) True and proper setting out and layout of the Works, benchmarks and provision of all necessary labour, instruments and appliances in connection therewith as specified or as directed by the Engineer;

c) All aspects of quality assurance, including testing of materials as per the approved Inspection and Test Plan and other components of the work, as specified or as directed by the Engineer;

d) Day to day cleaning of worksite throughout the execution period;

e) Maintenance of the completed Works during the period as specified or as directed by the Engineer;

f) Submission of completion (i.e., 'As-Built') drawings 06 (Six) sets in A-1 size and all other related documents as specified including scanned and AutoCAD copy with soft copies in both formats of all As-built drawings & documents.

g) Preparing Definitive Design, Construction Reference drawings, Good For Construction(GFC) drawings and working drawings for various components of the works and obtaining approval in respect thereof from the Engineer, inclusive of incorporation of all modifications, alterations, changes, etc. that may be required to be carried out as directed by the Engineer;

h) Compliance of requirements of Environmental, Social, Health and Safety (ESHS) Manual as per Appendix 13 of Employer's Requirements, Section VII-9

i) Results of sub-surface investigations conducted at project site are enclosed with the Tender documents. This information about the soil and sub-soil water conditions is being made available to the Contractor in good faith and the Contractor shall have to obtain the details of sub soil parameters independently. No claim whatsoever on account of any discrepancy/variation about the soil parameters and sub soil water conditions that may be actually encountered at the time of execution of the work and those given in these Tender Documents shall be admissible to the Contractor under any circumstances.

2.1.24 Other Works under Lump Sum

The Interface Management Document as per Appendix- 5 of Employer's Requirements shall also be complied with**.**

2.1.25 Safety of adjoining structures of KMP Expressway and IR

Alignment is passing adjacent to KMP Expressway/IR Tracks. The Contractor should ensure that the design and construction of the Works should be carried out with adequate measures for the safety & protection of KMP/IR structures. Construction activities shall be planned without affecting the operations of the existing system. It shall be ensured that no damage is caused to any element/person/ property of these systems. The Engineer/ Employer shall be indemnified against any damage caused to such structures at no extra cost.

2.1.26 Associated Works

Works to be performed shall also include all general works, preparatory works for the construction and works of any kind necessary for the design and satisfactory construction, completion and maintenance of the works to the intent and meaning of the drawings adopted and Outline Construction Specifications , to best Engineering standards and orders that may be issued by the Engineer from time to time, compliance with all Conditions of Contract, supply of all materials, apparatus, plants, equipment, tools, fuel, water, strutting, timbering, transport, offices, stores, workshop, staff, labour and the provision of proper and sufficient protective works, diversion, temporary fencing, lighting and watching required for the safety of the public and protection of works on adjoining land; first-aid equipment, sanitary accommodation for the

staff and workmen, effecting and maintenance of all insurances, the payment of all wages, salaries, fees, royalties, duties or the other charges arising out of the execution of works and the regular clearance of rubbish, clearing up, leaving the site perfect and tidy on completion.

2.1.27 Land for Contractor's Facilities & Site Office

For batching plants, field quality control laboratories, site offices and other activities (excluding labour camps), *land total admeasuring approx. 20,000 Sq. m will be made available at multiple locations between km 29.68 to km 61.5* by the Employer on as is where is basis free of cost. This land shall be made good for such offsite activities as needed by the Contractor at no extra cost to the Employer. The land shall be cleared from debris, all structures made by the Contractor including RCC footings and rafts etc. and reinstated to the line, level and to the same conditions as existed before the work started before handing over back to the Employer within 91 days after Taking over Certificate. The final bill shall be released to the Contractor after all structures from the Contractor facility and site office are removed & clearance of site. The cost of setting up of all the above mentioned facilities & the office and reinstatement of site is included in lump sum price in Schedule 'A'.

2.2 Scope under BOQ Schedule 'B'

Under this Schedule, the Contractor is required to carry out works which are not covered in Schedule 'A'. Broadly following works shall be carried out under this Schedule 'B':

a) Procurement, supply and installation (including joining and grouting) of precast retaining walls along the embankment at locations as given in ***Annexure F-4*** for heights upto 2 m from ground level.

b) Construction of cast in-situ retaining wall generally for heights more than 2m from ground level at locations as given in ***Annexure F-4***.

c) *Construction of Retaining wall/RE wall in station area as shown in Tender drawings.*

d) Construction of bridges including slope protection on bridge approaches and drainage & rain water harvesting system at Br.No.76 as shown in Tender drawings. List of bridges is mentioned in ***Annexure F-6***. Foundation of open web girders of 76.2 m span and 61.0 m span of Br.Nos.112 & all the piers and abutments of Br No.136 of Annexure F-6 shall be pile foundation only.

e) Permanent road diversion and regrading of existing roads required for construction of Bridge Nos. 150 and 153 on main line.

f) Temporary diversion and permanent regrading of existing roads required for construction of Bridge No. 73 on main line.

g) Temporary diversion of roads required for construction of Bridge No. 112 on main line.

h) Construction of station building at New Patli, ticket counter structures at Chandla Dungerwas & Pachgaon, elevated approach to Pachgaon and portico at stations.

i) Construction of approach road including RE wall/Retaining wall at Dhulawat, Chandla Dungerwas, Pachgaon, New Patli and Sultanpur Stations.

j) *Construction of precast RCC longitudinal drain of required capacity where HORC embankment overlaps with KMP expressway embankment to safely cater the surface runoff from the slopes of HORC embankment and KMP expressway embankment*.

k) Any other item as directed by the Engineer related to the work.

2.3 Scope under Schedule 'C' (General Electrical Services works)

Under this Schedule, the Contractor is required to carry out General Electrical Services works. Detailed Scope of Works is given in Section VII-7:General Electrical Services, Part 2-Employer's Requirements

2.4 Scope under Schedule 'D' (Item Rate for miscellaneous works)

Under this Schedule, the Contractor is required to carry out works which are not covered in Schedule 'A', Schedule 'B' and Schedule 'C' on specific instructions of the Engineer for the followings:

a) Diversion of all uncharted utilities, if required, as per approved plan.

b) Any other activity as directed by the Engineer

2.5 REFERENCE TO THE STANDARD CODES OF PRACTICE

2.5.1 All Standards, Outline Construction Specifications, Technical Specifications and Codes of Practice referred to shall be latest editions including all applicable official amendments and revisions. The Contractor shall make available at site all relevant Indian Standard Codes of practice, IRS, IS, IRC, UIC, as applicable.

2.5.2 Wherever Indian Standards do not cover some particular aspects of design/ construction, relevant International Standards will be referred to. The Contractor shall make available at site such standard codes of practice.

2.5.3 In case of discrepancy among Standard codes of practice and Section VII-6: Outline Construction Specifications-Civil (OCS), the order of precedence shall be as given below:

a. Outline Design Specifications-Civil

b. Outline Construction Specifications-Civil.

c. Standard Codes of Practice. In case of discrepancy among Standard Codes of Practice, the order of precedence will be

   i. IRS,

   ii. IS,

   iii. IRC,

   iv. other International codes

d. Indian Railway Unified Standard Specifications,

e. CPWD specifications,

f. NBC 2016,

g. MORTH Specification for Road & Bridges,

2.6 DIMENSIONS

As regards errors, omissions and discrepancies in Specifications and Drawings, relevant clause of Particular Specification will apply. The levels, measurements and other information concerning the existing site as shown on the conceptual / layout drawings are believed to be correct, but the Contractor shall verify them for himself and also examine the nature of the ground as no claim or allowance whatsoever shall be entertained on account of any errors or omissions in the levels or strata turning out different from what is shown on the drawings.

2.7 INSPECTION

The Employer may appoint an independent agency to ensure the quality checking of design, supply, fabrication, erection and construction of all works under scope of work. *Payment to the independent agency shall be made by the Employer separately.* The Contractor shall ensure complete co-operation with the agency to perform their work satisfactorily. In addition, the Employer also reserves right to undertake quality check and inspection directly by itself.

2.8 ALIGNMENT OF TRACKS

2.8.1 The alignment shall be as shown in the Tender drawings. The alignment has been developed by the Employer to meet operational and technical criteria. The Contractor is not required to evaluate the alignment for compliance with these criteria but shall review it with respect to his own design and construction proposals and shall satisfy himself that it suites to the available land width and there is no conflict with the clearances at proposed structures.

2.8.2 The Contractor is permitted to propose minor deviations in alignment to suit his construction proposals, but he must demonstrate that any such deviations shall comply with good design practice and the alignment requirement of the Design Criteria. Such deviations shall require prior approval of the Employer subject to following conditions:

i. There is no extra cost to the employer.

ii. Changes proposed are essentially required to suit the contractor's specific design.

iii. There is no change at the contract boundaries or if there is any, the same is agreed by the Contractor of the adjoining section without any extra cost to the employer**.**

2.8.3 *The ground levels shown in Conceptual Alignment Plan & L-Section Tender drawings are based on preliminary survey. Detailed survey will have to be carried out by the Contractor for confirming and preparation of final Alignment Plan & L-Section. No cost implication shall be considered for any variation in the ground levels with respect to ground levels shown in conceptual Alignment Plan & L-Section tender drawings.*

2.9 DURABILITY AND MAINTENANCE

The Permanent Works shall be designed and constructed such that, if maintained reasonably, they shall endure in a serviceable condition throughout their minimum lives as described in Section VII-5, Outline Design Specifications-Civil. The Permanent Works shall be designed and constructed so as to minimise the cost of maintenance whilst not compromising the performance characteristics and ride quality of the railway.

2.10 OPERATIONAL REQUIREMENTS

a) The vertical and horizontal alignments for the main and connectivity line shall comply with the conditions laid in para 2.8 (a) & (b) above.

b) During construction the Contractor shall be responsible for providing and maintaining adequate flood protection to ensure protection of the works.

2.11 ENVIRONMENTAL CONSIDERATIONS

All provisions and conditions contained in the Environmental, Social, Health and Safety (ESHS) Manual as per Appendix 13 shall be strictly complied with.

2.12 TRAFFIC MANAGEMENT

The Contractor shall carry out the Works so as to minimise disruption to road and pedestrian traffic. The Contractor shall prepare his traffic management plan based on his proposed construction methodology in co-ordination with the Engineer and in conjunction with the concerned road authority as per Appendix 10. He shall comply strictly with the approved plan during construction of his works.

2.13 CRS INSPECTION

The Contractor shall note that the Commissioner for Railway Safety (CRS) will inspect the Works from time to time for the purpose of determining whether the HORC Project complies with the terms of operational and infrastructural safety in accordance with the Laws of India. The Contractor shall note that CRS approval is mandatory for commissioning the system. Notwithstanding other provisions of the Contract, the Contractor shall ensure that the Works comply with the requirements of CRS in terms of construction to the drawings and shall make all necessary arrangements and assist the representatives of the Employer and CRS in carrying out their inspection duties and also comply with their instructions regarding rectifying any defects and making good any deficiencies. Contractor shall prepare and make available all drawings, documents, sketches, photographs etc. as required for submission of application for inspection of CRS as instructed by the Engineer.

2.14 STANDARDS

Equipment, materials and systems shall be designed, manufactured and tested in accordance with the latest issue of National and/or International codes and standards. The Contractor shall submit hard copies in original to the Engineer of all codes and standards used for the work.

Reference to standards or to materials and equipment of a particular manufacturer shall be regarded as followed by the words "or equivalent". The Contractor may propose alternative standard materials, or equipment that shall be equal to or better than those specified. If the Contractor for any reason proposes alternatives to or deviations from the specified standards, or desires to use materials or equipment not covered by the specified standards, the Contractor shall apply for the consent of the Engineer. The Contractor shall state the exact nature of the change, the reason for making the change and relevant specifications of the materials and equipment in the English language. The decision of the Engineer in the matter of quality will be final.

ANNEXURE-F-1

LIST OF MINOR BRIDGES***

A. MAIN LINE							
S. No.	**Br. No.**		***Chainage (m)**	**Type of Crossing**	**Type of Bridge**	**SPAN**	**No. of Tracks**
	Br No. as per RFP dated 11.11.2022	**Br No. as per Final RFP**				**No. x L (in m) x H (in m)**	
1	75	77	31365.0	RUB	RCC Box	1x6x4	2
2	76	78	32022.0	RUB	RCC Box	1x6x4	2
3	77	80	33155.0	RUB	RCC Box	1x6x4.5	2
4	78	81	33269.230	Canal	RCC Box	1x2x2	2
5	79	82	33450.0	Balancing Culvert	RCC Pipe	1x1.8	2
6	80	83	33673.045	RUB	RCC Box	2x7x5.65	2
7	83	87	35371.018	RUB	RCC BOX	1x5x3	2
8	84	88	35916.064	RUB	RCC BOX	1x5x3	2
9	86	90	37317.678	Balancing Culvert	RCC PIPE	1 x 1.8	2
10	87	91	37804.099	RUB	RCC BOX	1x5x3.15	2
11	89	94	39552.508	RUB	RCC BOX	1x5x3	2
12	91	96	40357.531	Balancing Culvert	RCC PIPE	1 x 1.8	2
13	92	97	40671.025	RUB	RCC BOX	1 x 4 x 2.5	2
14	93	98	41312.174	RUB	RCC BOX	1 x 4 x 3.0	2
15	94	99	41666.651	Balancing Culvert	RCC PIPE	1 x 1.8	2

A. MAIN LINE							
S. No.	**Br. No.**		***Chainage (m)**	**Type of Crossing**	**Type of Bridge**	**SPAN**	**No. of Tracks**
	Br No. as per RFP dated 11.11.2022	**Br No. as per Final RFP**				**No. x L (in m) x H (in m)**	
16	95	100	41925.899	Balancing Culvert	RCC BOX	1 x 2 x 2.0	2
17	97	102	42238.9	Balancing Culvert	RCC BOX	1 x 2 x 2.0	2
18	98	103	42578.906	RUB	RCC BOX	1X5x3	2
19	100	106	43758.291	RUB	RCC BOX	1 x 4 x 3.1	2
20	102	108	44281.401	Balancing Culvert	RCC BOX	1 x 4 x 5	2
21	103	109	44401.641	Balancing Culvert	RCC BOX	1 x 4 x 5	2
22	104	110	44420.238	RUB	RCC BOX	1X6X5	2
23	108	114	46635.175	Balancing Culvert	RCC BOX	1 x 6 x 6	2
24	109	115	46768.341	RUB	RCC BOX	1 x 6 x 6	2
25	110	116	46915.023	Balancing Culvert	RCC BOX	1 x 5 x 5	2
26	111	117	47300.018	RUB	RCC BOX	2 x 5 x 5	2
27	112	118	47500.360	Balancing Culvert	RCC BOX	1 x 4 x 4	2
28	113	119	47824.336	Balancing Culvert	RCC BOX	1 x 4 x 3	2
29	114	120	48093.515	Balancing Culvert	RCC BOX	1 x 4 x 4	2
30	115	121	48231.618	RUB	RCC BOX	1 x 4 x 4	2
31	116	122	48594.592	Balancing Culvert	RCC PIPE	1 x 1.8	2

A. MAIN LINE							
S. No.	Br. No.		*Chainage (m)	Type of Crossing	Type of Bridge	SPAN	No. of Tracks
	Br No. as per RFP dated 11.11.2022	Br No. as per Final RFP				No. x L (in m) x H (in m)	
32	118	124	48794.629	RUB	RCC BOX	1 x 4 x 4	2
33	119	125	49167.307	RUB	RCC BOX	2X5X3.6	2
34	120	126	49583.348	Balancing Culvert	RCC PIPE	1 x 1.2	2
35	137	137	56117.426	Balancing Culvert	RCC Box	1x5x4	2
36	138	138	56290.652	RUB	RCC Box	1x5x4	2
37	139	139	56465.029	Balancing Culvert	RCC Box	1x5x4	2
38	140	140	56755.035	Balancing Culvert	RCC Box	1x5x4	2
39	**	141	57154.991	Culvert	RCC Box	1x2x2	2
40	141	141A	57167.991	RUB	RCC Box	1x5x4	2
41	142	142	57520.000	Balancing Culvert	RCC Box	1x5x4	4
42	143	143	57670.809	RUB	RCC Box	2x7x5.25	5
43	144	144	57987.046	Balancing Culvert	RCC Box	1x2x2	5
44	145	145	58203.149	RUB	RCC Box	1x5x3	5
45	146	146	58564.993	Balancing Culvert	RCC Box	1x2x2	5
46	148	148	59884.954	RUB	RCC Box	2x5x5.25	2
47	149	149	60161.343	RUB	RCC Box	1x5x3	2
48	**	149A	60171.264	Balancing Culvert	RCC Box	1x2x2	2

A. MAIN LINE							
S. No.	**Br. No.**		***Chainage (m)**	**Type of Crossing**	**Type of Bridge**	**SPAN**	**No. of Tracks**
	Br No. as per RFP dated 11.11.2022	**Br No. as per Final RFP**				**No. x L (in m) x H (in m)**	
49	154	154	61163.504	Balancing Culvert	RCC Box	1x2x2	2

Notes:

1. *Main line Chainages start from Prithla station of HORC.
2. **No Bridge No. was given to these bridges in RFP dated 11.11.2022.
3. ***Payment of bridges in Annexure F-1 will be made in Cost Centre 'CB'-Bridges under lumpsum Schedule 'A'.

B.CONNECTING LINES							
S.No	**Br. No. as per RFP dated 11.11.2022**	**Br No. as per Final RFP**	**Chainage (m)** **(From Centre line of New Patli station)**	**Type of Crossing**	**Type of Bridge**	**SPAN** **No. x L (m) x H (m)**	**No. of Tracks**
NEW PATLI TO PATLI							
1	1	1	1046.562	RUB	RCC Box	1x5x3.25	1
2	2	2	1277.958	Balancing Culvert	RCC Box	1x2x2	1
3	3	3	1986.847	RUB	RCC Box	1x4x3.25	1
4	4	4	2518.489	RUB	RCC Box	1x5x5.25	1
5	5	5	2687.006	Balancing Culvert	RCC Box	1x2.5x3	1
NEW PATLI TO SULTANPUR							
1.	2	2	1548.996	Balancing Culvert	RCC Box	1x2x2	1
2.	4	4	2189.831	Balancing Culvert	RCC Box	1x2x2	1
3.	5	5	2823.679	RUB	RCC Box	1x5x4.25	1

Note: ***Payment of bridges in Annexure F-1 will be made in Cost Centre 'CB'-Bridges under lumpsum Schedule 'A'.

ANNEXURE-F-2

LIST OF MAJOR BRIDGES***

A. MAIN LINE

S. No.	Bridge No.		*Chainage (m)	Type of Crossing	Type of Bridge Super structure	Span Arrangement	No. of Tracks
	Br. No. as per RFP dated 11.11.2022	Br No. as per Final RFP					
1.	82	86	34899.045	RUB	PSC U SLAB	2x12.2	2
2.	101	107	44246.344	Waterway	**CG	1 x 18.3	2
3.	105	111	44570.310	RUB	PSC I GIRDER	1x18.3	2
4.	117	123	48663.628	Viaduct	PSC I GIRDER	1 x 18.3	2
5.	136	136	55724.752	ROR	**CG+#OWG	18.3(CG)+ 76.2(OWG)+ 18.3(CG)	2
6.	147	147	59106.085	RUB	#OWG	1x45.7 m	2
7.	150	150	60457.614	RUB (KMP Slip Road)	**CG	1x30.5 m	2
8.	151	151	60563.367	RUB	**CG	1x24.4 m	2
9.	152	152	60642.669	RUB	**CG	1x24.4 m	2
10.	153	153	60754.591	RUB (KMP Slip Road)	**CG	1x30.5 m	2

*Chainages start from Prithla station of HORC
**CG-Composite Steel Girders
#OWG- Open Web Girders

B. CONNECTING LINE-NEW-PATLI TO SULTANPUR

S. No.	Bridge No		*Chainage (m)	Type of Crossing	Type of Bridge Superstructure	Span Arrangement	No. of Tracks
	Br. No. as per RFP dated 11.11.2022	Br No. as per Final RFP					
11.	1	1	951.499	(RUB)	OWG	1x45.7 m	1
12.	3	3	1767.989	RUB	PSC U-Slab	1x12.2	1

Note:

1. *Chainages start from centre line of New Patli station of HORC.
2. ***Payment of bridges in Annexure F-2 will be made in Cost Centre 'CB'-Bridges under lumpsum Schedule 'A'.

ANNEXURE-F-3

List of items of works to be carried out at stations under Schedule 'A'

S. No	Item	New Patli	Sultanpur	Pachgaon	Chandla Dungerwas	Dhulawat
1	**Station Building and service building-**					
	a) Station Building.	-	1 No.	-	-	1 No.
	b) S & T service building.	1 No. on island PF	-	-	-	-
	c) S & T huts.	2 Nos	2 Nos	-	-	2 Nos.
2	**Platforms (HL) -**					
	a) Earthwork in filling above formation level, cast in-situ platform face Wall.	13m x 600m (island), 6m x 600m (end).	01 No. 6m x 600m	2 Nos. 6m x 425m each	2 Nos. 6m x425m each	13m x 600m (island), 6m x 600m (16m width adjacent to station building) end PF
	b) Surfacing of platform with VDC RCC precast coping, tactile tiles, precast fencing at end platforms.	For entire area of platform.	For entire area of platform.	For entire area of platform.	For entire area of platform.	For entire area of platform.
	c) PF Shelters	2 x 20m on each PF	2 x 20m	2 x 20m on each PF	2 x 20m on each PF	2 x 20m on each PF
	d) Mini PF Shelters	4 Nos. on each PF	4 Nos.	4 Nos. on each PF	4 Nos. on each PF	4 Nos. on each PF
	e) Passenger amenities-					
	i) Toilet blocks.	01 No. on each PF	01 No.	01 No. on each PF	01 No. on each PF	01 No. on each PF

S. No	Item	New Patli	Sultanpur	Pachgaon	Chandla Dungerwas	Dhulawat
	ii) Drinking water booths at platforms.	5 Nos. on each PF	5 Nos.	5 Nos. on each PF	5 Nos. on each PF	5 Nos. on each PF
	iii) Seating arrangement (Stainless steel).	48 Nos. on each PF	36 Nos.	48 Nos. on each PF	24 Nos. on each PF	36 Nos. on each PF
3	a) Subway for its platform transfer with covered stairs & ramps to platform, (lift well), flooring, dado, water proofing, drainages complete in all respects.	1 No.	Nil	1 No.	1 No.	1 No.
	b) Lift Well	3 Nos.	-	-	-	-
4	**Water supply system-**					
	a) Borewell & pump house.	Yes	Yes	Yes	Yes	Yes
	b) Underground RCC water storage tank. (litres)	50,000	50,000	50,000	50,000	50,000
	c) Overhead RCC water storage tank. (litres)	20,000	20,000	20,000	20,000	20,000
	d) Water supply distribution system complete from borewell to service building and platforms.	Yes	Yes	Yes	Yes	Yes
5	**Drainage, Sewerage & Rainwater Harvesting system-**					

S. No	Item	New Patli	Sultanpur	Pachgaon	Chandla Dungerwas	Dhulawat
	i) Platform drainage.	Yes	Yes	Yes	Yes	Yes
	ii) Station Yard drainage.	Yes	Yes	Yes	Yes	Yes
	iii) Sewerage system.	1 No. soak pit for island PF; 1 No. septic tank for 50 users at end PF; 1 No. septic tank for 100 users for S&T service building.	1 No. septic tank for 50 users at PF; 1 No. septic tank for 100 users at station building.	1 No. septic tank for 50 users at each PF.	1 No. septic tank for 50 users at each PF.	1 No. soak pit for island platform; 1 No. septic tank for 50 users for end PF and for 100 users for station building.
	iv) Rainwater harvesting for storm water of platform & station yard.	Yes	Yes	Yes	Yes	Yes
6	**Miscellaneous Work –**					
	a) Station name board at station building and at platform ends.	Yes	Yes	Yes	Yes	Yes
	b) Platform number board at each platform.	Yes	Yes	Yes	Yes	Yes

Annexure-F-4
Approximate Details of Retaining Wall under Schedule 'B'

Main Line (RHS)				
S. No.	Chainage (m)		Length (m)	Approx. Height(m) above ground level
	From	To		
1.	40240	40280	40	2.50-3.50
2.	40280	40300	20	1.75-2.0
3.	40300	40320	20	1.25-1.75
4.	40320	40360	40	2.50-3.50
5.	40360	40380	20	1.75-2.0
6.	40380	40400	20	1.25-1.75
7.	40400	40420	20	1.75-2.0
8.	40420	40460	40	1.25-1.75
9.	40460	40480	20	0.50-1.00
10.	40480	40500	20	1.25-1.75
11.	40500	40520	20	0.50-1.00
12.	40540	40560	20	0.50-1.00
13.	42480	42520	40	1.0-1.25
14.	42520	42540	20	2.50-3.50
15.	42560	42600	40	1.0-1.25
16.	42600	42660	60	0.50-1.00
17.	44120	44220	100	3.50-4.50
18.	44300	44340	40	3.50-4.50
19.	44340	44360	20	1.75-2.0
20.	44880	44900	20	0.50-1.00
21.	44900	44920	20	1.25-1.75
22.	44920	44940	20	4.50-5.50
23.	44940	44960	20	5.50-6.50
24.	44960	45000	40	1.0-1.25
25.	45000	45020	20	1.75-2.0
26.	45020	45040	20	0.50-1.00
27.	45160	45200	40	4.50-5.50
28.	45800	45820	20	3.50-4.50
29.	45820	45860	40	3.50-4.50
30.	45860	45940	80	1.75-2.0
31.	45960	46000	40	1.0-1.25
32.	46600	46620	20	3.50-4.50
33.	46620	46640	20	4.50-5.50
34.	46640	46660	20	5.50-6.50
35.	46660	46680	20	4.50-5.50
36.	46680	46700	20	6.50-7.50

Main Line (RHS)				
S. No.	Chainage (m)		Length (m)	Approx. Height(m) above ground level
	From	To		
37.	46700	46780	80	4.50-5.50
38.	46780	46840	60	3.50-4.50
39.	46840	46860	20	5.50-6.50
40.	46860	46900	40	6.50-7.50
41.	46900	46920	20	5.50-6.50
42.	46920	46980	60	4.50-5.50
43.	46980	47000	20	3.50-4.50
44.	47000	47100	100	4.50-5.50
45.	47100	47140	40	3.50-4.50
46.	47140	47160	20	4.50-5.50
47.	47160	47240	80	3.50-4.50
48.	47240	47260	20	4.50-5.50
49.	47260	47320	60	3.50-4.50
50.	47320	47380	60	2.50-3.50
51.	47380	47400	20	3.50-4.50
52.	47400	47440	40	2.50-3.50
53.	47440	47520	80	1.25-1.75
54.	47520	47540	20	1.75-2.0
55.	47540	47560	20	1.25-1.75
56.	47560	47580	20	1.0-1.25
57.	47580	47640	60	0.50-1.00
58.	47640	47680	40	2.50-3.50
59.	47680	47720	40	3.50-4.50
60.	47720	47740	20	1.25-1.75
61.	47740	47780	40	1.0-1.25
62.	47780	47800	20	3.50-4.50
63.	47800	47820	20	1.75-2.0
64.	47840	47860	20	1.0-1.25
65.	47860	47900	40	3.50-4.50
66.	47900	47920	20	1.0-1.25
67.	47920	47940	20	2.50-3.50
68.	47940	47960	20	1.75-2.0
69.	47960	47980	20	3.50-4.50
70.	47980	48140	160	0.50-1.00
71.	48000	48020	20	1.25-1.75
72.	55600	55640	40	7.50-8.50
73.	55800	55820	20	3.50-4.50
74.	55820	55860	40	2.50-3.50

Main Line (RHS)				
S. No.	Chainage (m)		Length (m)	Approx. Height(m) above ground level
	From	To		
75.	55860	55880	20	1.75-2.00
76.	55880	55920	40	1.25-1.75
77.	55920	55960	40	1.0-1.25
78.	55960	56000	40	0.50-1.00
79.	56000	56040	40	1.0-1.25
80.	56040	56100	60	3.50-4.50
81.	56120	56160	40	3.50-4.50
82.	56160	56200	40	1.25-1.75
83.	56200	56260	60	0.50-1.0
84.	56260	56270	10	3.50-4.50
85.	56270	56280	10	4.50-5.50
86.	56300	56440	140	3.50-4.50
87.	56440	56460	20	2.50-3.50
88.	56480	56520	40	2.50-3.50
89.	56520	56560	40	1.75-2.00
90.	56560	56580	20	1.25-1.75
91.	56580	56640	60	2.50-3.50
92.	56640	56680	40	1.75-2.00
93.	56680	56740	60	1.25-1.75
94.	56760	56780	20	1.00-1.25
95.	56780	56820	40	0.50-1.00
96.	56820	56900	80	2.50-3.50
97.	56900	56940	40	1.75-2.00
98.	56940	56980	40	0.50-1.0
99.	57080	57100	20	0.50-1.00
100.	57140	57160	20	0.50-1.00
101.	57320	57520	200	5.50-6.50
102.	59040	59060	20	2.50-3.50
103.	59160	59240	80	2.50-3.50
104.	59240	59260	20	1.25-1.75
105.	60500	60520	20	0.50-1.00
106.	60660	60700	40	3.50-4.50
107.	60740	60760	20	2.50-3.50
108.	60780	60800	20	1.0-1.25
109.	60800	60840	40	3.50-4.50
110.	60840	60920	80	2.50-3.50
111.	60920	61000	80	3.50-4.50
112.	61000	61040	40	2.50-3.50

Main Line (RHS)				
S. No.	Chainage (m)		Length (m)	Approx. Height(m) above ground level
	From	To		
113.	61040	61100	60	1.75-2.00
114.	61100	61140	40	1.25-1.75
115.	61140	61160	20	0.50-1.0
		Total	**4500**	
Main Line (LHS)				
S. No.	Chainage (m)		Length (m)	Approx. Height(m) above ground level
	From	To		
1.	55600	55620	20	3.5-4.5
2.	55620	55640	20	5.5-6.5
3.	55640	55660	20	6.5-7.5
4.	55800	55860	60	3.5-4.5
5.	55860	55960	100	4.5-5.5
6.	55960	56040	80	3.50-4.50
7.	56040	56080	40	3.50-4.50
8.	56080	56100	20	4.50-5.50
9.	56120	56160	40	3.50-4.50
10.	56160	56200	40	1.25-1.75
11.	56200	56220	20	1.00-1.25
12.	56220	56280	60	0.50-1.00
13.	56320	56460	140	3.50-4.50
		Total	**660**	

New Patli- Sultanpur Connectivity (LHS)				
S. No.	Chainage (m)		Length (m)	Approx. Height(m) above ground level
	From	To		
1.	1140	1180	40	4.50-5.50
2.	1180	1300	120	5.50-6.50
3.	1300	1360	60	4.50-5.50
4.	1360	1400	40	3.50-4.50
5.	1400	1520	120	2.50-3.50
6.	1520	1540	20	3.50-4.50
7.	1540	1580	40	4.50-5.50
8.	1580	1640	60	3.50-4.50
9.	1640	1660	20	1.25-1.75
10.	1720	1800	80	1.25-1.75
11.	1800	1860	60	2.50-3.50
12.	1860	1900	40	1.75-2.00
13.	1900	1920	20	1.25-1.75
14.	1940	1960	20	1.75-2.00
15.	2000	2020	20	0.50-1.00
16.	2020	2040	20	1.25-1.75
17.	2040	2060	20	1.75-2.00
18.	2060	2080	20	1.00-1.25
19.	2080	2100	20	1.25-1.75
20.	2100	2220	120	3.50-4.50
21.	2220	2340	120	2.50-3.50
22.	2340	2360	20	0.50-1.00
23.	2360	2380	20	1.00-1.25
24.	2380	2400	20	0.50-1.00
25.	2420	2520	100	0.50-1.00
26.	2520	2560	40	1.00-1.25
27.	2600	2620	20	1.25-1.75
28.	2620	2720	100	1.75-2.00
29.	2720	2760	40	1.25-1.75
30.	2760	2800	40	0.50-1.00
31.	2820	2920	100	0.50-1.00
32.	2920	2940	20	1.25-1.75
33.	2940	3000	60	0.50-1.00
34.	3880	3960	80	0.50-1.00
		Total	**1760**	

New Patli- Sultanpur Connectivity (RHS)				
S. No.	Chainage (m)	Length (m)		Approx. Height(m) above ground level
		From	To	
1	1140	1160	20	0.50-1.00
2	1360	1380	20	0.50-1.00
3	1380	1400	20	1.00-1.25
4	1400	1420	20	1.25-1.75
5	1420	1460	40	1.75-2.00
6	1460	1520	60	2.50-3.50
7	1520	1540	20	3.50-4.50
8	1540	1580	40	4.50-5.50
9	1580	1640	60	3.50-4.50
10	1640	1660	20	1.25-1.75
11	1720	1800	80	1.25-1.75
12	1800	1860	60	2.50-3.50
13	1860	1900	40	1.75-2.00
14	1900	1940	40	1.25-1.75
15	1940	1960	20	1.75-2.00
16	2120	2180	60	0.50-1.00
17	2180	2220	40	1.25-1.75
18	2220	2240	20	1.00-1.25
19	2240	2320	80	0.50-1.00
20	2620	2720	100	0.50-1.00
		Total	**860**	

New Patli-Patli connectivity (LHS)				
S. No.	Chainage (m)		Length (m)	Approx. Height(m) above ground level
	From	To		
1	840	860	20	4.50-5.50
2	860	1020	160	3.50-4.50
3	1020	1200	180	2.50-3.50
4	1140	1180	40	1.75-2.00
5	1200	1220	20	0.50-1.00
6	1300	1320	20	0.50-1.00
7	1360	1420	60	1.25-1.75
8	1440	1460	20	1.25-1.75
9	1460	1480	20	2.50-3.50
10	1480	1500	20	0.50-1.00
11	1500	1540	40	1.00-1.25
12	1540	1660	120	1.25-1.75
13	1660	1720	60	1.00-1.25
14	1720	1780	60	0.50-1.00
15	2520	2540	20	0.50-1.00
16	2540	2560	20	4.50-5.50
		Total	**880**	
New Patli- Patli Connectivity (RHS)				
S. No.	Chainage (m)		Length (m)	Approx. Height(m) above ground level
	From	To		
1	840	860	20	5.50-6.0
2	860	920	60	4.50-5.50
3	880	900	20	5.50-6.0
4	920	940	20	5.50-6.0
5	940	1060	120	4.50-5.50
6	1060	1080	20	5.50-6.0
7	1080	1200	120	4.50-5.50
8	1200	1240	40	3.50-4.50
9	1240	1280	40	0.50-1.00
10	1280	1300	20	3.50-4.50
11	1300	1320	20	4.50-5.50
12	1320	1360	40	3.50-4.50
13	1360	1420	60	4.50-5.50
14	1420	1440	20	1.25-1.75
15	1440	1480	40	4.50-5.50
16	1480	1500	20	2.50-3.50

17	1500	1520	20	3.50-4.50
18	1520	1540	20	2.50-3.50
19	1540	1580	40	1.75-2.00
20	1580	1620	40	1.25-1.75
21	1620	1640	20	1.00-1.25
22	1640	1680	40	0.50-1.00
23	2380	2460	80	0.50-1.00
24	2460	2480	20	1.00-1.25
25	2480	2500	20	1.25-1.75
26	2500	2540	40	1.75-2.00
27	2540	2560	20	2.50-3.50
		Total	**1040**	

ANNEXURE-F-5

LIST OF SUBWAYS*** AT STATIONS

S. No.	Bridge No.		*Chainage (m)	Type of Crossing	Type of Bridge	SPAN	No. of Tracks
	Br. No. as per RFP dated 11.11.2022	Br. No.as per Final RFP				No. x L (in m) x H (in m)	
1	**	79	32767	Subway	RCC Box	1x6x2.65	5
2	**	104	42700.983	Subway	RCC Box	1x6x2.65	2
3	107	113	46283.634	Subway	RCC Box	1x6x2.65	2
4	**	144A	58135.5	Subway	RCC Box	1x6x2.65	5

Note:-

1. *Chainages start from Prithla station of HORC
2. **No Bridge No. was given to these bridges in RFP dated 11.11.2022.
3. ** *Payment of above subways will be made in Cost Centre 'CS'-Stations under lumpsum Schedule 'A'

ANNEXURE F-6

LIST OF BRIDGES UNDER SCHEDULE 'B'							
S. No.	**Bridge No**		***Chainage (m)**	**Type of crossing**	**Type of Bridge**	**Tentative Span (m)**	**No. of Track**
	Br. No. as per RFP dated 11.11.2022	**Br. No. as per final RFP**					
A. MAIN LINE							
1.	71	73	30155	ROB (4 lane)	RCC Box	1x11.5x11	02
2.	**	74	30528	Syphon	RCC box	2x3x2	02
3.	**	75	30839	Syphon	RCC box	2x5x2.5	02
4.	**	76	31145	RUB	RCC box	2x6.2x5.65	02
5.	80A	84	33976.50	RUB	RCC box	1x6.0x5.0	02
6.	**	85	34280.218	RUB	RCC box	2x5.5x5.65	02
7.	85	89	36984.118	RUB	RCC box	2x7x5.65	02
8.	***	92	38456.750	RUB	RCC box	2x5.5x5.65	02
9.	***	93	39155	Balancing Culvert	RCC box	1x3x2	02
10.	***	95	40003.467	RUB	RCC box	2x5.5x5.65	02
11.	**	101	41962.645	RUB	RCC box	2x7x5.65	02
12.	99	105	43506.883	RUB	RCC box	2x7x5.65	02
13.	106	112	45495.969	RUB	OWG/CG	4x18.3(CG) +1x30.5(CG) +8x24.4(CG)	02

ANNEXURE F-6

LIST OF BRIDGES UNDER SCHEDULE 'B'							
S. No.	**Bridge No**		***Chainage (m)**	**Type of crossing**	**Type of Bridge**	**Tentative Span (m)**	**No. of Track**
	Br. No. as per RFP dated 11.11.2022	**Br. No. as per final RFP**					
						+1x76.2(OWG) +2x24.4(CG) +1x61(OWG)	
14.	**	146A	58720.513	GAIL pipe line	Inverted U slab	1x5x6.5(110 m long)	05
15.	***	147A	59587	Balancing Culvert	RCC box	1x2x2	2
*Main line Chainages start from Prithla station of HORC ** No Bridge Number was given to these bridges in RFP dated 11.11.2022. *** Additional bridges added in Final RFP.							
B. CONNECTING LINE-NEW PATLI- SULTANPUR							
S. No.	**Bridge No**		***Chainage (m)**	**Type of crossing**	**Type of Bridge**	**Tentative Span (m)**	**No. of Track**
	Br. No. as per RFP dated 11.11.2022	Br. No. as per final RFP					
16.	**	3A	1785	GAIL Pipe Line	Inverted U/Slab	1 x 5m x 6.5m (100m long)	01
17.	**	5A	3733	GAIL Pipe Line	Inverted U/Slab	1 x 5m x 3.5m (20m long)	01
*Chainages are from centre line of New Patli station ** No Bridge Number was given to these bridges in RFP dated 11.11.2022.							
Note:-Payment for construction of all the bridges included in Annexure F-6 shall be made under Schedule 'B'.							

Annexure F-7

Payment matrix for Design of Bridges, Temporary diversions, Permanent diversions, widening of existing roads and Restoration of existing roads for C23 package.

Sr No	Activity	Minor bridges in Annexure F-1 included in Schedule A	Major bridges in Annexure F-2 included in Schedule A	Subways at stations in Annexure F-5 included in Schedule A	Bridges in Annexure F-6 included in Schedule B
	Number of bridges covered	57	12	04	17
i.	a. Submission of design of permanent works, permanent diversion and regrading of roads and submission of As Built drawings and documents	Included in Cost Centre 'CD' of Price Schedule A	Included in Cost Centre 'CD' of Price Schedule A	Included in Cost Centre 'CD' of Price Schedule A	Included in Cost Centre 'CD' of Price Schedule A
	b. Design of Temporary works and temporary diversion/widening of roads	Included in Cost Centre 'CD' of Price Schedule A	Included in Cost Centre 'CD' of Price Schedule A	NA	Included in quoted lumpsum cost of works under Schedule-B
ii.	Construction of temporary diversions, if any including additional land (if any required beyond ROW) for constructing the same	Included in quoted lumpsum cost of works under Schedule A	Included in quoted lumpsum cost of works under Schedule A	NA	• Included in the rates quoted for Schedule B for all bridges except for Br No 73 & 112 • Temporary diversions (excluding cost of additional land required temporarily for diversion) of Br 73 & 112 will be paid separately under Schedule-B

Sr No	Activity	Minor bridges in Annexure F-1 included in Schedule A	Major bridges in Annexure F-2 included in Schedule A	Subways at stations in Annexure F-5 included in Schedule A	Bridges in Annexure F-6 included in Schedule B
	Number of bridges covered	57	12	04	17
iii.	Construction of permanent diversions and re-grading, if any required	Included in quoted lumpsum cost of works under Schedule A	• Included in quoted lumpsum cost of works under Schedule A, except for Br No.150 & 153 • Permanent diversion and regrading of Br No. 150 & 153 will be paid under Schedule B	NA	Will be paid separately under Schedule -B
iv.	Widening of existing roads (within HORC ROW)	Included in quoted lumpsum cost of works under Schedule A	Included in quoted lumpsum cost of works under Schedule A	NA	Included in quoted lumpsum cost of works under Schedule-B
v.	Restoration of existing roads damaged during construction activities	Included in quoted lumpsum cost of works under Schedule A	Included in quoted lumpsum cost of works under Schedule A	NA	Included in the rates quoted for Schedule-B

ANNEXURE F-8

LIST OF TRACK FITTINGS

TABLE OF BILL OF MATERIALS FOR 1 No. H- BEAM SLEEPERS 60Kg RUNNING RAIL WITH 52 Kg GUARD RAIL.

SL.NO.	DESCRIPTION OF PARTS	DRAWING NO.	SPECIFICATION	NO./SL.
1	H-BEAM (ISHB 200 X 200) 2655 mm LENGTH	BASED ON R.D.S.O./B-1636/4/R	BS : 45, IS : 4759, .	1
2	M.S. BASE PLATE	R.D.S.O./T-8760	IS.2062-2011	2
3	RAIL PAD WITH EMBEDDED STEEL PLATE	R.D.S.O./T-8761	IRS. SPECIFICATION FOR 10mm.THICK G. R. PAD(PROVISIONAL-1989) & STEEL AS PER PROVISIONAL-2019	2
4	SPL.CAST LINER (INNER)FOR 60KG RAIL	R.D.S.O./T-8762	IRS.SPECIFICATION PROVISIONAL-2019	2
5	SPL.CAST LINER (OUTER)FOR 60KG RAIL	R.D.S.O./T-8763	IRS.SPECIFICATION PROVISIONAL-2019	2
6	ELASTIC RAIL CLIP MK III	RDSO/T-3701	IRS T-31-2018	4
7	TAPPER WASHER (FOR GUARD RAIL)	R.D.S.O./T-5161	IS.226-1962	4
8	TAPPER WASHER (FOR GUARD RAIL)	R.D.S.O./T-5162	IS.226-1962	4
9	SINGLE COIL SPRING WASHER	R.D.S.O./T-10773	IRS T-42-1988	4
10	6mm GROOVED RUBBER PAD (FOR GUARD RAIL)	R.D.S.O./T-5163	IRS. SPECIFICATION FOR 6mm.THICK G. R. PAD(PROVISIONAL-1989)	4
11	305x300x25/30mm ELASTOMERIC PAD	R.D.S.O./B-1636/5	REV.-02 Dt-26/11/2012	2
12	TAPERED SPLIT PIN	CE's NO.22994/8	IS.226-1962	8
13	ø28 HOOK BOLT 347mm Length and 2 nos NUT & 3 Nos. washer	BASED ON R.D.S.O./B-1636/5	IS.226-1962	4
14	PACKING PLATE FOR GUARD RAIL 150X22X75		IS.226-1962	4
15	BOLT & NUT FOR GUARD RAIL	R.D.S.O./T-5164	IRS T-10-1968	2

Note: The above list excluding Sr No.1, 2 & 14 will be considered equal to 1 set of fittings. The Contractor shall supply spare set of fittings for 20% quantity of H Beam sleepers included in Schedule 'A'.

Section VII: Employer's Requirements

Section VII-3: Design (Civil)

EMPLOYER'S REQUIREMENTS – DESIGN (CIVIL)

1. INTRODUCTION

1.1 The Employer's Requirements - Design specifies the procedural requirements for the preparation of the design of the Permanent Works. These requirements are subdivided into those that are to occur during the Design Phase, those that are to occur during the Construction Phase, and those that are of general application.

1.2 In addition to the express requirements herein, the Contractor shall, whenever the Engineer so requests, provide information and participate in discussions that relate to design matters.

1.3 The Contractor shall engage the Designer who shall undertake and prepare the design of the Permanent Works and Temporary Works. The Contractor shall place his core design team at Gurgaon.

1.4 The Contractor shall ensure presence of Design team at Gurgaon at all times by staff whose seniority and experience are to the satisfaction of the Engineer and whose representative is available on the Site as necessary or as required by the Engineer.

1.5 The Contractor shall submit his Quality Assurance Plan as required at Appendix 11 for the design required by the Contract.

1.6 The Contractor shall furnish Designer's Warranty in the format approved by the Employer.

1.7 The Design and Construction Standards shall be in conformity with the requirements of "Rules for Opening of a Railway or a Section of a Railway for Public Carriage of Passengers" and to the satisfaction of the Commissioner of Railway Safety whose sanction is mandatory for commissioning of the System.

2. REQUIREMENTS DURING DESIGN PHASE

2.1 The principal requirements of the Design Phase are the production of the Preliminary Design and General Arrangement Drawings, the Definitive Design and the Construction Reference Drawings.

2.2 Preliminary Design and General Arrangement Drawings

The Preliminary Design shall define the main structural elements. In addition, General arrangement drawing, general construction methods and documentation needed to develop the Definitive Design shall be submitted.

2.3 Definitive Design shall be the design developed to the stage at which all elements of the structures are fully defined and specified and in particular:

a) Calculation and analysis are complete;

b) All main and all other significant elements are delineated;

c) All tests and trials and all selection of materials and equipment are complete;

d) Shall take full account of the effect on the Permanent Works of the proposed methods of construction and of the Temporary Works.

2.4 During the preparation of the Definitive Design, the Contractor shall complete all surveys, investigations and testing necessary to complete the design of the Permanent Works.

2.5 The Contractor shall sub-divide the proposed Definitive Design into Design Packages to be submitted in advance of the Definitive Design Submission and to be identified in the Design Submission Programme. The Design Packages are to relate to the significant and clearly identifiable parts of the proposed Definitive Design and shall address the design requirements as described herein. The Design Packages shall facilitate the review and understanding of the Definitive Design as a whole and shall be produced and submitted in an orderly, sequential and progressive manner.

2.6 Separate Definitive Design Submissions may be prepared for those major elements to be procured by sub-contract and which sub-contracts include design. Where such work is to be procured by the Contractor on the basis of outline design, design briefs and performance specifications, such documents may be submitted as Definitive Design Submissions.

2.7 Upon issue of the Notice in respect of the Definitive Design Submission, the Contractor shall complete the design in all respects and produce the Construction Reference Drawings, the purpose of which is to illustrate all the Permanent Works and to be the drawings governing construction.

2.8 Construction Reference Drawings shall fully detail for the construction of the elements covered by the Definitive Design and shall show in full the works to be constructed.

3. REQUIREMENTS DURING CONSTRUCTION PHASE

3.1 The principal requirements relating to design during the Construction Phase are the production of Working Drawings, the preparation of technical submissions as required under the Contract, the compilation of the Final Design and the production of the As-Built Drawings.

3.2 Working Drawings shall be prepared as required under the Contract. They shall be endorsed by the Contractor as being in accordance with the Construction Reference Drawings.

3.3 The Contractor shall endorse the submissions required under the contract that "all effects of the design comprising the submission on the design of adjacent or other parts of the works have been fully taken into account in the design of these parts"

3.4 At least 3 months but not more than 6 months prior to the anticipated date of substantial completion of the Works, the Contractor shall submit the Final Design to the Engineer.

3.5 The Final Design is the design of the Permanent Works embodied in:

a) the latest revisions of the documents comprised in the Definitive Design, taking account of comments in the schedules appended to Notices of No Objection

b) the latest revisions of the Construction Reference Drawings;

c) the calculations (see Clause 11 herein); and

d) such other documents as may be submitted by the Contractor at the request of the Engineer to illustrate and describe the Permanent Works and for which a Notice has been issued.

3.6 The Contractor shall maintain all records necessary for the preparation of the As-Built Drawings. Upon completion of the Works or at such time as agreed to or required by the Engineer, the Contractor shall prepare drawings which, subject to the Engineer's agreement, shall become the As-Built Drawings. All such drawings shall be endorsed by the Contractor as true records of the construction of the Permanent Works and of all temporary works that are to remain on the site. The Contractor shall also show the locations of utilities exposed and retained as directed.

4. DESIGN INTERFACES WITH INTERFACING CONTRACTORs

The Contractor shall co-ordinate all design and installation work with the Interfacing Contractors, i.e. *C-1, T-1, C-4, C-6, E-1 and ST-1*. The Contractor shall co-ordinate with all Interfacing Contractors to produce a detailed programme of access dates, equipment delivery routes and occupation periods for each work area.

5. DESIGN SUBMISSIONS: -

5.1 PRELIMINARY DESIGN and GAD SUBMISSION

The preliminary design shall provide initial design documents for review and shall be sufficiently detailed to show the element of the design main and documents required for preparation of the definitive design. It shall also include:

a) the quality assurance plan for design

b) a review of the outline design criteria

c) the submission of design manuals

d) the submission of one licensed copies of proposed software

e) the submission of specifications proposed for the work

f) the identification of design codes and standards

g) the CAD procedures

h) an alignment review

i) the preliminary construction methodology

j) the design submission programme (update)

k) the utility diversion plan

l) proposed site surveys and other field surveys

m) a review of permanent land requirement

n) the preliminary ground treatment

o) GAD of bridges after carrying out site survey and architectural drawings of stations

p) The preliminary reinstatement drawings.

5.2 DEFINITIVE DESIGN SUBMISSION

a) GENERAL

The Definitive Design Submission shall be a coherent and complete set of documents properly consolidated and indexed and shall fully describe the proposed Definitive Design. In particular, and where appropriate, it shall define:

a) the dimensions of all major features, structural elements and members;

b) all materials;

c) potential forces and movements due to all possible loadings and actions on the structures, and their accommodation;

d) all second order effects;

e) the layout and typical details of reinforcement in structural concrete members;

f) the locations and nature of all relevant joints and connections and details thereof;

g) Standard details;

h) location, geometry and setting-out of all main elements and features;

i) electrical and mechanical services and equipment and their interaction with the structures;

j) provisions and proposals for construction interfacing with the Interfacing Contractors;

k) Erection / launching scheme;

l) utilities to be diverted /supported;

m) Traffic or other civic service affected.

b) DRAWINGS

The Definitive Design Submission shall include drawings that shall illustrate the proposed Definitive Design and in particular shall include, without limitation:

a) general arrangements;

b) layouts and details of structural elements;

c) associated fittings;

d) slopes and earthworks;

e) structural and surface drainage;

f) existing and proposed utilities;

c) CONTRACT SPECIFICATION

The Specification included in the Outline Design Specifications and Outline Construction Specifications for Civil Works shall be amplified so as to specify comprehensively the design and construction of the Permanent Works.

d) DESIGN MANUAL

The Design Manual shall incorporate all design requirements, standards, codes, loading cases, permissible movements and deflections, limit states, design stresses and strains, material properties and all other documents or matters which are relevant to and govern the design. The Design Manual shall refer to all materials, codes and standards used, making clear their specific applications. The Design Manual shall be produced so that it can be used by those involved in the preparation or review of the design of the Permanent Works as a comprehensive reference text and efficient working document.

e) INTERFACE REPORT ON INTERFACING CONTRACTORS

This will include the following:

(i) Details of the design and construction of the Works adjacent to other contracts.

(ii) Details of provisions for the Interfacing Contractors, indicating arrangements for accesses, fixings, casting-in, openings, supports and the like;

(iii) updated interface management plan relating to design integration and co-ordination.

f) TESTING AND COMMISSIONING REPORT

Details of proposals for testing and commissioning procedures for all relevant elements and equipment contained in the Permanent Works.

g) SUPPORTING DOCUMENTS

The Definitive Design Submission shall be accompanied by the following documents, which will be considered by the Engineer in his review of the Definitive Design Submission. Where relevant or required, these documents shall be accompanied by a design note stating clearly how information has been used in the design of the Permanent Works.

i) GEOTECHNICAL INTERPRETATIVE REPORT

A report including site investigation results and covering the geotechnical interpretation of site investigation work including that undertaken by the Contractor in sufficient detail to confirm and justify parameters used in the bridges and other structures foundation and geotechnical designs. The report shall include the full logs and descriptions of confirmatory boreholes drilled by the Contractor.

ii) SURVEY REPORT

A report on all survey work undertaken by the Contractor, including checks on mapping, survey stations, co-ordinates and setting-out. Updated topographical and survey drawings shall also be included.

iii) UTILITIES REPORT

A report giving details of arrangements and working methods in respect of the existing utilities, including protection measures, diversions, reinstatements and programme allowances.

iv) TEMPORARY WORKS DESIGN REPORT

A report which provides sufficient information on the design of the Temporary Works to allow the Engineer to assess their effects on the Permanent Works and to enable these to be taken into account in the review of the Definitive Design.

v) INSTALLATION ANALYSIS REPORT

A report containing a stage-by-stage construction / installation sequence for all structures / equipment.

vi) CONSTRUCTION METHOD STATEMENT

A report which provides sufficient information on the methods of construction and Contractor's Equipment to allow the Engineer to assess their effects on the Permanent Works and to enable these to be taken into account in the review of the Definitive Design.

vii) PROJECT SCHEDULE REVIEW

The Contractor shall, prior to submitting the Definitive Design Submission, review the Project Schedule against the current version of the Design Submission Programme.

In the event that the Contractor considers that there are any discrepancies or inconsistencies between the Design Submission Programme and the Project Schedule, the Contractor shall submit with the Definitive Design Submission its proposed revisions to the Project Schedule such that the discrepancies or inconsistencies are removed.

The Contractor shall provide details of submissions of the proposed Working Drawings and their anticipated timing during the Construction Phase and shall identify information required from or actions to be undertaken by the Employer or others which are necessary to permit the completion of the design of the Permanent Works and the Working Drawings. Desired Dates for the receipt required by the Contractor of such information or for the completion of such actions shall be included with appropriate justification.

6. NOTICES ON DEFINITIVE DESIGN SUBMISSION

The Contractor may make Definitive Design Submissions and seek separate Notices in respect of:

(i) The temporary works for construction of the bridges

(ii) Major elements as identified under Clause 2.6 herein.

The issue of such separate Notices under (i) and (ii) above shall be conditional upon the Contractor having demonstrated, to the satisfaction of the Engineer, that the effect of each structure on other structures, utilities, etc., has been fully accommodated in the design.

7. DESIGN SUBMISSIONS - CONSTRUCTION REFERENCE DRAWINGS SUBMISSIONS

7.1 The Construction Reference Drawings shall be derived directly from the Definitive Design and shall detail and illustrate in full the Permanent Works. The Construction Reference Drawings shall form part of the Working Drawings to be used for construction purposes.

7.2 Prior to any Construction Reference Drawings Submission, the Contractor shall prepare a full list of Construction Reference Drawings in order to demonstrate, to the satisfaction of the Engineer, that such Construction Reference Drawings will be sufficient in extent to cover the construction of the whole of the Permanent Works.

7.3 Unless otherwise required by the Engineer, the Construction Reference Drawings need not include bar bending schedules, bar reference drawings, fabrication or shop drawings as well as other schedules or erection drawings which are to be provided by the Contractor during the Construction Phase.

7.4 The latest Construction Reference Drawing for which Notice has been issued by the Engineer shall be drawn on a tracing film duly signed by the Designer and the Contractor and shall be submitted to the Engineer for his approval. The Engineer will issue Notice in respect of such drawings, endorse them and return to the Contractor. The Contractor shall endorse such drawings as "Good For Construction (GFC)" and shall issue them to the Site for execution of the works.

8. DESIGN SUBMISSIONS – CONSTRUCTION PHASE

8.1 The Contractor shall prepare proposed Working Drawings such as site sketches, bar bending schedules, bar reference drawings, fabrication and shop drawings, construction erection sequences and the like. All such drawings shall be based on Construction Reference Drawings and shall comply with the requirements of the Contract. Working Drawings shall be submitted to the Engineer for his approval.

8.2 If the Working Drawings are considered in order, the Engineer shall issue Notice in respect of such drawings, endorse them and return to the Contractor. On the endorsement by the Engineer, the original will forthwith be returned to the Contractor as the Working Drawings. The Contractor shall endorse such drawings as "Good For Construction (GFC)" and shall issue them to the Site for execution of the works.

8.3 The contractor shall finalize details of the excavation scheme and installation sequence of primary support system and submit such finalized details to the Engineer for review. The proposed excavation scheme and primary support system requirement and installation sequence shall not adversely affect the final lining.

8.4 The Contractor shall finalise details of the proposed method of construction and submit such finalised details to the Engineer for review. The proposed method shall have no adverse effects on the partially completed Permanent Works and shall ensure the Works are statically and, if appropriate, aerodynamically stable.

8.5 The Contractor shall undertake and submit a stage by stage construction sequence and the effect of any Temporary Works and the Contractor's Equipment on the Permanent Works. This analysis shall be in sufficient detail to demonstrate that the Contractor's proposals are safe and have no adverse effects upon any parts of the Permanent Works.

8.6 As-Built Drawings, endorsed by the Contractor shall be submitted to the Engineer for agreement in accordance with Clause 5.5 of the GCC and in electronic format using a commercially available CAD program.

9. DESIGN SUBMISSIONS - REVIEW PROCEDURES

9.1 Submissions of Design Data shall be made and reviewed by the Engineer. The form and detail of the review shall be as determined by the Engineer and will not release or remove the contractor's responsibility for the design under the contract.

9.2 The issue of a Notice shall be without prejudice to the issue of any future Notices.

9.3 The Contractor shall, prior to the submission of the Design Data, obtain all required and/or statutory approvals that relate to that submission including, where appropriate,

the approval of the Concerned Government Authorities and utility undertakings, and demonstrate that all required approvals have been obtained.

9.4 All submissions shall be accompanied by two original copies of a `Design Certificate' as set out in Attachment D1 hereto and signed by the Contractor and the Designer.

10. DESIGN SUBMISSION PROGRAMME

10.1 The Contractor shall prepare the Design Submission Programme which is to set out fully the Contractor's anticipated programme for the preparation, submission and review of the Design Packages, the Definitive Design Submission and the Construction Reference Drawings Submissions and for the issue of Notices in relation thereto.

10.2 The Design Submission Programme shall:

a) be consistent with and its principal features integrated into the Works Programme, and show all relevant Key Dates;

b) identify dates and subjects by which the Engineer's decisions should be made;

c) make adequate allowance for periods of time for review by the Engineer and other review bodies;

d) make adequate allowance for the design and development of specialist works;

e) include a schedule identifying, describing, cross-referencing and explaining the Design Packages into which the Contractor intends to divide the Definitive Design and Construction Reference Drawings; and

f) indicate the Design Interface and Co-ordination periods for each Interfacing Contractor.

10.3 *Deleted*.

11. PROGRAMME FOR SUBMISSIONS DURING THE CONSTRUCTION PHASE

In accordance with Clause 4 of the Employer's Requirements - General, the Contractor shall identify submissions required during the Construction Phase.

12. CALCULATIONS

12.1 Unless otherwise required by the Engineer, calculations relevant to the Definitive Design and Construction Reference Drawings shall be submitted for review with the respective Design Packages or Submissions. The Engineer may require the submission of applicable software including in house software programmes/ worksheets developed by the Contractor, computer input and programme logic for its review prior to the acceptance of the computer output.

12.2 The Contractor shall prepare and submit a comprehensive set of calculations for the

Definitive Design in a form acceptable to the Engineer. Should the design of the Permanent Works be revised thereafter and such revision renders the calculations as submitted obsolete or inaccurate, the Contractor shall prepare and submit the revised calculations.

12.3 Similarly, the Contractor shall submit such further calculations as have been prepared in connection with the Construction Reference Drawings.

12.4 Calculations to be included as part of the submission herein shall comprise the up-to-date calculations in respect of the Definitive Design, the Construction Reference Drawings and such further calculations which the Contractor has prepared during the production of Working Drawings.

12.5 The Contractor shall submit all calculations necessary to support proposals relating to the construction methods.

13. DOCUMENTS REQUIREMENTS

13.1 Drawings shall be prepared generally to A1 size, but to A0 size where appropriate.

13.2 The Contractor shall submit 03 copies of his design and/or drawings for review by the Engineer. After receipt of "No Objection" from the Engineer's Representative, the Contractor shall submit 06 copies of design and/or drawing for the use of the Engineer.

13.3 The submission of drawings should be as per Appendix 9 of the Employer's Requirements.

13.4 The contractor to provide *one* licensed working software copy being used by its DDC to Employer/Engineer's design department maintained for the entire contract period.

ATTACHMENT D 1

DESIGN CERTIFICATE

This Design Certificate refers to design submission no. ..... , which comprises of Definitive Design submission / Construction Reference Drawings submission, working drawing submission scheduled in the attached transmittal, in respect of:

(Description of Permanent Works to which the submission refers)

DESIGNER'S STATEMENT:

We certify that:

a) the outline designs, design briefs and performance specifications of those elements of the Permanent works as illustrated and described in the documents scheduled in the attached transmittal, complies with the Outline Design Specifications and other contract provisions.

b) an in-house check has been undertaken and completed in accordance to approved Quality Assurance Plan (QAP) to confirm the completeness, adequacy and validity of the design of the Permanent Works as illustrated and described in the documents scheduled in the attached transmittal.

c) all necessary and required approval relating to the design of the Permanent Works, as illustrated and described in the documents listed in the attached transmittal, have been obtained.

d) all effects of the design comprising the submission on the design of adjacent or other parts of the works have been fully taken into account in the design of those parts.

Signed by Designer's Authorised Representative

Name : .....

Position : .....

Date : .....

CONTRACTOR'S CERTIFICATE:

The Certifies that all design has been performed utilizing the skill and care to be expected of a professionally qualified and competent designer, experienced in work of similar nature and scope. This further certifies that all works relating to the preparation, review, checking and certification of design has been verified by us and the design proposed by the designer has been accepted by us.

Signed by Contractor's authorised representative

Name : .....

Position : .....

Date : .....

Note 1

The Contractor shall insert one of the following, as applicable:

(i) the Contractor's Technical Proposals

(ii) the Contractor's Technical Proposals and Design Packages Nos. ..... for which a Notice of No Objection has been issued.

(iii) Design Packages Nos. ....….. for which a Notice of No Objection has been issued if such Design Packages develop and amplify the Contractor's Technical Proposals.

(iv) The Definitive Design

SAMPLE DESIGN/DRAWING TEMPLATE

(a) 'Design Quality Assurance' by designer & contractor:

DESIGN QUALITY ASSURANCE			
The responsibility of control, check and verification of accuracy, correctness, completeness, integration and full compliance of contract provisions in respect of design analysis and drawings rests with the design consultants and the contractor.			
By Designer			**By Contractor**
Sig. :	Sig. :	Sig. :	Sig. :
Date. :	Date. :	Date. :	Date. :
Name :	Name :	Name :	Name :
Designed by	Checked by	Approved by	Accepted By

(b) <u>Notice of 'No Objection' from the Engineer:</u>

Notice of 'No Objections' from the Engineer			
Notice of "No Objections" from the Engineer is being accorded for design Principles. However, the overall responsibility for the detailing and design accuracy lies with Design and Build Contractor.			
	REMARKS		
Design Engineer (GC/HORC)	Reviewed		
Senior Design Expert (GC/HORC)	Reviewed		
Chief Design Expert (GC/HORC)	Reviewed		
DPD (GC/HORC)	Reviewed & comments as marked on drawing		

<u>Section C</u>

[Contractor to attach copies of necessary and required approvals]

MINIMUM REQUIREMENT OF THE DDC'S ORGANIZATIONAL STRUCTURE

The DDC shall submit an Organisation Chart together with clear description of the responsibilities of each member within the overall works programme.

Sr.NO	Designation	Numbers	Experience
1	Team Leader	01	Graduate degree in Civil Engineering having experience not less than 10 years and would have handled minimum 02 projects as Team Leader of similar nature & complexity.
2	Bridge Design Expert	01	Graduate degree in Civil Engineering *with total experience of 10 years* and minimum 05 years of relevant experience in the concerned field and would have handled minimum 01 project involving railway bridge involving deep foundation.
3	Embankment Design Expert	01	Graduate degree in Civil Engineering with total experience of 10 years and minimum 5 years of relevant experience in the concerned field and would have handled minimum 01 project involving railway/highway embankment of minimum 6 m height.

NOTE:

1. Sufficient documentary proof to substantiate the qualification and work experience shall be submitted. The Contractor shall submit proposal of DDC experts having experience as mentioned above to the Engineer for approval before deployment.

2. The requirement given above is minimum. The Contractor shall be required to supplement the above mentioned design team as per requirement of the Works so as to adhere to the timelines given in Appendix-2- Contract Key Dates and Completion Date, Section VII-9: Appendices, Part 2- Employer's Requirements under the Contract.

Section VII: Employer's Requirements

Section VII-4: Construction (Civil)

Contents

EMPLOYER'S REQUIREMENTS – CONSTRUCTION (Civil)

1. CONTRACTOR'S SUPERINTENDENCE

The Contractor shall submit a Staff Organization Plan in accordance with the Attachment C-1

This plan shall be updated and resubmitted whenever there are changes to the staff. The plan shall show the management structure and state clearly the duties, responsibilities and authority of each staff member.

The Contractor's Representative and his associates/supervisors shall have experience and qualification appropriate to the type and magnitude of the Works as per Attachment C-2. Full details shall be submitted of the qualifications and experience of all proposed staff to the Engineer for his approval.

2. CONTRACTOR'S TEMPORARY WORKS DESIGN

The Contractor shall, prior to commencing the construction of the Temporary Works, submit a certificate to the Engineer signed by him certifying that the Temporary Works have been properly and safely designed and checked and that the Contractor has checked the effect of the Temporary Works on the Permanent Works and has found this to be satisfactory.

2.1 UTILITIES

a) Refer Employer's Requirements – Functional and Appendix-10 of Section VII-9: Appendices, Employer Requirements.

2.2 STRUCTURES, ROADS AND OTHER PROPERTIES

a) The Contractor shall immediately inform the Engineer of any damage to structures, roads or other properties.

2.3 SITE LABORATORIES

a) The Contractor shall provide, erect and maintain in a clean, stable and secure condition a laboratory, equipped for the routine testing of cement, aggregate, concrete and soil samples and for the storage and curing of concrete cubes or cylinders only. This laboratory shall be located at the Contractor's principal work site or at a location agreed to by the Engineer. Detailed requirements for this laboratory are set out in Appendix 12 to these Employer's Requirements.

3. TESTING

3.1 GENERAL

a) The Contractor shall provide and perform all forms of testing procedures applicable to the Works and various components and the interfacing of the Works with the other Contract works and shall conduct all necessary factory, site and acceptance tests.

b) All testing procedures shall be submitted at least thirty (30) days prior to conducting any Test. The Testing procedures shall show unambiguously the extent of testing covered by each submission, the method of testing, the Acceptance Criteria, the relevant drawing (or modification) status and the location.

c) The testing Procedures shall be submitted, as required, by the Contractor during the duration of the Contract to reflect changes in system design or the identification of additional testing requirements.

d) The Engineer shall have the facilities for monitoring all tests and have access to all testing records. Ample time shall be allowed within the testing programmes for necessary alterations to equipment, systems and designs to be undertaken, together with re-testing prior to final commissioning.

e) The Contractor is reminded that at some point, the High Voltage Power Supply system will be energised and the additional precautions for the safety of staff and co-ordination of activities after power-on shall be anticipated in its testing and commissioning programmes.

f) All costs associated with the Testing shall be borne by the Contractor, unless otherwise specified, including the services of any specialised personnel or independent assessors. The Contractor shall also bear any expenses incurred due to resetting caused by defects or failure of equipment to meet the requirements of the Contract in the first instance. No such testing shall relieve the Contractor from any obligation or responsibility

g) All testing equipment shall carry an appropriate and valid calibration labels.

3.2 BATCHES, SAMPLES AND SPECIMENS

a) A batch of material is a specified quantity of the material that satisfies the specified conditions. If one of the specified conditions is that the material is delivered to the Site at the same time, then material delivered to the Site over a period of a few days may be considered as part of the same batch if in the opinion of the Engineer there is sufficient proof that the other specified conditions applying to the batch apply to all of the material delivered over the period.

b) A sample is a specified quantity of material that is taken from a batch for testing and which consists of a specified amount, or a specified number of pieces or units, of the material.

c) A specimen is the portion of a sample that is to be tested.

3.3 SAMPLES FOR TESTING

a) Samples shall be of sufficient size and in accordance with relevant Standards to carry out all specified tests.

b) Samples taken on the Site shall be selected by, and taken in the presence of, the Engineer and shall be suitably marked for their identification. An identification marking system should be evolved at the start of works in consultation with the Engineer.

c) Samples shall be protected, handled and stored in such a manner that they are not damaged or contaminated and such that the properties of the sample do not change.

d) Samples shall be delivered by the Contractor, under the supervision of the Engineer, to the specified place of testing. Samples on which non-destructive tests have been carried out shall be collected from the place of testing after testing and delivered to the Site or other locations instructed by the Engineer.

e) Samples which have been tested may be incorporated in the Permanent Works provided that:

I. the sample complies with the specified requirements;

II. the sample is not damaged; and

III. the sample is not required to be retained under any other provision of the Contract.

f) Additional samples shall be provided for testing if in the opinion of the Engineer :

I. material previously tested no longer complies with the specified requirements; or

II. material has been handled or stored in such a manner that it may not comply with the specified requirements.

3.4 TESTING

a) The Contractor shall be responsible for all on-site and off-site testing and for all in-situ testing. All appropriate laboratory tests shall be carried out in the Contractor's laboratory, unless otherwise permitted or required by the Engineer. Where the laboratory is not appropriately equipped and/or staffed for some tests, or if agreed to by the Engineer, tests may be carried out in other laboratories provided that:

i. they are accredited for the relevant work to a standard acceptable to the Engineer; and

ii. particulars of the proposed laboratory are submitted to the Engineer for his consent.

b) In-situ tests shall be done in the presence of the Engineer.

c) Equipment, apparatus and materials for in-situ tests and laboratory compliance tests carried out by the Contractor shall be provided by the Contractor. The equipment and apparatus shall be ISI marked as far as possible and maintained by the Contractor and shall be calibrated before the testing starts and at regular intervals as permitted by the Engineer. The equipment, apparatus and materials for in-the situ tests shall be removed by the Contractor as soon as practicable after the testing is complete.

d) The Contractor shall be entitled in all cases to attend the testing carried out in the Employer's or other laboratories, to inspect the calibration certificates of the testing machines and to undertake the testing on counterpart samples. Testing of such samples shall be undertaken in laboratories and particulars of the laboratory proposed shall be submitted to the Engineer for consent prior to the testing.

e) Attendance on tests, including that by the Engineer, Contractor and Designer, shall be as laid down in the Quality Assurance procedures.

3.5 COMPLIANCE OF BATCH

a) The results of tests on samples or specimens shall be considered to represent the whole batch from which the sample was taken.

b) A batch shall be considered as complying with the specified requirements for a material if the results of specific tests for of the specified properties comply with the specified requirements for the properties.

c) If additional tests are permitted or required by the Engineer but separate compliance criteria for the additional tests are not stated in the Contract, the Engineer shall determine if the batch complies with the specified requirements for the material on the basis of the results of all tests, including the additional tests, for every properties.

3.6 RECORDS OF TESTS

a) Records of in-situ tests and laboratory compliance tests carried out by the Contractor shall be kept by the Contractor on the Site and a report shall be submitted to the Engineer within seven (7) days, or such other time stated in the Contract or in the Quality Assurance Programme, after completion of each test. In addition to any other requirements, the report shall contain the following details:

i. material or part of the Works tested;

ii. location of the batch from which the samples were taken or location of the part of the Works;

iii. place of testing;

iv. date and time of tests;

v. weather conditions in the case of in-situ tests;

vi. technical personnel supervising or carrying out the tests;

vii. size and description of samples and specimens;

viii. method of sampling;

ix. properties tested;

x. method of testing;

xi. readings and measurements taken during the tests;

xii. test results, including any calculations and graphs;

xiii. specified acceptance criteria; and

xiv. other details stated in the Contract.

b) Reports of tests shall be signed by the site agent or his assistant, or by another representative authorised by the Contractor.

c) If requested, records of tests carried out by the Employer's staff or by the Engineer shall be given to the Contractor.

4. RECORDS

4.1 DRAWINGS PRODUCED BY THE CONTRACTOR

a) Drawings produced by the Contractor including drawings of site layouts, Temporary Works, etc. for submission to the Engineer shall generally be to A1 size. They shall display a title block with the information as detailed in Appendix 9 to these Employer's Requirements. The number of copies to be submitted to the Engineer shall be as stated in the Contract, or as required by Engineer.

4.2 PROGRESS PHOTOGRAPHS

The Contractor shall provide monthly progress photographs and videography by drone which have been properly recorded to show the progress of the works to the Engineer. The photographs shall be taken on locations agreed with the Engineer to record the exact progress

of the Works. Videography by drone for the Works shall be carried out every month and submitted to the Engineer.

a) The Contractor shall mount each set of each month's progress photographs in a separate album of a type to which the Engineer has given his consent, and shall provide for each photograph two typed self-adhesive labels, one of which shall be mounted immediately below the photograph and one on the back of the photograph. Each label shall record the location, a brief description of the progress recorded and the date on which the photograph was taken.

b) All photographs shall be taken by a skilled photographer whose name and experience shall be submitted to the Engineer for consent and approval received. Processing shall be carried out by a competent processing firm to the satisfaction of the Engineer.

c) The Contractor shall ensure that no photography is permitted on the Site without the agreement of the Engineer. Contractor should be aware of the local regulations and conditions with regard to Photography.

5. MATERIALS

a) Materials and goods for inclusion in the Permanent Works shall be new unless the Engineer has consented otherwise. Preference shall be given to local materials where available. Approved Manufacturers/Suppliers of few important items have been given in Section VII-8: Tender Drawings and Documents. These materials shall be procured only for these manufacturers/Suppliers.

b) Certificates of tests by manufacturers which are to be submitted to the Engineer shall be current and shall relate to the batch of material delivered to the Site. Certified true copies of certificates may be submitted if the original certificates could not be obtained from the manufacturer.

c) Parts of materials which are to be assembled on the Site shall be marked to identify the different parts.

d) Materials which are specified by means of trade or proprietary names may be substituted by materials from a different manufacturer which has received the consent of the Engineer provided that the materials are of the same or better quality and comply with the specified requirements.

e) Samples of materials submitted to the Engineer for information or consent shall be kept on the Site and shall not be returned to the Contractor or used in the Permanent Works unless permitted by the Engineer. The samples shall be used as a mean of comparison which the Engineer shall use to determine the quality of the materials subsequently delivered. Materials delivered to the Site for use in the Permanent Works shall be of the same or better quality as the samples which have received consent.

6. PROVISIONS FOR INTERFACING CONTRACTORS

Interface responsibilities mentioned in Appendix–5 shall be followed by the Contractor.

7. RESTORATION OF AREAS DISTURBED BY CONSTRUCTION.

Unless otherwise directed by the Engineer, any areas disturbed by the construction activity, either inside or outside the Project Right of Way, shall be reinstated as follows:

All areas affected by the construction work shall be reinstated to their original condition, with new materials, including but not necessarily limited to, sidewalks, parking lots, access roads, roads, adjacent roads properties, footpath, kerb stone, boundary wall, grill, fencing, grill, any type of structures (underground & above ground), bore well, horticulture and landscaping. Grass cover shall be provided for any bare earth surface areas, along with proper provisions for surface drainage.

8. TAKING OVER OF WORKS / SECTIONS

8.1 Inspection

a) General

Within seven (7) days of receipt of the Contractor's written application for a Taking-Over Certificate, pursuant to Sub-Clause 10.1 of the General Conditions of Contract, the Engineer, in the company of the Contractor, will inspect the Works or Section covered by the application, as per the requirements described in this Sub-Clause. During the joint inspection, the Works or Section will be examined and relevant documentation will be reviewed. The Engineer will prepare a written list of outstanding items, if any, to be completed or corrected before issuance of the Taking-Over Certificate and a separate written list of items to be completed or corrected during the remainder of the Contract orthe Defects Notification Period. The list shall include an agreed date of correction for each deficiency.

The Contractor shall also obtain written confirmation from all applicable Interfacing Contractors that all interfacing matters have been concluded.

If there are no outstanding items to be completed or corrected before the Taking Over ofthe Works or a Section, the Contractor shall submit to the Engineer all guarantees, warranties, final certifications or similar documents or both as are required under the Contract.

b) Static Inspection

The inspection listed in the following table shall be conducted by the Engineer, in coordination with Interfacing Contractors as necessary.

The Contractor shall prepare and submit for review and approval by the Engineer a Static Inspection Plan detailing and explaining how the Contractor will plan, perform and document all tests and inspections that shall be conducted to verify and validate the Works.The Static Inspection Plan shall consist of a narrative description supported by graphics, diagrams and tabulations as required.

Structure	Inspection Item		Inspection Method		
			Confirmation of "As-Built" Records	Visual Inspection	Measurement Test Check
Earthwork	Formation width	At every 100m on straight line, at every 20m on curved line, at	✔		✔

Structure	Inspection Item		Inspection Method		
			Confirmation of "As-Built" Records	Visual Inspection	Measurement Test Check
		each terminal point of structures			
	Cross section	At every 100m on straight line, at every 20m on curved line, at each terminal point of structures.	✔		✔
	Retaining wall	List of location of retaining walls	✔	✔	
	Construction	Soil test records, compaction records, CBR & deformation modulus (Ev_2) records, construction photos	✔		
	Blanket	Blanket material test records, compaction test records, CBR & deformation modulus (Ev2) test records.	✔		
		Thickness	✔		✔
	Structures Crossing	List of structures crossing the Railway (earth cover, overhead clearance, etc.)	✔		✔
	Drainage system	Drainage works at embankment/cutting, drainage diagram	✔		✔
Bridges	Formation width	At each bridge	✔		✔
	Construction	Quality records of aggregate used, reinforcement, concrete quality control	✔		

Structure	Inspection Item		Inspection Method		
			Confirmation of "As-Built" Records	Visual Inspection	Measurement Test Check
		data, measurement records of cast-in-situ piles/ open foundation etc.			
	Repairing of structures	Records of repaired parts of structures	✔	✔	
	Rebar cover	Records of measurement of rebar cover	✔		
	Clearance under girder/slab	Above roads/rail	✔		✔
	Abutment/ pier structures/ RCC box etc.	All Structural drawings	✔	✔	
	Concrete strength	Schmidt hammer tests	✔		✔
	List of bridges	List of bridges	✔	✔	
	Pile load test	Pile load test parameters	✔		
	Steel Girder	Material test record, fabrication, welding & trial assembly records, dead load camber	✔		✔
	Bearings	Acceptance test record	✔	✔	
	Track on OWG	Track parameters at every sleeper location	✔		✔

Structure	Inspection Item		Inspection Method		
			Confirmation of "As-Built" Records	Visual Inspection	Measurement Test Check
	Load test	Load test parameters of superstructure (OWG/CG/PSC girders)	✔		✔
		Load test parameters of skew RCC box	✔		
Station	Platform length, width	At every 10m on straight line, at every 5m on curved line, control points of curve	✔		✔
	Clearance of isolated and continuous structures on platform as per SOD	All structures	✔		✔
	Staircase and pavement	Results of stair width measurement	✔	✔	
	Drainage of platform & yard	Section & slope at every 20m	✔		✔
	Safety fence, etc.	List of facilities (clearance from platform end to fixed/movable fence, etc.)	✔	✔	
Protective facilities	Fire protection	Fire extinguisher layout and numbers	✔	✔	

Structure	Inspection Item		Inspection Method		
			Confirmation of "As-Built" Records	Visual Inspection	Measurement Test Check
	Abutment/ Pier protection	Drawings	✔	✔	
	Slope protection works	List, location and Drawings of slope protection works	✔	✔	

After Static Inspection of the Works as mentioned above the Contractor shall submit the Inspection Report in the agreed format in four (4) signed copies to the Engineer for review and approval.

8.2 Remedial Action and Re-inspection

Within twenty-eight (28) days of receipt of a written application for a Taking-Over Certificate, the Engineer shall proceed in accordance with Sub-Clause 10.1 of the General Conditions of Contract.

8.3 Taking Over Certificate

If the Engineer does not issue a Taking-Over Certificate, but gives instructions in accordance with sub-paragraph (ii) of Sub-Clause 10.1 of the General Conditions of Contract, the Contractor shall, when he considers the work specified by the Engineer completed, give written notice to the Engineer and the Contractor.

The Contractor shall submit documents required by Commissioner of Railway Safety (CRS) and shall accompany him during his inspection along with necessary records.

9. Sub-Contractor for Fabrication, Assembly & Launching of Open Web Girders (OWG) Bridges

9.1 Upon award of the Contract, the Contractor shall engage Sub-Contractor for fabrication, assembly & launching of Open Web Girders (OWG) Bridges. The Contractor shall submit details of Sub-Contractor proposed to be engaged for fabrication, assembly & launching of OWG Bridges. *Sub-Contractor shall be engaged within 60 days of issue of LOA.*

9.2 Sub-Contractor to be engaged shall have the experience of execution of bridge work consisting of fabrication, assembly and launching of at least one span of Open Web Girders (OWG)/Bowstring Girder of 45.7m or longer spans in Railway/Metro/RRTS or Road Over Bridge (ROB) over Railway/Metro/RRTS in a single contract during last seven years.

9.3 Sub-Contractor to be engaged shall submit experience certificate issued from the Employer (owner of the Work).

9.4 The Contractor/ Sub-Contractor must own RDSO approved workshop or must submit an undertaking to the effect that on award of contract he will enter into a MOU with RDSO approved vendor workshop in Part-A for fabrication of Open Web Girders.

9.5 The Contractor is required to enter into legally enforceable agreement with the Sub-Contractor within 60 days of approval of Sub-Contractor and submit a copy of the agreement to the Engineer. The agreement must specify the specific role and responsibility of the Sub-Contractor.

ATTACHMENT - C-1

MINIMUM ORGANISATION STRUCTURE REQUIRED *& PENALTY FOR NON-DEPLOYMENT*

The figures indicated in Table 1 below are the minimum number of Project-Personnel required which are to be deployed as per the minimum level of supervision. The qualification/experience of such Project personnel is given under *Attachment-C-2*

S. No.	***Designation of Project Personnel***	***Minimum no. of Project-Personnel required***	***Penalty for Non-deployment per week or part thereof per person***
1.	Contractor's Representative/ Project Manager (Team Leader)	*1*	*Rs 1,00,000/-*
2.	Deputy Project Manager (Formation)	1+1	*Rs 40,000/- for first 3 months and Rs. 80,000/- thereafter*
3.	Deputy Project Manager (Bridges & station)	1+1	*Rs 40,000/- for first 3 months and Rs. 80,000/- thereafter*
4.	Planning Engineer	1+1	*Rs 40,000/- for first 3 months and Rs. 80,000/- thereafter*
5.	*Senior Quality Assurance /Quality Control Expert*	*1*	*Rs 40,000/- for first 3 months and Rs. 80,000/- thereafter*
6.	Quality Assurance /Quality Control Expert	1+1	-
7.	Civil Engineer (Formation)	3+3	-
8.	Civil Engineer (Bridge)	2+2	-
9.	Civil Engineer (Station)	1+1	-
10.	Civil Engineer (Fabrication & launching of steel OWG)	1+1	-
11.	Procurement Manager	1+1	-
12.	Health & Safety Expert	1+1	*Rs 40,000/- for first 3 months and Rs. 80,000/- thereafter*
13.	*Environmental Expert*	*1*	*Rs 40,000/- for first 3 months and Rs. 80,000/- thereafter*
14.	Surveyor	1+2	-
15.	*Civil Engineer (Concrete Expert)*	*1+1*	-

NOTES:-

i. The Contractor shall deploy resources as per the above-mentioned table. The Contractor shall also confirm to deploy manpower over and above the minimum numbers indicated above, if the work so requires.

ii. The work of C-23 is located in two different stretches. The list of project Personnel given above in the form of x+y means that a particular Personnel is required in x nos. in one stretch and in y nos. in another stretch.

iii. The performance of project personnel deployed will be evaluated periodically by the Engineer during the contract period. In case the performance of any of the project personnel is not satisfactory, the Contractor shall replace them with good personnel immediately as per directions of the Engineer.

iv. The personnel at Sr.No.1, must be deployed by Commencement Date. Personnel at Sr. No.2, 3, 4,5, 12 & 13 in the above table must be deployed within 30 days of Commencement Date. Non adherence to these provisions shall attract penalty as indicated in the table above.

v. The resources indicated in table above are for peak requirement. All resources need not be mobilized simultaneously for entire duration of the contract. The Contractor shall mobilize the resources as per the deployment programme approved by the Engineer.

vi. In case of non-deployment of project personnel, the penalty shall be imposed as indicated above and deducted from Contractor's running / final bills. The decision of the Engineer in this regard shall be final and binding.

ATTACHMENT C-2

Minimum level of supervision & qualification/ experience of Project Personnel is as follows:

S. No.	*DESIGNATION*	*QUALIFICATION*	*EXPERIENCE LEVEL*
1.	Contractor's Representative/ Project Manager (Team Leader)	Graduate in Civil Engineering	Minimum total experience of 15 years out of which, minimum *5* years as In-charge in *projects of Railway/ DFC/ Metro/ RRTS/ Highway /Expressways.*
2.	Dy. Project Manager (Formation)	Graduate/Diploma in Civil Engineering	Minimum total experience of 10/12 years out of which minimum 05/08 years in *projects of Railway/ DFC/ Metro/ RRTS/ Highway /Expressways*
3.	Dy. Project Manager (Bridges & station)	Graduate/Diploma in Civil Engineering	Minimum total experience of 10/12 years out of which minimum 05/08 years in *projects of Railway/ DFC/ Metro/ RRTS/ Highway /Expressways*
4.	Planning Engineer	Graduate in Civil Engineering with certification *in* Primavera software	Minimum total experience of 10 years out of which minimum 05 years in relevant field in planning of Infrastructure projects.
5.	*Senior Quality Assurance /Quality Control Expert*	*Graduate / Diploma in Civil Engineering*	*Minimum total experience of 10/12 years out of which minimum 05/07 years in QA (Field) and at least one year as In-charge in Infrastructure Project*
6.	Quality Assurance (QA) /Quality control Expert	Graduate / Diploma in Civil Engineering	Minimum total Experience of *08/10* years out of which minimum *03/05* years in *QA (Field) in* Infrastructure Project
7.	Civil Engineer (Formation)	Graduate / Diploma in Civil Engineering	Minimum total experience of *05/08* years out of which 2 years experience in relevant field in *projects of Railway/ DFC/ Metro/ RRTS/ Highway /Expressways*
8.	Civil Engineer (Bridge)	Graduate / Diploma in Civil Engineering	Minimum total experience of *05/08* years out of which 2 year experience in relevant field in *projects of Railway/ DFC/ Metro/ RRTS/ Highway /Expressways.*
9.	Civil Engineer (Station)	Graduate or Diploma in Civil Engineering	Minimum total experience of *05/08* years out of which 2 year experience in relevant field in *projects of*

S. No.	*DESIGNATION*	*QUALIFICATION*	*EXPERIENCE LEVEL*
			Railway/ DFC/ Metro/ RRTS/ Highway /Expressways.
10.	Civil Engineer (Fabrication & launching of steel OWG)	Graduate or Diploma in Civil Engineering	Minimum total experience of *05/08* years out of which 2 year experience in relevant field in *projects of Railway/ DFC/ Metro/ RRTS/ Highway /Expressways.*
11.	Procurement Manager	Graduate in Engineering / Diploma in procurement	Minimum total Experience of 05/08 *years* in Procurement in Infrastructure Project.
12.	*Health & Safety Expert*	Graduate / Diploma in Engineering/Science with *one year full time* Diploma in Industrial safety *or equivalent*	Minimum total Experience of 06/08 *years* with relevant experience of 3 years in infrastructure projects.
13.	*Environmental Expert*	*Graduate in Environmental Engineering/ Master's degree in Environmental Engineering/Environmental Science or equivalent*	*Minimum total experience of 06 years out of which 3 years of experience of working on environmental aspects in Infrastructure projects.*
14.	Surveyor	Diploma in Civil Engineering / ITI	Minimum total Experience of 05/08 years in survey work for *linear* Infrastructure project
15.	*Civil Engineer (Concrete Expert)*	*Graduate in Civil Engineering*	*Minimum total experience of 05 years out of which minimum 03 years in relevant field in Infrastructure projects.*

NOTES:

1. *The CVs of concerned personnel shall be submitted to the Engineer for approval. No person mentioned in table above shall be deployed in the project without Engineer's approval.*
2. *Relaxation in qualification / experience can be given by the Engineer in exceptional cases where candidates have got high level of professional competency. Decision of the Engineer in such cases shall be final and binding…..*

ATTACHMENT C-3

MINIMUM RESOURCES PROPOSED FOR THE PROJECT- PLANTS & EQUIPMENTS

The figures indicated below are the minimum number of equipment required.

S. No.	Types of Equipment Required for the Work	Minimum No. of Unit of Equipment Required for the Work
1.	Excavator (75 cum/hr)	03+03
2.	Grader	02+02
3.	Dozer (150 Cum/hr)	04+04
4.	Vibratory Roller (10 T)	04+04
5.	Tippers	30+30
6.	Pugmil/Crusher(200MT/hr)	01+01
7.	Concrete Batching Plant	01+01 Min. capacity of batching plant 30 cum/hr
8.	*Concrete Boom Placer*	*02*
9.	*Stationary* Concrete Pumps (36 cum/hr)	02+02
10.	Transit mixtures	06+06
11.	Survey Instruments (Total Station)	01+01
12.	Lab Testing equipment- fully equipped for site tests.	*As per Appendix 12 of Section VII-9: Appendices, Part 2- Employer's Requirements*
13.	Digital Level (Leica, Sokia)	2+2

Note:

i. The work of C-23 is located in two different stretches. The list of equipment given above in the form of x+y means that a particular equipment is required in x nos. in one stretch and in y nos. in another stretch.

ii. These resources are for peak period of each activity. All plants and equipment need not be mobilized simultaneously. Plants and equipment as required as per the progress of the work shall be brought at site in advance as directed by the Engineer.

iii. The *Contractor* must have a tie up for fabrication of steel bridge girders included in this contract with RDSO approved plant/workshop in Part-A.

Section VII-5: Employer's Requirements -Outline Design Specifications (ODS) – Civil

CONTENTS

1. INTRODUCTION

This part lays down the specifications/criteria for design of civil structures i.e., bridges, stations, embankments, retaining walls and other structures.

The broad parameters covered in these specifications are listed below:

1. Material Parameters (Concrete, Reinforcement steel & Structural Steel etc.)
2. Design Parameters
3. Loading Consideration (Dead Load, Super imposed Dead Load, Footpath Live Load, Railway Vehicular Load, Temperature Loads, etc.)
4. Load Combinations
5. Allowable stresses
6. Design Methodology
7. List of Design Codes and Standards

2. OUTLINE DESIGN SPECIFICATIONS- GENERAL

2.1 The bridges, stations and other structures to be designed in C-23 Package are mentioned in the Scope of Works. The design works include the preparation and approval of GADs/architectural drawings, Definitive Design and Construction Design for structures as per the Employer's requirement- Design.

Initially GADs of bridges shall be prepared by the Contractor after carrying out detailed topographical survey based on conceptual GAD and preliminary design. These GADs will be sent to the Site for checking feasibility of construction by Engineer's Representative and Contractor's Representative. The initial GADs shall be modified incorporating remarks of construction feasibility and submitted to the Engineer along with the preliminary design calculations. After approval of the Engineer, GADs shall be submitted to the stakeholders for approval, if any. Getting approval of GAD from the concerned stakeholders is the responsibility of the Contractor. The Contractor shall address all the queries of the stakeholders. However, the Employer will assist the Contractor in obtaining approval from the concerned stakeholders. The Contractor shall attend any meeting/presentation/joint site visit with stakeholders, as per the requirement, for the approval of GADs. After approval of the stakeholders, the GAD shall be finally approved by the Employer.

2.2 Employer's Inputs

The Employer shall furnish following documents to the Contractor: -

- **a)** *Conceptual* Plan and L-section of the main line
- **b)** *Conceptual* Plan and L-section of the connectivities
- **c)** *Conceptual* ESP of station yards
- **d)** Conceptual GAD of bridges
- **e)** Conceptual layout plan for station
- **f)** Preliminary Geo-technical investigation reports

2.3 Codes & Standards

For loadings, load combinations, analysis, and design of structures, all relevant IRS, IS, IRC and other relevant codes shall be followed.

The list of relevant codes and standards, listed in these specifications, is only tentative. The Contractor shall follow provisions of appropriate codes and standards in force for items which are not covered in the foregoing paras.

All codes & standards shall be of latest revision including all amendments & corrections.

2.4 Design Life

The design life of a structure is that period for which it shall be designed to fulfill its intended function.

The Contractor is required to submit a report demonstrating the approach in design, construction and selection of material so as to achieve the design life as specified.

The design life of each structure, facilities and systems shall be as follows:

a) Structures of the Civil works for Railway/Road Loading

The design life of bridges shall be 100 years.

b) Structures of the Building works

The design life of all building and structures shall be 50 years.

c) Mechanical, Electrical and Plumbing (MEP)

The design life of MEP services including water supply, drainage services and fire protection services etc. shall be *30* years.

d) Ventilation and Air-conditioning (VAC)

The design life of all VAC facilities, systems and services shall be 10 years. The design life of window AC shall be 5 years.

2.5 Maximum Moving Dimensions (MMD) and Clearances

The bridges and other structures shall be designed to cater for double stack container with high rise OHE. The Maximum Moving Dimensions, Structure Gauge and Clearances shall be as per IR Schedule of Dimensions for Broad Gauge.

2.6 Soil Parameters

Preliminary Geo-technical investigation reports shared with the Tender Document are indicative in nature and the Contractor shall carry out independent detailed GT investigations as per codal provisions. However, if there is a wide variation (>15%) in the design soil parameters compared to the parameters as per GT report of nearest bore hole given in the tender document, the same shall be brought to the knowledge of the Engineer and a confirmatory (repeat) bore bole shall be done to ascertain design soil parameters.

a) Liquefaction

Liquefaction shall be considered as per IS 1893-Part-1. The design ground water table shall be used for liquefaction potential calculation. The moment magnitude Mw to be taken in design shall be 7.0. The factor of safety shall be more than 1.0 to ascertain that the strata is not liquefiable.

b) Design Ground Water Table

The ground water table (Base value) shall be considered as maximum (in terms of RL) of ground water table data published by

(a) Central Ground Water Board (CGWB),

(b) Ground water table reported in Geotechnical report provided in Tender Documents,

(c) Ground water table encountered by the Contractor during GT investigation.

The design ground water table shall be taken as minimum3.0m higher than the Base value for evaluation of effects for liquefaction design purposes.

2.7 Differential Settlement

Differential Settlement between two adjacent bridge piers shall be as follows:

a) 12mm for Long Term Settlement;

b) 6mm for Short Term Settlement

Differential settlement shall be considered only in the design of continuous structures, if any.

2.8 General Design Requirements

a) The Project entails construction of BG double-track electrified railway lines capable of handling "25t loading -2008" double stack container for maximum train speed of upto 160 km/h. The project is a feeder route to DFC also. The embankment and cutting shall be designed for "DFC loading (32.5t axle load)". Bridge substructure shall be designed for "DFC loading (32.5t axle load)"and superstructure shall be designed for "25t loading – 2008" unless specified otherwise in the Contract.

b) All levels shall be quoted in meters correct to three decimal places and shall be to Mean Sea Level (MSL) Datum India. The rail level on a track shall refer to the top of the inner rail of the UP Line i.e. line going from New Prithala to Sonipat.

c) The Contractor shall comply with the provisions of IR Schedule of Dimensions, with regard to the clearance over the existing IR network.

d) *Deleted* .

e) Horizontal and vertical alignment has been given in the *Conceptual Plan and Longitudinal Section* Drawings. Proposed Right of Way (ROW) has been also marked on *these* Drawings. The Contractor should check the feasibility at site and may propose any minor modifications, if required.

f) All structures shall be designed and detailed to withstand earthquake forces for Seismic Zone IV.

g) Exposure conditions shall be considered as 'moderate' for all type of structures/bridges. However, in case of Nallah crossing (upto 50m on either side of the edge of Nallah), the exposure condition may be treated as "Severe".

h) Minimum Grade of reinforcement steel shall be Fe 500D conforming to IS 1786.

i) Backfill on *approaches* of *Minor* Bridge shall be placed in accordance with IRS Substructure Code. *Approaches of Major Bridges (i.e. bridges having span equal to or more than 12.2m) shall be provided transition system as per RDSO report GE:R-50 as shown in Sketch No. GC-HRIDC-SK-GEN-019.*

j) The data like bridge length, size, barrel length, type of crossing, total waterway and indicative span configuration etc. in respect of the proposed road/ waterway bridges has been shown in the conceptual GAD of the bridges. *The bridge opening (Horizontal and Vertical) shall not be less than that indicated in the Conceptual GADs.*

k) RCC drains shall be designed where existing KMP and new HORC embankment overlaps, for drainage of storm water from both the embankments.

l) In case of pile foundation, bored cast in-situ concrete piles of diameter 1.2m shall be designed.

m) Inspection platform all-round the abutment caps/pier caps shall be designed along with access ladder.

n) Trolley refuge on bridges shall be designed as per provisions of IRSOD/IRPWM.

o) In case, the bridge is at a location where the Right of Way is restricted, special type of abutment / pier / return wall / wing wall shall be proposed subject to approval of the Engineer.

p) The embankment on approaches of bridges shall be protected by stone pitching/CC blocks of suitable sizes, over 15cm thick consolidated gravel bed, encased in cast-in-situ RCC grid frames of suitable cross section having opening size of 1.75m x 1.75m, for a length of 30m on both sides for major bridges and subway & 15m on both sides for RCC boxes. Toe wall shall be designed at the end of the embankment slope as shown in tender drawings.

q) Inspection steps (1m wide) on either side of formation shall be designed with CC of M20 grade.

r) Adequate provision shall be kept for inspection and replacement of bearings without major disruption to railway operations or any activity underneath the bridge.

s) Necessary provisions for OHE mast shall be kept on bridges.

t) *Compensated Ruling Gradient for the Section is 1 in 150. Station yard gradients shall be as shown in the ESPs .*

3. OUTLINE DESIGN SPECIFICATIONS - EARTHWORK IN FORMATION

3.1 General

This part lays down criteria for design of formation in embankment/cutting.

3.2 Details of Structures to be designed

The Contractor shall design formation in embankment/cutting for various heights that are coming in C 23 Package. Design of embankment/cutting shall include, but not limited to, the following: -–

a) Design of formation for "DFC loading (32.5t axle load)"

b) Slope stability analysis and design of protection measures for erosion control

c) Design of drainage system- longitudinal and cross drains including catch water drains in cuttings.

d) Design of Trolley refuge

e) Design of *Pre-Cast RCC box of size 500x500 clear* for crossing *future* utilities

f) Any other item which is required for complete design of formation in embankment/cutting

3.3 Design Criteria

3.3.1 For design of formation, the "Comprehensive Guidelines and Specifications for Railway Formation: RDSO/2020/GE: IRS 0004", issued by RDSO (hereinafter written as RDSO Guidelines) shall be followed. The geometric parameters of embankment/cutting shall also conform to Indian Railway Schedule of Dimensions (IRSOD) and Indian Railway Permanent Way Manual (IRPWM). Blanket material shall conform to RDSO Guidelines.

3.3.2 The design criteria for design of embankment/cutting slopes shall be as under-

a) A minimum side slope of 2H:1V for embankment shall be adopted up to 4m height. For higher embankments (more than 4m height.), the slopes shall be designed. However side slope shall not be steeper than 2H:1V.

b) Both 'End-of-Construction' (EOC) and 'Long-Term' (LT) stability with most adverse drainage conditions shall be considered in design of slopes.

c) Design shall be carried out using effective stress analysis method both for EOC and LT stability conditions, adopting realistic values of shear strength and pore water pressure parameters.

d) Width of berm shall be adequate to suit the mechanical compaction of earth with heavy rollers. However, berm width shall be kept minimum 2m *on banks and 4m in cuttings.*

e) Erosion Control

i. The slopes of embankments and cutting shall be protected against erosion by providing a protective vegetative cover comprising perennial turf forming grass.

ii. The species of grass should be compatible with the local soil and climatic conditions.

iii. The materials and techniques proposed by the Contractor shall be suitable for the slope height and angle, soil type and climatic conditions and shall perform its function with minimum maintenance requirements.

iv. Coir netting shall be used for turfing of slopes of embankment/cuttings higher/deeper than 4.0m.

v. The coir netting shall not be lighter than 600 g/sqm. It shall conform to IS: 15869 'Open weave Coir Bhoovastra-Specification' and laid as per IS: 15872 'Application of Coir Geotextiles (coir woven Bhoovastra) for Rainwater Erosion Control in Roads, Railway Embankments and Hill Slopes-Guidelines' and IRC: 56.

vi. The contractor shall water and maintain the vegetation cover provided on slopes for a period of 12 months *from Taking Over* .

3.3.3 **Drainage Arrangement**

i. Top of the formation shall be finished to cross slope of 1 in 30 from centre of formation to both sides in case of single/ double line. However, in case of multiple lines, the cross slope shall be from one end to the other towards cess/drain provided in between.

ii. In the double track section, the longitudinal drain between two tracks shall not be provided *outside station yards*.

iii. In station yard a system of covered/underground RCC longitudinal and cross drains of adequate section shall be designed to ensure efficient drainage as shown in tender drawings. The Contractor shall submit a drainage plan for approval of the Engineer. Such plans shall be sufficiently detailed. The longitudinal drains shall be extended as necessary to lead the water clear of the Works to natural drainage courses, culverts or any other suitable outlets.

iv. In cuttings, a system of catch water drains of adequate capacity on both sides shall be designed to intercept the surface runoff of adjoining areas from entering into the cutting and to lead the surface runoff safely away from cutting. In addition, longitudinal side drains of adequate capacity on both sides of formation shall be designed to cater to the surface runoff from slopes and formation. *Typical Section of cuttings has been shown in Tender drawings*.

v. In high/deep embankments/cuttings (height/depth > 6m), a system of precast RCC longitudinal drain of adequate capacity shall be designed along the toe of berm and RCC chute (at about 50 m interval) to collect and lead the surface runoff safely away from the toe of embankment or to side drains in cutting. A concrete chamber shall be provided at the junction of longitudinal berm drain and chute. In embankments, chute shall be extended by about 1.0m beyond the toe of embankment to avoid erosion near the toe. At locations where retaining wall is provided, suitable outfall arrangement shall be provided to avoid erosion of retaining wall foundation.

vi. All cast-in-situ drains shall be designed with RCC of M25 grade.

vii. All the drains shall slope towards the nearest culvert or natural low ground or natural outlets existing nearby where the water shall be discharged with appropriately designed outfall arrangement duly consented by the Engineer.

3.3.4 **Trolley Refuge**

Trolly refuge shall be designed as shown in tender drawing. It shall be provided at 400m center to center on each Up and Dn tracks in a staggered manner in case of double line section *except platform area. In case of single line connectivities, Trolley Refuge shall be provided at an interval of 200m* center to center.

3.3.5 *Deleted*

3.4 Submittals

Prior to the start of construction operations, the Contractor shall submit to the Engineer all relevant documents, drawings, calculations and data including, but not limited to the following, and shall obtain the approval of the Engineer for the proposed materials, design, construction methods and quality control procedures

a) Geotechnical investigation reports and evaluation of sub-surface conditions along the alignment.

b) The Contractor shall submit the report detailing the identification of borrow areas for formation, blanket material, prepared subgrade. Geotechnical investigation reports for borrow areas duly indicating the soil properties of the proposed borrow areas.

c) Details of earthwork balance (cut & fill), properties of materials to be imported/exported, and management of excess materials. Material test reports for embankment fill, prepared sub-grade and blanket.

d) Cross-section of embankment/cutting along the alignment, at every 20 m interval.

e) Slope stability calculations. Analysis of the stability and settlement of formation and design of remedial measures if required. Details of earthwork design solutions and criteria used.

f) Details of construction equipment.

4. OUTLINE DESIGN SPECIFICATIONS -: BRIDGES

4.1 General

This part lays down specifications for design of bridges.

The Bridges in HORC Project comprises of simply supported Prestressed Girders (I/U)/ Steel Composite Girders / Open Web Girders (OWG)/RCC Box Bridges/Culverts with RCC sub-structure and open/deep foundation.

Minimum Centre to Centre distance between two tracks has been kept as 5.3m according to IR-SOD(BG). Maximum length of the track is ballasted except at OWG locations.

All the bridges shall be provided with bridge number plaque, painting of HFL and bridge boards, where required. Approach embankment of minor bridge approaches shall be provided protection measures for a length of 15m on either side as shown in Tender drawings.

Approach embankment of major bridge approaches shall be provided protection measures for a length of 30m on either side as shown in Tender drawings.

4.2 Details of Structures to be designed

The details of the items to be designed in this group are described as follows:

a) Bridges with superstructure of Steel Open Web Girder (OWG)

This group includes the bridges having steel OWG superstructure. Following standard RDSO drawings of OWG for 45.7m and 76.2m span for "DFC loading (32.5t Axle load)" shall be used:

S.No.	Span	Reference RDSO Drawings
		DFC loading (32.5t Axle load)
1	45.7 m	B-17081 to B-17098
2	61.0 m	B-17121 to B-17138
3	76.2 m	B-17101 to B-17118

Note: *Deleted* **.**

All connection in OWG shall be HSFG bolted connections instead of rivets as shown in the drawings. Grade of bolts to be used shall be of property class 8.8.

Spherical bearings shall be used instead of roller rocker bearings. *The Contractor shall design and shall carry out modifications to RDSO drawing of L0 joint of OWG for accommodating spherical bearings and shall get it approved from Chief Bridge Engineer (CBE), Northern Railway .*

Side pathway for maintenance shall be provided as per RDSO drawing No.: CBS-0045, on one side of the truss. Arrangement for prevention of train droppings on road/rail users underneath the track shall be provided.

The Contractor shall design substructure and foundation of these bridges.

The substructure of these bridges shall be designed for "DFC loading (32.5T axle load)". Bridge elements to be designed by the Contractor includes, but not limited to, the following: -

i. Abutments & abutment caps including foundations & wing/return walls
ii. Piers & pier caps including foundations
iii. Load on bearings, design and drawings of bearings including bearing pedestals, inspection platforms including arrangements for access from track. Spherical bearings shall be used.
iv. Provision of jacking arrangements on abutment caps & pier caps for lifting of superstructure
v. Seismic arrestors in pier/abutment cap
vi. Trolley refuge and man refuse on bridges as per latest IR standards
vii. Provision of supports for placing OHE mast for traction system *of 2x25kV*
viii. Protection works of abutments
ix. Inspection steps on approaches of bridges
x. Side pathway on bridges for maintenance
xi. Drainage arrangements
xii. Arrangement for supporting signalling & telecom cables and other utilities
xiii. Arrangement for prevention of train droppings on road/rail users' underneath track
xiv. Ground improvement technique/procedures, if required according to the GT data and design requirements along with the method of verification of the bearing capacity after implementation of ground improvement technique.
xv. Construction methodology
xvi. Any other item which is required for complete design and construction of substructure.

b) Bridges with superstructure of Composite Girder (CG)

This group includes the bridges having superstructure of steel CG. Standard RDSO drawings for "25t Loading-2008" will be used for superstructure of CG. However, the Contractor shall verify the adequacy of RDSO standard drawings of CG for double stack

containers. The Contractor is required to design foundation and substructure for these bridges for "DFC loading (32.5T axle load)".

Spherical bearings shall be used for 30.5m composite girders instead of standard elastomeric bearing. Standard RDSO elastomeric bearings shall be used for composite girders span less than 30.5m, if not in gradient.

Bridge elements to be designed by the Contractor includes, but not limited to, the following: -

i. Abutments & abutment caps including foundations & wing/return walls

ii. Piers & pier caps including foundations

iii. Load on bearings, design and drawings of bearings including bearing pedestals, inspection platforms including arrangements for access from track. Spherical bearings shall be used at locations where Composite girders are placed at gradient.

iv. Provision of jacking arrangements on abutment caps & pier caps for lifting of superstructure

v. Seismic arrestors in pier/abutment cap

vi. Trolley refuge and man refuse on bridges as per latest IR standards

vii. Provision of supports for placing OHE mast for traction system of *2x25kV*

viii. Protection works of abutments

ix. Inspection steps on approaches of bridges

x. Side pathway on bridges for maintenance (Arrangement for pathway shall be provided as per RDSO drawings No. CBS-0046.

xi. Drainage arrangements

xii. Arrangement for supporting signalling & telecom cables and other utilities

xiii. Ground improvement technique/procedures, if required according to the GT data and design requirements along with the method of verification of the bearing capacity after implementation of ground improvement technique.

xiv. Construction methodology

xv. Any other item which is required for complete design and construction of the bridges.

c) Bridges with superstructure of PSC U- slab

This group includes the bridges having superstructure of **PSC U- slab (**post tensioned). Standard RDSO drawings for "25t Loading-2008" will be used for PSC superstructure. The

Contractor is required to design foundation and substructure for these bridges for "DFC loading (32.5T axle load)".

Bridge elements to be designed by the Contractor includes, but not limited to, the following: -

i. Abutments & abutment caps including foundations & wing/return walls
ii. Piers & pier caps including foundations
iii. Load on bearings, bearing pedestals, inspection platforms.
iv. Provision of jacking arrangements on abutment caps & pier caps for lifting of superstructure
v. Seismic arrestors in pier/abutment cap
vi. Trolley refuge and man refuse on bridges as per latest IR standards
vii. Provision of supports for placing OHE mast for traction system of *2x25kV*
viii. Protection works of abutments
ix. Inspection steps on approaches of bridges
x. Drainage arrangements
xi. Arrangement for supporting signalling & telecom cables and other utilities
xii. Ground improvement technique/procedures, if required according to the GT data and design requirements along with the method of verification of the bearing capacity after implementation of ground improvement technique.
xiii. Construction methodology
xiv. Any other item which is required for complete design and construction of the bridges.

d) RCC Box Bridges

This group includes the bridges with RCC Box fit for "DFC loading (32.5t axle load)".

Bridge elements to be designed by the Contractor includes, but not limited to, the following: -

i. RCC Box
ii. Wing wall, return wall, drop wall, curtain wall, protection works
iii. Inspection steps at approaches of bridges

iv. Ground improvement technique/procedures, if required according to the GT data and design requirements along with the method of verification of the bearing capacity after implementation of ground improvement technique.

v. Construction methodology

vi. In case of RUB, drainage arrangement and height gauge

vii. Any other item which is required for complete design of RCC box bridge

Standard RDSO drawing for box culvert shall be followed *if available*. If standard RDSO drawing is not available for desired sizes/fill height, box shall be designed by the Contractor. However, thickness and reinforcement of the box shall not be less than the closest available box size & fill height of RDSO drawing.

RDSO box culvert for double track are available upto 2m fill height. In case of higher fill heights, the size and reinforcement of box shall not be less than that of box for single track with fill height of 2m more than actual fill height.

Any variation from the above, if required due to site constraints shall be adopted after the prior approval of the Engineer.

4.3 Design Requirements

For loadings, load combinations, analysis, and design of structures, all relevant IRS, IS, IRC and other relevant codes shall be followed..

The superstructure/bearing, sub-structure and foundation will be checked for one track loaded condition as well as multiple/all track loaded conditions as well as for single span and two adjacent spans loaded conditions, as the case may be.

Design of structures shall take into account construction methodology/ construction sequence to be adopted during execution.

The analysis and design will be carried out for all possible cases of rolling train loads. All the supporting structures such as superstructure, bearings, substructure and foundations shall be checked for the most onerous cases.

a) Railway Bridges

i. Superstructure shall conform to standard RDSO drawings for "25t Loading-2008" except for OWG bridges. Standard RDSO drawings for "DFC loading (32.5t Axle load)" shall be used for OWG .

ii. Substructure and foundation of bridges shall be designed for DFC loading (32.5T loading) as per IRS Bridge Rules and other relevant codes.

iii. Bridges shall be designed to accommodate curvature of the track alignment, wherever required.

iv. All ballasted deck bridges shall be capable of carrying long/continuously welded rail (LWR / CWR) as per the provisions of "UIC-774(3R) and RDSO guidelines.

v. *Side pathway with hand railing shall be provided on bridges on outer side of Up & Down track as per RDSO drawing No. CBS-0045.*

vi. Hand railing shall be provided for trolley/man refuge and inspection platforms on bridges. The design shall be such that it can be easily maintained and replaced, if required.

vii. Adequate arrangement shall be made on the bridges for providing electrical/ telecommunication cables and other utilities as required. Specifications and guidelines of the owning agencies in such cases shall be followed.

viii. Arrangements for enabling inspection of superstructure and bearings of OWG and CG shall be provided as per RDSO report BS-113.

ix. Bridge bearings shall be as per corresponding standard RDSO drawings for bearings (except for OWG & 30.5 m span CG superstructure). All bearings shall be replaceable without major disruption to railway operations or to any activity underneath the bridge. Bearings shall be placed on bearing pedestals designed in accordance with applicable codes. Appropriate jacking points, on the pier/abutment cap in consideration with the requirements of the superstructure for lifting, shall also be provided. The bearings shall be sandwiched between two true horizontal surfaces. Steel Wedge shall be provided to cater to longitudinal slope of superstructure, wherever required.

x. Expansion/Movement Joints and other necessary measures to control shrinkage and thermal effects shall be incorporated in the structural design so that the performance of the bridge/structures are not adversely affected during normal working conditions. Movement joints shall be designed to be easily maintained and replaceable.

xi. Height gauge for road – under – bridges shall be as per RDSO drawing no. RDSO/M-0001.

xii. *Minimum depth of foundation of waterway bridges shall be scour depth plus 1.75m below the bed level.*

b) RCC Box Bridges

i. Bridges shall be designed for "DFC loading (32.5t axle load)". In addition, the design shall consider the loading standards as applicable to the type of the crossing/existing road or Class A/Class 70R loading as per IRC 6-2017, as the case may be.

ii. Size of the Box openings (minimum required) has been shown in the conceptual GADs. Height of box shown includes clear height and wearing coarse of 150mm. Overall height of box may vary as per site requirement and actual road/ground profile.

iii. Barrel length of the culvert shall be decided based on the fill height and ROW.

iv. *Top of bottom slab of RCC box shall not be kept above the natural ground level beside the road. However, road level and vertical clearance above the road shall be maintained as shown in Tender drawings. Any variation due to site conditions as mentioned above shall be got approved from the Engineer*.

v. Fill Depth shall be the height of fill from the bottom of the sleepers to the top of the box and shall be inclusive of depth of ballast and depth of soil fill as per IRS Concrete Bridge Code (CBC).

vi. All waterway bridges shall be protected by a well-designed flooring system. The concrete floor shall be protected by curtain wall at upstream side and drop wall at downstream side. *The minimum depth of the curtain wall and drop wall shall be scour depth plus 1.75m below the bed level.*

vii. Other Requirements:

a. *Deleted* .

b. The approach roads to the RUBs shall be provided from RCC box to ROW of HORC for the width equal to clear opening of RCC box in concrete of M35 grade .

c. Suitable Height Gauges shall be provided on both sides of RUBs.

d. Crash Barriers / medians / footpaths / railings shall be provided as per the requirements of IRC Codes.

e. Inspection Steps shall be provided wherever required.

f. *Deleted* .

g. Provision for signages shall be kept on both side of RUBs.

h. *Drainage and rain water harvesting system shall be designed for RUBs where the road level in RUB is below the natural ground level in accordance with Section VII-6,Outline Construction Specifications, Part-2 Employer's Requirements. Protection works / ancillary works shall be designed for all RUBs as shown in the Tender drawings*.

Detailed Design criteria for the Bridges shall be as per the design criteria given in Clause 4.4 below.

4.4 Outline Design Specifications Criteria

This Outline Design criteria pertains to the Bridges for HORC Project.

a) ROADWAY AND RAILWAY CLEARANCES

The alignment of HORC crosses several existing roadways and existing railways. The general clearance requirements for these crossings shall be as follows:

b) CLEARANCES FOR ROAD TRAFFIC

Vertical clearance for road traffic shall be higher of the values as per clause 104.4.2 of IRC-5 plus 100 mm or as per Conceptual GAD.

General Arrangement Drawings at road crossings shall be approved by the relevant authorities/stake holders.

c) CLEARANCES FOR ROLLING STOCK

Clearance for railway traffic shall be as per Schedule of Dimensions of Indian Railways. General Arrangement Drawing at railway crossings shall be approved by the relevant Railway Authority.

d) MATERIALS PARAMETERS

i. CONCRETE

1) Grade of Concrete & Cover

   Grade of concrete shall be M-35 for RCC works and M-20 for plain cement concrete including levelling course. However, grade of concrete for bearing pedestals and seismic restrainers can be higher, if required.

   In case of foundation, cover shall be taken as 75mm for all conditions of exposure. For substructure, cover shall be taken as 50mm.

2) Cement

   The minimum cementitious material content, maximum water-cement ratio, total chloride content by weight of cement shall be as per IRS-CBC.

3) Density

   Density of concrete shall be 25 kN/m^3 for PSC and RCC, 25 kN/m^3 for Plain cement concrete and 26 kN/m^3 for Wet concrete.

4) Poisson's Ratio

   Poisson's ratio for all grades of concrete shall be 0.15.

5) Thermal Expansion Coefficient

Coefficient of thermal expansion shall be considered as 11.7 x10-6 ^{o}C in accordance with IRS-Bridge Rules.

6) Time-Dependent Characteristics of Materials

Long-term losses should be calculated in accordance with IRS- CBC.

The design shall be done according to construction sequence to be adopted in site.

ii. REINFORCEMENT STEEL (REBARS)

High strength deformed (HYSD) reinforcement bars of minimum Fe-500D grade, conforming to IS 1786 and IRS-CBC shall be used.

Young's Modulus	=	200,000 Mpa
Yield Stress(fy)	=	500 MPa.
Density	=	78.5 kN/m3

iii. STRUCTURAL STEEL (FOR OPEN WEB /COMPOSITE BRIDGES & OTHER STRUCTURES IF ANY)

Structural steel shall be used for OWG, composite girders and for miscellaneous use such as railing, supporting utilities, coverings etc.

1) Structural Steel for Miscellaneous Use

The design of miscellaneous structure shall be done as per IS: 800 and related provisions.

Hollow steel sections for structural use shall be as per IS: 4923.

Steel tubes for structural purpose shall be as per IS: 1161.

Steel for General Structural Purposes (Grade E250 – B0, E350 – B0) shall be as per IS: 2062.

2) Structural Steel for Open Web/Composite Bridges

(a) General

Structural steel conforming to IS: 2062(Grade E250 – B0, E350 – B0) shall be adopted .

Fabrication shall be done as per provisions of IRS B1 (Fabrication Code).

Design of steel structures shall be done as per IRS steel Bridge Code.

IRC Code: 22 shall be referred for steel-RCC composite construction.

Welding shall be done following IRS Steel Bridge Code, IRS welded Bridge code or relevant IS codes for welding.

(b) Young's Modulus shall be taken as 21,100 kg/mm2 as per IRS- Steel Bridge Code.

(c) Density: 7850 kg/m3

(d) Poisson's Ratio: 0.30 as per IRC: 24-2010.

(e) Thermal Expansion Coefficient: $12x10^{-6}$ as per IRC: 24-2010

Note: In case design of any component/member is done using foreign code, material shall confirm to the specifications of the relevant foreign code.

e) LOADS TO BE CONSIDERED FOR DESIGN

Following are the various loads to be taken into consideration for analysis and design of structures as prescribed in IRS-Bridge Rules up to latest up-to-date correction slip.

i. DEAD LOAD

Dead load shall be based on the actual cross section area and unit weights of materials and shall include the weight of the materials that are structural components of the bridge and permanent in nature.

ii. SUPER IMPOSED DEAD LOAD (SIDL)

Superimposed dead loads include all the weights of materials on the structure that are not structural elements but are permanent. It includes weight of track form ballast/sleepers/rails/ fasteners/ cables/parapet/ hand-rail OHE mast/ cable trough/ Signaling equipment etc.

iii. SHRINKAGE & CREEP

Shrinkage and Creep effects will be calculated as per IRS CBC.

iv. LIVE LOAD (LL)

(a) Railway Vehicular Load

Live load shall be followed as per clause 2.3 of IRS Bridge Rules.

(b) Dynamic Augmentation

CDA will be considered as specified in IRS Bridge Rule.

(c) Footpath Live Load

Footpath live load shall be taken as 490 kg/sqm. as per IRS Bridge Rules

(d) Longitudinal Force

Longitudinal force shall be followed as per clause 2.8 of IRS Bridge Rules.

Tractive force of one track and braking force of another track will be taken in the same direction to produce worst condition of loading.

As per IRS-Bridge Rules, in transverse / longitudinal seismic condition, only 50% of gross tractive effort/braking force will be considered.

Dispersion, of longitudinal forces is not allowed as per IRS Bridge Rules except during checking of Rail stress.

(e) Centrifugal Forces Due to Curvature of Superstructure

The horizontal centrifugal force due to moving load in curved superstructure is to be considered as per IRS: Bridge Rules.

C= (Wv^2)/127R

Where W is Live load & C is Centrifugal force (unit of C & W shall be same), v is maximum design speed in km/h and R is radius of curvature in m. This force shall be assumed to act at a height of 3m (same as in case of DFC loading) above rail top level on the safer side as cg is not defined for double stack containers.

For sharper curves, speed restrictions as per SOD shall be followed.

(f) Racking Force

The horizontal transverse force due to racking as specified in IRS-Bridge Rules is applicable to design.

v. Earth/Surcharge load

Earth pressure and surcharge load/pressure shall be taken as per the provisions of IRS Substructure & Foundation Code.

vi. TEMPERATURE EFFECTS

(a) Temperature

- Overall Temperature (OT)

  The loads shall be considered as per IRS-Bridge Rules and IRC:6. Temperature variation of + 35°C shall be considered, details of which are given below

  Maximum Temperature considered as per Annex. F of IRC 6: +49°C

  Minimum Temperature considered as per Annex. F of IRC 6: -0.4°C

  Temperature variation as per clause 215.2 of IRC 6 will be = (49-(-0.4)/2+10=34.7°C say 35°C.

- Differential Temperature (DT)

  The provision given in IRC 6, shall be considered to compute effect of differential temperature gradient in the absence of any provisions in IRS code.

(b) Rail Structure Interaction (LWR Forces)

A rail structure interaction [RSI] analysis for continuing Continuous Welded Rail/Long Welded Rail over ballasted bridge decks shall be done as per provisions

of "RDSO Guidelines for carrying out Rail-Structure Interaction studies on Indian Railways (BS 114 (version-2))".

- The following shall be adhered to:

  a. Track resistance in loaded and unloaded conditions shall be obtained from cl. 3.2.6 Track Stiffness of BS 114 (version-2). As per the clause, the recommended values for track stiffness for ballasted tracks are 60kN/m and 20kN/m for loaded and unloaded track respectively. The elastic limit is 2 mm for ballasted tracks. No change in track stiffness is permitted on account of actual track behavior.

  b. The temperature variations, to be used for analysis, shall be taken as per provisions of cl. 3.2.8 Temperature Variations of "BS 114 (version-2)". The following shall be used for analysis:

     - The temperature of the bridge does not deviate from the reference temperature by more than + $35\,^{0}$C
     - The temperature of the rail does not deviate by more than + 50^{0}C.
     - The difference in temperature between deck and track does not exceed + 20^{0}C.
     - The reference temperature is the temperature of the deck and the rail when the rail is fixed.

  c. Maximum additional stresses in rail in tension as well as compression on account of rail-structure interaction shall be within the permissible limits as prescribed in cl. 3.3.1 of "BS 114 (version-2)" for additional stresses in Rails The limit prescribed in the document shall be used as it is and no benefit on account of lesser axle load of actual rolling stock shall be permitted.

  d. The provisions of cl. 3.3.2 of "BS 114 (version-2)" Displacements of Bridge Elements shall be adhered to.

  e. Checks must be performed for break in rail continuity due to unusual conditions such as fractures or for maintenance purposes. The provisions of cl. 4.7 of "BS 114 (version-2)" for Rail Gap Analysis shall be followed.

  f. Minimum (unfactored) LWR force of 1.6t/m of span length shall be considered for design irrespective of number of tracks.

- Software and general methodology to be used for carrying out Rail Structure interaction analysis must be validated before adopting the same. A well-established document such as UIC 774-3R may be used for validation.

- Representative stretches must be chosen for carrying out Rail-Structure interaction which shall include special spans. The same shall be got approved from the Engineer.

vii. WIND LOAD (WL)

The wind load shall be calculated as per IRS: Bridge Rules and IS: 875 (Part 3).

Vb = Basic wind speed = 47m/s for Delhi Zone (as per IS 875 IS 87).

viii. SEISMIC FORCE (EQ)

The purpose of this section is to summarize the methodology and the assumptions that shall be used for the seismic analysis.

(a) Seismic Design

Seismic design philosophy as stated in IRS Seismic Code shall be considered. HORC project area lies in Seismic Zone IV of seismic map of India. The peak ground acceleration denoted as zone factor is taken as 0.24 for zone IV.

(b) Definition of Seismic Input

Spectral Acceleration (Sa/g vsT) as prescribed in IRS Seismic code, shall be used for seismic load computation.

(c) Horizontal Seismic Coefficient

The horizontal seismic design coefficient shall be calculated as per following expression

Ah = (Z/2) * (I/R) * (Sa/g)

Where,

Ah = horizontal seismic coefficient to be considered in design

Z = peak ground acceleration or zone factor = 0.24

I = importance factor = 1.5

R = response modification factor as per Table 3

Sa/g = normalized pseudo spectral acceleration for corresponding to relevant damping of load resisting elements (pier/columns) depending upon the fundamental period of vibration T

(d) Response Reduction Factor

Response Reduction Factor "R" shall be as per IRS Seismic code Table -3.

Note: In addition to the response reduction factor, reinforcement detailing of Piers/Portal Piers and joints with pier cap and foundations shall conform to ductility/capacity design requirements as per Annexure-B of IRS Seismic Code.

(e) Vertical Seismic Coefficient

The vertical seismic coefficient shall be 2/3 of horizontal seismic coefficient.

(f) Computation of Fundamental period of vibration

The fundamental time period shall be calculated by any rational method of analysis. Each pier is considered as a single degree of freedom oscillator with mass placed at the Centre of Gravity (COG) of the deck.

The time period can also be calculated as per IRS Seismic Code.

(g) Direction Combinations

The seismic forces shall be assumed to come from any horizontal direction. For this purpose, two separate analyses shall be performed for design seismic forces acting along two orthogonal horizontal directions. The design seismic force resultant (that is axial force, bending moment, shear force and torsion) at any cross section of abridge component resulting from the analysis in the two orthogonal horizontal directions shall be combined according to the expressions given below.

$$\pm 〖EL〗_X \pm 〖0.3EL〗_Y$$

$$\pm 〖.3EL〗_X \pm 〖EL〗_Y$$

ELX = Force resultant due to full seismic force along X direction, and

ELY = Force resultant due to full seismic force along Y direction

When vertical seismic forces are also considered, the design seismic force resultants at any cross-section of a bridge component shall be combined as below:

$$\pm 〖EL〗_X \pm 〖0.3EL〗_Y \pm 〖.3EL〗_Z$$

$$\pm 〖.3EL〗_X \pm 〖EL〗_Y \pm 〖.3EL〗_Z$$

$$\pm .3 〖EL〗_X \pm 〖0.3EL〗_Y \pm 〖EL〗_Z$$

Where ELX and ELY are as defined above and ELZ is the force resultant due to full seismic force along vertical direction.

Seismic on soil mass behind the abutment and confined between the retaining wall shall be considered in addition to dynamic increment in earth pressure.

(h) ERECTION TEMPORARY LOADS (ETL)

Erection forces and effects shall be considered as per IRS-Bridge Rules.

The weight of all permanent and temporary materials together with all other forces and effects which can operate on any part of structure during erection shall be considered in design. The loads arising from most onerous conditions of the construction methods adopted is awaited from the Contractor.

Special care shall be taken that no damage is caused by the construction contractor to the permanent structure. In case of any hole etc., drilled in permanent structural element, the same will be made good by using non-shrink, expansive, high strength grout and its strength shall be better than the structural element and will have to be demonstrated.

(i) DERAILMENT LOADS (DR)

Check shall be made in accordance with the IRS-Bridge Rules.

(j) FORCES ON PARAPET

The parapets shall be designed to resist lateral horizontal force & a vertical force of 150 kg/m applied simultaneously at the top of the parapet as per Clause 2.10 of IRS Bridge Rules.

(k) DIFFERENTIAL SETTLEMENT (DS)

Differential Settlement (post construction) between two adjacent bridge piers shall be as follows.

12mm for Long Term Settlement

6mm for Short Term Settlement

Differential settlement shall be considered only in the design of continuous structures, if any.

(l) BUOYANCY LOADS

The design of the foundation shall be done considering design ground water table as per Sub-Clause 2.6 (b) of Outline Design Specification- General.

In case of river bridges, stability check and calculation of base pressure, full buoyancy shall be considered on submerged portion of substructure and foundation up to HFL or LWL as the case may be, irrespective of the type of soil on which the foundation will rest.

Hydro dynamic forces will be considered as per IRS Seismic code.

(m)WATER CURRENT FORCES

Water current force in submerged portion of substructures and foundations shall be calculated as per IRS Bridge Substructure & Foundation Code.

(n) VEHICLE COLLISION LOAD (VCL)

The vehicle collision load on piers: as per of IRC: 6.

Rules specifying the loads for design of superstructure and sub-structure of bridges and for assessment of the strength of existing bridges should be done as per IRS: Bridge Rules.

All structure near railway track shall be checked for accidental impact from derailed trains as per IRS Bridge Rules as per Addendum & Corrigendum Slip No. 48 dated 22.06.2017.

(o) VIBRATION EFFECT

Effect of vibration due to movement of train on bridge structure will be taken into consideration. This will be checked in dynamic analysis.

f) LOAD COMBINATIONS

Provisions of IRS-CBC shall be followed. The partial load factors and load combinations shall be as per IRS-CBC.

Notes:

ULS-Ultimate Limit state.

SLS-Serviceability Limit state

Wind load and earth quake loads shall not be assumed to be acting simultaneously.

Load combination for Vehicle collision shall be as per IRC 6 but design of members under vehicle collision load combination shall be carried out as per IRS CBC.

i. The Superstructure/bearing, sub-structure and foundation will be checked for one track loaded condition as well as multiple/all track loaded condition, for single span and both spans loaded conditions, as the case may be.

ii. Design of bridge shall be done considering the construction methodology/ construction sequence to be adopted during execution.

iii. The analysis and design will be carried out for all possible cases of rolling train loads. All the structures, such as superstructure, bearings, substructure and foundations shall be checked for the most onerous cases.

g) DESIGN CHECK FOR REINFORCED CONCRETE STRUCTURE

Design of all RCC structures shall be done as per IRS CBC for Serviceability Limit State (SLS) and Ultimate Limit State (ULS)

If prestressing is to be used in any structural member, it shall be checked as per relevant clauses of CBC.

h) DESIGN CHECK FOR STEEL/COMPOSITE STRUCTURE

The design of steel structure shall be done as per IRS Steel Bridge Code/IRS-Welded Bridge Code. In case of steel structure, IRS-steel bridge code shall be followed. While designing for composite action IRC :22 shall be referred.

i) DURABILITY & CRACK WIDTH

(a) DURABILITY

Provision of IRS-CBC shall be followed. The exposure condition is Moderate and in case of Nallah crossing the exposure condition may be treated as "Severe".

(b) CRACK WIDTH CHECK

For SLS Combination, crack width in reinforced concrete members shall be calculated as per IRS-CBC.

The allowable crack width shall be as per exposure conditions given in IRS-CBC.

(c) DEFLECTION

Deflections shall be taken into account as per IRS: CBC while checking appearance, efficiency of the structure and minimum specified clearances. Clause no. 13 of IRS CBC shall be kept in view while calculating deflection/deformation. Permissible values of deformation shall be in accordance with provision of UIC-776-3R.

j) FATIGUE

Fatigue phenomenon shall be analyzed for those structural elements that are subjected to repetition of significant stress variation (under traffic load).

(a) PRESTRESSED/REINFORCED CONCRETE STRUCTURE

The fatigue shall be checked as per IRS-CBC. However, fatigue check for prestressed concrete structures does not need to be performed as long as the whole section (from top to bottom fiber) remains under compression under SLS load combination.

(b) STEEL/STEEL COMPOSITE STRUCTURES

IRS-Steel Bridge Code (up to latest correction slip) / IRS-Welded Bridge code shall be adopted for fatigue check of structural steel members and connections.

Annual Traffic Density for fatigue checks shall be considered as 50 GMT (Gross Million Tonnes per annum) per track (i.e. 100 GMT for two tracks).

Simplified approach method given in Clause 14 of Appendix-G of IRS Steel Bridge Code(Fatigue Assessment of steel bridges) shall be followed for fatigue assessment.

4.5 Drainage

The drainage of deck shall be designed to cater to the maximum envisaged rainfall intensity and suitable longitudinal and transverse slope shall be provided. Moreover, the provisions of Clauses-10.4.1.1 & 15.2.2 of IRS-CBC shall be followed.

The top of soffit slab will be profiled so as to collect the run-off water at multiple points by providing a cross slope of 2.5%. Drainage pipes will be provided to collect the run-off.

The drain pipe of double wall HDPE corrugated pipes with water collection box at top, shall be provided to discharge the water along pier with most pleasant aesthetics.

4.6 BEARING SYSTEM

(a) Type of Bearing System

Spherical bearings for OWGs *and Composite Girders of span 30.5 m and above* shall be designed as per IRC: 83 part-IV.

In case of other RDSO girders, standard bearing drawings shall be followed .

(b) Replaceability of Bearings

While finalizing the proposed bearing system, it shall be kept in mind that accessibility and replacement of each part of bearing are of paramount importance as the design life of bearings is shorter than that of the structure. Keeping in view the above cited criteria, all the bearings, pedestals and pier caps will be detailed for replacement of bearings in the future. The girders/end diaphragms shall be designed to facilitate the operations of jacks during maintenance as per clause IRS-CBC.

(c) Uplift

If required a holding-down device connecting the deck and the pier head shall be placed in order to prevent the deck from overturning. The holding-down device may be integrated in the bearing system or be a separate system constituted of bars embedded in pier cap and bridge with appropriate details, permitting translation/rotation. Other systems can also be foreseen.

Due to the lack of appropriate guidelines in Indian codes, the design criteria for holding down device (upward force limit requiring holding down device, design formulas) will be taken from the latest international practice.

4.7 SUBSTRUCTURE SYSTEM

(a) Pier Cap

For designing the pier cap as corbel the provisions of IRS-CBC should be followed. In case of shear span to effective depth ratio being more than 0.6, pier cap will be designed as flexural member.

Height of pedestal should be in between 150mm and 500mm as per IRC: 78.

The Pier cap shape shall be suitable at transition pier supporting different types of superstructure instead of providing raised/column pedestal over pier cap.

(b) Piers

The effective length of a cantilever pier for the purpose of slenderness ratio calculation will be taken as per IRS-CBC. Ductile detailing is mandatory.

The design of pier shall be done as per IRS CBC.

Shear reinforcement & ductile detailing shall be done as that of RCC column.

4.8 FOUNDATION SYSTEM

Foundation shall be designed as per IRS Bridge Substructure & Foundation Code, IRS Concrete Bridge Code, IRC-78, Manual on the design and construction of well foundation, IS- 2911.

4.8.1 Open foundation has been contemplated as first choice. Soil replacement may also be resorted, if the difference of bearing pressure and bearing capacity is upto 30%, keeping other practical aspect and site conditions in mind.

4.8.2 Pile Foundation

a) Foundation analysis and design will be based on IRS Code for Substructure & IRC-78. The forces applied by the pier are transferred to the bottom of the pile cap for this purpose. Reactions in pile are calculated using rivet theory. Various specific assumptions made for the pile and pile cap design are as follows:

i. Bored-cast-in-situ multiple pile groups will be adopted.

ii. Minimum 1.2m diameter (unless specified otherwise in tender drawing) bored cast-in-situ vertical piles in soil/rock have been contemplated for the foundation of piers. Minimum number of pile in each pile cap shall be 4.

iii. For piles and pile caps, load combinations shall be considered as per IRS-CBC, Table-12. The various specific assumptions made for the pile and pile cap design including pile load testing shall be as per IS: 2911, IRC-78 and IRS-Bridge Sub-structure and Foundation Code.

iv. For pile bearing capacity, all SLS Load combinations as per IRS-CBC will be considered.

v. Increase in vertical load capacity of pile shall be done as per Table-1 of IS 1893-Part-1.

vi. The lateral load capacity of pile shall be evaluated by using empirical formulae given in IS: 2911 (Part-1/ section-2) .

vii. Initial load tests (not on working pile) will be conducted as per IS: 2911 - Part IV. Initial test is proposed to be conducted for a load of 2.5 times as per the safe load based on static formula.

viii. The working load on pile for vertical and horizontal loads shall be verified through routine load tests during construction.

ix. In case of multiple pile system, spacing between the piles shall not be less than 3 times the diameter of pile in soil and 2.5 times the diameter when founded on rock.

x. In general, the top of pile cap shall be kept about min 500mm below the existing ground level and weight of the earth cover will be applied on top of pile cap when unfavorable. The earth cover on pile cap for any favorable effect (stability, soil horizontal capacity.) will be neglected.

xi. In case the location of foundation (all types) is within Load Impact Line of nearby passing load(rail/road) then the effect of surcharge (dead load + live load) corresponding to that passing load shall be taken into account.

b) Structural Design

i. Pile design shall be done according to IRS CBC. However, for crack control in piles, it will be clarified that actual axial load will be considered to act simultaneously.

ii. Where there is a risk of liquefaction, the lateral soil resistance of the liquefied layer will be taken as zero.

iii. Pile cap shall be designed based on IRS –CBC 1997. No support from soil below pile cap shall be considered.

iv. The thickness of the pile cap shall be kept minimum 1.5 times diameter of the piles for multiple-pile group as per IRC 78.

v. The structural design of the pile cap shall be carried out as IRS CBC. Crack width shall be checked for load combination 1 IRS CBC.

vi. Minimum reinforcement in pile caps at top shall be at least 0.12% in each direction in case of compression and in case of tension, it shall not be less than 0.2%.

c) **Soil Structure Analysis**

When designing element forces or estimating displacements the soil stiffness and other parameters shall be assessed based on the design ground water table.

4.8.3 Well Foundation & Open foundation

Well Foundation & Open foundation shall be designed as per IRS Bridge Substructure & Foundation Code/ IRC: 78, IRS-CBC.

4.9 CODAL PREFERENCE

The IRS Codes shall be followed in principle. Although main clauses have been mentioned in the ODS, the other relevant clauses as available in the IRS codes shall also be followed, whenever applicable. If provisions are not available in IRS, the order of preference shall be as follows, unless specified otherwise:

For railway loading related issues:

I. UIC Codes

II. Euro Codes

III. Any other code, which covers railway loading.

For other Design/ detailing related issues:

I. IS Codes

II. IRC Codes

III. EURO Codes

IV. AASHTO Codes

V. Any international code with approval of HRIDC.

5. OUTLINE DESIGN SPECIFICATIONS: STATION

5.1 General

Master Plan & Concept Plan of the station building shall be provided to the Contractor. The Contractor shall prepare the detailed architectural design and drawings of the station. The structural design of buildings and other works as mentioned in the Design Requirement Criteria shall be done by the Contractor as per the requirements briefed hereunder.

This Outline Design Specification (ODS) is applicable for station buildings and other Civil works at Stations of HORC project station which do not support IR/Road live loads.

5.2 Details of Structures to be designed

The details of the items to be designed in this group are described as follows:

a) Stations

The Contractor shall prepare and submit architectural drawings of various stations. Various architectural alternatives shall be prepared for the station building with better aesthetics, pleasing appearance, durability and environment friendliness.

The Contractor shall design station buildings and structures at five stations namely Dhulawat, Chandla Dungerwas, Pachgaon, New Patli and Sultanpur.

The design of station shall include, but not limited to, the following -

i. *Station Buildings*

ii. *Cast-in-Situ RCC Platform wall with pre-cast coping, platforms, platform shelter, mini platform shelter, water booths, toilets and seating arrangements at platforms*

iii. *Water supply system*

iv. *Rain-water harvesting system for storm water from station yard and platforms*

v. *RCC retaining walls within station yards*

vi. *Platform and Yard drainage*

vii. *Subway for inter-platform transfer including stairs & ramp with self supporting covering lift wells and waterproofing system*

viii. *Bore well, pump house, pipe connections, underground & overhead water storage tanks*

ix. *Septic tank and soak pits for toilets of station buildings and platforms*

x. *RCC portico*

xi. *Elevated approach along with stairs and ramp at Pachgaon station*

xii. *Approach road to stations*

xiii. *Ticket counter*

xiv. *RCC pre cast fencing at end platforms*

xv. *S&T huts*

xvi. *Design of platform back wall (Reinforced Earth) at all the four new stations*

The design of station building shall include, but not limited to, the following: -

i. *Architectural and structural design*

ii. *Plumbing arrangement*

iii. *Arrangement for ventilation*

All other building services as necessary for functioning of the station as per NBC 2016

5.3 Design Requirements

a) *Layout Criteria*

i. *The layouts of the stations, as prepared & provided by the Employer are indicative. The Contractor shall develop the layout so as to comply with the Employer's Requirements.*

ii. *Architecture and profile of all buildings shall conform to local aesthetics, cultural ethos, local architecture and environment and shall be subject to consent and approval of the Engineer.*

iii. *The functional and structural design of all the station buildings shall be carried out as per provisions of National Building Code 2016 and the by-laws of the local authorities to the extent of their applicability.*

iv. *Method of structural analysis shall be appropriate for the structure or component to be analysed and shall be carried out by the Contractor using well established software duly consented by the Engineer. However, critical designs shall be supported by manual checks.*

v. *Dynamic analysis shall be performed to obtain the design seismic force by Response Spectrum Method as per latest IS 1893. Analysis of framed structure shall be carried out considering fixed support at top of pile cap / Open foundation Structural design of building shall confirm to codal provision of IS 456, IS 4326 and IS 13920. Design of water retaining structure shall confirm to codal provision of IS 3370.*

vi. *Loading due to earthquake shall be assessed based on the provisions of IS: 1893 (Part I) and IRS seismic code, with latest revision.*

vii. *Loads and load combinations shall be for most unfavorable effects and shall comply with relevant Indian Standards including IS: 456 and IS:800.*

viii. *Overall stability and serviceability requirements shall be checked in accordance with the provisions of relevant Indian Standards.*

ix. *All the buildings shall have provision for concealed ducts/pipes for wiring of telecom facilities in addition to the wiring for power supply and distribution. Concealed ducts/pipes for wiring of telecom & power supply facilities shall be provided in consultation with the Engineer.*

x. *False ceiling shall be proposed at a clear height of about 3m in the rooms with air-conditioning facilities with a view to help in energy conservation.*

xi. *Station signages shall be designed as per IR standards.*

xii. *Benches at platform shall be four-seater bench with backrest, with seat partition as per RDSO drawing no. RDSO/WKS/2018/2.*

b) *VAC Requirements for Station Building*

Ventilation of station building shall be provided as per provisions of ISHARE / National building Code except for Signalling/ Telecommunication / UPS/ IPS/ Battery Rooms.

c) *Other requirements*

The minimum requirement of the facilities for Operation and Maintenance shall be as specified below: -

i. *Amenities for persons with disability (PwD) shall be provided as per as per extant Railway Board instructions/guidelines. All platforms shall be accessible for disabled passenger on wheelchair. Tactile tiles shall be provided on platforms, subway, entry & exit and other places to guide the visually impaired person as per the Railway Board guidelines.*

ii. *In stairs, riser shall be kept maximum as 125mm (net height) and tread minimum as 250 mm (clear width) in the station area and inter-platform connectivity.*

iii. *Approach roads shall be designed for 450 commercial vehicle /day & for a design period of 30 years or more as per IRC:58-2015. Approach road shall have VDC of minimum thickness 250 mm.*

iv. *Covered underground RCC water storage tanks shall be provided at all the station having minimum capacity of 50,000 litres. Effective depth of tanks shall be kept about 1.5 m to 2.0 m.*

v. *RCC overhead water storage tanks shall be provided for a capacity of 20,000 litres at all the stations over RCC staging of suitable height as per requirements.*

vi. *Platform-*

- *All platforms shall be high level.*
- *Platform surface shall be smooth and provided with fiber reinforced Vacuum Dewatered Concrete (VDC) flooring.*
- *End platforms shall be provided a slope of about 1:60 away from the track.*
- *Platform coping shall be of approximate size of 1125mmx530mmx100mm prefabricated from M-30 or higher grade concrete by vibro compaction in a factory under controlled environment.*
- *Effluent from drinking water taps etc. shall be collected and disposed of safely through underground drainage system.*
- *Two underground HDPE pipes of 150mm dia with manholes at about 25 m interval along the length of platform shall be provided for electrical and S&T wiring etc.*

vii. *Elevated approach at Pachgaon station - The contractor shall design the elevated approach with covered stairs and ramp.*

viii. *Stairs and ramps shall be provided with self-supporting covering in accordance with Section VII-6: OCS.*

5.4 OUTLINE DESIGN CRITERIA

a) Objective

The objective is to lay down the structural analysis & design of proposed station building. It also incorporates the design process to establish the overall design philosophy to be adopted in the Analysis and design.

b) Statutory Requirements

The design of the Civil Structure will comply with the requirements of the following:

i. National Building Code.
ii. Local Building Regulations.
iii. Bureau of Indian standard codes.
iv. Indian Railway Standard
v. International codes as applicable.
vi. Any other regulation as per requirements.

c) Structural Design Requirement

The main considerations followed for the design of structure are:

i. Structure safety and stability.
ii. Functional suitability
iii. To meet the demands of aesthetics conceived by the architect.
iv. Availability of material, equipment and expertise.
v. Constructability and ease of maintenance.
vi. Durability.
vii. Economy

d) Structural Arrangement

The proposed building is considered to be of RCC frame structure with Isolated/ Strip /Raft/Pile foundations.

e) Loads

The structural members are loaded with various loads combinations during its services conditions. The loads on the structure are taken for analysis and design as per the relevant latest IS codes of practice.

i. Dead load as per IS: 875 (Part-1) -1987

ii. Imposed live load as per IS: 875(Part-2) -1987

iii. Wind loads as per IS: 875(Part 3) – 2015

iv. Seismic Loads as per IS: 1893-2016

Dead loads comprise of the self-weight of all permanent construction including walls, slabs, beams, columns, water proofing treatment, water tanks, staircase, floor finish etc. Other super imposed loads shall be considered. The structure would be designed for earthquake resistance as per IS 1893:2016, with due consideration for the structural detailing as per provisions of IS 13920-2016 and SP 34-1987.

(a) Dead Load (DL)

Dead load shall be based on the actual cross-sectional area and unit weights of materials and shall include the weight of structural members of the station building.

(b) Super Imposed Dead Load For NON-TRACK Area (SIDL)

For platform slabs, the following loads in SIDL shall be taken

i. Floor finishes load shall be assumed minimum 3.6kN/m^2 uniform load as per architectural requirement.

ii. Suspension load shall be assumed minimum 2.0kN/m^2 uniform load (Suspension load will be considered as the load of false ceiling and services etc. This load will be considered wherever is applicable.

iii. Light partition wall load shall be assumed minimum 1.0kN/m^2 uniform load.

For concourse area, the following loads in SIDL will be considered:

i. Floor finishes load shall be assumed minimum 3.6kN/m^2 uniform load as per architectural requirement.

ii. Load due to additional fill in the toilets (brick bat) shall be considered as per architectural drawing.

iii. Suspension load shall be assumed minimum 2.0kN/m^2 uniform load (Suspension load will be considered as the load of false ceiling and services etc. This load will be considered wherever is applicable.

iv. Loads due to escalator / lift will be considered as per manufacturer's detail.

v. Light partition wall load shall be assumed minimum 1.0kN/m^2 uniform load.

vi. Loads due to solar panel shall be considered as 30 kg/m^2.

Note:

The walls loading will be taken based on actual location shown in architectural drawings. External wall load/glazing load will be taken as per details provided in architectural drawings.

It is proposed to take 230 mm thick brick wall with 20 mm thick plaster on either side. However, the same shall not be taken less than 2.4kN/m^2.

Above loads intensities are minimum loads to be considered in design, Actual load may be higher as per detailed architectural drawings.

(c) Live loads (LL)

Live loads shall generally follow the requirements of National Building Code and IS 875:(Part 2), except where the loadings given below are more severe:

(d) Earthquake Loads (EQ)

Location of proposal site lies in Zone IV. The design parameters shall be taken as per IS-1893 .

Seismic Ductile detailing

a. For RCC structures as per IS: 13920
b. For other structures as per IS: 4326

(e) Wind Loads (WL)

Wind Loads (longitudinal & transverse) shall be calculated in accordance with IS 875: Part 3.

Design wind speed Vz(m/s) = 50m/s (As per NBC)

(f) Construction and Erection Loads (ER)

The weight of all temporary and permanent materials together with all other forces and effects which can operate on any part of structure during erection shall be taken into account. Allowances shall be made in the permanent design for any locked in stresses caused in any member during erection.

(g) Temperature Load (TL)

As per IS: 456. Temperature gradient shall be considered as per IRC-6, if applicable.

(h) Shrinkage & creep

Shrinkage & creep strain shall be evaluated as per IS: 456 for plain and RCC structures and IS: 1343 for prestressed concrete structures.

(i) Earth Pressure (EP) & Water pressure (WP)

In the design of structures or part of structures below ground level, such as retaining walls and underground pump room/ water tanks etc. the pressure exerted by soil or water or both shall be duly accounted for. When a portion or whole of the soil is below the free water surface, the lateral earth pressure shall be evaluated for weight of soil diminished by buoyancy and the full hydrostatic pressure. (As per IS: 875-part 5).

All foundation slabs / footings subjected to water pressure shall be designed to resist a uniformly distributed uplift equal to the full hydrostatic pressure. Checking of overturning of foundation under submerged condition shall be done considering buoyant weight of foundation.

If any of the structure supporting railway loading is subjected to earth pressure, the loads and effects shall be calculated in accordance with IRS substructure code.

(j) Surcharge Load (SL)

In the design of structures or the parts of the structures below ground level, such as retaining walls & underground pump room/ water tank etc. the pressure exerted by surcharge from stationary or moving load, shall be duly accounted for. For the area approachable by road traffic, the minimum live load surcharge shall be taken as 24 kN/m^2.

(k) Other Forces and Effects

As per IS: 456.

f) Deflection Criteria

The deflection limitations as per IS: 456 for Plain and RCC Structures.

g) Settlement (DS)

Maximum and differential settlement shall not exceed, as provided in Table 1 of IS: 1904. The allowable settlement for pile group is 25mm (as per IS 2911-part 4).

h) Lateral Sway

The lateral sway at the top of the building due to wind loads should not exceeds H/500, where 'H' is the height of the building.

i) Load combinations

For loadings, load combinations, analysis, and design of structures, all relevant IRS, IS, IRC and other relevant codes shall be followed.

i. For steel structures, the load combinations shall be as per IS: 800.

ii. For RCC structures / elements, shall be as per Table 18 of IS: 456.

j) MATERIALS

i. Cement

For plain and reinforced concrete structures cement shall be used according to IS: 456. For PSC structures IS: 1343 shall be used.

ii. Concrete

The minimum grade of concrete shall be as per IS: 456 for Plain and RCC structures and IS: 1343 for PSC structures.

Concrete & Short term modulus of elasticity (Ec) shall be as per IS: 456 in case of Plain and Reinforced Concrete structures and as per IS: 1343 for Pre-stressed concrete structures.

The modular ratio for concrete grades shall be taken as per Annex B of IS: 456.

iii. Density

(a) 25 kN/m3 for Reinforced concrete & Prestressed concrete

(b) 25 kN/m3 for Plain concrete

(c) 26 kN/m3 for wet concrete

For density of strands and all other materials, the densities shall be considered as per IS Codes.

iv. Structural Steel

Structural **steel used shall conform to following:**

(a) Hollow steel sections as per IS: 4923

(b) Steel for general Structural Purpose as per IS: 2062

(c) Steel tubes for structural purpose as per IS: 1161

(d) Design of steel structure will be governed by IS 800. In case of composite (steel-concrete) structure it will be governed by IS: 11384 & IS: 3935.

(e) Fabrication shall be done in accordance with IS: 800.

v. Reinforcement Steel (Rebars)

High strength deformed (HYSD) reinforcement bars of Fe-500D grade, conforming to IS 1786 and Clause 4.5 & 7.1.5 of IRS-CBC shall be used.

Young's Modulus	=	200,000 Mpa
Yield Stress(fy)	=	500 MPa.
Density	=	78.5 kN/m3

k) Reinforcement Detailing Reinforcement Detailing

All reinforcement shall be detailed in accordance with IS: 456 & SP: 34 for plain and reinforced concrete structures and IS: 1343 for PSC structures.

The ductile detailing of seismic resisting RC elements shall comply with ductile requirements of IS: 13920.

l) DURABILITY

Durability of concrete shall be as per IS: 456 for Plain & RCC, as per IS: 1343 for PSC elements and as per IS: 800 for steel structures.

m) Cover to Reinforcement

From durability consideration, exposure condition is assumed to be moderate. The clear cover to main reinforcement shall be considered in the design, satisfying durability & 2 hrs. fire rating requirement, which shall be as follows (clause No. 26.4.2, Clauses 21.4-,26.4.3 and Fig 1 of IS 456-2000)

A	Footing	50 mm
B	Columns	40 mm
C	Floor/Roof Beams	30 mm
D	Floor /Roof Slab	25 mm
E	Lintel Beams, Chajja & Loft	15 mm
F	Staircase Waist Slab & Landing	25 mm
G	Plinth Beam	40 mm
H	Walls	25 mm

n) Fire Resistance Period

All the structural elements shall be designed for minimum period of fire resistant of 2 hour. The minimum element thickness for fire resistance shall be as per IS: 456 for concrete structures and as per IS: 800 for steel structures.

o) Crack width Check

All structural concrete elements shall be designed to prevent excessive cracking due to flexure, early age thermal and shrinkage. Flexural crack width shall be checked in accordance with IS: 456 for Plain and RCC structures and IS: 1343 for PSC structures. Crack width should not exceed 0.25 mm unless otherwise specified. Crack width for water retaining structure 0.2 mm as IS 3370.

p) Computation Methods – Modelling, Analysis, Design & Detailing

i. Modelling

The structure is idealized as a 3-D space frame model using the software packages STAAD pro/ Etabs. The masonry wall is used as filler wall and not cast monolithically with structure. Hence this is not modelled in the analysis. In this packages slab loads are applied as a floor loads. Wall loads are applied as UDL on beams. Self – weight is added in the software to have member loads.

The analysis of the proposed structure would be carried to

(a) Analyse to ensure elastic behaviour and fulfilment of serviceability criteria for un-factored load combination.

(b) Analyse to ensure adequate structural integrity for factored load combinations

(c) Obtain static displacements and rotations at various nodes.

(d) Obtain resultant member forces like bending moments, shear forces and axial forces.

(e) Support reactions (axial force and moment) coming on foundations.

ii. Control of Deflection (Vertical)

The deflections of a structure or part thereof shall not adversely affect the appearance or efficiency of the structure or finishes or partitions. The deflections shall generally be limited to the following (clause 23.2 of IS 456-2000):

(a) The final deflections due to all loads including heat effects of temperature, creep and shrinkage and measured from the as-cast level of the supports of floors, and all other horizontal members, should not normally exceed span/250.

(b) The deflection including the effects of temperature, creep and shrinkage occurring after erection of partitions and applications of finishes should not normally exceed span/350 or 20 mm whichever is less. When deflections are required to be calculated, the method given in Appendix – B of IS: 456-2000 will be used.

q) Design Philosophy

To meet the design life and durability requirements, codal provisions specified in clause 8.0 and table 5 of IS: 456- 2000 will be followed for reinforced Concrete Elements. All structural elements would be designed according to the Limit State Method as specified in IS: 456: 2000. M 35 grade of concrete shall be considered for design of all structural member. Along with specified analysis package, design sheets in MS Excel format shall be submitted as per Employer's requirement.

i. DESIGN OF FLOOR / ROOF SLAB

All floor/roof slabs be designed in accordance with Annex- D of IS: 456-2000 with corners held down. Cranking of reinforcement at the support will be provided. Torsion reinforcement will be provided at corners of the slab as per clause D-1.8 of Annex-D of IS: 456-2000.

The beams shall be designed for the envelopes of maximum bending moment and shear force for the load combination that gives the maximum stresses using the STAAD Pro2006 software as per the requirements of IS 456-2000. The critical members would

be check manually also. Main reinforcement will not be bent-up and hence shear reinforcement shall be in the form vertical stirrups only.

ii. DESIGN OF COLUMNS:

The columns shall be designed for vertical load (reduced in accordance with clause 3.2 of IS: 875 (part-2-1987) and uniaxial or biaxial bending depending on its location. Effective length of the column will be in accordance with Annex- E of IS: 456:-2000, considering fixed end on both ends. Minimum diameter of longitudinal steel is 12mm and that for ties is 8mm. The columns shall be designed for the envelopes of maximum value as per STAAD Pro/Etab. The critical members would be check manually also.

iii. DESIGN OF FOOTINGS

Assume 10% of the vertical load from the column as the self-weight of the footing a preliminary step for the design. The same shall be checked after designing the footing dimensions. The plan size of the footing will be determined on the basis of the SBC of the soil. The design pressure at the base of the footing shall be determined by algebraic addition of the pressure due to vertical load and that the due to moment at the base of the column. The design pressure shall be less than SBC of soil except when seismic load are considered, Where SBC can be increased as per Table-1 of IS: 1893-2016.

Base pressure = (P/A)+/-(Mx/Zx) +/- (My/Zy)

Where P = Vertical load on the footing

A = Plan area of the footing

Mx and My = Bending moment at the base of the column along the X and Y directions

Zx and Zy = Sectional modules of the footing along the X and Y directions = $ab^2/6$ or $ba^2/6$

a & b are the dimensions of the footing

The footing shall be designed in accordance with clause 34 of IS:456-2000. The footing will be checked for the following:

(a) Bending moment at a section on the face of the column /pedestal

(b) Shear force at a section at a distance equal to effective depth of the footing from the face of the column or pedestal.

(c) Bearing stress on the footing due vertical load of the column.

(d) Punching shear on the footing due to vertical load of the column.

The reinforcement will be determined as a rectangular section in accordance with Annex-G of IS:456-2000 and SP-16.

iv. DESIGN OF LINTEL BEAMS, CHAJJA & LOFT

The lintel beams will be designed for:

(a) Weight of brick masonry above the lintel level

(b) Load from RCC Chajja attached to the lintel.

(c) Torsion moment due to eccentricity of the Chajja/loft.

Lintel beam shall have a minimum bearing equal to the thickness of the wall on which it is supported or the depth of the lintel beam, whichever is greater. It shall be designed as a simply supported rectangular section. Chajja/loft will be designed as a cantilever slab.

v. DESIGN OF STAIRCASE

The Internal staircase shall be designed in accordance with clause 33 of IS: 456-2000. The Staircase is slab type without stringer beam. The waist slab shall be designed as a simply supported rectangular section. The size of main reinforcement steel shall not be less than 12mm. The staircase would be analysed, designed & detailed as per the provisions of SP-34.

vi. DESIGN OF OVERHEAD WATER STORAGE TANKS

Overhead water storage tanks shall be designed to sustain the water load at full tank condition as per the provisions of IS: 3370 (Part 1- Part4).

vii. Expansion &Construction Joints:

Seismic Expansion joints are recommended when structure exceeds 45m length. The width of the joints is being calculated as per IS-1893-2016, clause7.11.3.

viii. Detailing

The reinforcement layout should take into account the strength requirements as well as the economy of construction.

Following are the requirements of good detailing.

(a) Reinforcement detailing should be simple for fabrication and placing.

(b) Cracking of concrete should be within the permissible limits

(c) There should not be any free paths for propagation of cracks without being traversed by reinforcement

(d) Joints and discontinuities should be capable of withstanding the same forces as the adjoining sections

(e) Reinforcement should not deviate excessively from the direction of tensile stresses

(f) Reinforcement steel of same type and grade shall be used as main reinforcement in a structural member.

(g) Provisions of IS: 456-2000, IS 13920-1993 and IS: SP 34 will be followed for the purpose of detailing of reinforcement.

r) Design of Underground water storage tanks

Underground water storage tanks at stations shall be designed as a water retaining structure based on IS: 3370. Underground water tank would be designed to sustain the following two cases-

(a) Tank full and No earth fill

(b) Tank empty and active earth pressure acting from outside.

Various types of loadings shall be considered in the design of the underground tank. The side walls shall be subjected to earth pressure. Wherever encountered, horizontal pressure due to water table shall also be considered. Stability of water tank shall be checked against buoyancy and foundation raft shall be designed for the worst of buoyant force and soil pressure.

The tank shall also be designed for surcharge loading if any. Water proofing treatment shall be done on the external surface as well as in the internal surface.

s) MASONRY WALLS

All Masonry walls shall be treated as non-structural infill panels and shall be treated as one way / two way slab panels spanning between adjoining beams and columns to check structural safety. Masonry walls shall be designed as un-reinforced masonry as per IS: 1905 and IS: 4326. Shear connector reinforcement between walls & beams and walls & columns shall be provided for external wall while the internal partition walls shall be connected with roof slabs/beams using dry packing mortar between top of walls and soffit of slab / beam.

t) SUBWAY *AND LIFT WELLS*

Subway shall be designed to cater to DFC loading (32.5T) from the tracks along with the other loads from the platform. The requirements/criteria laid down in clause 4.1 & 4.2 for the design of Box bridges shall be followed for the design of Subway. Supporting arrangements for subways and lift wells shall be provided as shown in Tender drawings.

5.5 CODAL PREFERENCE

The design shall be carried out as per provision of these design specifications. Reference shall be made to the following codes for any additional information:

Order of preferences of codes shall be as follows:

(a) Bureau of Indian Standard codes

(b) Indian Railway standard

(c) National Building Code

(d) IRC

(e) BS or Euro Codes

(f) AASHTO

(g) Any international code with approval of HRIDC.

6. OUTLINE DESIGN SPECIFICATIONS: RETAINING WALLS

6.1 General

This part lays down criteria for design of Retaining Wall.

6.2 Details of Structures to be designed

The Contractor shall design the retaining walls of various heights that are required in C23 Package.

Retaining wall is required to be provided at some of the locations along the alignment due to limited availability of ROW. Retaining wall shall be located at the edge of ROW. On Left Hand Side (i.e. on KMP side) of main line, no retaining wall shall be provided except at locations where private land falls between HORC ROW and KMP ROW.

Precast RCC retaining walls shall be used upto minimum 2m height above ground level. The Contractor may use cast in-situ retaining wall for more heights. Minimum grade of concrete for precast retaining wall shall be M 40. Grade of concrete for cast in-situ retaining wall shall be M 35. Reinforced Earth wall (RE wall) shall not be permitted in railway embankments.

6.3 Design Criteria

a) Deleted

b) Deleted

c) The earth retaining structures, if required, shall be designed as per IRS Bridge Substructure and Foundation Code as per the following criteria:

i. In case the location of the earth retaining structure is within Axle Load Impact Line, it shall be designed for earth pressure as well as surcharge due to DFC loading (32.5T axle load).

ii. In case the location of the earth retaining structure is beyond the Axle-Load Impact Line, it shall be designed for retaining the earth.

d) Design and reinforcement detailing shall suit the lifting and handling requirements of the segments of precast retaining wall.

e) Joints between the segments shall be properly designed for required lap length also.

f) *Expansion joints shall be provided at an interval not exceeding 30m.*

LIST OF CODES

6.4 Introduction

The Contractor shall carry out the design on the basis of the codes and specifications given below. The list of codes mentioned herein is only for guidance. The Contractor may supplement these codes and standards with the consent of the Engineer if in his opinion it is essential to do so to comply with the Employer's Requirements.

The Contractor shall be responsible for detailing in his design report and specifications of the standards on which his materials and workmanship will be based and these will be of similar or higher standard than those listed below.

The Contractor shall also be responsible for getting the approval from the Engineer for the standards which he intends to apply for the detailing of his design and specifications additionally.

6.5 Relevant Standards

Apart from the basic data and specific requirements listed in the Employer's Requirement, all items of the Works shall be governed by the latest versions of the following codes and specifications as revised/corrected/amended (with latest correction slip) till the date of *opening of the Tender*. In case of contradiction in various codal provisions, the order of precedence shall be as follows:-

i. Specific provisions in the Employer's Requirements.

ii. IRS Codes and specifications

iii. IS Codes

iv. IRC Codes and specifications

v. International Codes

However, in case of ROBs and other highway loading related structures, IRC Codal provisions shall prevail over IRS Codal provisions. Notwithstanding the precedence specified above, the Contractor shall always seek advice from the Engineer in the event of any conflict for a final decision.

a) Loading Standards shall be as given in Design Requirements Criteria

b) Indian Railway Standard Codes and Specifications (IRS)

i. Bridge Rules

ii. Indian Railways Schedule of Dimensions (BG)

iii. Concrete Bridge Code

iv. Steel Bridge Code

v. *B1- Specification for fabrication and erection of Steel girder bridges*

vi. Welded Bridge Code

vii. Indian Railways Bridge Manual

viii. Indian Railways Permanent Way Manual

ix. Indian Railways Works Manual

x. Bridge Substructure & Foundation Code

xi. Well and Pile Foundation Code

xii. Seismic Code for Earthquake Resistant Design of Railway Bridges

c) RDSO Guidelines

i. BS-113 Guidelines for providing Arrangements for Bridge Inspection

ii. Comprehensive Guidelines and Specifications for Railway Formation: RDSO/2020/GE: IRS 0004

iii. BS-11 4 RDSO guidelines for carrying out rail-structure interaction studies on Indian Railways

iv. BS-126 Guidelines for continuation of LWR/CWR over ballasted deck bridges on Indian Railways

v. Report No. GE: R-50: Transitional System on approaches of bridges issued by RDSO.

vi. Report No. BS-111: Guidelines for use of High Strength Friction Grip (HSFG) bolts on bridges on Indian Railways.

vii. Guidelines for design of Spherical and Cylindrical bearings (in case of Steel Bridges).- Letter No.: RDSO/CBS/Bearing dated 22-06-2011

viii. RDSO drawing for H beam sleepers

ix. BS110 (R) -RDSO guidelines for steel girders

d) Indian Road Congress (IRC) Codes and Specifications

i. IRC: 5 Standard Specifications and Codes of Practice for Road Bridges Section – I – General features of design.

ii. IRC: 6 Standard Specifications and Codes of Practice for Road Bridges –Section – II – Loads and Stresses – Seismic provisions of this standard are to be adopted for the bridge design.

iii. IRC:112 Code of Practice for Concrete Road Bridges

iv. IRC: 22 Standard Specifications and Codes of Practice for Road Bridges Section – VI – Composite Construction.

v. IRC: 24 Standard Specifications and Codes of Practice for Road Bridges – Section V, Steel Road Bridges.

vi. IRC: 54 – Lateral and Vertical Clearances for Vehicular Traffic.

vii. IRC: 83 (Part – III) – Standard Specifications and Codes of Practice for Road Bridges – Section – IX – Bearings Part – III, Pot, POT cum PTFE Pin and Metallic Guide Bearings.

viii. IRC: 83 (Part – IV) – Standard Specifications and Codes of Practice for Road Bridges – Section – IX- Bearings Part – IV, Spherical and Cylindrical

ix. IRC-78: Sub-structure for Road Bridges.

x. IRS-87: Design and erection of false work for road bridges.

xi. Specifications for Road and Bridge Works issued by Ministry of Road Transport & Highways (MORTH).

e) Indian Standards Codes and Specifications (IS)

i. IS: 456 Plain and reinforced concrete - code of practice

ii. IS: 800 Code of practice for General Construction Steel

iii. IS: 875 Code of Practice for Design Loads Part 1, 2 3, 4& 5 (Other than Earthquake)

iv. IS: 1080 Design and construction of shallow foundations in soils (other than raft ring and shell)

v. IS: 1364 Hexagon Head Bolts, Screws & nuts of product grades A & B Part 1 (part 1 Hexagon, Head Bolts (size range M 1:6 to M64)

vi. IS 1367 Threaded Steel Fasteners

vii. IS: 13920 Ductile detailing of reinforced concrete structures subjected to seismic forces code of practice

viii. IS: 1489 Specification for Portland pozzolana cement (Fly ash based)

ix. IS: 1786 High strength deformed steel bars and wires for concrete reinforcement

x. IS: 1893 Criteria for Earthquake Resistant Design of structures

xi. IS: 1904 Design and construction of Foundations in soils: general requirements.

xii. IS: 2062 Specifications for weldable Structural steel

xiii. IS: 2502 Code of Practice for Bending and Fixing of Bars for Concrete Reinforcement

xiv. IS: 2911 Design and Construction of Pile Foundation- Code of practice Part 1Concrete Pile- Section 2 Board Cast-in-situ-piles

xv. IS 2911 Design and Construction of Pile Foundation- Code of practice Part 4 Load test on piles

xvi. IS: 2950 Design and construction of raft foundations

xvii. IS: 3935 Code of Practice for Composite Construction

xviii. IS: 4326 Code of practice for Earthquake resistant design and construction of Buildings

xix. IS: 4923 Hollow steel sections for structural use -specification

xx. IS: 8009 Calculation of settlements of shallow foundations

xxi. IS: 269 Specifications of OPC cement

xxii. IS: 9103 Specifications of Concrete admixtures

xxiii. IS: 11384 Code of practice for Composite Construction in Structural Steel and Concrete

xxiv. IS: 12070 Code of practice for Design and construction of shallow foundation on Rocks

xxv. IS: 14593 Design and Construction of Bored Cast-in-Situ Piles Founded on Rocks.

xxvi. IS 455Specifications for Portland Slag cement

f) International Standards

i. UIC Code 774-3 (R) Track and Bridge Interaction

ii. UIC Code 772-2 (R) Code for the use of rubber bearings for rail bridges

The list of standards given above is only indicative. The Contractor shall follow provisions of appropriate codes and standards in force for items which are not covered in the codes mentioned in foregoing paras.

Section VII: Employer's Requirements
Section VII-6: Outline Construction Specifications (Civil)

Chapter 1. GENERAL-CIVIL

1.1 GENERAL:

1.1.1 These Specifications contained herein shall be read in conjunction with other tender documents.

1.1.2 All Materials, works and construction operations for civil works shall conform to the following manuals:

a) Indian Railways Permanent Way Manual

b) Indian Railway Bridge Manual

c) Indian Railway Works Manual

d) Indian Railway Schedule of Dimensions

e) Indian Railways Unified Standard Specification (Formation Works, Bridge Works and P.Way Works), *Indian Railways Unified Standard Specification for Works and Material 2010, Indian Railways Unified Standard Schedule of Rates* 2019 and , *Indian Railways Unified Standard Schedule of Rates* -2010

f) The relevant IRS Specifications referred to in the above documents listed at (a), (b), (c), (d) & (e)

g) CPWD Specifications, Vol 1&2 – 2019 for building works *and Delhi Schedule of Rates (DSR) 2021*

h) In case of any contradiction in the various codal provisions, the order of precedence shall be as follows:-

i. IRS Codal provisions

ii. IRC Codal provisions

iii. IS (BIS) Codal provisions

1.1.3 The Work shall be carried out in accordance with the "Good for Construction" drawings and designs as would be issued to the Contractor by the Engineer duly signed and stamped by him. The Contractor shall not take cognizance of any drawings, designs, specifications, etc. not bearing Engineer's signature and stamp. Similarly, the Contractor shall not take cognizance of instructions given by any other Authority except the instructions given by the Engineer in writing.

1.1.4 The work shall be executed and measured as per metric units given in the Schedule of Quantities, drawings etc. (FPS units where indicated are for guidance only).

1.1.5 Absence of terms such as providing, supplying, laying, installing, fixing etc in the descriptions does not even remotely suggest that the Contractor is absolved of such providing, supplying etc. unless an explicit stipulation is made in this contract. The Employer shall bear no costs of materials, labour, equipment, duties, taxes, royalties etc.

1.1.6 The specifications may have been divided into different sections / sub-heads for convenience only. They do not restrict any cross-references. The Contractor shall take into account inter-relations between various parts of works/trades. No claim shall be entertained on the basis of compartmental interpretations.

1.1.7 Reference to the Standard Codes of Practice:

a) The contractor shall make available at site all relevant Codes of practice as applicable.

Legends	**Definition**
IRS	Indian Railway Standards
IR specifications	Indian Railways Unified Standard Specification (Formation Works, Bridge Works and P.Way Works) and), *Indian Railways Unified Standard Specification for Works and Material 2010*
IS	Indian Standards
IRC	Indian Road Congress
CPWD	Central Public Works Department
RDSO	Research Designs and Standards Organisation
UIC	International Union of Railways (UIC, French: Union international des chemins de fer)
MORTH	Ministry of Road Transport and Highways
EN	European Standard
ISO	International Organization for Standardization
ASTM	American Section of the International Association for Testing and Materials
BS	British Standard

1.1.8 Alternative or additional codes and standards proposed by the contractor shall be internationally recognized codes and shall be equivalent to or better than, Indian Standards issued by the Bureau of Indian Standards or any other Indian professional body or organization, subject to being, in the opinion of the Employer's Representative, suitable for incorporation or reference into the specifications.

1.1.9 Contractor to Provide:

The Contractor shall provide and maintain at site throughout the period of works the following at his own cost and without extra charge, except for the items specified in the Bill of Quantities the cost being held to be included in the Contract Rates:

a) General works such as setting out, site clearance before setting out and on completion of works. All weather approach roads to the site office should also be constructed and maintained in good condition.

b) All labour, materials, plant, equipment and temporary works, Overhead charges as well as general liabilities, obligations, insurance and risks arising out of GCC, required to complete and maintain the works to the satisfaction of the Engineer.

c) Adequate lighting for night work, and also whenever and wherever required by the Engineer.

d) Temporary fences, barricades, guards, lights and protective work necessary for protection of workmen, supervisors, engineers, General public and any other persons permitted access to the site. Contractor shall provide proper signages as directed.All fences, barricade shall be painted with colour shades as specified by the Engineer. The barricading should be of adequate height to ensure visual obstruction of work from public view.

e) All equipment, instruments, labour and materials required by the Engineer for checking alignment, levels, slopes and evenness of surfaces measurements and quality etc.

f) Design mixes and testing them as per relevant clauses of specifications giving proportion of ingredients, sources of aggregates and binder along with accompanying trial mixes. Test results to be submitted to the Engineer for his approval before adoption on works.

g) Cost of Preparation and compliance with provision of a quality assurance control program.

h) Cost of safeguarding the environment.

i) A testing laboratory as specified *in Appendix 12, Section VII-9: Appendices, Part 2-Employer's Requirements* by the Engineer equipped with the ISI marked *apparatus*, materials and competent trained staff required for carrying out tests, as specified in the relevant sections of the specifications.

1.1.10 Quality Assurance & Quality Control:

a) The work shall conform to high standards of design and workmanship, shall be structurally sound and aesthetically pleasing. The Contractor shall conform to the Quality standards prescribed, which shall form the backbone for the Quality Assurance and Quality Control system.

b) At the site, the Contractor shall arrange the materials, their stacking/storage in appropriate manner to ensure the quality. The Contractor shall provide all the

necessary equipment and qualified manpower to test the quality of materials, assemblies etc., as directed by the Engineer. The tests shall be conducted at specified intervals and the results of tests properly documented. In addition, the Contractor shall keep appropriate tools and equipment for checking alignments, levels, slopes, and evenness of the surfaces.

c) The Engineer shall be free to carry out such tests as may be decided by him at his sole discretion, from time to time, in addition to those specified in this document. The Contractor may provide the samples and labour for collecting the samples. Nothing extra shall be payable to the Contractor for samples or for the collection of the samples.

   i. The test shall be conducted at the Site laboratory that may be established by the Contractor or at any other Standard Laboratory selected by the Engineer.

   ii. The Contractor shall transport the samples to the laboratory for which nothing extra shall be payable. In the event of the Contractor failing to arrange transportation of the samples in proper time the Engineer shall have them transported and recover two times the actual cost from the Contractor's bills.

   iii. All testing shall be performed in the presence of Engineer. Testing may be witnessed by the Contractor or his authorised representative if permitted by the Test House. Whether witnessed by the Contractor or not, the test results shall be binding on the Contractor.

d) The Engineer shall have the right at all times to inspect all operations including the sources of materials, procurement, layout and storage of materials, all equipment including the concrete batching and mixing equipment, and the quality control system. Such an inspection shall be arranged, and the Engineer's approval obtained prior to starting of the particular item of work. This shall, however, not relieve the Contractor of his responsibilities. All materials which do not conform to these specifications shall be rejected and shall be removed from the site immediately. The Engineer shall have the powers to cause the Contractors to purchase and use materials from any particular source, as May in the Engineer's opinion be necessary for the proper execution of work.

1.1.11 Training

The Contractor shall arrange the following trainings for all his concerned persons and 30 persons of the Engineer and the Employer together:

a) 3 days training for fabrication of welded steel girders for railway including one day for practical demonstration at site.

b) 2 days training for concrete, testing, scaffolding and formwork including one day for practical demonstration at site

c) 2 days training on embankment construction and testing

The Contractor shall bear all the expenditure for training including boarding, lodging, airfare, transport, and remuneration of trainers. Training place shall be provided by the Employer free of cost. However, the Contractor shall bear the expenditure for refreshments and meals for all the participants during the training period. The syllabus of training and the names of the trainers shall be submitted to the Engineer for approval. Training shall be imparted only by those trainers who are approved by the Engineer.

1.1.12 Dimensions**:**

a) Figured dimensions on drawings shall only be followed and drawings to a large scale shall take precedence over those to a smaller scale. Special dimensions or directions in the specifications shall supersede all others. All dimensions shall be checked on site prior to execution.

b) The dimensions where stated do not allow for waste, laps, joints, etc. but the Contractor shall provide at his own cost sufficient labour and materials to cover such waste, laps, joints, etc.

c) The levels, measurements and other information concerning the existing site as shown on the drawings are believed to be correct, but the Contractor should verify them for himself and also examine the nature of the ground as no claim or allowance whatsoever will be entertained on account of any errors or omissions in the levels or the description of the ground levels or strata turning out different from what was expected or shown on the drawings.

1.1.13 Setting out of Works:

The Contractor shall set out the Works indicated in the Contract. The Contractor shall provide suitable stones with flat tops and build the same in concrete for temporary benchmarks. All the pegs for setting out the Works and fixing the levels required for the execution thereof shall, if desired by the Engineer, likewise be built in masonry at such places and in such a manner as the Engineer may direct. The Contractor shall carefully protect and preserve all benchmarks and other marks used in setting out the works. The contractor will make overall layout of complete work and get it checked from engineer. The cost of all operations of setting out including construction of benchmarks is deemed to be included in the quoted rates.

a) All the survey work except leveling work shall be carried out using total stations with one second accuracy. The leveling work shall be carried out using Auto level.

b) The triangulations point given by concerned organization before start of work shall be maintained during execution and handed over back to concerned organization after completion of work.

1.1.14 Materials:

a) Source of Materials:

It shall be the responsibility of the contractor to procure all the materials required for construction and completion of the contract. The contractor shall indicate in

writing the source of materials well in advance to the Engineer, after the award of the work and before commencing the work. If the material from any source is found to be unacceptable at any time, it shall be rejected by the Engineer and the contractor shall forthwith remove the material immediately from the site as directed by the Engineer.

b) Quality:

All materials used in the works shall be of the best quality of their respective kinds as specified herein, obtained from sources and suppliers approved by the Engineer and shall comply strictly with the tests prescribed hereafter, or where tests are not laid down in the specifications, with the requirements of the latest issues of the relevant Indian Standards.

c) Sampling and Testing:

All materials used in the works shall be subjected to inspection and test in addition to test certificates. Samples of all materials proposed to be employed in the permanent works shall be submitted to the Engineer at least 45 days in advance for approval before they are brought to the site.

Samples provided to the Engineer for their retention are to be labeled in boxes suitable for storage. Materials or workmanship not corresponding in character and quality with approved samples will be rejected by the Engineer.

Samples required for approval and testing must be supplied sufficiently in advance if required quality and number to allow for testing and approval, due allowance being made for the fact that if the first samples are rejected further samples may be required. Delay to the works arising from the late submission of samples will not be acceptable as a reason for delay in completion of the works.

Materials shall be tested before leaving the manufacturer's premises, quarry or resource, wherever possible. Materials shall also be tested on the site and they may be rejected if not found suitable or in accordance with the specification, notwithstanding the results of the tests at the manufacturer's works or elsewhere or test certificates or any approval given earlier.

The contractor will bear all expenses for sampling and testing, whether at the manufacturer's premises at source, at site or at any testing laboratory or institution as directed by the Engineer. No extra payment shall be made on this account.

d) Dispatch of materials:

Materials shall not be dispatched from the manufacturer's works to the site without written authority from the Engineer.

e) Test certificates:

All manufacturer's certificates of test, proof sheets, etc. showing that the materials have been tested in accordance with the requirement of this

specification and of the appropriate Indian Standard, are to be supplied free of charge on request to the Engineer.

f) Rejection:

Any materials that have not been found to conform to the specifications will be rejected forthwith and shall be removed from the site by the Contractor at his own cost within two weeks or as instructed by the Engineer.

g) The Engineer shall have power to cause the Contractors to purchase and use such materials from any particular source, as may in his opinion be necessary for the proper execution of the work.

1.1.15 Storing of Materials at site:

All materials used in the works shall be stored on racks, supports, in bins, under cover etc. as appropriate to prevent deterioration or damage from any cause whatsoever to the entire satisfaction of the Engineer.

The storage of materials shall be in accordance with IS 4082 "Recommendation on stacking and storage or construction materials on site" and as per IS 7969 "Safety code for handling and storage of building materials".

The materials shall be stored in a proper manner at places at site approved by the Engineer. Should the place where material is stored by the Contractor be required by the Employer for any other purpose, the Contractor shall forthwith remove the material from that place at his own cost and clear the place for the use of the Employer.

1.1.16 Water:

a) Water from approved source:

Potable water only shall be used for the works. Contractor shall have his own source of water duly approved by Engineer. The water shall be free from any deleterious matter in solution or in suspension and be obtained from an approved source. The quality of water shall conform to IS 456.

b) Storage:

The Contractor shall make his own arrangements for storing water, if necessary, in drums or tanks or cisterns, to the approval of the Engineer. Care shall be exercised to see that water is not contaminated in any way.

c) Testing:

Before starting any concreting work and wherever the source of water changes, the water shall be tested for its chemical and other impurities to ascertain its suitability for use in concrete for approval of the Engineer. No water shall be used until tested and found satisfactory. Cost of all such Tests shall be borne by the contractor.

1.1.17 Workmanship:

a) All works shall be true to level, plumb and square and the corners, edges and arises in all cases shall be unbroken and neat.

Any work not to the satisfaction of the Engineer or his representative will be rejected and the same shall be rectified, or removed and replaced with work of the required standard of workmanship at no extra cost.

1.1.18 Load Testing on Completed Structures

a) Load Testing of superstructure, in case of major bridges with OWG/ composite girders/ PSC girders and minor bridges with skew shall be done by the Contractor as per the directions of the Engineer. Payment of span load testing shall be made under relevant item of Schedule-D.

b) During the period of construction or within the defect liability period the Engineer may at his discretion order the load testing of any completed structure or any part thereof if he has reasonable doubts about the adequacy of the strength of such structure for any of the following reasons:

i. Results of compressive strength on concrete test cubes falling below the specified strength.

ii. Premature removal of formwork.

iii. Inadequate curing of concrete.

iv. Over loading during the construction of the structure or part thereof.

v. Carrying out concreting of any portion without prior approval of the Engineer.

vi. Honey combed or damaged concrete which in the opinion of the Engineer is particularly weak and will affect the stability of the structure to carry the design load, more so in important or critical areas of the structure.

vii. Loss of camber in OWG beyond permissible range as specified by Railway Board/RDSO.

viii. Any other circumstances attributable to alleged negligence of the contractor which in the opinion of the Engineer may result in the structure or any part thereof being of less than the expected strength.

c) All the loading tests shall be carried out by the Contractor strictly in accordance with the instructions of the Engineer, as per IRS:CBC and IRC:SP-51. Such tests shall be carried out only after expiry of minimum 28 days or such longer period as directed by the Engineer.

d) The structure shall be subjected to the load as approved for SLS condition in the design. This load shall be maintained for a period of 24 hours before removal. Incremental loading shall be done in accordance with IRC:SP-51, unless otherwise directed by the Engineer.

In case the recovery of the structure is not as per codal provisions, the

structure shall be considered to have failed the test and shall be deemed to be unacceptable.

e) In such cases the portion of the work concerned shall be taken down or cut out and reconstructed to comply with the specifications. Other remedial measures may be taken to make the structure secure at the discretion of the Engineer. However, such remedial measures shall be carried out to the complete satisfaction of the Engineer. Again, Load test shall be conducted as per codal provisions.

f) All costs involved in carrying out the tests (except integrity test for piles) and other incidental expense thereto shall be borne by the contractor regardless of the result of the tests. The contractor shall take down or cut out and reconstruct the defective work or shall make the remedial measures instructed at his own cost.

If the load testing is instructed on any ground other than mentioned in (i) to (ix) of Cl. 1.1.18(b), the cost of the same shall be reimbursed to the Contractor, if the result of the test are found to be satisfactory.

g) In addition to the load tests mentioned in Sub-Clause 1.1.18 (b), non-destructive test methods such as core test and ultrasonic pulse velocity test shall be carried out by the contractor at his own expense if so desired by the Engineer. Such tests shall be carried out by an agency approved by the Engineer and shall be done using only recommended testing equipment. The acceptance criteria for these tests shall be as per provisions in the relevant Indian/International standards and as approved by the Engineer.

1.2 STRUCTURAL WORK:

1.2.1 Unless specified, only controlled concrete with design mix and weigh batching is to be used for the work.

1.2.2 Minimum cement content specified in the codal specifications is purely from durability point of view. Larger content of cement shall have to be provided if demanded by mix design.

1.2.3 Provision of cement slurry to create bond between plain / reinforced concrete surface and subsequent applied finishes shall not be paid extra.

1.2.4 Mix design using smaller aggregates of 10mm down shall also be done in advance for the use in the junction having congested reinforcement.

1.2.5 Procedure of mixing the admixtures shall be strictly as per the manufacturer's recommendations if not otherwise directed by the Engineer.

1.2.6 All the water tanks and other liquid retaining concrete structures shall undergo hydro-testing.

1.2.7 Special benches shall be provided at site for stacking reinforcement bars of different sizes.

1.2.8 Formwork for beams of RCC areas shall be designed in such a way that the formwork

of the adjacent slabs can be removed without disturbing the props / supports of the beams.

1.2.9 *Deleted*.

1.2.10 Formwork is required for full height at all locations. Special precaution for such tall formwork shall be taken to ensure its safety. Extra costs for such formwork shall be deemed to have been included in the price quoted against relevant items.

1.2.11 In the mobilization period, the contractor shall carry out expeditiously and without delay the following works:

i. Material testing and mix designs of concrete as contemplated in the specifications.

ii. Setting up of full-fledged site laboratory as per the requirements of these specifications.

iii. Any other pre-requisite items required for final execution.

iv. Site office for the use of the Engineer staff.

v. Casting yard with full facilities.

1.2.12 *Deleted*

1.3 SUPPLY OF PROGRES PHOTOGRAPHS AND ALBUMS (DIGITAL):

The work covers the supply of digital photographs to serve as a permanent record of various stages/facets of work needed for an authentic documentation as approved by the Engineer.

The photographs shall be of acceptable quality and they shall be taken by a professionally competent photographer with camera having the facility to record the date of the photographs taken in the soft copy. Each photograph in the album shall be suitably captioned and dated.

The photographs and materials shall form a part of the records of concerned organization and same cannot be supplied to anybody else or published without the written permission of concerned organization.

1.4 SUPPLY OF VIDEO CDs:

The work consists of taking video films of important activities of the works as directed by the Engineer during the currency of the Project and editing them to a video film of playing time not less than 60 minutes. It shall contain narration of the activities in English by a competent narrator. The edition of the film and script of the narration shall be approved by the Engineer.

Drone videography of the whole package for inspection and monitoring of structures, shall be done by the Contractor once in a month.

The record of progress (photographs and videos) shall be submitted to the engineer on monthly basis or as directed by engineer.

1.5 SURVEY WORK:

The said work involves at the very start of work taking-over of reference point from the Engineer, establishment of control points, triangulation points, bench marks, grid layout for all the structures maintaining horizontal and vertical control within the permissible limits, incorporating changes (if any), submission of full data in the tabulation form and survey drawings including setting and layout of various works during the progress of work and matching of the station area track alignment with the alignment of the approaches at station ends and incorporating the changes (if any).

1.6 BARRICADING

The work covers barricading for the work done along the median and areas affecting road traffic and other areas like casting yard, batching plant, storage and other working area. All barricading shall be done at own cost by the Contractor. The detailed scope of work is as follows:

i. Providing and installing the barricade of the design and type as shown in the Tender Drawings furnished as per the approved plan firmly to the ground and maintaining it during the progress of work.

ii. Dismantling of barricading and other temporary installations from the site and cleaning the site as per direction of Engineer upon completion and acceptance of work.

iii. Providing earthing of Barricades.

iv. Providing Lighting on the periphery of Barricades for Direction illumination.

1.7 FINISHING WORK:

1.7.1 The Contractor shall incorporate seismic considerations of anchoring and isolation in the design and detailing of the finishes as directed by the Engineer. The element to be anchored shall have its motion suitably restrained whilst at the same time it shall be suitably isolated so as not to be affected by the deformations/ vibrations of the building during Construction.

1.7.2 Sub-Contractor:

Works as listed below and those dealing with proprietary materials/ products may be carried out by the Contractor through the Sub-Contractors as may be approved by the Engineer in writing. The Sub-Contractors must be firms of repute and long standing, having adequate experience and complete facilities to carry out all items of work required for completion as per Specifications and expected quality to the satisfaction of the Engineer. The Sub-Contractor must also have personnel experienced in preparing shop drawings. All such works, not limited to the following, shall be carried out under the direct supervision of the manufacturers of the proprietary materials/ products or their trained and accredited licensee.

i. Bearings

ii. Fabrication, assembly and launching of steel OWG

1.7.3 Responsibility for Shop drawings, Samples and Mock-ups:

Approval of shop drawings, samples and mock-ups for the various components shall not absolve the Contractor of his responsibility of completing the work to the specifications, standards, tests for performance and guarantees given in these documents and to a quality of finish as desired by the Engineer.

1.7.4 Cleaning:

Surfaces on which finishes are to be provided shall be cleaned with water jets or oil free compressed air or power tools with wire brushes and detergents all as approved by the Engineer.

1.8 Applicable Codes, Standards & Publications for Structural & Architectural Work:

The more important Codes, Standards and Publications to Contract are listed here under:

Any other code/publication, if found necessary by the engineer, may be referred to for such works. The latest revision along with all corrections slip & amendments shall only be followed

Sr. No.	Code No.	Code Name
General		
1.	IS: 875	Code of Practice for design loads (other than earthquake) for buildings and structures
2.	IS: 122 (part 4)	Methods of measurement of buildings and Civil engineering works-Stone masonry
3.	IS:1237	Specification for cement concrete flooring tiles
4.	IS: 1322	Bitumen felts for water proofing and damp-proofing
5.	IS: 1893	Criteria for earthquake resistant design of structures
6.	IS: 2185 (Part 1)	Concrete masonry units: Hollow and solid concrete
7.	IS: 2185 (Part 2)	Concrete masonry units: Hollow and solid light weight
8.	IS: 2185 (Part 3)	Concrete masonry units: Autoclaved cellular aerated concrete blocks
9.	IS: 2572	Code of Practice for construction of hollow concrete block Masonry
10.	IS: 3414	Code of practice for design and installation of joints in Buildings
11.	IS: 3462	Specification for unbacked flexible PVC flooring
12.	IS: 5318	Code of practice for laying of flexible PVC sheet and tile Flooring
13.	IS: 6408 (Parts 1,2)	Recommendations for modular co-ordination in building Industry-tolerances

Sr. No.	Code No.	Code Name
14.	IS: 8183	Bonded mineral wool
15.	IS:10958	General check list of functions of joints in building
16.	IS:11817	Classification of joints in buildings for accommodation of dimensional deviations during construction
17.	IS:11818	Method of test for laboratory determination of air permeability of joints in buildings
18.	IS:12440	Precast concrete stone masonry blocks
19.	CPWD	Specifications with up-to-date correction slips
20.	BS:476 (Part 7)	Method for classification of the surface spread of flame of Products
21.	BS:476 (Part 20)	Method of determination of the fire resistance of elements of construction (general principles)
22.	BS:476 (Part 22)	Methods for determination of the fire resistance of non-load bearing elements of construction
23.	BS: 1245	Specification for metal door frames (steel)
24.	BS: 3261	Specification for unbacked flexible PVC flooring
25.	BS:3261: Part 1	Homogeneous flooring
26.	BS:5215	Specification for one-part gun grade polysulphide-based Sealants
27.	BS:5606	Guide to accuracy in building
28.	BS:5725 (Part 1)	Specification for panic bolts and panic latches mechanically operated by a horizontal push-bar
29.	BS:6093	Code of practice for the design of joints and jointing in building construction
30.	BS:8200	Code of practice for the design of non-load bearing external vertical enclosure of building
31.	ASTM C 332	Specification for light weight aggregate for insulating Concrete
32.	ASTM C 635	Specification for the manufacture, performance and testing of metal suspension systems for acoustical tile and lay-in panel ceilings
33.	SP 7	National Building Code of India
34.	SP 23 (S&T)	Hand Book on Concrete Mixes
Bitumen		
35.	IS:702	Industrial Bitumen
36.	IS:3384	Specification for bitumen primer for use in waterproofing and damp-proofing
Building Construction Practices		
37.	IS: 1838 Parts I and II.	Specifications for preformed fillers for expansion joint in concrete pavements and structures
38.	IS: 1946	Code of Practice for use of fixing devices in walls, ceilings, and floors of solid construction.

Sr. No.	Code No.	Code Name
39.	IS: 3414	Code of Practice for design and installation of joints in buildings.
40.	IS: 6509	Code of Practice for installation of joints in concrete pavements.
41.	IS: 11134	Code of Practice for setting out of buildings.
42.	IS: 11433	Parts I and II. Specifications for one part Gun grade polysulphide based joint sealant
43.	IS: 12200	Code of Practice for provision of water stops at transverse construction joints in masonry and concrete dams
Cement		
44.	IS:269	33 grade ordinary Portland cement
45.	IS: 455	Portland Slag Cement
46.	IS: 650	Specification for standard sand for testing cement
47.	IS: 1489 (Part 1)	Portland pozzolana cement: Fly ash based
48.	IS: 1489 (Part 2)	Portland pozzolana cement: Calcined clay based
49.	IS: 3535	Method of Sampling Hydraulic Cements
50.	IS: 4031	(Parts 1 to 13) Methods of physical tests for hydraulic cement
51.	IS:4032	Methods of chemical analysis of hydraulic cement
52.	IS: 6925	Methods of test for determination of water-soluble chlorides in concrete admixtures
53.	IS:8042	White Portland Cement
54.	IS: 8112	Specification for 43 grade ordinary Portland cement
55.	IS:12269	Specification for 53 grade ordinary Portland cement
56.	IS: 12330	Specification for sulphate resistant Portland cement
57.	IRS: T40	Indian Railways standard specification for special grade cement for use in concrete sleepers
Concrete		
58.	IS:456	Code of practice for plain and reinforced concrete
59.	IS: 457	Code of practice for general construction of plain and reinforced concrete for dams and other massive structures
60.	IS: 460 (Part I TO III)	Specification for Test Sieves
61.	IS: 516	Methods of tests for strength of concrete
62.	IS: 1199	Methods of sampling & analysis of concrete
63.	IS: 1200	Methods of measurement of building and civil engineering
64.	IS: 1343	Code of practice for prestressed concrete
65.	IS: 1607	Methods of Test Sieving
66.	IS:2386	Parts I-VIII. Methods of tests for aggregates for concrete.
67.	IS:2430	Methods of Sampling of Aggregates of Concrete

Sr. No.	Code No.	Code Name
68.	IS:2438	Specification for roller pan mixer
69.	IS:2514	Specification for concrete vibrating tables
70.	IS:2571	Code of practice for laying in-situ cement concrete Flooring
71.	IS:2645	Specifications for integral cement water proofing Compounds
72.	IS:2722	Specifications for portable swing batchers for concrete (double bucket type)
73.	IS:2770	Methods of testing bond in reinforced concrete part I pull out test
74.	IS:3025	Methods of sampling and test (physical and chemical) for water & waste water
75.	IS:3370	Code of practice for concrete structures for storage of Liquids
76.	IS:3935.	Code of practice for composite construction
77.	IS:4326	Code of practice for earthquake resistant construction of Building
78.	IS:6925.	Methods of test for determination of water soluble chlorides in concrete Admixtures
79.	IS:7242	Specifications for concrete spreaders
80.	IS:7251	Specifications for concrete finishers
81.	IS:7861	Parts I & II. Code of practice for extreme weather concreting
82.	IS:7969	Safety code for handling and storage of building materials
83.	IS:8989	Safety code for erection of concrete framed structures
84.	IS:8142	Methods of test for determining setting time of concrete by penetration resistance
85.	IS: 9103	Specification for admixtures for concrete
86.	IS: 9013	Method of making, curing and determining compressive strengths of accelerated cured concrete test specimens
87.	IS: 9284	Method of test for abrasion resistance of concrete
88.	IS:10262	Recommended guidelines for concrete mix design
89.	IS: 4926	Code of Practice ready mixed concrete needs to be included in list
90.	MORTH	Specifications for Road and Bridge Works, Ministry of Road Transport and Highways (Roads Wing)
91.	SP 34	Handbook on Concrete Reinforcement and

Sr. No.	Code No.	Code Name
		Detailing
92.	IRS	Concrete Bridge Code
93.	IRC 112	Code of Practice for Concrete Road Bridge
94.	IRC 83 (Part 4)	Standard Specifications and code of practice for road bridges Section IX Bearings (Spherical & Cylindrical)
95.	ASTM-C-94	Ready Mix Concrete
Construction Plant and Machinery		
96.	IS: 1791	Specification for batch type concrete mixers
97.	IS: 2505	General requirements for concrete vibrators: Immersion type.
98.	IS: 2506	General requirements for screed board concrete vibrators.
99.	IS: 3366	Specification for pan vibrators
100.	IS: 3558	Code of Practice for use of immersion vibrators for consolidating concrete
101.	IS: 4656	Specifications for form vibrators for concrete.
102.	IS: 4925	Specification for concrete batching and mixing plant.
103.	IS: 11993	Code of Practice for use of screed board concrete vibrators.
Formwork		
104.	IS: 4990	Specifications for plywood for concrete shuttering work
105.	IRC: 87	Guidelines for the design and erection of false work for road bridges.
106.	IS: 806	Code of practice for use of steel tubes in general building construction.
107.	IS: 1161	Specification of steel tubes for structural purposes.
108.	IS: 1239	Specification for mild steel tubes, tubular and other wrought steel fittings
Gypsum and Gypsum Board		
109.	IS: 2095	Gypsum plaster boards
110.	IS: 2542 (Part 1/Sec to 12)	Methods of test for gypsum plaster, concrete and products: plaster and concrete
111.	IS: 2542 (Part 2/Sec 1to 8)	Methods of test for gypsum plaster, concrete and

Sr. No.	Code No.	Code Name
		products: Gypsum products
112.	IS: 2542 (Part1)	Gypsum building plaster: Excluding premixed lightweight plaster
113.	IS: 2547 (Part 2)	Gypsum building plaster: Premixed lightweight plaster
Handling and Storage		
114.	IS:4082	Recommendation of Stacking and Storage of construction materials
115.	IS:8348	Code of practice for stacking and packing of stone slabs for transportation
116.	IS:8759	Code of practice for maintenance and preservation of stones in building
Instruments for Testing Cement and Concrete		
117.	IS:5513	Specification for vicat apparatus.
118.	IS:5514	Specification for apparatus used in Le-Chatelier test.
119.	IS:5515	Specification for compaction factor apparatus.
120.	IS:7320	Specification for concrete slump test apparatus.
121.	IS:7325	Specification for apparatus to determine constituents of fresh concrete.
122.	IS:10080	Specification for vibration machine.
123.	IS:10086	Specification for moulds for use in tests of cement and concrete.
124.	IS:10510	Specification for vee-bee consistometer.
	Joint Fillers	
125.	IS:1838 (Part 1)	Preformed fillers for expansion joint in concrete pavements and structures (non extruding and resilient type): Bitumen impregnated fibre
Paints and Coatings		
126.	IS:102	Ready mixed paint, brushing, red lead, non-setting, priming
127.	IS:109	Ready mixed paint, brushing, priming, plaster, to Indian Standard Colour No. 361 and 631 white and off white.

Sr. No.	Code No.	Code Name
128.	IS:218	Creosote and anthracene oil for use as wood preservatives
129.	IS:347	Varnish, shellac, for general purpose
130.	IS:348	French Polish
131.	IS:2074	Ready mixed paint, air drying, red oxide-zinc chrome, priming
132.	IS: 4833	Methods of field testing of preservatives in wood
133.	IS:10013 (Parts 1 to 3)	(Part -1) Water soluble type wood preservatives
134.	IS:10013 (Parts 1 to 3)	(Part-2) Acid-copper-chrome preservative
135.	IS: 10013 (Part 1 to 3)	(Part-3) Copper-chrome-boron wood preservative
136.	BS:6496	Specification for powder organic coatings for application and stoving to aluminium alloy extrusions, sheet and preformed sections for external architectural purposes, and for the finish on aluminium alloy extrusions, sheet and preformed sections coated with powder organic coatings
137.	BS:EN:10152	Specification for electrolytically zinc coated cold rolled steel flat products. Technical delivery conditions
138.	ASTM A 164-71	Specification for electrodeposited coatings of zinc on steel
Pigment for cement		
139.	BS:1014	Specification for pigments for Portland cement and Portland cement products
Reinforcement & Structural Steel		
140.	IS:206	Code of Practice for use of Steel Tubes in General Building Construction
141.	IS:210	Grey Iron Castings
142.	IS:280	Mild steel wire for general engineering purposes
143.	IS:432	Part I. Mild steel and medium tensile steel bars. Part II Hard drawn steel wire.
144.	IS:451	Technical Supply conditions for Wood Screws

Sr. No.	Code No.	Code Name
145.	IS:806	Code of practice for use of steel tubes in general building construction
146.	IS:815	Classification coding of covered electrodes for metal arc welding of structural steels
147.	IS:1239	Specification for mild steel tubes, tubulars and other wrought steel fittings
148.	IS 1343	Code of Practice for Prestressed Concrete
149.	IS:1363	Black hexagon bolts, nuts and lock nuts and black hexagon screws.
150.	IS:1365	Slotted countersunk screws.
151.	IS:1566	(Part I) Specifications for hard-drawn steel wire fabric for Concrete reinforcement
152.	IS:1786	Specification for high strength deformed steel bars and wires for concrete reinforcement.
153.	IS:2502	Code of Practice for bending and fixing of bars for concrete reinforcement.
154.	IS:2629	Recommended practice for hot-dip galvanising of iron and steel.
155.	IS:2751	Code of Practice for welding of mild steel plain and deformed bars for reinforced concrete construction.
156.	IS 4000	Code of practice for high strength bolts in steel structures
157.	IS:4759	Hot-dip zinc coating on structural steel and other allied products.
158.	IS:5525	Recommendations for detailing of reinforcement in reinforced concrete works
159.	IS:9417	Recommendations for welding cold-worked steel bars for reinforced concrete construction.
160.	IS:14268	Uncoated stress relieved low relaxation steel class 2 for Prestressed concrete
161.	IS:226	Structural steel (Standard Quality)
162.	IS:800	Code of practice for use of structural steel in general building construction.

Sr. No.	Code No.	Code Name
163.	IS:813	Scheme of symbols for welding
164.	IS:814	Covered electrodes for metal arc welding of structural steel. (Part I & Part II)
165.	IS:816	Code of practice for use of metal arc welding for general construction in mild steel.
166.	IS:822	Code of practice for inspection of welds.
167.	IS:961	Structural steel (High Tensile)
168.	IS:1024	Code of practice for use of welding in bridges and structures subject to dynamic loading.
169.	IS:1030	Carbon steel casting for General Engineering Purposes
170.	IS:1120	Coach Screws
171.	IS:1367	Technical Supply Conditions for Threaded Fasteners
172.	IS:1161	Steel tubes for structural purposes.
173.	IS:1182	Recommended practice for radiographic examination of fusion welded butt joints in steel plates.
174.	IS:1915	Code of Practice for Steel Bridges
175.	IS:2016	Plain Washers
176.	IS:2062	Structural steel (Fusion welding quality)
177.	IS:3063	Single Coil Rectangular Section Sprint Washers for Nuts, Bolts and Screws
178.	IS:3443	Crane Rail Sections
179.	IS:3757	Specification for high tensile friction grip bolts
180.	IS:5624	Specification for foundation bolts
181.	IS:3600	Code of practice for testing of fusion welded (Part I) joints and weld metal in steel
182.	IS:4923	Hollow steel sections for structural use.
183.	IS:6227	Code of practice for use of metal arc welding in tubular structure.
184.	IS:801	Code of practice for use of cold formed light gauge steel

Sr. No.	Code No.	Code Name
		structural members in general building construction.
185.	IS:811	Specifications for cold formed light gauge structural steel sections.
186.	IS:8500	Structural steel Micro alloyed (Medium and high strength qualities)
187.	IS:8910	General requirements of supply of weldable structural steel
188.	IS:9595	Recommendations for metal arc welding of carbon & carbon- manganese steels.
189.	IS 16172	Reinforced Couplers for Mechanical Splices of Bars in Concrete
Sand		
190.	IS:383	Coarse and fine aggregates from natural sources for concrete.
Scaffolding		
191.	IS:2750	Specification for steel scaffoldings
192.	IS:3696 (Part 1)	Safety Code of scaffolds and ladders: Scaffolds
193.	IS:3696 (Part 2)	Safety Code of scaffolds and ladders: Ladders
194.	IS:4014 (Part 1)	Code of practice for steel tubular scaffolding: Definition and Materials
195.	IS:4014 (Part 2)	Code of practice for steel tubular scaffolding: Safety regulations for scaffolding
196.	IRC:87	Guidelines for the design and erection of falsework for Road bridge
Sealants		
197.	IS: 10959	Glossary of terms for sealants for building purposes
198.	IS: 11433 (Part 1)	One part grade polysulphide base joint sealant: General requirements
199.	IS: 11433 (Part 2)	One part grade polysulphide base joint sealant: Methods of test
200.	IS: 13055	Methods of sampling and test for anaerobic adhesives and sealants
201.	BS: 5889	Specification for one part gun grade silicone based sealants.

Sr. No.	Code No.	Code Name
Wood		
202.	IS: 303	Plywood for General Purposes
203.	IS: 848	Synthetic resin adhesives for plywood (phenolic and aminoplastic)
204.	IS: 1141	Seasoning of Timber – Code of Practice
205.	IS:1328	Veneered decorative plywood
206.	IS: 1659	Blocks Boards
207.	IS: 2046	Decorative thermosetting synthetic resin bonded laminated sheets
208.	IS: 2202 (Part 1)	Wooden flush door shutters (solid core type): Plywood face panels
209.	IS: 2202 (Part 2)	Wooden flush door shutters (solid core (type): Particle face panels and hardboard face panels
Bearing		
210.	IRC: 83 Part-II	Standard specifications and code of practice for road bridges Elastomeric Bearings
211.	IRC: 83 Part-III EN 1337gh	Standard specifications and code of practice for road bridges Pot Bearings
212.	IRC: 83 Part-IV	Standard Specifications and Code of Practice for Road Bridges (Section – IX) Bearings (Spherical and Cylindrical)
Piling		
213.	IS: 2911 (All Parts)	Bored Cast in-situ Concrete Piles
214.	IRC: 78	Standard specifications and code of practice for road bridges Foundation And Substructure
All Indian Railway & RDSO Standards, any other code or publication as approved by engineer in-charge		
Metal		
215.	IS: 276	Austenitic manganese steel castings
216.	IS: 733	Wrought aluminium and aluminium alloy bars, rods and sections for general engineering purpose.
217.	IS: 737	Specifications for wrought aluminium and aluminium alloy sheet and strip for general engineering purpose.
218.	IS: 3614 (Part 1)	Specification for fire check doors: Plate metal covered and rolling type
219.	IS: 3614 (Part 2)	Specification for metallic and non-metallic fire check doors: Resistance test and performance criteria

Sr. No.	Code No.	Code Name
220.	IS: 7196	Specification for Hold Fasts
221.	ASME set 2 Part A	Ferrous Material Specification
222.	ASTM B 221	Specification for aluminum-alloy extruded bars, rods, wires, shapes, and tubes
223.	BS: 4873	Specification for Aluminum alloy windows
224.	BS: 7352	Specification for strength and durability performance of metal hinges for side hanging applications and dimensional requirements for template drilled hinges
225.	BS EN: 10143	Specification for continuously hot-dip metal coated steel sheet and strip. Tolerances on dimensions and shape
Stone and Facings/Linings		
226.	IS:1121-(Parts 1 to 4)	Methods of test for determination of strength properties of natural building stones
227.	IS:1121-(Parts 1 to 4)	(Part-1 Compressive strength)
228.	IS:1121-(Parts 1 to 4)	(Part-2 Transverse strength)
229.	IS:1121-(Parts 1 to 4)	(Part-3 Tensile strength)
230.	IS:1121-(Parts 1 to 4)	(Part-4 Shear strength)
231.	IS:1122	Method of test for determination of true specific gravity of natural building stones.
232.	IS:1123	Method of identification of natural building stones.
233.	IS:1124	Method of test for determination of water absorption, apparent specific gravity and porosity of natural building stones.
234.	IS:1125	Method of test for determination of weathering of natural building stones
235.	IS:1126	Method of test for determination of durability of natural

Sr. No.	Code No.	Code Name
		building stones.
236.	IS:1127	Recommendations for dimensions and workmanship of natural building stones for masonry work.
237.	IS:1128	Specification for Limestone (Slabs and Tiles)
238.	IS:1129	Recommendation for dressing of natural building stones.
239.	IS:1130	Specification for marble (blocks, slabs and tiles)
240.	IS:1597 (Part 2)	Code of practice for construction of stone masonry Ashlar masonry
241.	IS:1706	Method for determination of resistance to wear by abrasion of natural building stones
242.	IS:1805	Glossary of terms relating to stones, quarrying and Dressing
243.	IS:3620	Specification for laterite stone block for masonry
244.	IS:3622	Specification for Sandstone (slab & tiles)
245.	IS:4101 (Part 1)	Code of practice for external facing and veneers: stone Facing
246.	IS:4101 (Part 2)	Code of practice for external facing and veneers: Cement concrete facing
247.	IS:4101 (Part 3)	Code of practice for external facing and veneers: Wall tiling and mosaics
248.	IS:4121	Method of test for determination of water transmission rate by capillary action through natural building stones
249.	IS:4122	Method of test for surface softening of natural building stones by exposure to acidic atmospheres
250.	IS:4348	Method of test for determination of permeability of natural building stones
251.	IS:5218	Method of test for toughness of natural building stones
252.	IS:8381	Recommended practice for quarrying stones for construction purposes
253.	IS:14223 (Part 1)	Polished building stones: Granite
254.	BS: 8298	Code of practice for design and installation of natural stone

Sr. No.	Code No.	Code Name
		cladding and lining

Chapter 2. EARTHWORK IN FORMATION, HUME PIPES AND RETAINING WALLS

2.1 FORMATION IN EMBANKMENT/CUTTING

Earthwork in formation and blanketing shall be carried out as per RDSO specification No. RDSO/2020/GE: IRS-004 September 2020 "Comprehensive Guidelines and Specifications for Railway Formation" and in accordance with the approved drawings.

The contractor shall arrange suitable borrow areas at his own cost and get them approved from the Engineer before using soil from such borrow areas.

Soils mentioned in Clause 3.7 (a) of the RDSO Guidelines shall not be used.

SQ-1 type of soils shall not be used in prepared subgrade and top layer of subgrade.

MDD in laboratory shall be determined by using Heavy Proctor test as per IS 2720 Part-16.

MDD achieved in the field compaction trial shall not be less than 98% of the MDD achieved in laboratory.

Degree of compaction of soil in prepared subgrade/top layer of subgrade shall not be less than 98% of MDD achieved in field as a result of Field Compaction Trial.

Degree of compaction of soil in lower layer of subgrade shall not be less than 97% of MDD achieved in field as a result of Field Compaction Trial

Before undertaking turfing, extra earthwork on slopes of embankment shall be cut to final design profile, dressed and compacted with vibratory rollers of approved capacity and make as per RDSO guidelines.

Blanketing material shall be as per RDSO Guidelines.

The type of test, frequency and acceptance criteria for quality check of earthwork and blanketing shall be as given in Chapter 7 of RDSO Guidelines.

2.2 NP-4 pipe of 450mm diameter, conforming to IS 458, shall be provided at about 500m interval throughout the alignment in embankments having fill heights upto 5m *including ballast cushion of 350 mm*. In embankments having fill heights more than 5m *including ballast cushion of 350 mm* precast RCC box of 500mmx500mm clear size shall be provided for the purpose of future utilities. Installation conditions for the pipe shall be designed as per the IS-783, according to the fill height.

2.3 Precast retaining wall shall be manufactured from high strength reinforced concrete in factory under controlled environment and shall be steam cured. Dimensional tolerance shall be 0+/- 2 mm. Shuttering/formwork for cast-in-situ retaining wall shall be adequate to permit construction of retaining walls upto 3 m height in single pour. In case, construction of retaining wall upto 3 m height in single pour is found impracticable, the Contactor shall take specific approval of the Engineer for the proposed Shuttering/form. Where retaining walls are required to be constructed for retaining embankment, earthwork may be carried out upto the height of the retaining wall prior to construction of retaining wall leaving

sufficient space for construction of retaining wall and backfill. 500 mm width of bank shall be cut in proper slope and the cut soil removed from the Site and used at other places. Retaining wall shall be constructed as per approved drawings. Backfilling shall be carried out in layers with proper compaction as per RDSO Guidelines. Complete space between retaining wall and the embankment shall be filled up and compacted with backfill material. Thereafter earthwork will proceed further above the height of the retaining wall as per approved method statement. Wherever retaining walls are not provided, the side slopes of the banks after cutting of 500 mm width at both edges shall be compacted with mechanical vibrators before providing erosion control measures.

Chapter 3. BRIDGES

3.1 General

3.1.1 Scope of Specifications

This specification shall be applicable for carrying out bridge works.

3.1.2 Applicable Standards

The applicable standards shall be as follows:

a) Indian Railway Standard Codes and Specifications (IRS)

i. Bridge Rules
ii. Concrete Bridge Code
iii. Steel Bridge Code
iv. Well and Pile Foundation Code
v. Fabrication Specification No. B1-2001
vi. Specification No. B-2 for Steel Structures (other than Girder Bridges)- Part 3.
vii. Welded Bridge Code
viii. Bridge Sub-structure & Foundation Code
ix. Specification No.M-28, Classification, testing and approval of metal arc welding electrodes for use-Indian Railway
x. Specification No.M-29, Classification, testing and approval of submerged arc welding with flame combination
xi. Indian Railways Unified Standard Schedule of Rates - 2019
xii. Indian Railways Unified Standard Specification (Formation Works, Bridge Works & P.Way Works) - 2019
xiii. Indian Railways Permanent Way Manual (IRPWM)
xiv. Indian Railways Works Manual (IRWM)
xv. Indian Railways Bridge Manual (IRBM)
xvi. Indian Railways Engineering Code
xvii. Manual on the design and construction of Well and Pile foundations
xviii. Indian Railways Schedule of Dimensions (BG)
xix. IRS Seismic code for Earthquake Resistant Design of Railway bridges.

b) RDSO Guidelines

i. BS-113 Guidelines for providing Arrangements for Bridge Inspection
ii. Comprehensive Guidelines and Specifications for Railway Formation:

RDSO/2020/GE: IRS 0004.

iii. Report No. GE: R-50: Transitional System on approaches of bridges

iv. Report No. BS-111: Guidelines for use of High Strength Friction Grip (HSFG) bolts on bridges on Indian Railways

v. Guidelines for design of Spherical and Cylindrical bearings (in case of Steel Bridges).- RDSO/CBS/Bearing dated 22-06-2011

vi. RDSO drawings for H-beam sleepers

vii. Report No. BS 115 : Guidelines for Composite Construction Including Stud Shear Connectors

c) Indian Standards Codes and Specifications (IS)

i. IS: 456 Plain and reinforced concrete - code of practice

ii. IS: 800 Code of practice for General Construction Steel

iii. IS: 875 Code of Practice for Design Loads Part 1, 2 3, 4& 5 (Other than Earthquake)

iv. IS: 1080 Design and construction of shallow foundations in soils (other than raft ring and shell)

v. IS: 1367 Technical Supply Conditions for Threaded Steel Fasteners

vi. IS: 13920 Ductile detailing of reinforced concrete structures subjected to seismic forces code of practice

vii. IS: 1489 Specification for Portland pozzolana cement (Fly ash based)

viii. IS: 1786 High strength deformed steel bars and wires for concrete reinforcement

ix. IS: 1904 Design and construction of Foundations in soils: general requirements.

x. IS: 2062 Specifications for weldable Structural steel

xi. IS: 2502 Code of Practice for Bending and Fixing of Bars for Concrete Reinforcement

xii. IS: 2911 Design and Construction of Pile Foundation - Code of practice Part1 Concrete Pile- Section 2 Bored Cast-in-situ-piles

xiii. IS: 2911 Design and Construction of Pile Foundation- Code of practice Part1 Concrete Pile- Section 4 Precast Concrete Piles in Prebored Holes

xiv. IS 2911 Design and Construction of Pile Foundation- Code of practice Part 4 Load test on piles

xv. IS: 2950 Design and construction of raft foundations

xvi. IS: 3935 Code of Practice for Composite Construction

xvii. IS: 4923 Hollow steel sections for structural use -specification

xviii. IS: 1161 Steel Tubes for Structural Purposes- specifications

xix. IS: 8009 Calculation of settlements of shallow foundations

xx. IS: 269 Specifications of OPC cement

xxi. IS: 9103 Specifications of Concrete admixtures

xxii. IS: 12070 Code of practice for Design and construction of shallow foundation on Rocks

xxiii. IS: 14593 Design and Construction of Bored Cast-in-Situ Piles Founded on Rocks.

xxiv. IS 455 Specifications for portland slag cement

d) Other Standards

i. CPWD specifications, (Vol 1 & 2) -2019

ii. Delhi Schedule of Rates, (Vol 1 & 2) - 2021

iii. UIC Code 772-2 (R) Code for the use of rubber bearings for rail bridges

iv. IRC:83-2018 (Pt. II) - Standard Specifications and Code of Practice for Road Bridges (Section – IX) Bearings (Elastomeric Bearings)

v. IRC:83-2014 (Pt. IV) - Standard Specifications and Code of Practice for Road Bridges (Section – IX) Bearings (Spherical and Cylindrical)

vi. ISO 6892 – Tensile Testing of Metallic Materials

vii. ISO 13918-2008 – Welding- Studs and Ceramic Ferrules for Arc Stud Welding

3.2 Bridge Works: Substructure

3.2.1 GENERAL

a) Coverage

The Specifications given in this chapter deal with items pertaining to all types of foundations for bridges and bridge superstructure viz., Piers, abutments, wing walls, bed blocks and ballast walls / dirt walls.

3.2.2 Setting out for foundations

a) Setting out for Minor Bridges and Culverts

Shall be carried out by a competent / qualified engineer, employed by the Contractor and checked by the Engineer's representative for all bridges and culverts. Contractor shall provide necessary instruments, linear tapes, pegs etc.

The setting out for foundations and sub-structure shall be carried out with a theodolite and steel tapes / Invar tapes in case of works not involving deep foundations or standing water.

All levels will be measured using a precise levelling instrument. Errors in location of piers / abutments and fixing levels shall be within following limits.

Linear Measurements	±5 mm
Levels	±3 mm

b) Setting out for Major Bridges

i. Locations of piers and abutments along with the centre line of the bridge should be accurately laid out by establishing one or more base lines as directed and a system of pegs and posts. Also sufficient reference pegs and pillars should be established for checking the positions with ease during progress of work. Reference Bench Marks for levelling should be established nearby on a permanent structure or on a pillar to be built up in vicinity.

ii. The principal reference lines and level pegs should be established at easily accessible locations. They include-

1) Longitudinal Centre line

2) Transverse Centre lines of abutments and piers

3) Tangent points of the curve at either end, if alignment is on a curve.

iii. For Bridge Works involving deep excavations, pile driving or well sinking and / or where there is standing water, use of base line is obligatory. They should be preferably at right angle to centre line of bridge, with one on either end on high bank in case of long bridges or on one side bank of bridge for shorter ones.

iv. In case of bridges of length exceeding 1000 Metres, base lines and reference towers will have to be established. Provision of all assistance in form of measuring instruments, linear tapes as may be required by the surveyor, technical and skilled staff and labour required to assist them, fixing pegs, pillars and towers including all building materials and maintaining and guarding them including supply of all materials, tools and plant shall be done by the Contractor at his cost. Nothing extra will be payable to them on this account. Important points to be observed in this activity are:

1) Linear Measurement shall be carried out with invar tape or electronic distance measuring instruments

2) Spring balances shall be used for giving specified tension to the tape. Tape readings shall be corrected for tension, temperature and slope.

3) Concrete pillars with steel plates fixed over them shall be located at intermediate points (at tape lengths) and ends.

4) Reference pillars at pier and abutment position along centre lines and reference pillars on base lines shall be to standards to be prescribed by the Engineer. During construction, since centre line pillars at abutment / pier locations will be disturbed, reference pillars and lines shall be fixed around each structure by the Contractor under Site Engineer's supervision. Reference

diagrams at Annexures 4/1 and 4/2 and Clause 401 of IRBM shall be referred to for more details.

3.3 Soil Exploration

Soil exploration and test shall be carried out conforming to Indian Railways Codes and Specifications according to soil type, foundation type and site requirement.

3.4 Earthwork in excavation

Excavation shall be made only to the exact depth as shown on the drawings. In the event of excavation having been made deeper than that shown on the drawing or as ordered by the Engineer, the extra depth shall be made up with M10 concrete in case of foundation resting on soil and with concrete of the same grade as that of the foundation, in case of foundation resting on rock.

3.4.1 Method Statement

The Contractor shall submit Method Statement for carrying out the work of excavation in foundations and flooring etc. suiting to local ground conditions and safety measures conforming to IS: 3764 (Excavation Work- Code of Safety) to the Engineer for approval. The work shall be carried out strictly in accordance with the approved Method Statement and drawings.

3.4.2 Site Clearance

Site clearance shall be done as per the Contract.

3.4.3 Setting Out

After the site has been cleared, the limits of excavation shall be set out true to lines, curves, slopes, grades and sections as shown on the drawings or as directed by the Engineer. The Contractor shall be responsible for the setting out of works and the establishment and maintenance of benchmarks, other marks & stakes as long as in the opinion of the Engineer, they are required for the work.

a) Excavation shall be carried out in all types of soil encountered at site and to the lines, levels and profiles shown on the drawings that have NONO from the Engineer. The Work shall be carried out by the Contractor in such a way as to avoid soil erosion and groundwater pollution, accidents in habitational or frequented places, disturbance to the surrounding ground or structures, accident to workmen and any other untoward incident. Fencing, caution signages with red lights and other safety measures shall be employed to avoid accidents. Where necessary, signal men shall be employed to guide the movement of people, vehicles and equipment.

b) The work shall be carried out in a careful manner to ensure that the exposed surfaces are as sound as the nature of the material permits and that no point shall protrude inside the lines shown on the Drawings.

c) The Contractor shall be responsible for the safety and stability of all excavations performed by him or under his control. In case of any slips or blows in the excavation, the same shall be cleared by the Contractor at his own cost.

d) The Contractor shall notify the Engineer without delay of any permeable strata, joints, faults, fissures or unusual ground conditions encountered during excavation and any excavation instability and/or collapse.

e) The Contractor shall ensure that no air pollution takes place during excavation, storage and transportation of earth/spoil by providing suitable measures such as appropriate cover and the like.

f) The Contractor shall carry out ground stabilization measures without delay before and/or after excavation, if required.

g) The Contractor shall make provision for all shoring, de-watering, dredging, bailing out or draining water whether subsoil or rain or other water and the excavation shall be kept free of water while concrete work is in progress until the Engineer considers the work well set. The sides of trenches shall be kept vertical and the bottom level throughout or properly stepped as directed by the Engineer. No extra payment shall be made on this account.

h) De-watering shall be carried out by suitable means with adequate stand-by arrangements as may be approved by the Engineer. The Contractor shall be deemed to have satisfied himself with regard to feasibility of all aspects of de-watering including site constraints due to existing structures. Though the method of de-watering is left to the Contractor, he shall be required to submit method statement of de-watering scheme including requisite justifications to obtain approval from the Engineer.

i) Approval of the Engineer, however, shall not relieve the Contractor of the responsibility of adequacy and appropriateness of de-watering and protection arrangements for the quality and safety of the work.

j) The Contractor shall erect and maintain during progress of works temporary fences/ barricading around the work area with all safety measures as shown in Reference Information/Reports. The excavations near habitations, public movement areas and all works along the roads shall be provided with proper caution signs and marked with red lights, reflectors at night to avoid accidents. The Contractor shall take all adequate protective measures to see that excavation operations do not affect or damage adjoining structures.

k) Disposal of muck: The surplus excavated material (that cannot be used in the Works), shall be treated as contractor's property. The contractor shall be free to take away and make use of this surplus excavated material in the manner he wishes to, including disposal in spoil dumps or elsewhere as approved by the Engineer/concerned parties and regulating authorities. The employer takes no responsibility for the arrangement of dumping areas and these will have to be arranged by the Contractor at his own cost. The Contractor is required to carry out detailed survey to identify dumping areas, clearances required, leads involved etc. The quoted rates shall be deemed to have taken all these factors into account. The excavated material that can be used in the Works, shall be temporarily stockpiled, if required, in a dump site as proposed by

the contractor and agreed by the Engineer and the concerned regulating authorities. Any royalty, if to be paid to local authorities on the excavated material, is to be borne by the Contractor at his own cost irrespective of whether the excavated material is used for the Works or being used for any other purpose or being disposed off as surplus. Truck drivers shall be trained and educated by the Contractor to follow the traffic rules.

l) The Contractor shall ensure that traffic management on roads and railways is carried out in accordance with Sub-Division 6070 of the General Specifications.

3.4.4 Excavation beyond True Lines and Levels

If due to any cause whatsoever excavations are carried out beyond their true line and level, the Contractor shall make good excavation at his own cost to the required line and level with the appropriate grade of filling or with concrete subject to the NONO from the Engineer.

3.4.5 Backfill to Structures

a) Prior to commencement of backfill, the Contractor shall submit Method Statement for carrying out work such that the optimum use may be made of excavated material and obtain approval from the Engineer. The proposals shall include details of the compaction plant and methods for adjusting the moisture content of the material.

b) No filling shall commence until approval has been received from the Engineer.

c) The Contractor shall not backfill around structures until the structural elements have attained adequate strength.

d) The backfill material shall be selected excavated material, thoroughly compacted mechanically in layers not exceeding 300mm loose thickness to achieve a density of at least 90% of the maximum dry density.

3.4.6 Tolerance

Permissible Tolerance for excavation

Item	**Standard value (mm)**
Finished depth of excavation	±25
length/width	0 to +50

3.5 Bored cast in-situ Piling

Piling shall be carried out by hydraulic piling rig.

3.5.1 Method Statement

The Contractor shall submit Method Statement for carrying out the work of piling. The work shall be carried out strictly in accordance with the approved Method Statement, Manual on the design and construction of Well and Pile foundations, the Specification and the Drawings.

3.5.2 Materials

a) **Concrete**

Piles shall be constructed in accordance with the details shown in the drawings using the grade of concrete indicated, produced and placed in accordance with provisions of Annexure OCS-1 of these specifications.

b) **Reinforcement Steel**

Reinforcement steel shall comply with the provisions of Annexure OCS-2 of these specifications.

c) **Temporary Casings**

Temporary casings, as approved by the Engineer, shall be used to maintain the stability of pile bore hole. Temporary casings shall be free of distortion and shall be of uniform cross-section throughout each continuous length. During concreting, they shall be free of internal projections and encrusted concrete which may prevent proper formation of the pile.

d) **Stabilizing Material**

The stabilizing material to maintain the sides of pile bores shall preferably be natural drilling mud. If natural mud is not available, then stabilizing fluid having bentonite, controlled with a polymer like CMC (Carboxyl Methyl Cellulose), shall be used. The stabilizing material shall be approved by the Engineer. Bentonite, when used, shall conform to IS 2911 (Part 1/ Section 4).

3.5.3 Pile Installation

a) General

i. Bored cast-in-situ concrete piles shall conform to IS 2911 (Part 1/ Section 2), where not contravening to the following provisions. Based on borehole reports and drawings, installation of piles shall be carried out as per pile layout drawings, installation criteria, approved Method Statement and instructions of the Engineer. Any changes to the pile design, based on test-piles results, bore-hole data or soil conditions encountered during boring, shall be as instructed by the Engineer.

ii. The equipment and accessories for installation of piles shall be selected giving the due consideration to the sub-soil conditions, ground water conditions and type of founding material. These shall be of standard type and shall have been approved

by the Engineer.

iii. Before installing the initial test pile, the Contractor shall finalise the pile testing arrangement and obtain approval of the Engineer.

iv. It is envisaged that the working piles shall be installed after the successful completion of the initial pile load test.

v. In case the Contractor desires to install the working pile, pending successful completion of initial pile load test, he may be permitted to do so, provided he gives undertaking to the Engineer to bear all associated risks and costs involved to make up for the short falls in the pile capacity, in the event of the failure of the initial pile load tests to establish specified 'Design Ultimate Load' carrying capacity of initial test pile.

vi. The Engineer reserves the right to reject any pile which in his opinion is defective on account of less carrying capacity, structural integrity, position, alignment, concrete quality etc. Piles that are defective shall be pulled out or left in place as judged convenient by the Engineer, without affecting the performance of adjacent piles. The Contractor shall install additional piles to substitute the defective piles, as per the directions of the Engineer, at no additional cost to the Employer. Further, the cost of additional piles and increase in the pile cap size, if any, on account of additional piles, shall be borne by the Contractor.

vii. Each pile shall be identified with a reference number and shall be as shown in the Drawings. The convenience of installation may be considered while scheduling the sequence of piling in a group.

viii. In a pile group, the sequence of installation of piles shall normally be from the center to the periphery of the group or from one side to the other.

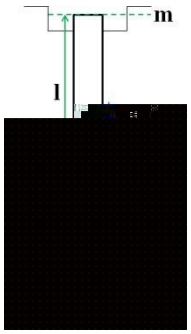
ix. Level marks shall be accurately painted on each pile immediately after its installation. Subsequently, if any pile displays any tendency to heave up due to installation of other piles or due to any other reasons, the same shall be reinstalled firmly as per the directions of the Engineer without any additional cost.

x. The Contractor shall record all the information during installation of piles, including pile-bore observations before concreting each pile. The data sheet for recording pile data shall be as approved by the Engineer. On completion of each pile installation, pile record shall be submitted to the Engineer within two days of completion of concreting of the pile.

b) Control of Position and Alignment

Piles shall be installed as accurately vertical as possible. The permissible tolerances with respect to position and inclination/alignment are as shown below:

Tolerances

No	Item	Permissible tolerance	Figure
1	Level of top i.e. Cut-off-Level (m)	-25mm to 25mm	
2	Position of the head in plan at Cut-off-Level (d)	75mm or less	
3	Embedded depth in bearing stratum (l)	Design value or more	
4	Diameter of the pile (D)	Design value or more	
5	Variation from vertical at Cut-off-Level (v)	1.5% or less	

c) Pile Boring

i. Boring Operation:

- Boring operations shall be done by rotary hydraulic feed drilling rigs with reverse mud circulation or other suitable boring methods that have been approved by the Engineer. The boring or drilling equipment shall have suitable and adequate accessories for boring or drilling through all types of strata expected at site.
- The size of cutting tools shall not be less than the diameter of the pile by more than 75 mm. However, the pile bore shall be of the specified size.
- The boring centre shall be aligned with the pile centre and the boring machine shall be installed so as not to move or incline. The sides of the bore-hole shall be stable throughout.
- Working level shall be above the Cut-off-Level. After the initial boring of about 1.0 m, temporary guide casing of suitable length shall be lowered in the pile bore for vertical pile. The diameter of guide casing shall be such as to give the necessary finished diameter of the concrete pile. The centre line of the guide casing shall be checked before continuing further boring. Guide casing shall be minimum of 1.0 m length. Additional length of casing may be used depending on the condition of the strata, ground water level etc.
- The temporary guide casing (if provided) shall be withdrawn cautiously, after concreting is done up to the required level. While withdrawing the casing, concrete shall not be disturbed.
- For providing permanent MS liner, Clause 709.1.4 of IRC:78 shall be complied with. Whenever stricter provision has been given in the drawings, the same shall be followed.
- If boring operation becomes difficult before reaching the predetermined depth, further plan of action shall be submitted by the Contractor and

approval shall be obtained from the Engineer for the same. The piles shall be founded on rock or other suitable strata as approved by the Engineer.

ii. Maintaining the bore hole:

- For maintaining bore hole wall while boring, a stabilizing material, according to the soil shall be used and the level of the stabilizing fluid shall be maintained at not less than 2.0 m above the ground water level or at such other level as will ensure that the fluid pressure is at all times in excess of pressures exerted by the soils and external groundwater. The stabilizing fluid shall be under constant circulation till start of concreting. The level of stabilizing fluid for all piles shall be recorded by the Contractor and reported to the Engineer, including the confirmation of the bore-hole wall shape after boring. Where temporary casings or an alternative method for maintaining stability of a boring are used, these shall be subject to the Engineer's approval.
- Consistency of the stabilizing material suspension shall be controlled throughout concreting operations in order to keep the bore stabilized, as well as to prevent concrete getting mixed up with the thicker suspension of the mud.
- When the boring is done by rotary drilling rigs, the verticality of Kelly bar shall always be maintained. In the soil layer such as sandy soil layer where the bore hole tends to collapse, care shall be taken to ensure the drilling bucket does not hit the hole wall. While boring in the founding soil layer, the drilling bucket shall be raised at appropriate speed to prevent loosening of the soil by suction.

iii. Stabilizing material management:

In addition to the requirements that are already stated, the following shall be considered:

- The stabilizing material shall be controlled so as to prevent pile-bore wall collapse and ensure the quality and shape of the concrete.
- While boring, the Contractor shall periodically check the properties of the stabilizing material and control the management items (specific gravity, marsh funnel viscosity, pH, etc.) to be within the values set in the Method Statement that has been approved by the Engineer.
- Stabilizing fluid shall comprise of bentonite, complying with the specifications of IS 2720, IS 2911 (Part 1/ Sec2; ANNEX D) or otherwise approved by the Engineer, thoroughly mixed with clean fresh water along

with the required Polymer like CMC, to form a suspension meeting the specification requirements as submitted to and consented by the Engineer.

- The Contractor shall obtain manufacturers' certificates of the bentonite powder consigned to the Site giving properties of each consignment and shall submit them to the Engineer prior to commencing the work and whenever required.
- The frequency of testing stabilizing material and the method and procedure of sampling shall be proposed by the Contractor and approved by the Engineer prior to the commencement of piling work. Such control tests on the bentonite suspension as required or as approved by the Engineer shall be carried out during the piling work.
- Prior to concreting a pile, the Contractor shall take measures to remove any heavily contaminated stabilizing material which could impair the free flow of concrete from the tremie pipe. Placing of concrete shall proceed only with due modification as per consent of the Engineer.
- All reasonable steps shall be taken to prevent the spillage of bentonite suspension in the Site in areas outside the immediate vicinity of boring.

iv. Confirmation of bearing stratum for termination level:

- Confirmation of the support layer shall be carried out by boring depth and comparing excavated soil and soil survey material. Also, the pile designated as per approved Method Statement or by the Engineer shall receive necessary confirmation.
- The boring depth shall be measured at two or more places to the bottom of the hole immediately after completion of boring operations. The results shall be reported promptly.
- A protocol shall be maintained regarding the strata at the founding level, Standard Penetration Test (SPT) value, percent core recovery, Unconfined Compressive Strength (UCS) from the nearest borehole, socketing horizon, flushing of pile bore, time interval between end of boring and start of concreting, bentonite density prior to the commencement of concreting.

v. Cleaning of pile bore just after boring:

- After completion of the pile bore up to the required depth, the pile bore shall be cleaned of loose, disturbed or re-moulded soil from the base of the pile.
- The cleaning shall preferably be achieved by three stages flushing of slurry using airlift technique, as per approved Method Statement. The bottom of the pile bore shall be thoroughly cleaned by airlift technique. Cleaning shall ensure that the pile bore is completely free of sludge or bored material, debris of rock or boulder etc. Necessary checks shall be made to ensure the thorough cleaning of the pile bore.

- Concreting operations shall not proceed if the contaminated stabilizing material at the bottom of the pile bore possesses a density of more than 1.12 g/ml. The stabilizing material sample shall be collected from the bottom of pile bore. For this a solid cone shall be lowered by a string to the bottom of pile bore. A sampler tube closed at top with a central hole (hollow cylinder) is lowered over the cone, then a top cover shall be lowered over the cylinder. Care shall be taken for proper fittings of assembly to minimise the leakage, while lifting the cone assembly to the ground surface. The slurry collected in the sampler tube shall be tested for density and sand content.
- When the boring is done by rotary drilling rigs, cleaning-bucket attached to the Kelly shall be used for cleaning the bore. Wherever stabilizing material is used, after using the cleaning-bucket, the bore shall be flushed with fresh slurry.
- The Contractor shall measure the final depth after this cleaning and confirm its effect by comparing with the depth at the end of boring.

vi. Cleaning of pile bore just before concreting:

- Pile bore shall be cleaned by fresh stabilizing material through tremie pipe or as specified in the Method Statement, before (in case delay in concreting after the completion of bore) and after placing the reinforcement cage and just before the start of concreting. Pile boring shall be inspected and approved by the Engineer, in accordance with approved Method Statement, before concreting.
- The Contractor shall measure the final depth after this cleaning, when there is a delay in concreting after completion of the bore, for knowing the casting pile length, and confirm its effect by comparing with the depth at the end of boring.

vii. Other relevant considerations for pile boring:

- Care shall be taken not to harm a recently concreted pile due to driving the casing nearby before the concrete has sufficiently set in that pile. The danger of doing harm is greater in compact soils than in loose soils.
- For bored holes, the finishing and cleaning of the bore, lowering of reinforcement cage and concreting of the pile for full height must be accomplished in one continuous operation without any stoppage.
- Pumping from a boring shall not be permitted unless approval has been issued by the Engineer.
- A pile excavation shall be backfilled without delay where a rapid loss of drilling fluid occurs and no further excavation at the location of that pile shall be carried out until the Engineer's approval is obtained.

- After each pile has been cast, any empty bore which may remain shall be protected and carefully backfilled as soon as possible to the satisfaction of the Engineer.
- Carriage and Disposal: The bored spoil material and contaminated mud and bentonite slurry shall be disposed at the designated areas identified by the Contractor and as per the procedure approved by the Engineer and as mandated by other relevant Contract provisions.

d) Concreting

i. Cast-in-Situ pile concreting shall conform to provisions of Annexure OCS-1 of these Specifications and the relevant provisions of IS 2911 (Part 1/ Sec 2), where not in contravention to the following provisions.

ii. Concreting shall not be done until the Engineer is satisfied that the termination level of pile, is as per the installation criteria and the Method Statement that has been approved by the Engineer.

iii. Concrete in the pile shall be coherent, rich in cement with high slump and restricted water cement ratio. The slump of concrete shall vary between 150 mm to 180 mm for bored piles. For long or large diameter piles, use of retarding plasticiser in concrete is desirable.

iv. The time interval between the completion of boring and placement of concrete in pile bore shall not exceed 6 hours. In case the time interval exceeds 6 hours, the pile bore shall be abandoned. However, the Engineer may allow concreting provided the Contractor extends the pile bore by 0.5 m beyond the termination level and clean the pile bore. The entire cost of all operation and materials for this extra length shall be borne by the Contractor.

v. The concrete shall be properly graded, self-compacting and shall not get mixed with soil, excess water, or other extraneous matter. Special care shall be taken in silty clays and other soils which have the tendency to squeeze into the newly deposited concrete and cause necking. Adequate head of green concrete shall be maintained to prevent inflow of soil or water into the concrete.

vi. Concreting shall be done by tremie method. The operation of tremie concreting shall be governed by IS 2911 (Part 1/ Sec 2). Stabilizing material shall be maintained sufficiently above the ground water level, as specified elsewhere in this Specifications.

vii. Concreting by tremie shall continue to allow the initial pours of concrete, mixed with stabilizing fluid, sludge and cut spoils from the bore to overflow and the consistency and quality of the overflowing concrete is comparable to that of design mix. The length of overflow shall be decided by the Engineer.

viii. It shall be ensured that the volume of concrete poured is at least equal to the theoretically computed volume of the pile shaft being cast.

ix. The tremie shall have uniform and smooth cross-section inside. The tremie shall

be water-tight throughout its length and have a hopper attached at its head by a water-tight connection. All tremie tubes shall be scrupulously cleaned before and after use.

x. While concreting the tremie shall be withdrawn slowly ensuring adequate height of concrete outside the tremie pipe at all stages of withdrawal.

xi. An adequate quantity of concrete within the pipe shall be maintained at all times to ensure that the pressure from it exceeds that from the water or drilling fluid.

xii. The tremie pipe shall be lowered to the bottom of the bore-hole, allowing water or stabilizing material to rise inside it before pouring concrete. The tip of the tremie pipe shall not be separated from the bottom of the hole more than necessary (when plunger is used, it is about 0.2 m or less from the hole bottom)

xiii. The tremie pipe shall always be kept full of concrete and shall penetrate well into the concrete in the borehole, at least 2 m or more, with adequate margin of safety against accidental withdrawal if the pipe is surged to discharge the concrete.

xiv. During concreting, the cycle time of concreting, concreting volume, concrete placement height and the height of the tremie pipe tip in concrete shall be checked for all the piles and reported in a format that has been approved by the Engineer.

xv. To prevent the reinforcement cage from floating during placement of concrete, appropriate countermeasures shall be made in advance, as per the Method Statement that has been approved by the Engineer. The same shall be monitored for all piles and reported.

xvi. Temporary casings, when used, shall be extracted carefully to the satisfaction of the Engineer, whilst the concrete is sufficiently workable to ensure it is not disturbed or lifted, and the reinforcement cage does not get disturbed. During extraction, sufficient quantity of concrete shall be maintained inside the casing to overcome the pressure from external water, soil or stabilizing material and to ensure that no reduction in section by way of necking or shearing of concrete and contamination of the pile takes place.

xvii. Segregation of the ingredients shall be prevented. The displacement or distortion of reinforcement during concreting shall be avoided. If the concrete is placed inside precast concrete tubes or consists of precast sections, subject to the approval of the Engineer, these shall be free of cracks or other damage before being installed.

xviii. While concreting uncased piles, voids in concrete shall be avoided and adequate head of concrete shall be maintained to prevent inflow of soil or water into the concrete. It is also necessary to take precautions during concreting to minimise the softening of the soil by excess water. Uncased cast- in-situ piles shall not be allowed where mudflow conditions exist.

xix. Where concrete is placed in dry borings, measures, subject to approval of the Engineer, shall be taken to avoid segregation and bleeding and to ensure that the concrete at the bottom of the pile is not deficient in grout.

xx. Where enlarged bases are required, as per site conditions and as approved by the Engineer, these shall be mechanically formed and shall be concentric with the pile shaft within a tolerance of 10% of the shaft diameter and shall not be smaller than the required dimension. The sloping surface of the frustum forming the enlargement shall make an angle of not less than 55° to the horizontal.

xxi. Grouting at base of pile shall be done wherever the results of proof coring (in case of rock), sonic logging and/or loading test etc. confirm that there is a void/ sludge at the pile base. The grouting shall be done with cement slurry under suitable pressure after concrete in the pile attains the desired strength, if required by the Engineer. For this purpose, conduit pipes with easily removable plugs at the bottom end shall be placed in the bore along with reinforcement cage before concreting

3.5.4 Top of Concrete in Pile, Cut-off-Level (COL):

a) Cut-off-Level of piles shall be as indicated in the drawings.

b) The top of concrete in pile cast shall be above the Cut-off-Level by 1.0 m (minimum) and as per the Method Statement, to remove all laitance and weak concrete and to ensure good concrete at Cut-off-Level, for the proper embedment into the pile cap. Any exceptions, due to contingent situation, will be subject to the approval of the Engineer.

c) Preparation of pile head: The area surrounding the piles shall be excavated up to the bottom of the pile caps. After seven days of concreting of pile, the exposed part of concrete above the COL shall be removed or chipped off and made rough at COL. In case a part of extra-pile concrete before curing is handled, the Contractor shall obtain prior approval from the Engineer. The projected reinforcement above COL shall be properly cleaned and bent carefully, only where required, to the required shape and level to be anchored into the pile cap as per the drawing. While finishing the pile head, care shall be taken to ensure no harmful damage, such as cracks, occurs in the concrete. The pile top shall be embedded into the pile cap by 150 mm as per the Drawings and as agreed by the Engineer. All loose material on the top of pile head after chipping to the desired level shall be removed and disposed as per contractual procedure and as directed by the Engineer.

3.5.5 Reinforcement Steel

a) Reinforcement steel, along with its inspection and testing shall conform to Annexure – OCS-2 of these Specifications, along with IS 2911 (Part 1/ Sec 2) and used as per the drawings.

b) The reinforcement shall be assembled before placing in the moulds and all hoops and links shall be of uniform length firmly wired into position. Ends of helical

reinforcement, if used, shall be firmly secured. Diagonal fork spacers shall be of a pattern that has been approved by the Engineer.

c) Lap joints in main longitudinal bars will be permitted only when, in the opinion of the Engineer, each bar cannot be supplied in one complete length. Where permitted, joints shall be provided at agreed centres, designed to develop the full strength of the bar across the joint, provided with adequate links or stirrups and staggered in position from those of adjacent longitudinal bars or as indicated in the drawings, subject to the approval of the Engineer.

d) The 'L' bends in the reinforcements at the bottom of the piles shall not be provided to avoid the formation of soft toe.

e) Jointing of Reinforcement Steel for Piles: Only lap joints shall be provided as shown in the drawings.

f) Lowering of the reinforcement cage:

i. The reinforcement cage shall be properly aligned with the pile core and kept vertical without collapsing the hole wall. In lowering of the reinforcement cage, it shall avoid deformations, damages, etc. by using reinforcing material as necessary. In the lap joint part of the reinforcement cage, the upper and lower cages shall be in a straight line, with the joints tightly bound.

ii. Proper cover to reinforcement and central placement of the reinforcement cage in the pile bore shall be ensured by use of suitable concrete spacers or rollers cast specifically for the purpose, as directed by the Engineer. The longitudinal reinforcement shall project above Cut-off-Level as indicated in the drawings.

iii. After lowering of the reinforcement cage, the height of the top end of the reinforcement shall be measured and reported. The axes of the reinforcement cage and the pile core shall be matched, checked and reported.

3.5.6 Breaking off of Piles

If any pile already cast requires breaking due to subsequent change of Cut-off-Level, then the same shall be carried out, not before seven days of casting without affecting the quality of existing pile, such as loosening, cracking etc., and to the satisfaction of the Engineer.

3.5.7 **Pile** Caps

The ground shall be excavated, levelled, prepared and then layers of coarse aggregate and blinding concrete shall be constructed below pile cap. The pile cap shall then be cast as per the Drawings and conforming to Annexure OCS-1 and Annexure OCS-2 of these Specifications, subject to tolerances mentioned therein.

3.5.8 **Tests on Piles**

a) General

When preparing for conducting a pile test, the Contractor shall follow the requirements of the various acts, orders, regulations and other statutory instruments that are applicable to the work for the provision and maintenance of safe working conditions, and shall in addition make such other provision as may be necessary to safeguard against any hazards that are involved in the testing or preparations for testing.

b) Load Test on Piles

i. Sub-Clause 5.5.8(d) to Sub-Clause 3.5.8(g) of these Specifications covers the requirements for initial vertical load and routine vertical load tests on reinforced concrete single vertical piles of specified diameter to assess their vertical load carrying capacities. All pile load testing shall conform IS 2911 (Part 1/ Sec 4)

ii. Full details of the equipment proposed to be used, the test setup and pile testing scheme along with detailed design, drawings shall be submitted to the Engineer, before making arrangements to carry out the tests, for obtaining his approval. Approval of the Engineer shall also be obtained after the test setup is complete, prior to commencement of loading.

iii. The work shall include mobilization of all necessary equipment, kentledge, anchor piles and rock anchors, or combination of kentledge and anchor piles and rock anchors, providing necessary engineering supervision and technical personnel, skilled and unskilled labour as required, to carry out the complete pile testing and submission of test reports.

iv. In all cases, the Contractor shall ensure that when the hydraulic jack and load measuring device are mounted on the pile head the whole system will be stable up to the maximum load to be applied.

v. Necessary means shall be provided to enable dial gauges to be read from a position clear of the kentledge stack or test frame in conditions where failure in any part of the system due to overloading, buckling, loss of hydraulic pressure and so on might constitute a hazard to personnel.

vi. The hydraulic jack, pump, hoses, pipes, couplings and other apparatus to be operated under hydraulic pressure shall be capable of withstanding a test pressure of one and a half times the maximum working pressure without leaking.

vii. The maximum test load or test pressure expressed as a reading on the gauge in use shall be displayed and all operators shall be made aware of this limit.

viii. Where kentledge is used, the Contractor shall construct the foundations for the kentledge and any cribwork, beams or other supporting structures in such a manner that there will not be differential settlement, bending or deflection of an amount that constitutes a hazard to safety or impairs the efficiency of the operation. The kentledge shall be adequately bonded, tied or otherwise held together to prevent it falling apart, or becoming unstable because of deflection of the supports. The weight of kentledge shall be greater than the maximum test load and if the weight is estimated from the density and volume of the constituent materials, an adequate

factor of safety against error shall be allowed.

ix. It is essential that all the equipment and instruments are properly calibrated both at the commencement and immediately after the completion of tests, so that they represent true values. If the Engineer desires, the Contractor at his own cost shall arrange for calibration of the instruments in presence of the Engineer, at a laboratory having Engineer's approval, and the test report and calibration certificate shall be submitted to the Engineer.

x. The complete jacking system including the hydraulic jack, hydraulic pump and pressure gauge shall be calibrated as single unit. The complete unit shall be calibrated over its complete range of travel for increasing and decreasing loads same as that of test loads. The calibration certificate shall be submitted to the Engineer.

xi. The reaction load to be made available for the test shall be at least 25% greater than the maximum jacking force. The reaction system as relevant shall be designed for the total reaction load. All reaction loads shall be stable and balanced during all operations of testing. During testing, stability of reaction system shall be ensured.

xii. The vertical displacement of pile shall be measured using dial gauges having a least count of 0.01 mm.

xiii. Load test shall be conducted at pile Cut-off-Level (COL). If the water table is above the COL, the test pit shall be kept dry throughout the test period by suitable dewatering methods.

xiv. In case of initial vertical load test, where the water table level is higher than the COL, the Contractor may use anchor piles and rock anchors for testing purposes. The Engineer, at his discretion, may decide to raise the COL above water table.

xv. All operations in connection with pile load test shall be carried out in a safe manner to prevent exposure of the people to hazard and also to ensure the safety of manpower and material.

xvi. Test record and report for pile load tests shall be as per IS 2911 (Part 1/ Sec 2) and as approved by the Engineer. The reports shall be submitted to the Engineer immediately on completion of each test.

xvii. Two fixed independent benchmarks shall be established as reference points at least 15 m from the test pile to monitor the settlements.

xviii. If any initial pile load test gets abandoned and is not successfully completed, then the Contractor shall install another test pile and repeat the initial test after correcting the fault, at his own cost.

xix. On completion of a test all equipment and measuring devices shall be dismantled, checked and either stored so that they are available for use in further tests or removed from the Site.

c) Test Pile Installation

i. Piles shall be installed as per Sub-Clause 3.5.3 herein above.

ii. Pile installation data as applicable shall be furnished along with the load test results to the Engineer.

d) Types of Tests

i. Initial vertical (compression) load test and lateral load test shall be carried out on test piles, which are not to be incorporated in the work, to assess the 'Ultimate Load Capacity of Pile' before the commencement of the installation of working piles.

ii. The test piles shall have the same design details as of the working piles typically adopted in the predominant soil profile in that area.

iii. Routine vertical (compression) load test and lateral load test shall be conducted to verify the load carrying capacity of working pile.

iv. Pile integrity test shall be carried out on each pile by The Low Strain Method as per IS 14893 to verify the structural integrity, shape and continuity of pile as detailed in Sub-Clause 3.5.8(i).

e) Number of Tests:

i. **Initial pile-load tests:** The number of load tests shall be as per IS 2911 (Part 4) depending upon the total number of piles but not less than two (2). Wherever the soil strata are erratic or there is change in structure type (such as river bridge, rigid frame), additional tests shall be required as directed by the Engineer.

ii. **Routine pile-load tests:** The number of tests may generally be 0.5 percent of the total number of piles required, but not less than one (1). The number may be increased up to 2% depending upon the nature, type of structure and sub-strata condition.

iii. Initial and routine tests may be suitably increased for important structures or cases with large variation in the subsurface strata as directed by the Engineer.

iv. Pile load tests shall be carried as per IS 2911 (Part 4).

f) Testing-Piles

i. The testing-piles for routine load test shall be identified by the Engineer. For initial load test, testing-pile shall be installed as a test-pile, separate from working piles, as directed by the Engineer.

ii. A minimum time period of four weeks shall be allowed between the time of pile casting and testing. Testing-pile head shall be prepared for testing purposes only, one week after casting the pile.

iii. Testing-piles shall be cut off at the proper level and provided with a proper cap, to provide a plane bearing surface for the test plate and for proper arrangements for seating of the jack and dial gauges.

g) Static Vertical Load Test

i. The tests shall conform to IS 2911 (Part 4).

ii. Equipment and Test Setup

- A steel plate of adequate thickness and not less than 50 mm shall be centered on the pile cap to prevent it from getting crushed under applied load. The size of the circular test plate shall not be less than the pile size nor less than the area covered by the base of the hydraulic jack(s).
- The datum bars shall be supported on immovable supports, preferably of concrete pedestals or steel sections, placed sufficiently far away from the test pile. The distance shall not be less than 3 times the diameter of testing-pile and in no case less than 2 metres from the edge of testing-pile. These supports shall be placed at an adequate depth below ground to be unaffected by ground movements.

iii. Loading System

The test load on pile shall be applied by means of hydraulic jack(s) which obtain reaction in one of the ways mentioned in Cl.7.1.3 of IS 2911 (Part 4).

The measurement of strains for load monitoring may also be done by load cell connected to a digital read out unit.

iv. Test Procedure

- Application of Load:- The test should be carried out by applying a series of vertical downward incremental load each increment being of about 20 percent of safe load on the pile. For testing of raker piles it is essential that loading is along the axis.
- This is applicable for both initial and routine test. In this method application of increment of test load and taking of measurement or displacement in each stage of loading is maintained till rate of movement of the pile top is not more than 0.2mm/h or until 2 h has elapsed, whichever is earlier subject to a minimum of 1 h. The test load shall be maintained for 24 h.
- Duration of vertical loading shall be as per Cl. 7.2 of IS 2911 (Part 4)
- Settlement:- Settlement shall be recorded as per Cl. 7.1.4 of IS 2911 (Part 4).
- The safe vertical load on single pile for the initial test shall be as per Cl. 7.1.5 of IS 2911 (Part 4).
- Items to be measured:

  The following items shall be measured:

  - Time;
  - Applied pressure;
  - Applied load;
  - Displacement at the pile head;

- Movement of reaction devices;
- Others, as decided by the Engineer.

- Commencement, interruption and completion of the test:
  - The test shall be commenced after ensuring the conditions surrounding the site, preparations of all equipment and the suitability of the weather condition.
  - If any abnormal conditions are noticed during the test, the test shall be interrupted promptly. The test can only be resumed when the cause of the abnormal condition has been detected and rectified.
  - The test shall be completed when the objectives of the test shall have been achieved, or when it is judged that abnormal conditions make it impossible to continue the test.
- Loading on the pile shall be continued till as given in IS 2911 (Part 4).

h) Lateral load tests – Lateral load tests shall be carried out on test pile as well as on working pile safe load capacity determined as per Clause 8 of IS 2911 (Part 4).

i) Pile Integrity Test on Working Piles (other than piles subjected to routine load test):

i. Pile integrity test shall be carried out on each pile by The Low Strain Method as per IS 14893:2001. In case of large diameter piles, the tests shall be conducted at 5-6 places to cover the entire section of the pile.

ii. The tests shall be conducted on piles whose length is correctly recorded or on test piles where available, to determine the value of stress wave velocity and characteristic or reference signal for comparing the signals for testing subsequent piles.

iii. The area surrounding the pile should be free from standing water and kept dewatered during the tests. The pile head should be accessible.

iv. Testing should be free of work likely to cause disturbance. The cast-in-situ piles should not be tested normally before 14 days of casting.

v. The test piles, if available at site, can be used to determine the pulse velocity and characteristic or reference signal generated. Where no test pile is available information can be obtained from cast piles whose length is accurately recorded.

vi. Methodology for Low Strain Integrity test:

- This is a system of assessing the integrity of piles by the use of low stress wave imparted to the pile shaft and is also known as Sonic Integrity or Sonic Echo Test. A small metal/hard rubber hammer is used to produce a light tap on top of the pile. The shock traveling down the length of the pile is reflected back from the toe of the pile and recorded through a suitable transducer/accelerometre (also held on top of the pile close to the point of

impact) in a computer disk or diskette for subsequent analysis. The primary shock wave which travels down the length of the shaft is reflected from the toe by the change in density between the concrete and sub-strata. However, if the pile has any imperfections or discontinuities within its length these will set up secondary reflections which will be added to the return signal.

- The reflected stress wave can be monitored using either processing technique, the observed signals are amplified and converted into digital display as velocity versus length or frequency versus mobility records, providing information on structural integrity of piles. The stress wave velocity and approximate pile lengths are provided as input for the integrity testing. The stress wave velocity is dependent on the Young's modulus and mass density of pile concrete. This value generally lies between 3000-4000 metre per second depending on the grade of concrete used (M15-M25).

j) Sampling, Testing, Inspection, and Acceptance Criteria Including Construction Tolerances of Piles

i. Frequency of sampling, testing and quality assurance including the method of conducting the tests, acceptance criteria and construction tolerances shall be as mentioned herein above and included in the Method Statement that has been approved by the Engineer. The tests shall be performed and reported as per the Method Statement that has been approved by the Engineer.

ii. Forcible corrections for any deviations shall not be made to concrete piles.

iii. Data Reporting and processing

- The assessment of structural integrity is based on two equally important aspects:
  - Quality of signals, and
  - Accurate analysis and interpretation of signal.
- Piles requiring remedial measures should be so marked immediately on completion of the field integrity testing and rectification measures selected.
- The final report should include signals of each integrity test and structural condition of piles.

iv. Submission of Results: Immediately after testing, a signed copy of all the raw data of a pile shall be given to the Engineer. A test report shall be submitted to the Engineer within 3 days after testing.

3.5.9 Safety

The Contractor shall adopt appropriate method and practice conforming to IS 5121 (Piling and other deep foundation - Code of Safety) suiting to local ground characteristics.

3.6 Formwork

Form work for bridge foundations, sub structure and superstructures shall be as per IS-3696, IS-4014 and Annexure OCS-1. It includes all temporary or permanent forms required for forming the concrete of the shape, dimensions and surface finish as shown on the drawing or as directed by the Engineer, together with all props, staging, centering, scaffolding and temporary construction required for their support.

3.7 Substructure

3.7.1 Piers and Abutments

a) Concrete and reinforcement for piers and abutments shall conform to relevant sections of these specifications and drawings. In case of concrete piers, minimum grade will be M 20 unless otherwise specified / approved. The number of horizontal construction joints shall be kept to minimum. Construction joints shall be avoided in splash zones unless specifically permitted by the Engineer and provided they are treated in accordance with special provisions. No vertical construction joint shall be provided. Shear connectors in the form of vertical plumbs, dowels, bond bars or rail cut pieces shall be provided at all horizontal joints as directed by Engineer. The work shall conform strictly to the drawings or as directed by the Engineer.

b) In case of tall piers and abutments, use of slipform shall be preferred. The design, erection and raising of slip form shall be subject to special specifications which will be furnished by the Contractor. The concrete shall also be of higher grade and subject to additional specifications as necessary. All specifications and arrangements shall be subject to the approval of the Engineer.

c) The surface of foundation / well cap / pile cap shall be scraped with wire brush and all loose materials removed. In case reinforcing bars projecting from foundations are coated with cement slurry, the same shall be removed by tapping, hammering or wire brushing. Care shall be taken to remove all loose materials around reinforcements. Just before commencing masonry or concrete work, the surface shall be thoroughly wetted.

d) In case of solid (non-spill through type) abutments, weep holes as shown on the drawings or as directed by the Engineer, shall be provided.

e) The surface finish shall be smooth, except the earth face of abutments which shall be rough finished or left as form finished.

f) In case of abutments likely to experience considerable movement on account of backfill of approaches and settlement of foundations, the construction of the abutment shall be followed by filling up of embankment in layers simultaneously with filter backing behind to the full height to allow for the anticipated movement during construction period before casting of superstructure.

g) *Transitional system as per guidelines of RDSO Report No. GE: R-50 shall be provided in railway bridge approaches of ballasted and non ballasted deck bridges having span equal to or more than 12.2m.*

3.7.2 Pier Cap and Abutment Cap (Bed Blocks)

a) Form work, Concrete and reinforcement shall conform to relevant paras of Concrete work & RCC of these specifications and the Drawings. Unless otherwise specified, minimum grade of concrete mix shall be M 35.

b) The locations and levels of pier cap / abutment cap / pedestals and bolts for fixing bearings shall be checked carefully to ensure alignment in accordance with the drawings of the bridge.

c) The surface of cap shall be finished smooth and shall have a slope for draining of water as shown on the drawings or as directed by the Engineer. For short span slab bridges with continuous support on pier caps, the surface shall be cast horizontal. The top surface of the pedestal on which bearings are to be placed shall also be cast horizontal.

d) The surface on which elastomeric bearings are to be placed shall be wood float finished to a level plane which shall not vary more than 1.5mm from straight edge placed in any direction across the area. The surface on which other bearings (steel bearings, pot bearings) are to be placed shall be cast about 25mm below the bottom level of bearings and as indicated on the drawings. Specified rich levelling mortar shall be provided over this at the time of placing of bearing.

3.7.3 Dirt / Ballast Wall, Return Wall and Wing wall

a) Dirt / ballast walls ,return wall & wing walls shall be in RCC. Minimum grade of concrete will be M35 unless otherwise specified. In case of cantilever return walls, no construction joint shall generally be permitted. Wherever feasible, the concreting in cantilever return walls shall be carried out in continuation of the ballast wall.

b) For concrete return and wing wall, the surface of foundation shall be prepared in the same manner as prescribed for construction of abutment. No horizontal construction joint shall be provided. If shown on drawing or directed by the Engineer, vertical construction joint may be provided. Vertical expansion gap of 20mm shall be provided in return wall / wing wall at every 10 metre intervals or as directed by the Engineer. Weep holes shall be provided as prescribed for abutments or as shown on the drawings.

c) Form work, reinforcement and concrete in dirt / ballast wall shall conform to relevant sections of these specifications.

d) The finish of the surface on the earth side shall be rough/form finish while the front face shall be smooth finished.

e) Architectural coping for wing wall / return wall in brick masonry shall conform to Drawings.

3.7.4 Tests and Standards of Acceptance

The materials shall be tested in accordance with these specifications and shall meet the prescribed criteria.

The work shall conform to these specifications and shall meet the prescribed standards of acceptance.

3.7.5 Tolerances in Concrete elements

a) Variation in cross-sectional dimensions: + 10mm, -5mm

b) Misplacement from specified position in plan: 10mm

c) Variation of levels at the top: + 10mm

d) Variations of reduced levels of bearing areas: + 5mm

e) Variations from plumb over full height: + 10mm

f) Surface irregularities measured with 3m straight edge

- All surfaces except bearing areas: 5mm
- Bearing areas: 3 mm

3.7.6 For construction of Br Nos. 150 and 153 temporary diversions of existing roads will be required first. Then existing roads will be lowered by about 1.90 m at the site of the bridges and regraded to join the existing roads. Thereafter Br Nos. 150 and 153 will be constructed. Similarly, for construction of Br. No. 71, temporary diversions of existing roads will be required first. Thereafter, RCC box bridge will be constructed on the original alignment over which roads will be restored back by suitable regrading.

3.8 Bridge Work : Superstructure

3.8.1 GENERAL

a) Coverage

This chapter covers specifications for the following types of superstructures:

i. RCC Box

ii. Prestressed concrete girders and slabs

iii. Steel- Open Web Girders (OWG) and Composite Girders

3.8.2 RCC BOX

All concrete works for RCC box shall conform to **Annexure OCS-1 & 2**.

3.8.3 STEEL Open Web Girders (OWG) and Composite Girders

Fabrication and erection of steel girders shall conform to Annexure OCS-3.

Concrete and reinforcement for composite girders shall conform to **Annexure OCS-1 & 2.**

3.8.4 PRE-STRESSED CONCRETE GIRDERS AND SLABS

All prestressed works for bridges shall be carried out in accordance with Annexure OCS-1 to 4.

3.8.5 Linking of Track on Open Web Girder (OWG)

Galvanised H-beam bridge sleepers shall be as per RDSO Drawing No. B-1636/4/R, 5 & 9. Zero toe load fastening shall be as per RDSO Drawing No. T-8759 to T-8765 for 60kg running rail and 52 kg guard rail. Both H-beam bridge sleepers and track fittings/fastenings shall be procured from RDSO approved source. Inspection of material shall be done by the Engineer or any other agency nominated by the Employer at factory premises before dispatch. The Contractor shall arrange for necessary inspection/testing of material at factory premises.

Linking of track on H-beam sleeper with 60 kg running rail and 52 kg guard rail shall include bending of guard rail, drilling of holes, cutting of rails, providing wooden wedge at the end of guard rail, provision of gang pathway of 6 mm thick MS chequered plate as per RDSO Drawing No. B-1636 /5 on H-beam sleeper and making track fit for normal sectional speed.

Chapter 4. STATION- CIVIL

4.1 General

Specification for various activities involved in station shall generally be in accordance with CPWD specification-2019 for Civil Works Volume 1 & 2, as amended up to date unless stated otherwise in these specifications. In case of any contradictory instruction in the specification, Engineer's decision shall be final & binding.

4.1.1 Earthwork

Earthwork in excavation and filling/backfilling in station buildings shall be carried out as per CPWD specifications. Soil for filling shall be arranged by the Contractor from outside the ROW. No Earth is to be taken from the Railway*/HORC* premises except surplus earth from excavation for the building.

4.1.2 Concrete Work

All plain and reinforced concrete works shall be carried out as per IS 456:2000 and Annexure OCS-1 and 2. Design Mix concrete as approved by the Engineer shall only be used.

4.1.3 Anti-Termite Treatment

Pre-Construction Anti-Termite Treatment shall be done as per clause 2.28 of CPWD specification 2019 Vol.-1. The chemical shall be approved by the Engineer and used as per the manufacturer's instructions/specification.

4.1.4 Plinth Protection

Plinth protection shall be of 1000 mm wide all around the building, it comprises of 50mm thick M-25 concrete over 75 mm thick bed of dry brick aggregate of 40mm nominal size, grouted with fine sand. The outer edge or face edge shall be lined 2nd class bricks laid on the edge and joints laid in cement mortar 1:4. It shall be laid to the required width and slope in outward direction.

4.1.5 Damp Proof Course (DPC)

Unless otherwise mentioned in the drawings, DPC will consist of 40mm thick M25 CC with two coats of bitumen over it shall be provided as per clause 4.4 of CPWD Specification 2019 Volume-1.

4.1.6 Masonry Work

Fly ash bricks or cement concrete blocks (hollow/solid) confirming to the BIS or *brick* masonry *will* be used. All outer and load bearing walls shall be of minimum 230 mm thickness or more as per design, in cement mortar 1:6, all partition walls shall be 115 mm thick in cement mortar 1:4 as per Clause 6 of CPWD Specification Volume-I 2019.

4.1.7 Plaster

Plaster of 15-19mm thick in cement mortar 1:4 on all outer and inner walls except in ceiling. Inner walls shall be finally finished with POP. Underside of the slabs shall be

rendered smooth wherever required and finished with POP as per Clause 3 of CPWD Specification Volume-I 2019.

4.1.8 Painting

Two coats of synthetic enamel paint of 1st quality over a priming coat of Asian, Berger, Nerolac or equivalent brand and shade as approved by the Engineer, on all exposed steel and wooden surfaces.

4.2 Sanitary fittings/sewerage system:

4.2.1 Manholes

Manholes and junction chambers to be constructed by Contractor as per the design by the Contractor & approved by the Engineer and to be connected with RCC pipes of 150/200 mm dia. with each other and to septic tank or to existing sewerage arrangement (up to 30m from extreme outer wall of building in the direction of source to be connected), including obtaining necessary clearance from concerned authorities required from the same. In case sewage system is not be connected with trunk sewer, contractor will furnish appropriate design of septic tank for 50/100 No. of users to be approved by the Engineer and will construct the Septic Tank accordingly.

4.2.2 Rainwater pipes

Adequate number of rainwater pipes of min 125mm dia, PVC of approved quality and make as approved by the Engineer to be provided. Inlet of the rainwater pipe to be provided with shoe and CI gratings and at the outlets necessary protection to be done to prevent erosion of soil.

4.2.3 Soil and vent pipes

PVC pipes of min 100 mm dia to be provided for soil and vent pipes including all branches of required degree, access door and other accessories as necessary for laying the pipes of approved quality and make as approved by the Engineer to be provided. Before embedding the pipes under the floor/platform the same will have to be tested against any leakage. Necessary floor traps, gully traps as essential will be provided. Storm water drain of suitable size to be provided as approved by the engineer.

4.2.4 Wash Basins, Sink and Water closet

Wash basins (Ceramic) of approved size, colour and make as per IS: 2556 (Part 1) and IS: 2556 (Part 4) shall be provided in ladies and gents toilet with shelf, looking glass and towel rails (CP Brass). Urinal in gent's toilet shall be of Bowl type with flushing rim & partition slab and in ladies toilet Squatting plate type (ceramic) of approved size and make as per IS: 2556 (Part 6) with ceramic flushing cisterns as shown in tender drawings. Water closet shall be Indian (Orissa type) as per IS: 2556 (Part3) / European type as per IS: 2556 (Part1) and IS: 2556 (Part2) with ceramic flushing cisterns as shown in tender drawings. Stainless steel/Ceramic sinks as per IS: 771 (Part2) of approved size and makes to be provided in battery rooms. All water services and sinks will be connected through bottle traps to concealed outlet pipe.

4.2.5 Water supply

a) Bore well shall be constructed as per IS 2800 Part 1 & Part 2. Chlorinator using common salt shall be provided at each tube well for chlorination of water.

b) Necessary layout for water supply distribution in the water booth, toilets and bathroom to be designed by the contractor and submitted for approval of the Engineer. All internal pipes shall be laid concealed in walls and tested for leakages for minimum 12m head of water. All GI pipes shall be of minimum class 'B.' All necessary taps, stop valve etc. of approved size and make to be provided by Contractor to make the toilets and kitchens functional including provision of RCC underground & overhead water tanks of designed capacity. This will include provision of float valve, copper/brass rod and plastic ball with inlet, outlet, overflow, washout connections etc. for the water tank complete in all respect. Taps in platform toilets & water booths shall be self-closing type.

4.2.6 Water proofing of roofs:

Water proofing of roof shall be carried out by the Contractor as approved by the Engineer.

4.2.7 Drip courses

Drip course of approved design shall be provided all around the building, chajjas etc.

4.3 S&T Buildings/Rooms/Hunts

4.3.1 Finishes

a) **Interior finish**

Two coats of 1st quality oil bound distemper of approved shade over POP coating to make the surface smooth. 3rd coat may be done before handing over of assets.

b) Exterior finish

Two coats of 1st quality cement paint of approved shade over POP coating to make the surface smooth. 3rd coat shall be done before handing over of assets.

4.3.2 Flooring

a) **Tele/OFC Room**

Tele/OFC Room, Equip Room, maintenance room IPS room, , store etc. : 40mm thick, cement concreate flooring with M-25 CC laid in one layer finished with cement slurry to a true smooth surface with proper joints duly provided with glass strips of 4mm thick to form panels not exceeding 1200x1200mm, laid over 100mm thick CC M-10 over 100mm thick sand filling over well rammed and consolidated earth filling as per Clause 11.2 of CPWD Specification Volume-I 2019.

b) **Battery Room**

Acid proof tiles conforming to IS 4457-1967 as approved by the Engineer over 20m thick cement sand mortar 1:4, over 100mm thick CC M-10 over 100mm thick sand filling over well rammed consolidated earth filing. Acid proof tiles also to be

provided in dado as per requirement up to 1.5 m height as per Clause 11.14 of CPWD Specification Volume-I 2019.

c) **Staircase**

Kota Stone 25 mm thick to be provided in risers, treads and landings of steps laid on with neat cement slurry mixed with pigment to match the shade of kota stone including rubbing polishing complete on 20mm thick cement sand mortar 1:3 and 150 mm height skirting of same Kota Stone as per Clause 11.22 of CPWD Specification Volume-I 2019. Kota stone provided on riser & tread of steps shall be minimum 1.8 m long & shall cover full height/width of the step. Exposed end of kota stone on treads shall be rounded to provide nosing. Kota stone tile at other places shall be of minimum 600 mm x 600 mm size. Stone at edges can be cut in smaller sizes to fill up the residual areas.

d) **Verandah Flooring & Ground Floor Passage**

Kota Stone 25 mm thick flooring and 150 mm height skirting laid on with neat cement slurry mixed with pigment to match the shade of kota stone including rubbing polishing complete on 20mm thick cement sand mortar 1:3 over 100mm thick CC M-10 over 100mm thick sand filling over well rammed consolidated earth filing and 150 mm height skirting of same Kota Stone as per Clause 11.22 of CPWD Specification Volume-I 2019. Kota stone tile shall be of minimum 600 mm x 600 mm size. Stone at edges can be cut in smaller sizes to fill up the residual areas.

e) **Toilets**:

Finished floor to be kept 25mm below the normal floor of the building. 300x300mm ceramic anti-skid floor tiles of minimum 10 mm thickness conforming to IS 13630-1993 of Kajaria, Nitco or similar make and shade and approved by Engineer laid over 20mm thick bed of cement and sand mortar 1:4 with neat cement slurry mixed with pigment to match the shade of tiles between joints and over the base in floors laid over 100mm thick CC M-10 over 100mm thick sand filling on well rammed and consolidated earth filling on ground floor. On subsequent floors the tiles will be laid directory on mortar bed. Glazed tiles of suitable size (300mmx300mm or 300mmx450mm) and minimum 06mm thickness confirming to IS 13630-1993 of Kajaria, Nitco or similar make, quality and shade as approved by the engineer to be provided on wall for full height up to ceilings over 13mm thick cement mortar 1:3. All the tiles to be laid with zero gaps between them.

f) **Interlocking cum Axle Counter Rooms**

Interlocking/Axle counter room,, Panel Room and other S&T structures etc. 1st quality 600x600mm vitrified floor tiles of minimum 10 mm thickness conforming to IS 13630-1993 of Kajaria, Nitco or similar make and shade as approved by Engineer laid over 20mm thick bed of cement and sand mortar 1:4 with neat cement slurry mixed with pigment to match the shades of tiles between joints and over the base in floors over 100mm thick CC M-10 over 100mm thick sand filling on well rammed and consolidated earth filling for ground floor. On subsequent floors tiles shall be laid directly on mortar

bed. Glazed tiles of suitable size (300mm x 300mm or 300mm x 450mm) and minimum 06mm thickness confirming to IS 13630-1993 of Kajaria, Nitco or similar make, quality and shade as approved by the Engineer to be provided on walls in dado up to 90cm height from floor level or up to the window sill. All the tiles to be laid with zero gap between them as per Clause 11.15 & 11.16 of CPWD Specification Volume-I 2019.

Note:-

Color and make of all the flooring shall be as per the direction of the Engineer.

4.3.3 Door, Windows and Ventilation

a) **Door frames:**

Door frame shall be manufactured from hot rolled steel section as per IS:7452-1990. Sizes of steel sections used for manufacture of door, window & ventilator frames shall be as per IS:7452 and IS:1038. Requisite number of holes shall be made in the frame for fixing fittings.

b) **Door Shutter**:

35mm thick flush door shutter, commercial type thermosetting synthetic resin bound core of block board construction with lipping of 1st class commercial quality timber, such as elm or its equivalent, battens on all edges and well-matched commercial ply veneering with vertical grains on both faces of shutters. Veneer and board shall as per BIS specifications with brass fittings of approved size and make as per requirement.

c) **Windows/Ventilators**

Steel windows shall be manufactured from rolled steel sections and shall conform to 7IS:452 and IS: 1038. Glass panes 4mm thick with glazing clips and special metal sash putty, of approved make with brass fittings of approved size and make as per requirement.

d) Windows in relay room shall be mix of double shutters/fix panes to provide insulation for effective air conditioning.

e) MS grill of approved design/drawing shall be provided in the windows and ventilators.

f) Necessary exhaust fan opening to be provided as required.

4.4 Station Building

4.4.1 Doors, Windows & Ventilators

a) **Exterior Doors**

Main entrance from circulating area to the station building shall be provided with fully glazed Aluminum Door. Remaining portion of entrance shall be provided with fixed glazing with aluminum frames as per approved drawing. The frames shall be

manufactured from extruded aluminum alloy sections of standard sizes and designs as per IS 1948 and IS 1949 or as manufactured by Indian Aluminum Co. Ltd or approved equivalent. The alloy used shall conform to the IS designation HE9-WP of IS:733. Glazing shall be of 10 mm thick clear glass, horizontally tempered (toughened) as per DIN:1249 Part-12 with no tong or suspension mark and edges machined with no burrs or sharp surfaces. All Toughened Glass shall be heat soak test certified as per BS EN-14179-1.

b) **Door frames** of office of Station Master/SS//Waiting Rooms/Booking Office shall be of well-seasoned steam beech/2nd class of teak wood of minimum section 65mmx100mm.

c) **Door Shutter**

The door shutters shall be of 35mm thick flush door shutter, commercial type thermosetting, synthetic resin bound core of block board construction with lipping of 1st class commercial quality timber, such as elm or its equivalent, battens on all edges and well-matched commercial ply veneering with vertical grains on both faces of shutters. Veneer and board shall be of BIS specifications. These door shutters may be partially glazed as per requirement, as per drawing approved by the Engineer. Glazing shall be of glass pane of 6mm thickness. Doors shall be finished with duco painted of desired shade and colour of melamine polished complete with all fittings including door closures.

d) **Windows/Ventilators Shutters**

The frames of windows and ventilators in the station building shall be of powder coated aluminum (coating thickness 60-80 micron) with extruded built up standard tubular sections/ Z sections of approved make conforming to IS: 733 and IS:1285 fixed with dash fasteners of required dia and size with fully glazed shutters of 5 mm thick float glass provided with EPDM rubber/ neoprene gasket with complete fittings as per CPWD specifications Vol.-II.

e) **Door/Window fittings**:

These shall be chromium plated brass, of size and make as approved by the engineer.

4.4.2 Finishes

a) **Interior finish**

Two coats of 1st quality oil bound distemper of approved shade over POP coating to make the surface smooth. 3rd coat may be done before handing over of assets.

b) **Exterior finish**

Two coats of 1st quality cement paint of approved shade over POP coating to make the surface smooth. 3rd coat shall be done before handing over of assets.

4.4.3 Flooring and Dado

a) 1st quality 600x600mm vitrified floor tiles of minimum 10 mm thickness conforming to IS 13630-1993 of Kajaria, Nitco or similar make and shade as approved by Engineer laid over 20mm thick bed of cement and sand mortar 1:4 with neat cement slurry mixed with pigment to match the shades of tiles between joints and over the base in floors over 100mm thick CC M-10 over 100mm thick sand filling on well rammed and consolidated earth filling. On subsequent floors tiles shall be laid directly on mortar bed. Glazed tiles of suitable size (300mm x 300mm or 300mm x 450mm) and minimum 06mm thickness confirming to IS 13630-1993 of Kajaria, Nitco or similar make, quality and shade as approved by the Engineer to be provided on walls in dado up to 90cm height from floor level or up to the window sill. All the tiles to be laid with zero gap between them over 13mm thick cement mortar 1:3. as per Clause 11.15 & 11.16 of CPWD Specification Volume-I 2019.

b) Stairs-

Kota Stone 25 mm thick to be provided in risers, treads and landings of steps laid on with neat cement slurry mixed with pigment to match the shade of kota stone including rubbing polishing complete on 20mm thick cement and sand mortar 1:3 and 150 mm height skirting of same Kota Stone as per Clause 11.22 of CPWD Specification Volume-I 2019. . Kota stone provided on riser & tread of steps shall be minimum 1.8 m long & shall cover full height/width of the step. Exposed end of kota stone on treads shall be rounded to provide nosing. Kota stone tile at other places shall be of minimum 600 mm x 600 mm size. Stone at edges can be cut in smaller sizes to fill up the residual areas.

c) Toilets

Finished floor to be kept 25mm below the normal floor of the building. 300x300mm ceramic antiskid floor tiles of minimum 10 mm thickness conforming to IS 13630-1993 of Kajaria or similar make and shade as approved by Engineer laid over 20mm thick bed of cement and sand mortar 1:4 with neat cement slurry mixed with pigment to match the shade of tiles between joints and over the base in floors laid over 100mm thick CC M-10 over 100mm thick sand filling on well rammed and consolidated earth filling. Glazed tiles of suitable size (300mm x 300mm or 300mm x 450mm) and minimum 06mm thickness conforming to IS 13630-1993 of Kajaria or similar make, quality and shade as approved by the Engineer to be provided on walls for full height up to ceilings over 13mm thick cement mortar 1:3.Tiles shall be laid with zero gaps between them as per Clause 11.15 & 11.16 of CPWD Specification Volume-I 2019.

4.4.4 Ticketing Room

a) Booking Counter & Facia

Counters & facia to be made with Granite Top of 20mm thick on with neat cement slurry mixed with pigment to match the shade of Granite slab including rubbing polishing complete on 20mm thick cement and sand mortar 1:3 on RCC shelf as per approved design.

b) Flooring & Skirting

1st quality 600x600mm vitrified floor tiles of minimum 10 mm thickness conforming to IS 13630-1993 of Kajaria, Nitco or similar make and shade as approved by Engineer laid over 20mm thick bed of cement and sand mortar 1:4 with neat cement slurry mixed with pigment to match the shades of tiles between joints and over the base in floors over 100mm thick CC M-10 over 100mm thick sand filling on well rammed and consolidated earth filling. On subsequent floors tiles shall be laid directly on mortar bed. Glazed tiles of suitable size (300mm x 300mm or 300mm x 450mm) and minimum 06mm thickness confirming to IS 13630-1993 of Kajaria, Nitco or similar make, quality and shade as approved by the Engineer to be provided on walls in dado up to 90cm height from floor level or up to the window sill. All the tiles to be laid with zero gap between them over 13mm thick cement mortar 1:3. as per Clause 11.15 & 11.16 of CPWD Specification Volume-I 2019.

c) **Booking Window**

Booking window shall be of toughened sheet glass 10mm thick with a hole for intercommunications at suitable height above the countertop and a suitable gap between the partition and counter for collection of fare and issue of tickets, the partition being protected on the passenger side by aluminum grill of approved design.

d) **Ramp**

Slope of ramp shall not be steeper than 1:12. Width shall be sufficient to permit smooth movement of passengers and stainless steel railing (SS 304) shall be provided on both edges. Facilities provided shall be as per the provisions of "The persons with disabilities" (Equal opportunities protection of rights and full participation): Act 1995. Flooring of ramp shall be of Chequered terrazzo tile 22mm thick with graded marble chips size up to 6mm fixed with neat cement slurry mixed with pigment to match the shade of tile including rubbing polishing complete on 20mm thick cement sand mortar 1:4 over 100mm thick CC M-10 over 100mm thick sand filling on well rammed and consolidated earth filling as per Clause 11.12 & 11.13 of CPWD Specification Volume-I 2019.

e) **Portico**

At subway entrance a RCC portico 20 m wide and covering entire road width shall be provided as per approved drawing and Annexure-OCS-1 & OCS-2.

f) ***Elevated approach to Pachgaon station***

Elevated approach shall be fabricated as per Specification No. B-2 for Steel Structures (other than Girder Bridges)- Part 3. Flooring of *elevated approach* shall be of Chequered terrazzo tile 22mm thick with graded marble chips size up to 6mm fixed with neat cement slurry mixed with pigment to match the shade of tile including rubbing polishing complete on 20mm thick cement sand mortar 1:4 over 100mm thick CC M-10 over 100mm thick sand filling on well rammed and consolidated earth filling as per Clause 11.12 & 11.13 of CPWD Specification Volume-I 2019.

4.4.5 Subway & inter platform connectivity

a) **Flooring**

Kota stone 25 mm thick to be provided in flooring laid on with neat cement slurry mixed with pigment to match the shade of kota stone including rubbing polishing complete on 20mm thick cement and sand mortar 1:3 as per Clause 11.22 of CPWD Specification Volume-I 2019. Kota stone tile shall be of minimum 600 mm x 600 mm size. Stone at edges can be cut in smaller sizes to fill up the residual areas.

b) **Dado**

Glazed tiles of suitable size (300mm x 300mm or 300mm x 450mm) and minimum 06mm thickness confirming to IS 13630- 1993 of Kajaria, Nitco or similar make, quality and shade as approved by the Engineer to be provided on walls in dado up to 2.5 m height from floor level.

c) **Stairs & Ramps**

Kota Stone 25 mm thick to be provided in risers, treads and landings of steps laid on with neat cement slurry mixed with pigment to match the shade of kota stone including rubbing polishing complete on 20mm thick cement and sand mortar 1:3 and 150 mm height skirting of same Kota Stone as per Clause 11.22 of CPWD Specification Volume-I 2019. . Kota stone provided on riser & tread of steps shall be minimum 1.8 m long & shall cover full height/width of the step. Exposed end of kota stone on treads shall be rounded to provide nosing. Kota stone tile at other places shall be of minimum 600 mm x 600 mm size. Stone at edges can be cut in smaller sizes to fill up the residual areas.

d) **Railing**

Assembly and erection as per approved drawing on stairs, ramp & subway of Stainless steel of material grade SS 304 as per CPWD specification Vol.-1 2019.

e) **Covering for Stairs & Ramp**

Self supported roofing system of colour coated Galvalume sheet shall be provided as approved by the Engineer. Material shall be of following specification, BMT 0.90mm to 1.00mm, APT 0.95mm Tolerance +/- 0.02mm thick, 605 mm width or as approved by the Engineer (Tolerance +/- 2mm.

The roofing system shall be without trusses, purlins or any ancillary support and shall be designed by the contractor and shall be got proof checked at his own cost from Govt. approved agencies.

f) **Waterproofing of Subway**

1) Waterproofing of subway shall be carried out by a manufacturer having minimum 10 years of experience in manufacturing waterproofing product of the type specified, able to provide test report showing compliance with the specifications, and able to provide on -site technical representation to advise on installation.

2) The installation shall be carried out either by the manufacturer or his approved applicator having experience of minimum 05 years in application of waterproofing products in underground structures. The waterproofing shall be carried out by manufacturer's applicators strictly in accordance with the recommendation of the manufacturer.

3) All components and elements, which are required to make the structures watertight, shall be demonstratable and proven to work together. There shall be a single source of responsibility and performance of the material and products. Specifically, material and water stops shall be manufactured out of virgin raw material and only form the same formulation of raw material. The manufacturer shall confirm full, demonstratable and proven compatibility of the entire waterproofing system in writing. The waterproofing system provided shall be installed without damage and protected against construction operations. The contractor shall carry out a trial application of the waterproofing and submit the report containing the details and method statement to obtain approval from the Engineer.

4) The waterproofing shall be provided on outside side of vertical walls and top slab.

5) Waterproofing scheme

i. Outside of vertical walls and top slab shall be provided with spray applied liquid coating of minimum thickness 2.0 mm as per IS 16471 (Type A).

ii. Construction joints in vertical walls shall be provided with PVC water stops as per IS 16471 (Type B).

iii. Use of waterproofing admixture to the concrete of slabs and walls of subway

6) Spray applied liquid coating on external side of vertical walls and top slab

i. System and properties of materials

Fully bonded spray-applied liquid polymer two component, solvent free, hybrid polyurea polyurethane/ polyurea/ polyurethane applied elastomeric seamless membrane of minimum 2 mm Dry Film Thickness (DFT) shall be used. DFT shall be achieved in minimum 2 coats (of two different contrasting colors), over and above one coat of a solvent free two component epoxy primer which shall be compatible with the liquid polymer and from the same manufacturer. No sand broadcast layer is permitted in the system. The system must be such that it is thixotropic, can be applied by airless spray; as well as the same product shall be capable of being applied manually only for local detailing and patch repairs

(maximum area 1 m^2). The product shall be applied in accordance with the manufacturer's instructions.

ii. The waterproofing membrane shall have following minimum properties:
   a. Tensil strength> 15MPa as per ASTM D 412.
   b. % Elongation>300% as per ASTM D 412.
   c. Bond strength on concrete > 2 MPa as per ASTM D 7234.
   d. Minimum crack bridging capability of over 2.0 mm.
   e. Specific Gravity of 1.15 (+/-10%)

iii. Code and standards for reference:

Code and standard Number	Code and Standard Title
ASTM D 412	Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers - Tension
ASTM D 7234	Standard Test Methods for Pull-off Adhesion Strength of Coating on concrete Using portable Pull – off Adhesin Testers.

iv. Inspection

The thickness of spray applied liquid coating waterproofing membrane shall be checked for every 20 m^2 area of water proofing. The thickness at the point of checking shall not be less than 2 mm.

7) Construction joints in vertical walls

i. The contractor shall construct his concrete works so as to minimize the likelihood of water penetration.

ii. Before placing new concrete against concrete that has already hardened, the face of the old concrete shall be treated in accordance with manufacturer's recommendation.

iii. Inside rendering shall not be accepted as a method of making joints watertight.

iv. Water stops shall be of PVC strips. The water stops shall be installed so that they are securely held in their correct positions whilst the concrete is being placed. No holes shall be made through any water stop except were provided for by the manufacturer. Water stops shall be provided as per manufacturer recommendations. The contractor shall submit the method statement for providing water stops to the Engineer for approval.

8) Use of waterproofing admixtures in concrete of slabs and vertical walls of subway

Waterproofing admixtures shall be used in conjunction with other waterproofing components supplied by the same manufacturer, for example, water stops, achieve watertight structures.

9) Surface preparation

Waterproofing work shall commence only after obtaining approval from the Engineer. Application of waterproofing system shall only commence upon the completion of curing of concrete. All cracks on the exposed concrete surfaces of external structural members shall be effectively sealed before applying any waterproofing system. The Contractor shall ensure that surfaces to which waterproofing is to be applied, shall be clean, dust-free and dry and shall be prepared fully in accordance with the manufacturer's recommendation. The waterproofing shall be carried out by the manufacturer's applicators strictly in accordance with the recommendations of the manufacturer and with accepted best practice in the trade.

4.4.6 Platform Covering

a) **Main Platform Shelter**

Main Platforms Shelters shall be fabricated from rolled steel sections conforming to IS:2062/4923. Roof shelter shall have arrangement for collection and safe outlet of rainwater. Shelter roofing shall be of aluminum sheet of 0.9 mm thickness.

b) **Mini Shelter**

All mini shelter shall be with seating capacity of 6 passenger as shown in tender drawing. Roofing with 6MM thick multiwall translucent Polycarbonate sheet both side UV protected make in curved shape as shown in tender drawing.

c) **Shelter Flooring**

VDC flooring shall be provided under PF shelter as per Sub-Clause 4.4.7 of these specifications.

4.4.7 Platform Surfacing-

a) **VDC Flooring**

100mm thick fiber reinforced Vacuum Dewatered Concrete (VDC) flooring of grade M25 of stone aggregate 20 mm and downsize laid as specified in CAMTECH/2021/C/VDF/1.0 2021 of RDSO publication over 100mm thick CC M-10 over 100mm thick fine sand filling over well rammed and consolidated earth

filling.

The area to be paved with VDC should be divided into suitable panels by fixing screed strips. The depth of screed strips should be equal to the combined thickness of base concrete and topping. Generally, no dimension of panel shall exceed 4 m in case of floor finish laid monolithically with the base concrete and 2m in case finish laid separately on a hardened base. Length of panel shall not exceed 1.5 times its breadth. Reinforcement shall be provided as per design. Before placement of base concrete sub-base shall be properly wetted.

Tactile path shall be provided at 1.8 m from the coping edge along the entire length of platform and at entrance & exit points of platform to station as per direction of the Engineer. Tactile floor tile shall have a minimum thickness of 10 mm excluding the flat top blister like domes or flat topped bars and shall conform to IS 4457 and IS 15622 and "Handbook for barrier free accessibility"-CPWD.

Note: The position of trenches and pipes for services such as water, drainage, electric, S&T etc. must be fixed before floor concreting starts.

b) **Platform slope**

For End platform cross slope of 1 in 60 to be provided away from the track while on island platform cross slope 1 in 60 to be provided from center of track towards the end of coping/Track side.

c) **Joints**

At panel interfaces groove of about 3-5 mm wide shall be cut in top surface in both lateral & longitudinal direction for prevention of cracks as per instruction of the Engineer. These grooves shall be filled with suitable sealant.

4.4.8 Water Booth-

a) **Water Booth Platform**

Granite Stone cladding with Granite Top of 20mm thick on with neat cement slurry mixed with pigment to match the shade of Granite including rubbing polishing complete on 20mm thick cement and sand mortar 1:3.

b) **Drainage & its covering-**

On island platform an underground drain of 125 -150 mm dia with manhole at suitable interval shall be provided to safely carry the effluent from water booths, PF shelters, toilets etc and on end platform underground/open drain with removable MS grating cover shall be provided on the far end of the platform as shown in the tender drawings.

c) **Duct For Utilities-** ***HDPE pipes for Electrical and S&T***

These pipes shall be provided by the side of the drains. HDPE pipes shall conform to IS 4984.

d) **Taps**

Self-closing Taps with CP Brass/PTMT bib cock provided with quarter turn ceramic cartridges.

Miscellaneous items shall be as given below-

Item No.	Description of items	Material Spec.
1.	Orissa WC Pan (Indian Style) with low level dual flushing ceramic cistern	Ceramic
2-	European Type Wall Hung/Floor Mounted WC with seat, lid and low level dual flushing ceramic Cistern	Ceramic
3-	Water Jet/Health Faucet with European WC	CP Brass
4-	Ceramic Wash Basin with CP brass pillar Tap / with Quarter Turns Ceramic Cartridges.	Ceramic
5-	Tap (Toilet, Bath & WC) CP Brass/ bib cock provided with quarter turn ceramic cartridges	CP Brass
6-	Mirror (600 x 450mm) with each wash basin with PTMT glass shelf	PTMT
7-	Towel rail	CP Brass
8-	Soap Rack for each wash basin	CP Brass

4.4.9 Waterproofing Application

Waterproofing materials shall be installed only by the manufacturer of the products or his approved applicator.

Application of waterproofing system shall only commence upon completion of curing of the concrete. The contractor shall ensure that surfaces to which waterproofing is to be applied shall be clean, dust free and dry and shall be prepared fully in accordance with the manufacturer's recommendation.

All cracks on exposed surfaces of external structural members shall be effectively sealed in accordance with the relevant clauses of the M & W specification before applying any waterproofing system. Inside rendering shall not be accepted as a method of making the joint watertight.

The Engineer may require the Contractor to carry out a trial application of the waterproofing materials for the proposed waterproofing system. No waterproofing works shall commence without the written consent of the Engineer. In case of liquid applied polymer membrane applied to roof slabs, the membrane shall be protected with 25mm thick extruded polystyrene boards, which shall be spot bonded to the membrane. A 6-mill polyethylene separating membrane. shall then be laid before covering with a protective concrete slab of lean concrete mix of minimum 75mm thickness.

Where the roof slab has been cast against a diaphragm or other face, the protective slab shall be provided with an up stand at the perimeter to provide a minimum 75mm concrete protection over the turned-up membrane. This is to ensure that the membrane termination is protected from damage or dislodging prior to backfill. Damaged or non-compliant sections of membrane shall be repaired in accordance with the manufacturer's recommendations and as accepted by the Engineer.

WATERPROOFING AT CONSTRUCTION JOINTS

Construction joints are to be constructed as follows

a. *All construction joints in external slab and wall will be provided with PVC water stop located at the center of the element.*
b. *In the top surface of base and roof slabs at junction with diaphragm walls, a 25x25mmrecess will be cast in the slab and subsequently filled with a high performance water stop grout of the crystalline growth type.*
c. *All construction joints in external slab and walls will be cast with a25x25 recess on the outer face (expect the base slab where it will be provided on the upper face). The recess will be filled with a high performance water stop grout of the crystalline growth type.*
d. *All construction details and material are to be submitted to the Engineer for the approval.*

4.4.10 WATERPROOFING TO BASE SLAB OF UNDERGROUND STRUCTURES

a. *General*

Concrete waterproofing admixture shall of the crystalline growth type. The admixture shall have a proven track record of successful application in similar conditions.

This admixture shall be applied to the full thickness of the base slab and extend to the sidewall of sumps and similar depression of the base slab to form a continuous water light surface.

b. *Trials*

Prior to construction, trial mixes are to be conducted under the supervision of the Engineer or his Representative and with the manufacturer present to confirm that the proposed mix conforms to strength, w/c ratio, slump, and other requirements. The trial mix concrete shall further have an average water permeability coefficient when tested at 28 days of not greater than 5x10-13 m/s under 5kgf/cm2 and an average penetration depth not greater than 15mm as measured by DIN 1048 Part 5:1991.

4.4.11 WATERPROOFING TO ROOF SLABS

The spray applied liquid polymer membrane shall be suitable for use in an ambient temperature range not greater than 40°C. It shall allow diffusion of water vapors to prevent any buildup of pressure between the membrane and substrate. The membrane shall meet or surpass the following requirements: -

Total membrane thickness	*2.5mm minimum dry film thickness and sprayed in a minimum of two coats of contrasting colors, with the second coat applied to the first coat only after the first coat has cured.*
Tensile strength	*4.0MPa minimum in any of the three orthogonal planes of the membrane*
Membrane elongation at break	*130% minimum*
Peal adhesion to concrete (ASTMD4541)	*2.0MPa minimum*
Static crack bridging (tested to recognized international standard acceptable to the Engineer)	*2mm minimum*

The cured membrane shall be chemically resistant to the effects of hydraulic fluids, diesel fuel and diluted mineral acids etc.

The substrate shall be prepared and primed in strict accordance with the manufacturer's recommendations and requirements. The membrane shall be of a thixotropic nature and cold applied to ensure consistent thickness is achieved over all substrate irregularities.
The materials used must be based upon resin systems that do not react with moisture although the substrate should be dry during application.
The liquid polymer membrane shall be continued 1 meter down the vertical side of the roof slab where the roof is cast by bottom up sequence.
All components of waterproofing system shall be provided by one manufacturer. All materials must be supplied to site in unopened packaging, with batch numbers marked and corresponding manufacturer's certificates of conformity and must be used within the product's shelf life. All components of the system exposed to rain within the curing period shall be replaced unless agreed otherwise by the Engineer.
The membrane wet film thickness should be checked every 10 square meters during application of of each layer, using a pin or comb gauge. Destructive testing to measure dry film thickness shall be carried out on the cured membrane at every 100 square meters or at every working shift, whichever occurs sooner, and shall be made good to the satisfaction of the Engineer.
Tests to the acceptance of the Engineer shall be carried out on the cured membrane to identify any discontinuities in the membrane and to prove the integrity of the membrane.

DIAPHRAGM WALLS

4.4.12 *All leaks in the diaphragm wall shall be sealed. At the junction with the base slab and roof slab as a minimum 25x25 recesses filled with water stop grout*

Chapter 5. STATION- PLUMBING AND FIRE FIGHTING

5.1 Water Supply and Plumbing Works

5.1.1 Applicable Standards

The Contractor shall ensure the compliance to the following codes and standards:

IS 458: 2003	Specification for Precast Concrete Pipe
IS 783: 1985	Code of Practice for Laying of Concrete Pipes
IS 1172: 1993	Code of Basic Requirements for Water Supply, Drainage & Sanitation
IS 1239 (Part-1):2004	Steel Tubes, Tubulars and Other Wrought Steel– 2004 Fittings, Part 1: Steel Tubes
IS 1239 (Part-2):2011	Steel Tubes, Tubulars and Other Steel Fittings– 2011, Part 2: Steel Pipe Fittings
IS 1726: 1991	Specification for Cast Iron Manhole Covers & Frames
IS 3624: 1987	Specification for Pressure and Vacuum Gauges
IS 4984: 1995	Specification for Water Supply HDPE pipes
IS 7634 (Part 2): 2012	Specification of Installation for Water Supply HDPE Pipes
IS 8110:2000	Well screens and slotted Pipes.
IS 8329: 2000	Centrifugally Cast (spun) Ductile Iron Pressure Pipes for Water, Gas and Sewage
IS: 9439:2002	Glossary of terms used in Water-well drilling technology.
IS 9523: 2000	Ductile Iron Fittings for Pressure Pipes for Water, Gas and Sewage
IS:11189: 1985	Method of Tubewell Development
IS 12288: 1987	Specification for Laying Ductile Iron Pipes
IS:12818: 2010	Unplasticized polyvinyl chloride (PVC-U) Screen and casing pipes for Borewell/tubewell specification
IS 16098 (Part-2) :2013	Structured-wall Plastics Piping Systems for Non-Pressure Drainage and Sewerage
BIS - SP (QAWSM) 56: 1994	Location, operation and Maintenance of tube/bore wells - Guidelines

5.1.2 Storage Tanks for Water Supply

Storage tanks for water supply shall be constructed in accordance with IS 3370 (Part 1 & Part 2) and as per drawings approved by the Engineer.

5.2 Plumbing and Firefighting

5.2.1 General

a) General Requirements

i. The workmanship shall be as per best industrial practices and shall conform to the specifications and Indian Standard Specifications in every respect and shall be as approved by the Engineer.

ii. All relevant certificates shall be submitted by the Contractor to show that the materials comply with the requirements and technical data specified in this document. The Engineer may require additional testing of materials to verify the compliance as per specifications for which the costs shall be borne by the Contractor.

b) Testing and Commissioning

i. Hydrostatic Pressure Testing of Pressure Pipes

ii. All pressurized pipelines shall be tested as specified in Sub-Clause 4.15, Part 9, Section 1 of NBC 2016.

iii. Testing of Non-Pressure Pipes

iv. All non-pressure pipelines shall be tested as specified in Sub-Clause 6.4.4.3 of 'Manual on Water Supply and Treatment", CPHEEO.

c) Flushing

The Contractor shall be responsible to check that the water pipework is flushed and chemically cleaned against unwanted substances. Contamination may occur during storage of materials, due to surface oxides and mill scale, or the application of protective grease and oils. During the installation period, the pipework can become further contaminated by construction material debris such as welding and jointing materials, swarf and dust. The Contractor responsible for installing the system shall ensure that care is taken to limit the amount of dirt entering the system during installation.

d) Site Acceptance Test, Commissioning and Inspection

i. The Contractor shall submit the schedule and Method Statements for testing and commissioning of all plumbing & fire-fighting equipment, materials, goods and systems to the Engineer, as soon as possible after the award of the Contract. Tests shall be conducted in the presence of the Engineer to his satisfaction. The Contractor shall submit these to obtain approval from the Engineer.

ii. The Contractor is responsible to ensure that all testing equipment, materials and personnel are available at the appropriate time for testing. The Contractor shall prepare forms to record all test procedures and results for the review of the Engineer. These forms shall constitute a record of testing and they are aimed for assisting the

Engineer in giving his review of operations, performances and functions for equipment, materials, goods and systems.

iii. During the installation phase of the project, the Contractor shall carry out initial testing and pre-commissioning of all plumbing and fire-fighting services and systems, followed by final commissioning. This shall include the pressure testing, flushing and cleaning of pipework,

iv. Method Statements shall be submitted for review to the Engineer allowing enough time for review, comment and re-issue.

v. The Contractor shall be responsible to take date stamped photographic records of testing and commissioning; in case the Engineer is unavailable to attend a test demonstration. These shall be produced by the Contractor and submitted to the Engineer along with testing and commissioning records for review or request to re-demonstrate.

5.2.2 Plumbing

a) Qualification

The plumbing works shall be carried out by the plumbing sub-contractor / plumber who holds a valid plumbing license issued by the Municipal authority or other competent authority as per Clause 3.3 under Section-2 Part -IX of NBC-2016. The Contractor shall keep constant liaison with all relevant authorities and shall be responsible for obtaining all approvals related to water supply, sewerage and drainage system. He shall also be responsible for co-ordination with other Interfacing Contractors.

b) Materials

i. Piping Materials

All materials shall comply with the following specifications, unless otherwise specified. If after tests, any materials, work or portions or work are found defective, the Contractor shall remove the defective material from the site, pull down and re-execute the works at his own cost to the satisfaction of the Engineer. To prove that the materials used are as specified, the Contractor shall furnish the Engineer with original invoice on demand.

1) Water supply pipes

Pipes for water supply shall be as follows –

(A) Ductile Iron (DI) shall conform to IS 8329 and fittings to IS: 9523. All pipe joints shall be with couplers or jointing fixtures as per respective IS codes and manufacturers recommendations

(B) HDPE pipes shall conform to IS 4984.

(C) GI pipes shall conform to IS 1239.

2) Sewage and drainage pipes

Sewage and drainage pipes shall be as follows –

(A) Non pressure HDPE pipes shall conform to IS 16098 Type B. Typical classification of pipes shall be double wall corrugated (DWC)SN8.

(B) RCC pipes shall be socket & spigot centrifugally spun conforming to IS 458 of NP-3 Class.

ii. Water supply pipeline

The Contractor shall install all piping and fittings in their final position in accordance with approved trial assemblies and as per drawings that have been approved by the Engineer. The installation shall be done as per CPHEEO/CPWD/IS specifications

1) DI pipes shall be laid as per IS 12288.

2) HDPE pipes shall be laid as per IS 7634 Part 2.

3) GI pipes

iii. Sewer and drainage pipeline

1) Structured wall plastic piping system shall be laid as per IS 16098.

2) Concrete pipes shall be laid as per IS 783.

3) Soil, waste water and drainage pipes from buildings shall be connected with sewerage and drainage systems through manholes to be constructed by the Contractor.

iv. Manholes

1) Manholes shall be constructed as specified in Sub-Clause 4.4.10 under Part-9, Section-2 of NBC-2016.

2) Manholes shall be provided with cast iron covers and frames embedded in RCC slab or SFRC precast concrete covers as per drawing approved by the Engineer.

v. Disinfection of Storage Tanks

The Contractor shall arrange to disinfect the water storage tanks before commissioning. The water storage tanks shall first be filled with water and thoroughly flushed out. The storage tanks shall then be filled with water again and disinfecting chemical containing chlorine added gradually while tanks are being filled to ensure thorough mixing. Adequate amount of chlorine shall be used to give water a dose of 50 parts of chlorine to one million parts of water

5.2.3 Sourcing of water

i. Borewells

1) Location of bore-well shall be proposed by the Contractor for the Engineer's approval.

2) The Contractor shall provide borewells including borewell room, pumps,

pipeline and electric wire rope hoist for lifting and lowering of pumps as per drawings approved by the Engineer. The Contractor shall provide pipe line with valves, fittings and accessories from borewell to storage tank as shown in the drawings. The well screen and slotted pipe shall conform to IS 8110 Type D. Material of wire of screens shall be stainless steel (SS) of designation XO4Cr18Ni10 of IS 6528. The housing and casing pipe shall conform to IS 4270 or IS 12818. Borewell shall be provided with sluice valve, pressure gauge, non-return valve and flow meter. Borewell shall be constructed and tested as per IS 2800 Part 1 and Part 2. The Contractor shall furnish information after completion of the borewell as per IS 2800 Part 2 to the Engineer for approval. Provisions of IS:SP(QAWSM) 56 shall be followed for ground water exploration, siting, construction and development of borewell.

5.2.4 Storage tanks for water supply

The Contractor shall construct underground and overhead water storage tanks as per the drawings approved by the Engineer.

5.2.5 Water **Supply** distribution system

The Contractor shall provide water supply distribution system including piping, pumping, valves and fittings to the required gradients and profiles as the drawings approved by the Engineer. The Contractor shall follow provisions of "Manual on Water Supply and Treatment" published by the Central Public Health and Environment Engineering Organization, Ministry of Urban Development, Govt. of India, (CPHEEO), CPWD Specifications (Vol. 2) and NBC 2016 for carrying out and testing the works of water supply distribution system.

5.2.6 Yard Drainage System

The Contractor shall provide yard drainage as per the drawings approved by the Engineer. The Contractor shall follow provisions of "Manual on Storm Water Drainage Systems" published by CPHEEO, CPWD Specifications (Vol. 2) and NBC 2016 for carrying out the works of yard drainage system.

5.2.7 Sewage Disposal System

The Contractor shall provide sewage disposal as per the drawings approved by the Engineer. The Contractor shall follow provisions of "Manual on Sewerage and Sewage Treatment Systems" published by CPHEEO, IS SP-35 "Handbook on Water Supply and Drainage" and NBC 2016 for carrying out and testing the works of sewage disposal system.

5.2.8 Rainwater Harvesting System

The Contractor shall provide rainwater harvesting system as per the Tender drawings. The Contractor shall generally follow provisions of "Manual for Rainwater Harvesting and Conservation" (CPWD), IS: 15792 (Guidelines for artificial recharge to ground water) and guidelines issued by CGWB and local authorities

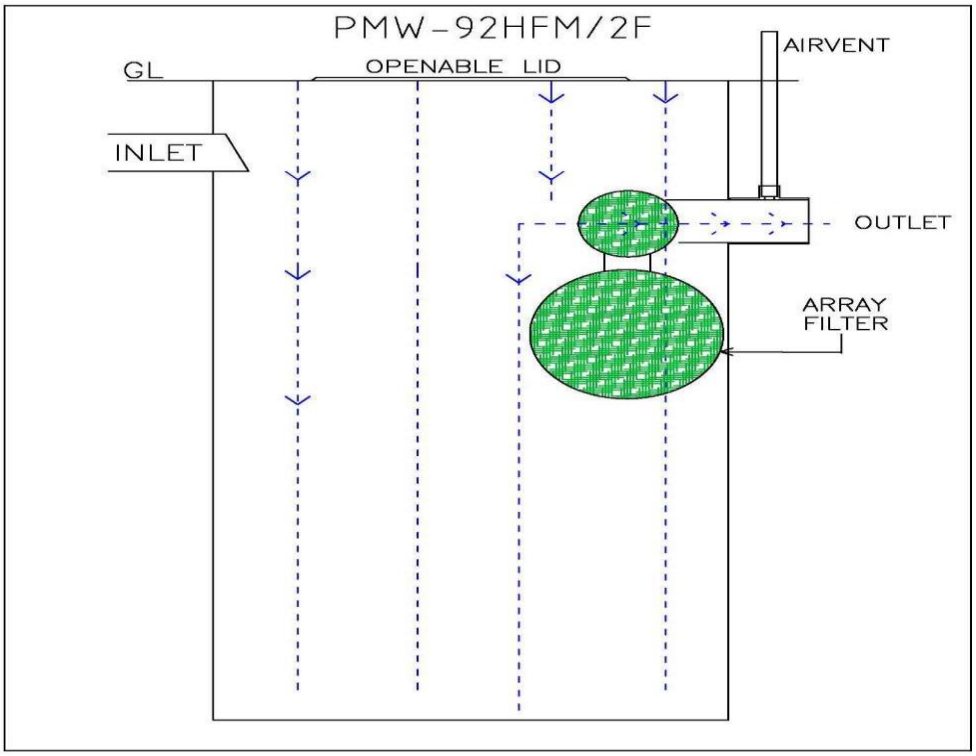
5.2.8.1 Construction of Rainwater Harvesting System for Railway Station Platform:

The Contractor shall carryout survey, hydrological investigations for construction of recharge well, submission and approval of working drawings including all layout sections, typical details, working drawings, As-built drawings & implementation schedule. Rainwater harvesting system to be constructed at stations will consist of:

i. Collection Chamber
ii. Horizontal filtration Module (**HFM**)
iii. Sand filtration Module (**SFM**),
iv. Holding tank Module **(HT**)
v. Recharge well.

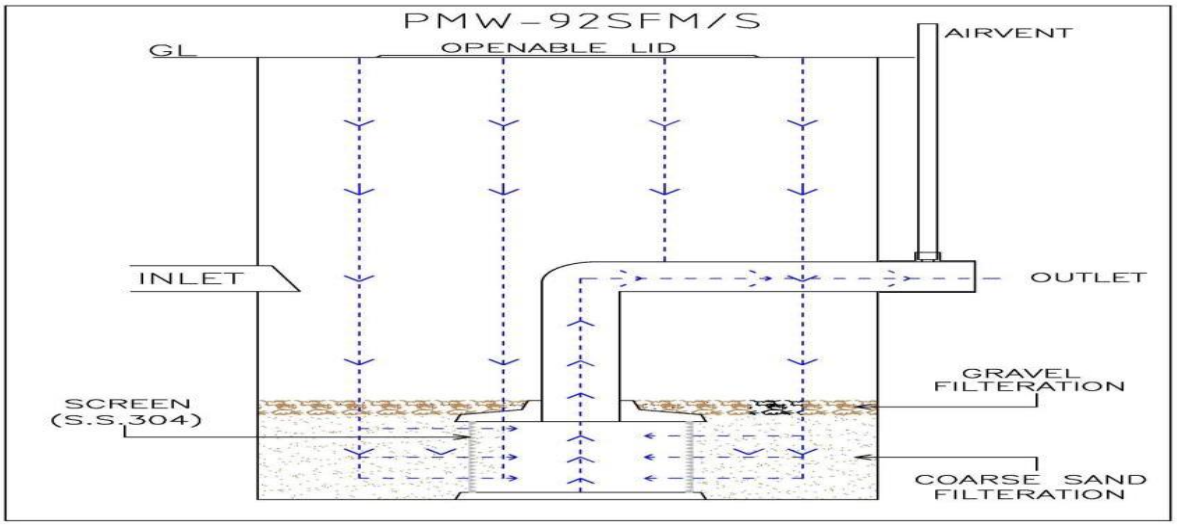
(a) **Collection Chamber**: Collection chamber shall be square in shape (600 mm x 600 mm) having 600 mm depth and 150 mm diameter as shown in Tender drawings.

(b) **Horizontal Filtration Module (HFM)**: This module shall capture sediments primarily from surface runoff water. It shall be octagonal shaped` M-25 grade cement concrete module having circumscribing diameter and height of 918 mm and 1614 mm respectively. The module will consist of 2 Nos. removable Array filters shall be able to be cleaned within or outside the module using pressurised water. Total filtration area will be approximately 3000 cm^2 and filtration capacity will be $8m^3$ to $10m^3$ per hour. The inlet and outlet will be 110mm dia uPVC pipes connected with sand Filtration module.

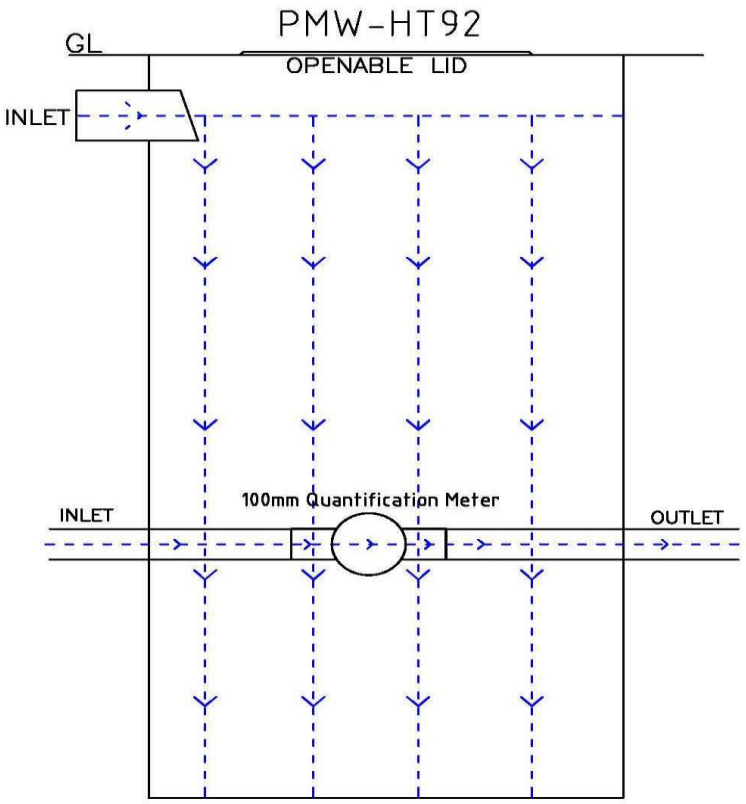


PMW-Precast modular step well

(c) **Sand Filtration Module (SFM)**: This will be octagonal shaped M-25 grade cement concrete module having circumscribing diameter and height of 1000 mm and 1614 mm respectively with SS 304 screen and natural filters. This module will be fixed below ground level. Filtration capacity of the module will be $8m^3$ to $10m^3$ per hour. The inlet and outlet of the system will be 90 mm dia uPVC pipes. The module will hold a filter media in the form of sand bed around a continuous slot fine aperture stainless screen (420 mm diameter and 240 or 300 mm length). Screen will be fixed to the bottom slab and fully covered by 0.10 m^3 filtration sand with 40 mm graded gravels. Screen will create entry points for the filtered water. The filtered water will be finally connected to holding tank module.

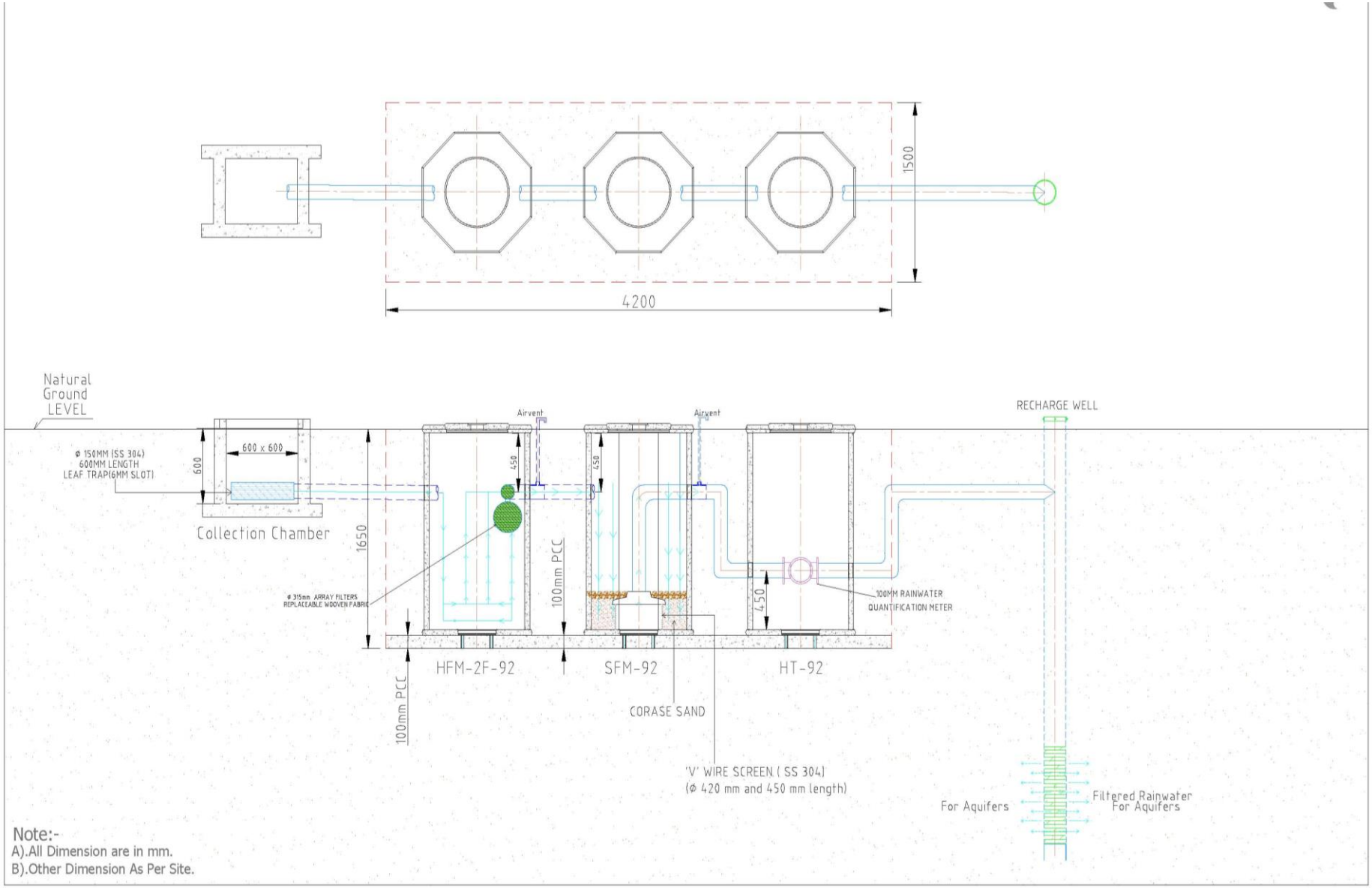


(d) **Holding Tank Module (HT)**: This shall be octagonal shaped M-25 module having circumscribing diameter and height of 918 mm and 1614 mm respectively. Each precast slab (1500 mm x 330 mm x 40 mm thick) will be held together between two horizontal pre cast octagonal slabs (with 1500 mm edge length, 50 mm thick and hole of 110 mm diameter in the centre). The top surface of well will be flushed with ground level. The module will be connected with 100 mm quantification meter fixed at bottom or middle of module.



(e) **Recharge Well**: For recharge well, the Contractor will follow the following specifications:

i. Drilling with suitable rig having 14"/16" dia bore size in all kind of strata except hard rock.
ii. Supply & fixing of 8" UPVC Plain Pipe & Slotted Pipe of Astral/Apollo/Duke Make. (IS 12818)
iii. Lowering of 8" UPVC Plain & Slotted Pipe of Astral/Apollo/Duke Make.(IS 12818)
iv. Supply of sorted gravel including loading /unloading (Filling of bore hole by gravel surrounding 200mm pipe)
v. Supply of sand (Filling of bore hole by river sand surrounding 200mm pipe) -if required .
vi. Development of tube well for each water bearing zone through air compressor.
vii. Providing & fixing of Recharge well pipes Fittings like bail plug, cap, etc.


1500
4200
Natural Ground LEVEL
Ø 150MM (SS 304) 600MM LENGTH LEAF TRAP(6MM SLOT)
600 x 600
600
Collection Chamber
1650
Airvent
Airvent
450
450
100mm PCC
Ø 315mm ARRAY FILTERS REPLACEABLE WOOVEN FABRIC
100MM RAINWATER QUANTIFICATION METER
450
HFM-2F-92
SFM-92
HT-92
100mm PCC
CORASE SAND
'V' WIRE SCREEN (SS 304) (Ø 420 mm and 450 mm length)
RECHARGE WELL
For Aquifers
Filtered Rainwater For Aquifers
Note:-
A).All Dimension are in mm.
B).Other Dimension As Per Site.

5.3 Firefighting System

5.3.1 Handheld Fire Extinguishers

The firefighting extinguishers works shall consist of the following:

i. Distribution or installation of fire extinguisher shall be in accordance with IS 2190 or IS 15683.

ii. Hand appliances shall be installed in easily accessible locations with the brackets fixed to the wall by suitable anchor fasteners by skilled workmen.

iii. Each appliance shall be provided with an inspection card indicating the date of inspection, testing, change of charge and other relevant data.

iv. The extinguishers shall be treated for anti-corrosion internally and externally and painted with fire red paint. The paint shall be stove enamelled.

v. The description of extinguishers shall be marked with 2.5cm height in block letters within a triangle of 5cm each side.

vi. Fire extinguishers shall be counted in numbers and shall include installation of all necessary items required as given in the specifications.

5.3.2 Clean Agent Extinguisher

i. Clean agent type fire extinguishers i.e. stainless-steel body made shall be placed as per approved drawing.

ii. Clean agent fire extinguishers capacities as per city chief fire officer's recommendations & other suggestions shall be followed as per IS 15683.

iii. Clean agent extinguishers shall cover A, B & C type fire.

5.3.3 Dry Chemical Powder Extinguisher

i. The extinguisher shall be filled with grade 40 Mono Ammonium Phosphate (40%) from any approved manufacturer.

ii. The capacity of the extinguisher when filled with dry chemical powder as first filling as per IS 4308, Part II shall be 5 Kg ±2% or 10 Kg ±3%.

It shall be operated upright with a squeeze grip valve to control discharge. The plunger neck shall have a safety clip fitted with a pin to prevent

accidental discharge. It shall be pressurised with dry nitrogen as expellant and shall be charged at a pressure of 15 Kg/cm^2.

5.3.4 Water Type Extinguisher (Gas Pressure Type)

i. The extinguishing medium shall be primarily water stored under normal pressure, and the discharge shall be by release of carbon dioxide gas from a cylinder.

ii. The capacity of extinguisher when filled up to the indicated level, shall be 9L±5%.

5.3.5 Mechanical Foam Type Fire Extinguisher

Mechanical foam fire extinguisher suitable for Class A and Class B fire shall be used for fire extinguishing. Foam being an effective smothering agent is used for liquid fires mainly. It shall react by flowing over the liquid fuel oil surface and isolating the fire from the air and shall also prevent re-ignition due to the foam stability.

Chapter 6. ROADWORK

6.1 CONTROL OF TRAFFIC

The contractor shall take all necessary precautions in co-ordination with and to the requirements of all the competent authorities concerned to protect the work from damage until such time as the seal coat or surface treatment has developed sufficient strength to carry normal traffic without any damage to it.

The new work shall be opened to traffic only after it is authorised by the Engineer.

The contractor shall submit a detailed traffic diversion/or control and regulation plan taking all safety measures during the course of work permitted by the concerned authorities to the Engineer for his consent before start of work.

The contractor shall take all precautions to avoid or minimise delays and inconvenience to road users during the course of the work. Where adequate detours or side tracks are available, traffic shall be temporarily diverted while the work is in progress depending on volume of traffic and subject to approval by Traffic Police. Adequate signs, signals, barriers and lamps for the warning and guidance of traffic shall be provided at all times during the course of the work till it is opened to traffic.

The Contractor shall take all reasonable precautions to protect traffic against accident, damage or disfigurement by construction equipment, tools, and materials, splashes and smirches of bitumen/ bituminous material or any other construction materials and shall be responsible for any claims arising from such damage or disfigurement.

Traffic signs erected shall be in accordance with the IRC Standards and/or as prescribed and approved by the Traffic Police Department.

6.2 GRANULAR SUB-BASE (NON-BITUMINOUS)

This work shall consist of laying and compacting well-graded material on prepared subgrade in accordance with the requirements of these specifications or as per MORTH standards. The material shall be laid in one or more layers according to lines, grades and cross-sections shown on the drawings.

6.2.1 Material

The Material to be used for the work shall be natural sand, moorum, gravel, crushed stone, or combination thereof depending upon the grading specified in MORTH specifications for Roads and Bridges. The material shall be free from organic or other deleterious constituents.

6.2.2 Physical requirements

The material shall have a 10 percent fines value of 50 KN or more (for sample in soaked condition) when tested in compliance with BS:812 (Part III). The water absorption value of the coarse aggregate shall be determined by IS:2386 (Part 3); if this value is greater than 2 percent, the soundness test shall be carried out on the material delivered to site as per IS:383. CBR Value shall be determined at the density and moisture content likely to be developed in equilibrium conditions which shall be taken as being the density relating to a uniform air voids content of 5 percent.

Table 6.2.1: Grading for Close-Graded Granular Sub-base Material

S.N.	IS Sieve Designation	Percentage by weight passing the IS Sieve		
		Grading I	Grading II	Grading III
1	75.0 mm	100	-	-
2	53.0 mm	80-100	100	-
3	26.5 mm	55-90	70-100	100
4	9.5 mm	36-65	50-80	65-95
5	4.75 mm	25-55	40-65	50-80
6	2.36 mm	20-40	30-50	40-65
7	0.425 mm	10-25	15-25	20-35
8	0.075	3-10	3-10	3-10
9	CBR Value (Minimum)	30	25	20

Note- Material passing 0.425 mm sieve for all the three gradings when tested according to IS:2720 (Part 5) shall have liquid limit and plasticity index not more than 25 and 6 percent respectively.

6.2.3 Strength of sub-base

It shall be ensured prior to actual execution that the material to be used in the sub-base satisfies the requirements of CBR and other physical requirements when compacted and finished.

6.2.4 Construction Operations

(i) Preparation of sub-grade

Immediately prior to the laying of sub-base, the sub-grade already finished or existing surface shall be prepared by removing all vegetation and other extraneous matter, lightly sprinkled with water if necessary and rolled with two passes of 80 – 100 KN smooth wheeled roller. Damage to the subgrade shall be made good before sub base is laid.

(ii) Spreading and compacting

The approved sub-base material shall be spread on the prepared sub-grade by a grader of suitable type and adequate capacity.

When the sub-base material consists of combination of materials, mixing shall be done mechanically by the mix-in-place method.

The equipment used for mix-in-place construction shall be approved equipment capable of mixing the material to the desired degree.

Moisture contents of the loose material at the time of compaction shall be checked in accordance with IS: 2720 (Part 7) and suitably adjusted.

Rolling procedure shall be as described under relevant Subsection except stated herein.

Rolling shall be continued till the density achieved is at least 98% of the maximum dry density for the material determined as per IS:2720 (Part 8).

6.3 WATER-BOUND MACADAM SUB-BASE/ BASE (NON-BITUMINOUS)

6.3.1 Description

The work shall consist of furnishing, placing, watering and compacting sub-base material mechanically interlocked by rolling and bounded together with screening and/ or binding material to the required degree on a prepared sub-grade/ sub-base or the existing surface as the case may be in accordance with these Specifications, and to the lines, levels, grades, dimensions and cross sections as shown on Drawings and/ or required by the Engineer.

6.3.2 Materials

a) Coarse aggregate

The coarse aggregates shall be hard and durable crushed stones, free from deleterious matter conforming to one of the gradings as set forth in Table 6.3.1, the physical requirements given in Table 6.3.2 subject to the Engineer's consent.

Table 6.3.1 Grading requirements of coarse aggregates

Grading	Size Range	IS Sieve Designation	Percent Passing by weight
1.	90 mm to 45 mm	125 mm	100
		90 mm	90-100
		63 mm	25-60
		45 mm	0-15
		22.4 mm	0-5

Grading	Size Range	IS Sieve Designation	Percent Passing by weight
2.	63 mm to 45 mm	90 mm	100
		63 mm	90-100
		53 mm	25-75
		45 mm	0-15
		22.4 mm	0-5
3.	53 mm to 22.4 mm	63 mm	100
		53 mm	95-100
		45 mm	65-90
		22.4 mm	0-10
		11.2 mm	0-5

Note: The compacted thickness for a layer with Grade 1 shall be 100 mm while for a layer with Grade 2, it shall be 75 mm.

Table 6.3.2

Physical requirements of coarse aggregates or water-bound macadam sub-base and base courses

S. No.	Test	Test Method	Requirement (Maximum)
1.	* Los Angeles Abrasion value	IS 2386 (Part-4)	50 per cent
2.	* Aggregate Impact value	IS 2386 (Part-4)	40 per cent
3.	Flakiness Index	IS : 2386 (Part-1)	15 per cent

* Aggregate may satisfy requirements of either of the two tests

b) Screenings

Screenings to fill voids in the coarse aggregate shall generally consist of the same material as the coarse aggregate or of gravel (other than round material) or moorum as approved by Engineer. However, where permitted non-plastic material such as moorum may be used for this purpose provided liquid limit and plasticity index of

such material are below 20 and 6 respectively and fraction passing through 75 micron sieve does not exceed 10 percent.

As far as possible screenings shall conform to the gradings set-forth in Table 6.3.3 Screenings of type A shall be used with coarse aggregate of grade I of Table 6.3.1 Screenings of type A or B as specified shall be used with coarse aggregates of grading 2. Type B screenings shall be used with coarse aggregates of grading

TABLE 6.3.3

Grading for Screenings

Grading Classification	Size of Screenings	IS Sieve Designation	Percent by Weight Passing Sieve
A	13.2 mm	13.2 mm	100
		11.2 mm	95 -100
		5.6 mm	15 - 35
		180 micron	0 – 10
B	11.2 mm	11.2 mm	100
		9.5 mm	80-100
		5.6 mm	50 - 70
		180 micron	05 - 25

Binding material

Binding material to be used for water-bound macadam as a filler material meant for preventing ravelling, shall be a suitable material and having a Plasticity Index (PI) value of less than 6 as determined in accordance with IS : 2720 (Part-5).

6.3.3 Construction Method

a) Preparation of Sub-grade/ sub-base

(i) The surface of the sub-grade/ sub-base or existing surface shall be shaped and prepared to the lines, levels, grades, dimensions and cross sections as shown in drawings. Damage to or deterioration of sub-grade/ sub-base shall be made good before sub-base/ base is overlaid.

(ii) Inverted Choke

If water bound macadam is to be laid directly over the sub grade, without any intervening pavement or soling course, a 25 mm course of screenings or coarse sand shall be spread and compacted on the prepared subgrade before application of the coarse aggregate. In case of fine sand or silty or clayey sub grade, a 100 mm insulating layer of screenings or coarse sand shall be laid, the gradation of which will depend on drainage requirements. Alternatively, appropriate geosynthetics performing

functions of separation and drainage layer may be used over the prepared sub-grade subject to the satisfaction of the Engineer.

(b) Spreading coarse aggregates

i. The coarse aggregates of specified size and grading shall be spread uniformly to proper profile in layers with each compacted layer thickness not more than 100mm for Grading 1 and 75 mm for Grading 2 and in a manner that prevents segregation into fine and coarse materials.

ii. Immediately following at spreading of the coarse aggregate, it shall be compacted to the full width by rolling with either the three- wheel- power -roller of 8 to 10 tonnes capacity or an equivalent vibratory roller. Initially, light rolling is to be done, which shall be discontinued when the aggregate is partially compacted with sufficient void space in them to permit application of screenings. The rolling shall begin from the edges and progress gradually towards the centre, only slight sprinkling of water may be done during rolling, if required.

iii. After the coarse aggregate has been lightly rolled to the required true surface, screenings shall be applied gradually over the surface to completely fill the interstices.

iv. The screenings shall be applied at a slow rate (in three or more applications) so as to ensure filling of all voids. Rolling and brooming shall continue with the spreading of the screenings. Damp and wet screenings shall not be used under any circumstances.

v. After spreading the screening and rolling the surface shall be copiously sprinkled with water, swept and rolled. Hand brooms shall be used to sweep the wet screening into the voids and to distribute them evenly. Additional screenings applied where necessary until the coarse aggregates are well bonded and firmly set for the entire depth.

vi. After the application of screenings and rolling, a suitable binding material shall be applied at a uniform and slow rate in two or more successive thin layers. After each application of binding material, the surface shall be copiously sprinkled with water and the resulting slurry swept in with brooms so as to fill the voids properly. The surface shall then be rolled by a 8-10 tonne roller.

(c) Tolerance

The finished sub-base/ base at any point shall not vary more than 15mm below and 12mm above the planned grade or adjusted grade with 3m straight edge applied to the surface parallel to the centreline of the road. With the template laid transversely

the maximum permissible variation from specified profile shall be 12mm and 8mm respectively.

The sub-base/ base course completed in each day's work shall have an average thickness not less than the required thickness. Sub-base/ base course which does not conform to the above requirements shall be reworked.

6.4 B ITUMINOUS MATERIALS

6.4.1 Materials

Materials shall meet the requirements of the relevant IS Codes. These shall be of the following types.

a) Cut back Bitumen

Cut back bitumen shall be Rapid Curing (RC), Medium Curing (MC) or Slow Curing (SC) conforming to IS : 217.

b) Cationic Emulsion

Bitumen emulsions of the cationic type for roads shall conform to IS: 8887. Emulsified bitumen shall be Rapid Setting (RS), Medium Setting (MS), or Slow Setting (SS).

The physical and chemical requirements of the three types emulsions shall comply with the requirements specified in Table 1 of IS: 8887.

c) Paving Bitumen

Paving bitumen shall be conforming to IS: 73 and of the following two types:

Type 1 Paving bitumen from non-waxy crude shall satisfy the requirements given in Table 1 of IS: 73.

Type 2 Paving bitumen from waxy crude shall satisfy the requirements given in Table 2 of IS: 73.

The temperature at application of bituminous materials shall be maintained as per manufacturer's instructions and/or as directed by the Engineer's Representative.

An anti-stripping and bonding agent should be used in all final restoration road works. It should confirm to IS: 14982-2001 Specifications. The percentage can be from 0.5% to 1.25% by weight of bitumen content. The optimum dose can be ascertained using M.O.S.T. / BIS guidelines.;

6.4.2 Methods of Storage and Handling

Asphaltic material shall be handled and stored with due regard for safety and in such a way that at the time of use in the work the material conforms to the Specifications. Following precautions shall be taken while using these materials:

a) Work with these materials shall be carried out in good weather conditions and it shall be carried out in warm and dry weather, and not in wet or extremely cold weather.

b) Emulsified asphalt shall be handled with care and not subjected to mechanical shocks or extremes of temperature likely to cause separation of the asphalt. Emulsified asphalt showing sign of separation shall not be used.

c) During heating, no water or moisture shall be allowed to enter the boiler.

d) Heating of bitumen shall be done to the correct temperature range, as prescribed by the manufacturer for the grade used. The temperature shall be controlled with the use of a suitable thermometer, and the material shall be drawn and used while still at such temperature as is prescribed by manufacturer or in accordance with MOST specifications.

e) It shall be ensured that mixing of ingredients is through and all particles of aggregates are coated uniformly and fully.

6.5 TACK COAT

6.5.1 Description

This work shall consist of furnishing and applying bituminous material to a new WBM surface or to an existing road surface before laying another premix carpet layer over it.

6.5.2 Materials

Bitumen: This shall be straight-run bitumen of grade VG- 10 conforming to IS 73 specifications

(a) 0.75 kg/sqm on W.B.M./ W.M.M. Surface

(b) 0.50 kg/sqm on bitumen surface

6.5.3 Construction Methods

a) Cleaning Surface

Prior to the application of bitumen, all vegetation, loose sealing compound, caked mud, dust, dirt and foreign material shall be removed from the entire surface of the pavement by means of mechanical sweepers and blowers,

otherwise with steel wire brushes, small picks, brooms or other implements as approved by the Engineer-in-Charge.

b) Weather Limitation

The tack coat shall not be applied nor any bitumen work done during rainy weather or when the surface is damp or wet or when the atmospheric temperature in the shade is not more than 16o C.

c) Application of tack coat material

Bitumen shall be heated in a boiler to a temperature of 165 deg. C to 175 deg. C and maintained at that temperature.

Hot bitumen shall be applied evenly to the clean, dry surface by means of a pressure sprayer at specified rate. Even and uniform distribution of bitumen shall be ensured. Bitumen shall be applied longitudinally along the length of the pavement.

6.6 B ITUMINOUS MACADAM

6.6.1 Description

The work shall consist of one or more applications of compacted crushed aggregates premixed with bituminous binder (suitable grade) to a primed non-bituminous surface or previously constructed bituminous surface and in conformity with the lines, grades, dimensions and cross-sections shown on the Drawings This shall comprise of a single course of 50mm to 75mm thickness as specified in the approve or as Directed by Engineer.

6.6.2 Materials

a) Bitumen

The bitumen shall be paving bitumen of suitable grade approved by the Engineer and conforming to IS: 73.

b) Additives

Adhesion and Ant-stripping agent shall be added to the bitumen subject to Engineer's consent at the required percentage of additive. The additive shall be thoroughly mixed with the bituminous material in accordance with the manufacturer's instructions.

c) Aggregates

Aggregates shall consist of clean and hard crushed stone free from dust, clay, dirt and any other deleterious matter. The physical requirements shall be as given in Table 6.7.1.

Aggregates shall conform to one of the two gradings given in Table 6.7.2 depending on the compacted thickness; the actual grading shall have the consent

of the Engineer.

Table 6.7.1

Physical requirements of aggregates for bituminous macadam

S.No	Test	Test Method	Requirement (maximum)
1.	* Los Angeles Abrasion value	IS :2386 (Part-4)	40 per cent
2.	* Aggregate Impact value	IS :2386 (Part-4)	30 per cent
3.	Flakiness and Elongation Index Indices (Total)	IS : 2386(Part-1)	30 per cent
4.	Coating and Stripping of Bitumen aggregate mixtures	AASH T-182 TO	Minimum retained coating 95%
5.	Soundness : (i) Loss with Sodium Sulphate 5 cycles (ii) Loss with Magnesium Sulphate 5 cycles		 12 percent 18 percent
6.	Water absorption	IS : 2386(Part-3)	2 per cent

* Aggregates may satisfy requirements for either of the two tests.

Table 6.7.2

Aggregate grading for bituminous macadam

IS Sieve Designation	Per cent by weight passing the sieve	
	Grading 1	Grading 2
45.0mm	100	-
26.5mm	75-100	100
22.4mm	60-95	75-100
11.2mm	30-55	50-85

IS Sieve Designation	Per cent by weight passing the sieve	
	Grading 1	Grading 2
5.6mm	15-35	20-40
2.8mm	5-20	5-20
90.0 micron		

Bitumen content for pre mixing shall be 4% by weight of total mix unless otherwise approved by Engineer.

6.6.3 Construction Methods

a) Weather and Control of Work

The work of laying shall not be undertaken during rainy or foggy weather or when the base course is damp or wet, or during dust storm or when the atmospheric temperature in shade is 15 degree C or less.

The Engineer may order work to cease temporarily on account of adverse weather, unsatisfactory condition of materials, equipment or any conditions which he considers may affect the work adversely.

b) Cleaning and Preparation of Surface

Prior to the application of binder, loose dirt and other objectionable material shall be removed from the surface to be treated by means of the power broom or blower or both. If this does not provide a uniformly clean surface, additional sweeping shall be done by hand, using stiff brushes or similar brooms. The areas inaccessible to the cleaning means shall be cleaned manually. The sweeping shall extend 200mm beyond each edge of the area to be treated.

Adherent patches of objectionable material shall be removed from the surface by steel scraper or other approved method and where the Engineer so directs the scraped area shall be washed down with water and hand brooms.

No application of bituminous material shall be undertaken until the surface has been cleaned to the satisfaction of the Engineer.

Before application of the bituminous material any necessary preliminary patching of the surface of the road (To fill in potholes.) shall be done to the complete satisfaction of the Engineer.

Tack coat shall be applied in accordance with these Specifications. Prime coat if required, shall conform to Subsection 6.5.

c) Plant and Equipment

All plant used by the Contractor for the preparation, hauling and placing of

asphalt mixtures shall be subject to the consent of the Engineer and shall minimise smock, dust and noxious emission and odours. These shall generally meet the following requirements:

i. The mixing plant shall be a batching plant and shall have adequate capacity sufficient to supply the finisher on the road continuously when spreading the asphaltic mix at normal speed and required thickness.

ii. Scale for any weigh box shall be designed to be accurate to within 1% of the maximum load required and shall be fully automatically controlled.

iii. The Contractor shall provide and have at hand not less than ten 25 kilograms weights for frequent testing of all scales.

iv. Weigh box or hopper shall include a means for accurately weighing each bin size of aggregate in a weight box or hopper, suspended on scales, ample in size to hold a full batch without running over.

v. The asphaltic materials shall be stored in storage tanks designed to keep the temperature of the asphaltic material at maximum temperature of 110 degree C. The properties of the asphaltic material kept in that storage tanks shall be in good condition before mixing.

vi. The plant shall be provided with a circulating system to ensure continuous circulation between the storage tank and the mixer.

vii. The plant shall be provided with a cold bin for feeding the aggregates. Bin shall have a calibration gate and a mechanical means to insure uniform feeding of the aggregates into the drier as required by the Engineer.

viii. The rotary drier shall be capable of drying and heating the aggregates to the specified temperature.

ix. The plant shall be provided with plant screens capable of screening all aggregates to the specified sizes.

x. The plant shall include at least 3 hot bins for storing the aggregates fed from the drier after passing through the screen. Each bin shall be provided with an overflow pipe to prevent any backing up of material into other bins.

xi. The plant shall be provided with asphaltic control unit by weighing to obtain the proper amount of asphaltic material in the mix within the tolerance specified for the job-mix.

xii. The batch mixer shall be an approved twin pugmill type and capable of producing a continuous uniform mixture within the job-mix tolerances.

The mixer capacity shall not be less than 1000 kilogram batch.

xiii. An armoured thermometer reading from 50 degree C to 200 degree C shall be fixed in the asphaltic feed line at a suitable location near the discharge valve at the mixer unit.

xiv. The plant shall be further equipped with an electric pyrometer, or other approved thermometric instrument so placed at the discharge chute of the drier as to register automatically or indicate the temperature of the heated aggregate.

xv. The plant shall be equipped with a dust collector.

xvi. The plant shall be equipped with accurate positive means to govern the time of mixing and to maintain it constant. The time of mixing shall be divided into two steps, dry mixing and wet mixing. For dry mixing, the aggregate from hot bins shall be mixed for a period of 5-15 seconds. For wet mixing, the mixing time shall begin with the start of the asphalt spray after dry mixing. The wet mixing shall take about 30-45 seconds. The mixing time shall be extended if in the consideration of the Engineer the material obtained is not homogeneous.

d) Equipment for Hauling and placing

i. Trucks for hauling asphaltic mixtures shall have tight, clean, and smooth metal beds that have been sprayed with soapy water, thinned fuel oil, or lime solution to prevent the mixing from adhering to the beds (The amount of sprayed fluid shall however be kept to the practical minimum. Each load shall be covered with a canvas or other suitable material of such size as to protect the mixture from the weather). Any truck causing excessive segregation of material by its spring suspension or other contributing factors, or that shows oil leaks in detrimental amounts, or that causes undue delays, shall upon direction of the Engineer be removed from the work until such conditions are corrected.

ii. The equipment for spreading and finishing shall be mechanical, self powered pavers, capable of spreading and finishing the mixture true to the lines, grades, dimensions and cross sections.

The pavers shall be equipped with hoppers and distributing screws of the reversing type to place the mixture evenly.

The pavers shall maintain trueness of grade and confine the edges of the pavement to true lines without the use of stationary side forms. The equipment shall include blending or joint levelling devices for smoothing and adjusting longitudinal joints between lanes. The assembly shall be adjustable to give the cross-section shape

prescribed and shall be so designed and operated as to place the thickness or weight per square metre of material required.

Pavers shall be equipped with activated screeds and devices for heating the screeds to the temperature required for the laying of the mixture without pulling or marring.

The term "screed" includes any cutting, crowing, or other practical action that is effective in producing a finished surface of the evenness and texture specified, without tearing, shoving, or gouging.

If, during construction, it is found that the spreading and finishing equipment in operation leaves in the pavement surface tracks or indented areas or other objectionable irregularities, the use of such equipment shall be discontinued and other satisfactory spreading and finishing shall be provided by the Contractor forthwith.

e) Preparation and transport of mix

Bituminous macadam mix shall be prepared in a hot-mix plant either owned by the Contractor or it may be taken from an approved hot mix plant before supply of mix for the work, consent for the use of the mix shall be taken from the Engineer. The hot-mix plant should be of adequate capacity of batch mix type with the features as described under Subsection 6.7.3 or otherwise approved by Engineer unless some work specific features are required and capable of yielding a mix of proper and uniform quality with thoroughly coated aggregates. The plant shall meet the overall requirements through stringent quality control practices.

The mineral aggregates shall be dried and heated to a temperature between 150 degree C and 163 degree C

The contractor shall submit for consent the exact temperature to the Engineer. Surfaces of aggregates shall be clean and free of carbon and unburnt fuel oil. The aggregates, immediately after heating, shall be screened into three or more fractions and conveyed into separate bins ready for combining and mixing with asphaltic material.

The dried mineral aggregates prepared as prescribed above, shall be combined in the plant in the amount of each fraction of aggregate required to meet the job-mix formula for the particular mixture. The proper amount of asphaltic material shall be distributed over the mineral aggregate and the whole thoroughly mixed for a period of at least 30 seconds, or longer if necessary to produce a homogeneous mixture in which all particles of the mineral aggregates are coated uniformly. The total mixing time shall be regulated by a suitable locking means.

The mixture shall when emptied from the mixer be at a temperature between 150degree C and 163degree C even for tolerances.

The mixture shall be transported from the mixing plant to the point of use in vehicles conforming to the requirements of Subsection 6.7.3 unless otherwise approved by the Engineer.

f) Application of the Pre-mix

The application of the mix shall proceed immediately after application of tack coat. The mix shall be spread immediately by means of self-propelled mechanical paver with suitable screeds capable of spreading, tamping, and finishing the mix true to lines, levels, dimensions and cross-sections specified. Any bare or insufficiently filled areas shall be re-treated by the mechanical spreader or covered by hand as necessary to give uniform and complete coverage. Any aggregate spread in excess of the agreed rate shall be scattered and evenly distributed on the road or otherwise removed and stockpiled.

The temperature of the mix at the time of laying shall be in the range of 120 or 160degree C.

g) Rolling

After the spreading of the mix, the rolling shall be done by road roller of suitable type and capacity. Rolling shall start as soon as possible after the material has been spread and it shall be completed within limited time frame, and to meet this, the Contractor shall deploy a set of rollers. Rolling shall be done with care to avoid unduly roughening of the pavement surface. It shall commence at the edges and progress towards the centre longitudinally except that on super-elevated and unidirectional cambered portions, it shall progress from the lower to the upper edge parallel to the centre line of the pavement.

The speed of the rollers shall not exceed 5 kilometre per hour for steel wheeled rollers and 7 kilometre per hour for pneumatic tired rollers and shall be at all times slow enough to avoid displacement of the hot mixture. Any displacements occurring as a result of reversing the direction of the roller or from any other cause shall at once be corrected with rakes and fresh mixture where required. Care shall be exercised in rolling not to displace the line and grade of the edges.

Rolling shall progress continuously as may be necessary to obtain uniform compaction while the mixture is in a workable condition and until all roller marks are eliminated.

Heavy equipment or rollers shall not be permitted to stand on the finished surface until it has thoroughly cooled or set.

Any petroleum products dropped or spilled from the vehicles or equipment employed by the Contractor upon any portion of the pavement under construction is cause for the removal and replacement of the contaminated pavement by the Contractor.

When the roller has passed over the whole area once, any high spots or depressions which become apparent shall be corrected by removing or adding premixed material. Rolling shall then be continued until the entire surface has been rolled to 95 % of the average laboratory density, and there is no crushing of aggregates. and all roller marks are eliminated. In each pass of the roller, preceding track shall be overlapped uniformly by at least 1/3rd width. The roller wheels shall be kept damp to prevent premix from adhering to the wheels and being picked up. In no case shall fuel/ lubricating oil be used for this purpose.

Along kerbs, man-holes etc., and at any other locations where proper consolidation by rollers is not practicable, alternative means such as steel rammers shall simultaneously be used to secure adequate consolidation.

6.6.4 Surface Control

a) Surface Regularity

Maximum permissible undulation in longitudinal profile with 3m straight edge shall be as 12mm.

Maximum permissible variation from specified cross profile under camber template shall be as 8mm.

Surface evenness requirements in respect of both longitudinal and cross profiles should be simultaneously satisfied.

Tests for conformity with the specified crown and grade shall be made immediately after initial compaction, and variations shall be corrected by removing or adding materials as may be necessary. Rolling shall then be continued as specified. After final rolling, the smoothness of the course shall be checked again and any irregularity of the surface exceeding the permissible limits corrected as agreed by the Engineer's Representative, including removal and replacement.

b) Surface Finish

The bituminous macadam shall be covered with either the next pavement course or wearing course, as the case may be, without any delay. If there is to be any delay, the course shall be covered with the seal coat. The seal coat in such cases shall be considered incidental to the work and shall not be paid separately.

6.7 PPE-MIX CARPET

6.7.1 Description

This work consists of applying a tack coat on the prepared base followed immediately by spreading aggregates pre-coated with specified binder to camber and

consolidated. The consolidated thickness of this type of treatment shall be 2 cm or 2.5 cm as specified.

Premix carpet shall not be laid during rainy weather or when the base course is damp or wet or, when the atmospheric temperature in the shade is not more than 16^0 C.

6.7.2 Materials

a) Binder

Binder shall be bitumen paving asphalt grade VG-10/VG-30 of suitable grade meeting the requirements of the work and other environmental conditions. This shall be conforming to the requirements of IS : 73.

b) Coarse aggregates

Coarse aggregates consist of crushed stones and shall be clean, strong, durable, and free from organic or other deleterious materials. The aggregates shall be hydrophobic and of low porosity.

The aggregates shall meet the requirements given in Table 6.7.1 except that the water absorption shall be limited to 1 per cent. The Stone Polishing Value as measured by BS : 812-(Part-114) shall not be less than 55.

c) Proportioning of Materials

They shall comprise of a mix of stone chipping 13.2mm size (passing 22.4 mm sieve and retained on 11.2 mm size) and 11.2 mm size (passing 13.2 mm sieve and retained on 5.6 mm sieve.) The contractor shall propose material proportions to the Engineer for his consent.

6.7.3 Construction Methods

a) Tack Coat

This shall be applied as per Subsection 6.5.

b) Preparation and transport of Premix

The binder shall be heated to a temperature appropriate to the grade of bitumen in boilers of suitable design avoiding local overheating and ensuring a continuous supply.

The aggregates shall be dry and suitably pre-heated to the required temperature before they are placed in a mixer. After about 15 seconds of dry mixing, the heated binder shall be distributed over the aggregates at the rate specified. Mixing shall be continuous and thorough to ensure a homogeneous mixture in which all particles are coated uniformly and the discharge temperature shall be within the specified range.

The mixing of binder with chippings shall be continued until the chippings are thoroughly coated with binder. The mix shall be discharged and immediately transported from mixer to the point of use in suitable vehicles or wheel barrows. The vehicles employed for transport shall be clean and the mix being transported

should be covered in transit and protected from any kind of damage.

c) Spreading and Rolling
Immediately after the application of tack coat, premixed material shall be spread by means of mechanical paver finisher truly to lines, levels, dimensions and cross section as specified. The areas not covered by the mechanical means shall be treated with manual means for which the Engineer has given his consent.

d) Rolling
This shall be carried out as per Subsection 6.6.3

6.8 BITUMINOUS CONCRETE

6.8.1 Description

This work shall consist of a surfacing of single-layer bituminous concrete of specified thickness on previously prepared bituminous surface to the lines, grades, dimensions and cross section as shown on Drawings. It shall be 25mm/40mm thick as required by Engineer.

1.1. Materials

a) Bitumen
The bitumen shall be paving bitumen of suitable penetration grade within the range S 35 to S 90 or A 90 to IS: 73. The actual grade of bitumen to be used shall be appropriate to the requirements of the work and environmental conditions.

b) Coarse aggregates
The aggregates shall satisfy the physical requirements given in Table 6.7.1. Flakiness index shall not exceed 30% and water absorbed not more than 1%

c) Fine aggregates
Fine aggregates shall be the fraction passing 2.36 mm sieve and retained on 75 micron sieve, consisting of crushed run screenings, natural sand or a mixture of both. These shall be clean, hard, durable, uncoated, dry and free from any injurious, soft or flaky pieces and organic or other deleterious substances.

d) Filler
Filter shall consist of finely divided mineral matter such as rock dust, hydrated lime or cement. The filter shall be graded within following limits:

IS Sieve	**Per cent passing by weight**
600 micron	100
300 micron	95 – 100
75 micron	85 – 100

The filter shall be free from organic impurities and have a Plasticity Index not greater than 4. The Plasticity Index requirement shall not apply if filter is cement or lime. When coarse aggregate is gravel, 2 per cent of mass of total aggregate of Portland cement or hydrated lime shall be added and percentage of fine aggregate reduced accordingly. Cement or lime is not required when the gravel is lime stone.

e) Aggregate gradation

Mineral aggregates, including filler shall be so graded or combined as to conform to gradings set forth in Table 6.9.1 below.

Table 6.9.1

Sieve Designation	**Per cent by weight passing through sieve for**		
	25mm thick Grade 1	**25-40mm thick Grade 2**	**>40mm thick Grade 1**
26.5mm	--	--	100
22.4mm	--	100	75-100
13.2mm	100	80-100	--
11.2mm	90-100	75-95	50-85
5.6mm	60-80	55-75	20-40
2.8mm	40-55	40-55	5-20
710micron	20-30	20-30	--
300micron	15-25	15-25	--
180micron	10-20	10-20	--
90micron	5-11	5-11	0-5

6.8.2 Mix Design

a) Requirement of Mix

Apart from conformity with grading and quality requirements of individual ingredients, the mix shall also meet the requirements set forth in Table 6.9.2.

Table 6.9.2

Requirements of Bituminous Concrete Mix

S.NO	Description	Requirements
1.	Marshall stability (ASTM Designation: D-1559) determined on Marshall specimens compacted by 75 compaction blows on each end	820 Kg (1800 pounds)
2.	Marshall flow (mm)	Minimum 2-4
3.	Per cent air voids in mix	3-5
4.	Per cent voids in mineral aggregate (VMA)	Minimum 11-13
5.	Percent voids in mineral aggregates filled by bitumen (VFB)	65-75
6.	Binder content, per cent by weight of mix	Minimum 4.5
7.	Water sensitivity (ASTM : D-1075) loss of Stability on immersion in water at 60 deg. C	Minimum 75% Retained strength
	Swell Test (Asphalt Instt. MS-2, No. 2)	Maximum 1.5%

b) Binder content

Binder content shall be so determined as to achieve the requirements of the mix set forth in Table 6.9.2. Marshall method for arriving at binder content shall be adopted.

c) Job Mix Formula

Before starting work the Contractor shall submit to the Engineer for his consent. The job mix formula for the mixture shall fix a single percentage of aggregate passing each required sieve size, a single percentage of asphalt to be added to the aggregate, and a single temperature at which the mixture is to be delivered on the road, all of which shall fall within the ranges of the composition and the temperature limits. The formula shall give the following details:

I. Source and location of all materials

II. Proportions of all materials as described under :

III. Binder- as percentage by weight of total mix Coarse aggregate/Fine aggregate/ Mineral Filler- as percentage by weight of total aggregate including Mineral Filler

IV. A single definite percentage passing each sieve for the mixed aggregate (Vide Table 6.9.1)

V. The results of test as per specifications obtained by the contractor

VI. Test results of physical characteristics of aggregates to be used

VII. Mixing temperature and compacting temperature

d) Application of job-mix formula and Allowable Tolerances

The approved job mix formula shall remain effective unless and until modified. Each day as many samples of the materials and mixtures shall be taken and tested considers necessary for checking the required uniformity of the mixture. All mixture furnished shall conform to the job-mix formula within the range of tolerances set in forth in Table 6.9.3.

Table 6.9.3

Permissible variations from the job-mix formula

S. No	Description of Ingredients	Permissible Variation by Weight of Total mix in Percentage
1	Aggregate passing 13.2mm sieve and larger	± 8
2	Aggregate passing 9.5mm sieve and 4.75mm sieve	± 7
3	Aggregate passing 2.36mm sieve & 1.18mm sieve	± 6
4	Aggregate passing 600 micron sieve & 300 micron sieve	± 5
5	Aggregate passing 150 micron sieve	± 4
6	Aggregate passing 75 micron sieve	± 3
7	Binder	± 0.3
8	Mixing Temperature (Centigrade)	± 10

When unsatisfactory results or changed conditions make it necessary, a new job mix shall be submitted to the Engineer.

Should a change in a material be encountered or should a change in a source of material be made, a new job mix formula shall be submitted before the mixture containing the new material is delivered.

6.8.3 Construction Methods

a) Weather Limitation
The control over the weather conditions shall be as described under Subsection 6.5.3 above.

b) Progress of Work
No work shall be performed when there is insufficient hauling, spreading or finishing equipment, or labour to ensure progress at a rate not less than 75% of the capacity of the mixing plant.

c) Preparation of Existing Surface
The surface on which the mix is to be laid shall be swept thoroughly and cleaned of all loose dirt and other objectionable material using mechanical broom immediately before start of work. In portions where mechanical means cannot reach, the surface shall be prepared, shaped and conditioned to specified levels, grade and cross-fall (camber).

d) Preparation of Mix
A Hot-mix plant of adequate capacity and capable of producing a proper and uniform quality mix shall be used for preparing the mix. The plant may be either a weigh batch type or volumetric proportioning continuous or drum mix type. The plant shall have co-ordinated set of essential units capable of producing uniform mix as per the job-mix formula. The temperature of the binder at the time of mixing shall be in the range of 150 to 163 degree C and of aggregates in the range of 155 to 163 degree C, provided also that at no time shall the difference in temperature between the aggregates and binder exceed 14 degree C. The Contractor shall submit the exact temperatures and total mixing time for the consent of the Engineer. Mixing shall be thorough to ensure that a homogeneous mixture is obtained in which all particle of mineral aggregates are coated uniformly.

e) Transportation and Delivery of Mix.
The mix shall be transported from the mixing plant to the point of use in suitable tipper vehicles. The vehicles employed for the transport shall be clean and be covered in transit.

f) Spreading and Finishing
The mix transported from the hot mix plant to the site and shall be spread by means of a self- propelled mechanical paver with suitable screeds capable of spreading, tamping and finishing the mix to specified grade, elevation, and cross-section. However, in restricted locations and narrow widths, where available equipment cannot be operated, other suitable means shall be employed subject to the consent of the Engineer. The mixture shall be laid upon an approved surface and only when weather conditions are considered suitable. The temperature of the mix, at the time of laying, shall be in the range of 120 degree

C to 160 degree C.

The prime coat and tack coat to be applied shall be as per Subsections 6.4 and 6.5 respectively.

Spreading, finishing and compacting of the mix shall be carried out during daylight hours only, unless satisfactory illumination is provided by the Contractor.

g) Compaction of Mixture

Immediately after spreading of mix by paver, it shall be thoroughly and uniformly compacted by rolling with a set of self-propelled rollers moving at a speed not more than 5 km per hour, immediately following close to the paver. Generally with each paver, two steel wheeled tandem rollers and one pneumatic tired roller will be required. The initial or breakdown rolling shall be with 8 to 10 ton static weight smooth three wheeled steel roller and finish rolling with 6 to 8 ton tandem roller. The breakdown rolling shall preferably be followed by an intermediate rolling with a smooth wheel pneumatic roller of 10 to 25 ton having a tire pressure of 7kg/sqcm moving with a speed not more than 7 km per hour and shall be at all times slow enough to avoid displacement of the hot mixture. Means shall be provided for checking and adjusting the tire pressure on the job at all times. All compaction operations, i.e., breakdown rolling can be accomplished by using vibratory roller of 8 to 10 ton static weight. During initial or breakdown rolling and finished rolling, the vibratory shall be switched off. The joints and edges shall be rolled with a 8 to 10 ton three wheeled static roller.

No delays in rolling the paved surface shall be tolerated, the breakdown roller must be right up to the paver at all times and the intermediate pneumatic roller right up to the breakdown roller. The compaction of the asphaltic concrete shall be controlled by temperature as follows:

Roller	Temperature
Breakdown	120˚C - 135˚C
Pneumatic	95˚C - 115˚C
Finishing	< 65˚C

Rolling procedure shall be as specified under Subsection 6.6.3

Rolling shall be continued till the density achieved is at least 98% of that of laboratory Marshall specimen. Rolling operations shall be completed in all respects before the temperature of the mix falls below 100 degree C.

h) Joints

Both longitudinal and lateral joints in successive courses shall be staggered so as not to be one above the other. Longitudinal joints and edges shall be constructed true to delineating lines parallel to the centre line of the road.

Longitudinal joints shall be offset by at least 150mm from those in the lower course.

Longitudinal and transverse joints shall be made in a careful manner so that well bonded and sealed joints are provided for the full depth of the course.

i) Surface regularity

Surface shall be tested for undulations in longitudinal and cross profiles with 3 m straight edge and crown template respectively. Crown template shall conform to the typical cross section.

Maximum permissible undulation in longitudinal profile with 3m straight edge shall be as 8mm.

Maximum permissible variation from specified cross profile under camber template shall be as 4mm.

Surface evenness requirements in respect of both longitudinal and cross profiles should be simultaneously satisfied.

j) Protection of the pavement from traffic

Subsection 6.1 shall apply except as stated below.

Section of the newly finished works shall be protected from traffic of any kind until the mixture

has cooled to approximately ambient air temperature and well set.

6.9 SEAL COAT

6.9.1 Description

This work shall consist of application of a seal coat for sealing the voids in a bituminous surface laid to the specified levels, grade, and cross fall. Seal coat used shall be of premix type unless otherwise approved by the Engineer.

1.2. 6.9.2 Materials

a) Binder

The binder shall be bitumen of a suitable grade appropriate to the requirements of the work and other environmental conditions as directed by the Engineer and satisfying the requirements of IS : 73, 217, 454 or other cut back as applicable.

b) Aggregates

The aggregates shall be sand or grit and shall consist of clean, hard, durable, dry particles and shall be free from dust, soft or flaky/ elongated material, organic matter or other deleterious substances. The aggregates shall pass 2.36mm sieve and be retained on 180 micron sieve. The quantity used for premixing shall be 0.06 cum per 10 sq m area.

6.9.3 Construction Methods

a) Preparation of base

The seal coat shall be applied immediately after laying of bituminous course which is required to be sealed. Before application of seal coat materials, the surface shall be cleaned free of any dust or other objectionable matter.

b) Preparation and Application of Mix

Mixtures of approved type shall be employed for mixing aggregates with suitable bituminous binder.

The binder shall be heated in boilers of suitable design, to a temperature appropriate to the grade of bitumen. The aggregates shall be clean, dry and suitably heated to a temperature before the same are placed in the mixture. Mixing of binder with aggregates to specified proportions shall be continued till the latter are thoroughly coated with the former.

The mix shall be immediately transported from the mixing plant to the point of use and spread uniformly on the bituminous surface to be sealed.

c) Rolling

As soon as sufficient length has been covered with pre-mixed material, the surface shall be rolled with 8-10 ton smooth wheeled steel, suitable vibratory or other equipment.

As regards procedure for rolling it shall be as specified under Subsection 6.7.3.

d) Control of Traffic Subsection 6.1 shall apply.

6.10 C EMENT CONCRETE PAVEMENTS

1.3. 6.10.1 General

This work shall consist of constructing Plain/ or Reinforced Cement Concrete Pavements as required in accordance with these Specification and in conformity with the lines, levels, grades and dimension in accordance with the design.

6.10.2 Materials

a) General

The concrete materials viz. cement, aggregates, water, steel reinforcement, admixtures shall be in accordance with Annexure OCS -1 (Concrete: Plain and Reinforced) except as specified herein.

b) Dowel and Tie bars

Dowel bars shall be plain round bars. They shall be free from burring or other deformation restricting slippage in the concrete. Before delivery to the Works, one half of the length of each dowel bar shall be painted with one coat of bituminous material.

Tie bars shall be deformed bars free from oil, dirt, loose rust and scale.

These shall conform to the requirements of IS : 432, IS : 1139 and IS : 1786 as relevant.

c) Sleeves

The sleeves for dowel bars of expansion joints shall be of plastic material. This shall be designed to cover the dowels specified by the Designer, with a closed end, and with a suitable stop to hold the end of the sleeve a distance equal to the thickness of joint filler or at least 30mm from the end of the dowel bar. These shall be of such design that they do not deflect or collapse during construction, and the arrangement of sleeves shall be in accordance with these Specifications.

d) Waterproof Membrane

Where Waterproof membrane is to be provided, it shall be an impermeable polythene plastic sheeting. Where an overlap of underlay material is necessary this shall be at least 300mm. Water shall not be allowed to pond on the membrane which shall be completely dry when the concrete is laid.

e) Jointing Materials

i. Joint Filler

The expansion joint fillers shall conform to the requirements of IS: 1838. They shall be punched to admit the dowels where called for as specified by the Designer. The filler for each joint shall be furnished in a single piece for the full depth and width required for the joint. When the use of more than one piece is authorized for a joint, the abutting ends shall be fastened closely together securely and accurately to shape by stapling or other satisfactory positive fastening.

ii. Joint Primer

Joint primer shall be fully compatible with the joint sealant and shall be applied strictly in accordance with the manufacturer's instructions.

iii. Joint Sealing Compound

The Sealing Compound of hot poured, elastomeric type shall conform to AASHTO M282 and cold applied sealant shall be in accordance with BS 5212 (Part 2).

6.10.3 Equipment and Tools

a) General

The concrete paving shall be carried out by use of mechanised method. Equipment and tools necessary for handling materials and performing the work shall have the consent of the Engineer as to design, type, capacity and mechanical, condition shall be at the site of the work before work is started. In special cases like a very short length of road to be laid at a location, other methods may be approved by Engineer.

b) Batching and Mixing Plant

This shall be of suitable type, capacity and make meeting the requirements of work.

i. Paving Equipment

The concrete shall be placed with an approved fixed form or slip form paver with independent units designed to (i) spread, (ii)consolidate, screed and float finish, (iii)texture and cure the freshly placed concrete in one complete pass of the machine in such a manner that a minimum of hand finishing will be necessary and so as to provide a dense and homogeneous pavement in conformity with the plans and Specifications.

Vibrators for full width vibration of concrete paving slabs may be either the surface pan type or the internal type. They may be attached to the spread finisher. They shall not come in contact with the joint, sub base or side forms.

The frequency of the surface vibrators shall not be less than 3500 impulses per

minute and for the internal type not less than 5000 impulses per minute. The variable vibration setting shall be provided in the machine.

At least two spare vibrators and one generating unit shall be on hand in case of any breakdown of the vibrating equipment being used.

ii. Concrete Saw for joint cutting

The mechanical saw for cutting concrete shall be adequately powered to cut rapidly with a water-cooled diamond edge saw blade to the depth required. A water tank with flexible hoses and pump shall be made available in this activity on priority basis. The Contractor shall have at least one standby saw in good working condition.

iii. Forms

Straight side forms shall be metal forms having a thickness of at least 5mm and have a depth equal to the prescribed edge thickness of the pavement slab. Curved forms shall be of the radius called for as specified by the Designer and acceptable flexible forms shall be installed with that radius. Built-up forms with horizontal joints shall not be used. Forms shall be free from kinks, bend or wraps. Forms shall not deflect more than 6 mm when tested as a simple beam with a span of three metres under a load equal to that which the finishers or other construction equipment will exert on them. The top of the form shall not vary from a three metre straight edge by more than 3mm at any point and the side by more than 6mm at any point. The forms shall contain provision for locking together tightly the ends of abutting from sections and for secure setting.

iv. Curing Compounds

The curing compounds shall have a water retention efficiency index of 90% in accordance with BS 7542.

6.10.4 Construction Methods

a) Preparation of Sub-base

The sub-base, which shall generally be of water-bound macadam (WBM) conforming to Subsection 6.3.3. The sub base shall be wetted adequately or provided with a water proof membrane so that it dose not absorb any water from the concrete to be laid over it. Concrete shall not be placed on any portion of the sub-base until the consent of the Engineer is given.

b) Setting Forms

The sub-base under the forms shall be compacted and cut to grade so that forms, when set to the position are within + 3mm of a straight line formed by the top of the

forms. If the sub-base is found to be below the required grade at the form line, the grade line shall be lifted by placing lean concrete mix 1:4:8 beneath the form and setting the form when it is set. Imperfections and variations above grade shall be corrected by tamping or cutting to the degree required.

The alignment and grade elevations of the forms shall be checked and the necessary corrections made by the Contractor immediately before and after placing the concrete. When any form has been disturbed or any roadbed has become unstable, the form shall be reset and rechecked.

On final setting of the forms, these shall be checked for at least half the length of pavement to be concreted in a particular day before concreting commences on that day. While concreting long lengths, the setting up of forms to the exact grade and alignment shall be in advance of the concreting operation by at least 60 m.

Forms shall be cleaned and oiled prior to the placing of concrete. The forms shall be removed not earlier than 24 hours after the concrete has been laid.

c) Preparation of Concrete

i. Trial Mix / Mix Design Subsection 6.2.1 shall be followed Minimum grade of concrete to be used is M25.

ii. Batching, Mixing and Transporting Materials Subsection 6.2.4 shall apply. The Ready-Mixed Concrete (RMC) shall conform to Subsection Annexure OCS-1.

d) Placing Concrete

Concrete shall be placed only on a prepared sub-base as specified in Subsection 6.3.3. No concrete shall be placed around structures until they have been brought to the required grade and alignment nor until expansion joint material has been placed around them.

The concrete shall be spread, compacted and finished by a mechanical paver and in accordance with Subsection 6.10.3. The mixing and placing of concrete shall progress only at such a rate as to permit proper finishing, protecting and curing of the pavement.

The truck mixers, truck agitators and other approved hauling equipment shall be equipped with means for discharge of concrete into the hopper of the paver without segregation of the materials. In all cases, the temperature of the concrete shall be measured at the point of discharge from the delivery vehicle.

The acceptance criteria regarding level, thickness, surface regularity, texture, finish, strength of concrete and all other quality control measures for hand laid concrete shall be the same as in the case of machine laid work.

The concrete shall be thoroughly consolidated against and along the faces of all forms by means of vibrators inserted in the concrete. Vibrators shall not be permitted to come in contact with a joint assembly, the sub-base or a side form. In no case shall the vibrator be operated longer than 30 seconds in any location. The vibrator shall be inserted in the concrete and worked along the full length and both sides of a joint.

Concrete shall be deposited as near to expansion and contraction joints as possible without disturbing them, but shall not be dumped from the discharge bucket on to a joint assembly.

Except at construction joints, concrete shall be shovelled against both sides of the joint simultaneously, maintaining equal pressure on both sides. It shall be deposited to a height of approximately 5 cm more than the depth of the joint, and shall be vibrated so that all honeycombing and voids are prevented. The vibrator shall be inserted in the concrete and worked along the full length and both sides of the joints.

e Initial strike-off and Placement of Reinforcement

Where the concrete is laid in two layers, the bottom layer of concrete shall be struck off for the full width between longitudinal construction joint true to crown at the required distance below the finished surface elevation, for placement of reinforcement or for placement of a top layer of the required thickness.

The striking-off shall be accomplished by use of the finishing machine, unless some other approved device is allowed. The reinforcement shall be placed as called for by the Designer and pouring of concrete over it shall only be allowed after placement of reinforcement is proper in all respects and approved by the Engineer.

f Joints

i) General

Joints shall comply with the design approved for the construction.

A strip of the preformed expansion joint filler shall be placed around each structure which extends into or through the pavement before concrete is placed.

ii) Transverse Expansion Joints

These shall be formed at the design spacings. The material for a transverse joint shall be assembled at the roadbed, and placed into position as a unit.

iii) Transverse Contraction Joints

Transverse Contraction joints shall consist of planes of weakness created by forming or cutting grooves in the surface of the pavement. Transverse contraction joints shall also include load transfer dowel-bars where these are specified by the Designer.

The contraction joints shall be cut as soon as the concrete has undergone initial hardening and is hard enough to take up the load of joint sawing machine without causing damage to the slab. Grooves shall be at right angles to the centreline of the pavement and shall be true to line, subject to a tolerance of 5 mm in the width of the slab.

Any procedure for sawing joints that results in premature and uncontrolled cracking shall be revised immediately by adjusting the sequence of cutting the joints or the time interval involved between the placing of the concrete and cutting of the joints.

Load transfer assemblies for transverse contraction joints shall consist of dowel bars without sleeves and an approved auxiliary spacing and supporting element.

The assembly shall be placed into position so that the dowels are parallel to the centreline and shall be staked into position in such a way as to hold the assembly securely in position throughout construction.

iv) Longitudinal Joints

Longitudinal joints shall be constructed in conformity with the design. Planes of weakness shall be created by forming or cutting grooves in the surface of the pavement in accordance with the applicable provisions of this Section.

When adjacent lanes of pavement are constructed separately, steel side forms shall be used which will form a keyway along the construction joint. The bars may be bent at angles against the form of the first lane constructed and straightened into final position before the concrete of the adjacent lane is poured.

v) Transverse Construction Joint

Transverse construction joints shall be placed whenever concreting is completed after a day's work or is suspended for more than duration permissible for continuous pouring of concrete.

Joints shall be formed by placing installing bars or suitable bulkhead material so that a vertical face with approved key is formed or shall be butt joints formed with suitable material so that a vertical face is formed with no key. No tie bars shall be necessary when key joints are formed but dowel bars of the same dimensions and at the same spacing as for contraction joints shall be

necessary at all butt joints.

g)Finishing

i)Machine Finishing

As soon as the concrete has been placed, it shall be struck off and screeded by an approved finishing machine or tools to the grades and cross sections specified by the Designer and to a level slightly above grade so that when properly consolidated and finished the surface of the pavement will be at the exact level and grade. The machine or tool shall go over each area of pavement as many times and at such intervals as necessary to give the proper compaction and to leave a surface of uniform texture, true to grade and cross section.

Excessive operation over a given area shall be avoided. The tops of the forms shall be kept clean by an effective device attached to the machine and the travel of the machine on the forms shall be maintained true without lift, wobble or other variation tending to effect the precision finish.

After concrete has been placed on both sides of the joint and struck off, the installing bar or channel cap shall be slowly and carefully withdrawn, the concrete shall be carefully spaded and additional freshly mixed concrete worked into any depression left by the removal of the installing bar.

A diagonal finishing machine shall be used if available.

ii) Hand Finishing

A portable screed shall be provided for use. The screed shall be at least 60 cm longer than the width of the slab to be struck off and consolidated. It shall be of approved shape, sufficiently rigid to retain its shape and constructed either of metal or of other material shod with metal. (If necessary, a second screed shall be provided for striking off the bottom layer of concrete).

The screed shall then be placed on the forms and slip along them, without lifting, in a combined longitudinal and transverse shearing motion moving always in the direction in which the work is progressing. If necessary this shall be repeated until the surface is of uniform texture, true to grade and contour, and free from porous areas.

h) Edging at Forms and Joints

After the concrete's initial set, the edges of the pavement along each side of each slab, and on each side of transverse expansion joints, planes of weakness except when sawed transverse construction joints, and emergency construction joints shall be worked with an approved tool and rounded to a radius of 5 mm. A well defined and continuous radius shall be produced and a smooth, dense mortar finish obtained. The surface of the slab shall not be unduly disturbed by tilting of the tool during use.

All joints shall be tested with a straight edge before the concrete has set, and correction shall be made if one side of the joint is higher than the other or if they are higher or lower than the adjacent slabs.

i) Surface Texture

The surface of the carriage-way shall be textured by wire brushing in a direction at right angles to the longitudinal axis of the carriage-way. The pavement shall be given this broomed texturing as soon as surplus water has risen to the surface.

The wire brushes shall be either mechanically operated or manual methods may be allowed depending upon the type of paver being used on the Work. In either case the wire broom shall be not less than 450 mm wide with two rows of spring steel. At least two brooms in working order shall be on the site at all times.

The surface texturing shall be completed before the concrete is in such condition that the surface is torn or unduly roughened by the brooming. The broomed surface shall be free from rough areas, porous areas, irregularities, or depressions.

j) Surface Requirements

After the concrete has hardened sufficiently, the surface shall be given a further test for tureens, using an approved 3 m straight edge laid on the surface. Any portion of the surface, when tested in the longitudinal direction, which shows a variation or departure from the testing edge of more than 3.5mm but not exceeding 7mm shall be marked and immediately ground down with an approved grinding tool until the variation does not exceed 3.5mm.

Whenever the variation or departure from the testing edge is more than 7.0mm the pavement shall be removed and replaced. Such removal shall

be of the full depth and width of the slab and at least 3m long.

k) Curing

Immediately after the surface texturing, the surface and sides of the slab shall be cured by approved curing method for not less than 7 days. During this period measures shall be taken to prevent the loss of moisture.

The concrete shall not be left exposed between stages of curing.

The surface shall be inspected regularly to ascertain the earliest time at which it is able to withstand the spreading of moisture retaining material. This shall be by ponding of water or spreading and wetting either two layers of burlap or two mats of cotton / jute or a layer of sand or other approved highly absorbent material. Whatever material is used it shall be kept continuously moist for not less than 7 days and to a degree which will ensure that 100% humidity is maintained adjacent to the concrete surface. A membrane curing compound meeting the requirements of BS 7542 may be used subject to the consent of the Engineer.

Concrete surfaces which are subjected to heavy rainfall within three hours after the curing compound has been applied shall be resprayed by the method and the coverage specified above.

Concrete surfaces to which membrane curing compounds have been applied shall be adequately protected for the duration of the entire curing period from the pedestrian and vehicular traffic, except as required for joint sawing operations and surfaces tests, and from only other cause which will disrupt the continuity of the membrane. The curing membrane so formed shall be maintained intact for a period of not less than 14 days. The entire surface shall be protected from the effects of solar radiation and in addition by the use of frames covered with material with heat and light reflecting properties.

Concrete liable to be affected by running water shall be adequately protected from the damage during the setting period.

l) Removing Forms

Forms shall be removed only after stipulated period and carefully so as to avoid damage to the pavement.

m) Protection of Pavement

The Contractor shall erect and maintain suitable barricades and shall employ watchmen to exclude public traffic and that of his employees and agents from the

newly constructed pavement until opened for use. These barriers shall be arranged as not to interfere with public traffic on any lane intended to be kept open and necessary signs and lights shall be maintained by the Contractor clearly indicating any lanes open to the public.

Where any stipulated public traffic lane is contiguous to the slab or lane being placed, the Contractor shall provide, erect, and subsequently remove a substantial temporary guard fence along the prescribed dividing line, which shall be maintained there and protected by signages until the slab is opened to traffic. The Contractor's plan of operation shall be such as to obviate any need for encroachment on the public traffic lane or lanes under use.

The same shall be approved by the local competent authority. Any part of the pavement damaged by traffic or other cause prior to its final acceptance shall be repaired or replaced by the Contractor.

n) Sealing Joints

Before the pavement is opened to traffic, and as soon after the curing period as is feasible, all joints both longitudinal and transverse, shall be filled with the material approved for use as seal.

Both primer and sealing compound shall be treated and applied strictly in accordance with the manufacturer's specifications/ instruction and by use of approved equipment.

The sealing material shall be poured into each joint opening as directed by the Engineer. The pouring shall be done in such a manner that the material will not be spilled on the exposed surfaces of the concrete. Any excess material on the surface of the concrete pavement shall be removed immediately and the pavement surface cleaned.

CHAPTER-7: ITEMS INCLUDED IN SCHEDULE-B

7.1 Schedule B1

This Schedule includes items of work based on North Western Railways Unified Standard Schedule of Rates (NWR USSOR)-2019

The scope of work, specifications, method of measurement and payment for items included in Schedule No. B1 shall be governed by NWR USSOR and Indian Railway Unified Standard Specifications (Formation works, Bridges and P.way Works) – 2019.

7.2 Schedule B2

This Schedule includes items of work based on Northern Railways Unified Standard Schedule of Rates (NR USSOR)- 2010

The scope of work, specifications, method of measurement and payment for items included in Schedule No. B2 shall be governed by NR USSOR and Indian Railway Unified Standard Specifications for Works and Material – 2010.

7.3 Schedule B3

This Schedule includes items of work based on Delhi Schedule of Rates (DSR), 2021

The scope of work, specifications, method of measurement and payment for items included in Schedule B3 shall be governed by DSR 2021 and CPWD Specifications - 2019.

7.4 Schedule-B4

This Schedule includes Non-Schedule (NS) items.

7.4.1 NS Item No. 1: Earthwork in Railway Embankment

Earthwork in embankment for 32.5t axle load and as per RDSO specification No. RDSO/2020/ GE:004 September 2020 "Comprehensive Guidelines and Specification for Railway Formation" with contractor's own earth from borrow areas including all lead, lift, ascent, descent, royalty, taxes, cess, compensation, crossing of nallahs /stream and other obstructions including mechanical compaction in layers with watering, handling, re-handling, dressing of banks to the final profile with all labour, material, tools, plant, machinery and equipment, taxes, cess etc. as a complete job in accordance with the specification and drawings.

Note: 10% of payment shall be withheld till the slopes are dressed to the required profile and compacted mechanically with vibratory slope rollers as per RDSO guidelines.

I. Method Statement

The Contractor shall submit Method Statement for carrying out earthwork in embankment to the Engineer for approval.

II. Execution

Earthwork in embankment shall be carried as per Clause 3 of Section VII-5: Employer's requirements-ODS-Civil and Chapter 2 of Section VII-6: Employer's Requirements-OCS-Civil

III. Method of Measurement

Measurement for payment for earthwork in embankment shall be in-situ volume as measured in cubic meter (cum) from the levels recorded prior to any filling work and the lines and grades shown on the Drawings or established at the Site by the Engineer. Payment shall be made at the Unit Price per cubic metre, entered in the Priced Bill of Quantities. 10% payment shall be withheld till the slopes are dressed to the required profile and compacted mechanically with vibratory slope rollers as per RDSO guidelines.

7.4.2 NS Item No. 2: Blanketing material

Supplying and laying blanketing material produced through mechanical means using crushers and pug mill for 32.5 T axle load as per RDSO specification No. RDSO/2020/GE:004 September 2020 "Comprehensive Guidelines and Specification for Railway Formation" over the top of subgrade including all lead, lift, ascent, descent, royalty, taxes, cess, crossing of nallahs /stream and other obstructions including mechanical compaction in layers not exceeding 300 mm thick with vibratory rollers, watering, handling, re-handling and dressing of formation to the final profile with all labour, material, tools, plants, machinery and equipment, taxes, cess, etc. as a complete job in accordance with the specification and drawings.

Note: 10% of payment shall be withheld till the slopes are dressed to the required profile and compacted mechanically with vibratory rollers as per RDSO guidelines.

I. Method Statement

The Contractor shall submit Method Statement for providing blanketing to the Engineer for approval.

II. Execution

i. After conducting necessary tests and field trials the Contractor shall get the blanket material approved from the Engineer.

ii. The work of blanketing shall be carried out in accordance with RDSO specification No. RDSO/2020/GE:004 September 2020 "Comprehensive Guidelines and Specification for Railway Formation".

III. Method of Measurement

Measurement for payment of blanketing shall be as per the cross section shown in the Drawings or established at the Site by the Engineer. Payment will be made at the Unit Price per cubic metre, entered in the Priced Bill of Quantities. 10% payment shall be withheld till the slopes are dressed to the required profile and compacted mechanically with vibratory slope rollers as per RDSO guidelines.

7.4.3 NS Item No.3: Reinforced Cement Concrete

Supplying and laying in position M-35 RCC as per approved design mix with admixtures and manufactured in fully automatic batching plant and transported to site of work in transit mixer for all lifts & leads, having continuous agitated mixer, pumping concrete from transit mixer to site of laying, compacting, finishing & curing, with all labour, material, tools, plants, machinery and equipment, taxes, cess etc., as a complete job ,but excluding supplying & fixing form work (centering & shuttering), in accordance with the specification and drawings.

Notes: –

(i) Cost of cement is included in the above item.
(ii) Cost of Reinforcement steel is not included in the above item and will be paid separately under relevant item of Schedule B1.
(iii) Cost of supplying & fixing form work (centering & shuttering) is not included in the above item (except pile cap & open foundation) and will be paid separately under relevant item of Schedule B1

I. Method Statement

The Contractor shall submit Method Statement for carrying out the work of bridges to the Engineer for approval. The work shall be carried out strictly in accordance with the approved Method Statement, the Specification and the Drawings. RCC work shall comply with the provisions of Annexure OCS -1 & 2 of Section VII-6: Employer's requirements-OCS-Civil.

II. Method of Measurement

Measurement for payment of this item shall be the quantity of RCC worked out/measured in cum from the Drawings. Payment will be made at the Unit Price per cubic meter entered in the Priced Bill of Quantities.

7.4.4 NS Item No.4: Bored cast in-situ Piling

Boring 1200 mm diameter piles using Hydraulic Rig in all kinds of strata including boulder studded soil, underground structure like channel, sewer manholes, old foundation or any other obstruction, irrespective of sub-soil water level in all conditions whether dry or under water, shoe and temporary casing pipe, if required, with contractor plant, machinery & equipment for pile boring, use of bentonite slurry including all operations, cleaning of bore holes, supplying and laying in-situ with tremie pipe M-35 RCC in piles as per approved design mix with admixtures and manufactured in fully automatic batching plant and transported to site of work in transit mixer for all lifts & leads, having continuous agitated mixer, pumping concrete from transit mixer to site of laying including supplying & fixing form work (centering & shuttering), compacting, finishing, curing, chipping off pile top to remove laitance concrete above cut off level, removal and disposal of surplus excavated earth/debris/muck outside ROW including all lead, lift, ascends, descends, loading, unloading handling, re-handling, crossing of stream, nallahs, railway track, level crossing etc. with all labour, material, tools, plants, machinery and equipment, taxes, cess etc. as a complete job in accordance with the Specification and the Drawings.

Notes:

i. Cost of cement is included in the above item.
ii. Cost of Reinforcement steel is not included in the above item and will be paid separately under relevant item of schedule-B1.
iii. Cost of temporary casing pipe is included in the above item. However, the cost of permanent casing pipe is not included in this item and shall be paid separately under relevant item of schedule B1, if required and approved by the Engineer.

I. Method Statement

The Contractor shall submit Method Statement for carrying out the work of piling. The work shall be carried out strictly in accordance with the approved Method Statement, Manual on the design and construction of Well and Pile foundations, Sub-clause 3.5.3 to 3.5.9 of Section VII-6: Employer's requirements-OCS-Civil and Annexure OCS-1 & 2 of Section VII-6: Employer's requirements-OCS-Civil) and the Drawings.

II. Method of Measurement

The method of measurement for payment of piles shall be the length of pile in running metres from founding level to bottom of pile cap as established at the Site by the Engineer. Payment will be made at the Unit Price per running metre, entered in the Priced Bill of Quantities.

7.4.5 NS Item No.5: Earthwork in Filling

Earthwork in filling with contractor's own earth of approved quality from borrow areas including all lead all lead, lift, ascent, descent, royalty, taxes, cess, compensation, crossing of nallahs /stream and other obstructions including mechanical compaction in layers with watering to 95% of MDD (as per IS 2720 part 8), handling, re-handling, dressing to the final profile with all labour, material, tools, plant, machinery and equipment, taxes, cess etc. as a complete job in accordance with the specification and drawings.

I. Method Statement

This item will be used for earthwork in filling for other than Railway embankment. The Contractor shall submit Method Statement for carrying out the work to the Engineer for approval. The work shall be carried out strictly in accordance with the approved Method Statement.

II. Method of Measurement

Measurement for payment for earthwork in filling will be the in-situ volume as measured in cubic meter (cum) from the levels recorded prior to any filling work and the lines and grades shown on the Drawings or established at the Site by the Engineer. Payment will be made at the Unit Price per cubic metre, entered in the Priced Bill of Quantities. 10% payment shall be withheld till the slopes are dressed to the required profile and compacted mechanically with vibratory rollers

7.4.6 NS Item No.6: Self Supported Galvalume Roof

Providing, fabricating & laying of colour coated galvalume (Proflex system roofing) material for self supported roofing system , material shall be of following specification, BMT 0.90mm to 1.00mm,APT 0.95mm tolerance +/- 0.02mm thick ,Width 605 mm or as decided by railway (Tolerance +/- 2mm),including supplying, loading ,transporting, uploading & stacking at site ,fabricating and laying with all contractors tools, plants, machineries materials and fixtures labours including all lead and lift and laps/wastage if any etc. complete. The colour of sheet will be decided by the Engineer. The rate is also inclusive of designing of roofing system, proof checking and providing execution drawing. Fabrication and installation of self supported roofing.

I. Method Statement

The Contractor shall submit Method Statement for carrying out the work to the Engineer for approval. The work shall be carried out strictly in accordance with the approved Method Statement and the Drawings. The work shall comply with the

provisions of RDSO Repot No. RDSO/WKS/2015/3 -April'2015 on Self Supporting Roofing System.

II. Method of Measurement

Measurement for payment of this item shall be the area of roof in plan worked out/measured in square meter (Sqm) from the Drawings/site. Payment will be made at the Unit Price per Sqm entered in the Priced Bill of Quantities

7.4.7 NS Item No. 7: Stainless Steel Railing

Providing and fixing stainless steel (Grade 304) railing made of hollow tubes, channels, plates etc., including welding, grinding, buffing, polishing and making curvature (wherever required) and fitting the same with necessary stainless steel nuts and bolts complete, including fixing the railing with necessary accessories & stainless steel dash fasteners , stainless steel bolts etc., of required size, on the top of the floor or the side of waist slab with suitable arrangement as per approval of the Engineer, (for payment purpose only weight of stainless steel members shall be considered excluding fixing accessories such as nuts, bolts, fasteners etc.)

I. Method Statement

The Contractor shall submit Method Statement for fixing of stainless steel (Grade 304) for railing in staircase, balconies, pedestrian subway, Enquiry/Reservation counters to the Engineer for approval. The work shall be carried out strictly in accordance with the approved Method statement and the Drawings.

II. Material

The stainless steel (304 grade) shall conform to IS 6911 : 2017. Fabrication of railing shall be done as shown in the Drawings. Fabrication of all stainless-steel sections should be done only with tools dedicated to stainless steel materials. Tooling and work surfaces must be thoroughly cleaned before use.

Following items shall be ensured:

i. Removal of all moisture by blowing with dry air or heating with a torch.
ii. Elimination of organic contaminates like oil, paints, anti-spatter compounds, grease, pencil marks, cutting compounds, adhesive from protective paper, soap used for leak testing etc.
iii. Plasma cutter to be used for cutting stainless steel.
iv. Zinc contamination to be avoided.
v. Brushes or tools previously used on galvanized steel not to be used.

III. Fixing

Railing shall be fixed with necessary accessories and stainless-steel dash fasteners & stainless-steel bolts etc. of required size, on the top of the floor or the side of waist slab with suitable arrangement as per approval of the Engineer.

IV. Method of Measurement

Only weight of stainless-steel members shall be considered in kg for the purpose of measurement. Fixing accessories such as nuts, bolts, fasteners etc. shall be deemed to be included in this item and shall not be paid separately. The rate shall include the cost of materials and labour involved in all the operations described above. Nothing extra shall be paid for fixing arrangements i.e. drilling, providing nuts & bolts etc.

7.4.8 NS Item No. 8: H- beam sleeper

Supplying, fabricating, transportation and fixing galvanized H-Beam sleepers as per RDSO drawing RDSO/B/1636/4/R & RDSO/B/1636/5 with latest alteration and specifications thereto complete with all fittings and fixtures including the cost of all steel sections, all fittings and fixtures ,elastomeric pad, galvanized bolts, nuts, washer, split pin, fish plates 1m and 0.6m long along with fish bolts and nuts for 60Kg running rail and 52Kg guard rail respectively, track fittings and fastenings (Zero Toe Load Fastening) for 60 kg running rail and 52 Kg guard rail as per RDSO drg -RDSO/T-8759 to RDSO/T8765. labour, lead, lift, plants and equipment including galvanized work of full steel components complete in all respects as per approved drawing and technical specifications & as per direction of Engineer on Open Web Girder (OWG) bridges. The rate is also inclusive of the cost of supply of approved quality of epoxy/adhesive and fixing of elastomeric pads with different components of steel sleepers & girder in accordance with approved drawings. The steel to be supplied by the contractor for fabrication of steel H-Beam sleepers shall conform to IS-2062-2006, Grade B0 only. The rate is also inclusive of inspection charges of components of sleepers including all fixtures & fastening, galvanization etc. from the reputed laboratory/organization. Elastomeric pad plate and other track fittings shall be procured from RDSO approved source.

Notes: Payment under this item shall be made in following manner;

i. 75% of the rate shall be paid after fabrication, galvanization and transportation of H beam sleepers to the site and submission of material test certificate of manufacturer and inspection certificate of the agency nominated by the Engineer.
ii. 15% of the rate shall be paid after supply of fittings to the site and submission of inspection certificate of the agency nominated by the Engineer.
iii. iii. 10% of the rate will be paid after fixing H Beam sleepers to the girder in satisfactory manner.

iv. In case fixing is not required, then balance payment will be released on handing over of the sleepers after making recovery @ Rs.850/- per sleeper.

I. Method Statement

The Contractor shall submit Method Statement for fabrication and inspection/testing of steel-H beam sleeper and its fittings/fixtures to the Engineer for approval.

II. Execution

i. Steel used for fabrication of H-beam sleepers shall be of grade E-250 B0 quality as mentioned in para 8.2 of IRS B 1-2001.

ii. H-beam sleepers shall be fabricated as per RDSO drg. RDSO/B-1636/4/R & RDSO B-1636/5 & RDSO specification No. BS: 45 and other relevant specifications.

iii. Tie angle on H-beam sleepers can be dispensed with.

iv. All track fittings shall be procured from RDSO approved source. H- beam sleeper and fittings shall be inspected and passed by agency approved by the Engineer at the fabricator's/ manufacturer's works before supply.

III. Measurement

Measurement of H-beam sleepers shall be done in number. Payment under this item shall be made in following manner.

i. 75% of the rate shall be paid after fabrication, galvanization and transportation of H beam sleepers to the site and submission of material test certificate of manufacturer and inspection certificate of the agency nominated by Engineer.

ii. 15% of the rate shall be paid after supply of fittings to the site and submission of inspection certificate of the agency nominated by Engineer.

iii. 10% of the rate will be paid after fixing H Beam sleepers to the girder in satisfactory manner. In case fixing is not required, then balance payment will be released on handing over of the sleepers after making recovery @ Rs.850/- per sleeper.

7.4.9 NS Item No.9: Pathway on Open Web Girder Bridges

Supplying, fabrication and fixing pathway on Open Web Girder bridges with hollow steel, rolled and chequered plate including welding / bolting, priming painting with one coat ready mix Zinc Chromate conforming to IS:104 with DFT of 25-30Microns, followed by one coat of Zinc Chrome red oxide conforming to IS:2074 with DFT of 25 Microns with all material, labour, T&P as a complete job as RDSO drawing No. CBS 0045

I. Method Statement

The Contractor shall submit Method Statement for carrying out the work of pathway on OWG bridges to the Engineer for approval. The work shall be carried out strictly in accordance with the approved Method Statement, the Specifications and the Drawings. The work shall comply with the provisions of Annexure OCS-3 of Section VII-6: Employer's Requirements-OCS-Civil. Hollow steel sections shall conform to IS: 4923, steel tube sections to IS: 1148, chequered plate to IS:3502 and rolled sections to IS:2062.

II. Method of Measurement

Measurement for payment of this item shall be the weight of metal in the fabricated structure worked out/computed on the basis of nominal weight of materials and exact cut size of the member used in the structure as per drawing in MT. No additional payment shall be made for welds, bolt & nuts etc. Payment will be made at the Unit Price per MT entered in the Priced Bill of Quantities.

7.4.10 NS Item No. 10: Protection work using Precast CC blocks

Casting, supplying and laying of Pre-cast CC blocks of size 25x25 x20cm. or of required size as directed by the Engineer for protective works at bridges & banks like pitching, flooring, etc. using M20 design concrete mix with 20mm aggregate size including Contractor's shuttering, leading to bridge site from casting depot, including dressing and levelling of surface, providing gravel backing, laying & jointing blocks with cement mortar 1:3 with Contractor's labour and as directed by Engineer-in-charge (All labour and material including cement by contractor).

Notes:

i. Cost of cement is included in the item

ii. Payment for gravel backing will be paid under. NS item no -11of this Schedule.

iii. 60% Payment shall be made after casting of pre-cast concrete blocks and bringing them at work site. The balance 40% will be made on completion of laying and finishing.

iv. Measurement is based on quantity calculation of blocks used only (no. of blocks x volume of one block).

I. Method Statement

The Contractor shall submit Method Statement for, supplying and laying of precast concrete blocks for protective works at bridges to the Engineer for approval. The work shall be carried out strictly in accordance with the approved Method Statement and Tender drawings (GC-HRIDC-SK-GEN-015) given in Section VII-8: Tender Drawings and Documents, Part-2 Employer's Requirements.

II. Material

The work shall consist of precast cement concrete blocks in M-20 grade of size 25 cm x 25 cm x 20 cm in a casting yard. The Contractor shall establish a casting yard for manufacture of precast cement concrete blocks. The casting yard shall have facilities for casting, compaction by mechanical vibration, curing and loading of cement concrete block into trucks/tractor trollies. Concrete shall conform to Annexure OCS -1 of Section VII-6: Employer's requirements-OCS-Civil.

III. Execution

a) Before laying the pitching, the sides of banks shall be trimmed to profile and compacted by vibratory roller to the required slope and profiles marked by means of line and pegs at intervals of 3 metres to ensure regular straight work and a uniform slope throughout. Depressions shall be filled and thoroughly compacted.
b) A layer of 150 mm thick well graded gravel/ stone aggregate shall be laid over prepared earth slope, watered and compacted.
c) Over the compacted gravel/stone aggregate layer, a RCC grid frame of size 1750 mm x 1750 mm of M-35 grade concrete shall be laid. After these grids have attained sufficient strength pre-cast CC block shall be placed inside the grids. The joints of CC blocks shall be sealed with cement mortar 1:3.
d) Toe wall shall invariably be provided at the location of pitching. The pitching shall proceed from toe wall towards the top. Payment of toe wall shall be made separately under Schedule 'B1'

IV. Method of Measurement

Measurement shall be in cubic meter based on quantity calculation of only the blocks used (i.e. number of blocks x volume of one block). Payment of RCC used in grid frame shall be done under Item No. NS-3 of this Schedule.

7.4.11 NS Item No. 11: Gravel Base Layer Below Pre-Cast CC Block

Supplying and laying of 150mm thick well graded stones aggregate/gravel as base layer over the embankment slopes with manual dressing, watering & compaction including the cost of supply of all material, labour, lead, lift, tools, plants, crossing of tracks etc. complete as per approved drawings and technical specifications.

I. Method Statement

The contractor shall submit method statement for laying of stone aggregate/gravel layer to the Engineer for approval.

II. Material

Stone aggregate/gravel for base layer shall be hard & well graded. Maximum particle size shall be limited up to 40 mm and fines (particle <75micron) shall be limited upto 12%.

III. Execution

Stone aggregate/gravel shall be laid in uniform layer over levelled and compacted embankment slopes. Base layer shall be watered and compacted manually before laying of CC blocks.

IV. Method of Measurement

Measurement shall be in cubic meter based on the area and thickness of layer.

7.4.12 NS Item No.12: Boulder Backing

Providing Boulder Backing behind wing wall, return wall, retaining wall with hand packed boulders & cobbles not less than 15cm in any direction & not less than 15kg (except smaller boulders required for filling voids) including all lead, lift, labour & other incidental charges as complete work in all respect. Cost of boulder/cobbles is included in this item.

I. Method Statement

The Contractor shall submit Method Statement for carrying out the work to the Engineer for approval. The work shall be carried out strictly in accordance with the approved Method Statement.

II. Method of Measurement

Measurement for payment of this item shall be the quantity of boulder backing worked out/measured in cum from the Drawings/site. Payment will be made at the Unit Price per cubic meter entered in the Priced Bill of Quantities.

7.4.13 NS Item No. 13: Weep Holes

Providing and fixing of 75mm dia PVC pipe for weep holes in abutments, Wing Wall, Return Wall, Face wall, retaining wall etc. at suitable intervals as directed by the Engineer-.

I. Method Statement.

The method statement for providing and fixing of weep holes shall be submitted by the Contractor to the Engineer for approval. The pipes for weep holes shall be UPVC pipe, Type A conforming to IS:13592

II. Execution

Pipe for weep holes shall be placed at the specified locations and spacing in abutment, return walls and retaining walls etc. as shown in the Drawings.

III. Method of Measurement

Measurement for payment for weep holes shall be in running metres as shown in the Drawings.

7.4.14 Item No.14: Precast RCC Retaining Wall

Manufacturing, transportation (including loading & unloading) and installation in position (including joining and grouting) M-50 or higher grade precast reinforced cement concrete segmental retaining walls of specified height (height measured from founding level) as per the directions of the Engineer. Precast reinforced retaining walls shall be factory-made, and steam cured in a controlled environment with weep holes and in-built inserts for handling/ transportation. Dimensional tolerances shall be as per IS: 6408 (part 2) for PC Class 6.

Notes:

1. This item includes cost of all the materials, labour, machinery, tools & plant etc. complete required for manufacture of precast segments except Steel Reinforcement which shall be paid separately under relevant item of schedule B1.

2. Boulder Backing and backfilling of filter media behind wall shall be paid separately under NS-12 of this schedule and relevant item of schedule B1.

3. Excavation of soil for foundation shall be paid separately under item (USSOR item No. 022010) of Schedule B1.

4. Before placing of wall segments, 20 mm thick stiff 1:3 cement mortar bedding layer shall be laid over a levelling course of 150 mm thick of M20 concrete. Payment for M20 concrete shall be made under relevant item (USSOR-2019 item 022040) of Schedule B1and for mortar under relevant item (DSR Item no. 3.8) of Schedule- B3.

5. 60% of the rate shall be paid on receipt of the precast retaining wall segments at site and balance 40% will be paid on fixing the same in position in satisfactory condition.

I. Method Statement

The Contractor shall submit detailed design & drawings and Method Statement for carrying out the work to the Engineer for approval. The work shall be carried out strictly in accordance with the approved Method Statement and the Drawings. RCC work shall comply with the provisions of Annexure OCS -1 & 2 of Section VII-6: Employer's requirements-OCS-Civil. Special care shall be taken in lifting and transportation of precast segments to avoid impact and damage.

II. Method of Measurement

Measurement for payment of this item shall be the quantity of concrete in precast segment worked out/measured in cum from the Drawings. Payment will be made at the Unit Price per cubic meter entered in the Priced Bill of Quantities.

7.4.15 NS Item No.15: Precast RCC Drain with Cover

Manufacturing, transportation (including loading & unloading) and installation in position (including joining and grouting) M-50 or higher grade precast reinforced cement concrete U-shaped drain with cover as per the directions of the Engineer. Precast reinforced U-shaped drain shall be factory-made, and steam cured in a controlled environment with inserts for handling/transportation. Dimensional tolerances shall be as per IS: 6408 (part 2) for PC Class 6.

Notes: -

1. This item includes cost of all the materials, labour, machinery, tools & plant etc. complete required for manufacture of precast segments except Steel Reinforcement which shall be paid separately under relevant item of schedule B1.
2. Excavation of soil for foundation shall be paid separately under item (USSOR item No. 022010) of Schedule B1.
3. Before placing wall segments, 20 mm thick stiff 1:3 cement mortar bedding layer shall be laid over a levelling course of 150 mm thick of M20 concrete. Payment for M20 concrete shall be made under relevant item (USSOR-2019 item 022040) of Schedule B1and for mortar under relevant item (DSR Item no. 3.8) of Schedule- B3.
4. 60% of the rate shall be paid on receipt of the precast drain segments at site and balance 40% will be paid on fixing the same in position in satisfactory condition.

I. Method Statement

The Contractor shall submit detailed design & drawings and Method Statement for carrying out the work to the Engineer for approval. The work shall be carried out strictly in accordance with the approved Method Statement and the Drawings. RCC work shall comply with the provisions of Annexure OCS -1 & 2 of Section VII-6: Employer's requirements-OCS-Civil. Special care shall be taken in lifting and transportation of precast segments to avoid impact and damage.

II. Method of Measurement

Measurement for payment of this item shall be the quantity of concrete in precast segment worked out/measured in cum from the Drawings. Payment will be made at the Unit Price per cubic meter entered in the Priced Bill of Quantities.

7.4.16 Item No. 16: Linking of Track on H- beam sleeper

Linking of track on H- beam sleepers on Open Web Girder (OWG) bridges with 60 Kg running rail and 52 kg guard rail with track fittings/fastenings including leading of Running and guard rails from bridge approach and fixing of running rails & guard rails, bending of guard rails, notching, drilling of holes, cutting of rails etc., as directed and making track structure fit for normal speed. (Rails will be supplied by the Employer free of cost)

I. Method Statement

The Contractor shall submit Method Statement for linking of track to the Engineer for approval.

II. Execution

i. Running rail and guard rail shall be fixed on H- beam sleeper as per assembly drawings (No. RDSO/T-8759 to RDSO/T-8765 with latest alterations/corrections) and provisions of IRPWM.

ii. Holes in the flange of guard rail shall be drilled after fixing the sleeper and running rail in position.

iii. Track shall be fit for normal speed and tolerances shall be as per permissible limits specified in IRPWM.

III. Measurement

Measurement for payment of linking of track shall be done in running track meter

7.4.17 NS Item No.17: MS angle expansion Joint

Supplying and fixing M.S. Angles 100 mm x 100 mm x 10mm size conforming to IS:2062 in expansion joint of Composite girder bridges including provision of 10mm dia dowel bar & 12mm dia anchor bolts at 150 mm centre to centre, and 250mm wide GI plate over the top of angles as per relevant RDSO standard drawing with all material, labour, T&P as a complete job.

I. Method Statement

The Contractor shall submit Method Statement for carrying out the work of expansion joint in composite bridge girders to the Engineer for approval. The work shall be carried out strictly in accordance with the approved Method Statement, the Specifications and the Drawings. The work shall comply with the provisions of Annexure OCS-3 of Section VII-6: Employer's Requirements-OCS-Civil. Mild steel bolt and nuts shall conform to IS: 226 & IS: 1148 but shall have minimum tensile strength of 44 Kg/sqm and minimum percentage elongation of 14.

II. Method of Measurement

Measurement for payment of this item shall be the length of the expansion joint across the track measured/worked out in meter as per the Drawings. Payment will be made at the Unit Price per meter entered in the Priced Bill of Quantities.

7.4.18 Item No.18: Metallic Guided bearing

Supply and fixing of Metallic Guided Bearing in position true to line and level as per RDSO drawing No. RDSO/B-11754/3R2 and IRC:83 pt. III-2018 including supply & grouting of anchor bolts with approved non-shrinking epoxy grout with all material, labour, T&P as a complete job.

I. Method Statement

The Contractor shall submit Method Statement for carrying out the work to the Engineer for approval. The work shall be carried out strictly in accordance with the approved Method Statement, the Specifications and the Drawings.

II. Method of Measurement

Measurement for payment of this item shall be in number. Payment will be made at the Unit Price per unit entered in the Priced Bill of Quantities.

7.4.19 NS Item No.19: Bed Plate

Supply, fabrication and erection of bed plate of approved sizes as per relevant RDSO drawing No. RDSO/B-11751/4R2, B-11753/5R1, B-11754/3R2 with upto date corrections, in exact position over bed block on pier/abutments by giving full and even bearing, setting them on the layer of free flow non-shrinkable grouting compound, scrapping or chipping of bed block, if required, fabrication and fixing of HD bolts of suitable sizes along with nuts, washers etc., grouting of holes by epoxy mortar after fixing HD bolts with all labour, material, T & P as a complete job..

I. Method Statement

The Contractor shall submit Method Statement for carrying out the work to the Engineer for approval. The work shall be carried out strictly in accordance with the approved Method Statement, the Specifications and the Drawings. The work shall comply with the provisions of Annexure OCS-3 of Section VII-6: Employer's Requirements-OCS-Civil.

II. Method of Measurement

Measurement for payment of this item shall be the weight of metal in the fabricated structure worked out/computed on the basis of the drawing in Kilogram. No additional payment shall be made for bolt & nuts etc and no deductions shall be made for holes.

Payment will be made at the Unit Price per kg entered in the Priced Bill of Quantities. Payment will be made at the Unit Price per unit entered in the Priced Bill of Quantities.

7.4.20 NS Item No.20: Precast RCC Facia Panels of RE Wall

Designing, Providing and erection of specified grade precast RCC Facia Panel of thickness 180 mm made with M-35 Grade Concrete Batching plant, Transit Mixer, Concrete Pump and Vibrator for retaining earth with all element and accessories including reinforcing element complete as per approval drawing and Section 3100 of MORT&H specification including all material labour machinery etc. (Scope of work including designing, getting approval, casting in yad, curing, storing, Transporting, lifting, placing in position, erection with all necessaries fasteners etc complete). The cost of cement & steel are include in this item & no separate payment shall be paid whatsoever. The rate also include cost for excavation, foundation, reinforcing element, fasteners, drainage layer, drain pipe, coping beam and other accessories for which nothing extra shall be paid.

Mode of Payment:

1- **Casting of RE Panel: 60%**
2- **Erection & fixing: 35 %**
3- **Completion in all respects: 5%**

I. Method Statement

The Contractor shall submit detailed design & drawings and Method Statement for carrying out the work to the Engineer for approval. The work shall comply with the provisions of Section 3100 of MORTH Specifications for Road and Bridge Works. Geogrid shall be used as reinforcing element. The work shall be carried out strictly in accordance with the approved Method Statement and the Drawings. RCC work shall comply with the provisions of Annexure OCS -1 & 2 of Section VII-6: Employer's requirements-OCS-Civil. Special care shall be taken in lifting and transportation of precast segments to avoid impact and damage.

II. Method of Measurement

Measurement for payment of this item shall be the area of precast facia panels worked out/measured in Sqm from the Site/Drawings. Payment will be made at the Unit Price per Square meter entered in the Priced Bill of Quantities.

7.4.21 NS Item No.21: Back Fill in RE Wall

Providing Placing & Compacting to desired density approved backfill material in layers as per approved methodology including testing of reinforced fill portion in approaches

between reinforced soil (RS) wall panels as per approved drawing as per Section 3103 of MORT&H Specification. The soil should be predominantly coarse grained, not more than 10 % of particles should pass 75 micron sieve. The item shall be measured and paid for the finished volume of backfill and sub-grade placed in position excluding the volume of filter media at base and behind the RE Wall.

I. Method Statement

The Contractor shall submit Method Statement for carrying out the work to the Engineer for approval. The work shall comply with the provisions of Section 3100 of MORTH Specifications for Road and Bridge Works. Geogrid shall be used as reinforcing element. The work shall be carried out strictly in accordance with the approved Method Statement and the Drawings.

II. Method of Measurement

Measurement for payment of this item shall be the quantity of back fill worked out/measured in cum from the Drawings/site. Payment will be made at the Unit Price per cubic meter entered in the Priced Bill of Quantities.

7.4.22 NS Item No.22: RCC Crash Barrier

Providing & constructing of RCC Crash Barrier of M35 at the edge of road , approaches to bridge structures and medians, constructed with specified grade of concrete using batching plant , transit mixer, concrete pump and vibrator with 450 mm long at expansion joint filled with premolded asphalt filler board, keyed to the structure on which it is built and installed as per design and dimension in the approved drawing and at location directed by the engineer, all as specified as per Section 809 of MORT&H Specification including all material labour, scaffolding etc.

I. Method Statement

The Contractor shall submit Method Statement for carrying out the work to the Engineer for approval. The work shall be carried out strictly in accordance with the approved Method Statement and the Drawings. RCC work shall comply with the provisions of Annexure OCS -1 & 2 of Section VII-6: Employer's requirements-OCS-Civil.

II. Method of Measurement

Measurement for payment of this item shall be the quantity of concrete in crash barrier worked out/measured in cum from the Drawings/site. Payment will be made at the Unit Price per cubic meter entered in the Priced Bill of Quantities.

Annexure OCS-1

PLAIN AND REINFORCED CEMENT CONCRETE

1. MATERIALS

a. Before bringing to the site, all materials for concrete shall be approved by the Engineer. All approved samples shall be deposited in the office of the Engineer before placing orders for the materials with suppliers. The materials brought on to the works shall conform in every respect to their approved samples.

b. Fresh samples shall be deposited with Engineer whenever type or source of any material changes. The contractor shall check fresh consignment of materials as it is brought on to the works to ensure that they conform to the specifications and/or approved samples.

c. The Engineer shall have the option to have any of the materials tested to find whether they are in accordance with specifications at the contractor's expense. All bills vouchers and test certificates which in the opinion of the Engineer are necessary to convince him as to the quality of materials or their suitability shall be produced for his inspection when required.

d. If fly ash is used in concrete, the contractor shall demonstrate the quality control procedure including source of fly ash, its properties, handling as per the relevant IS & international codes etc. and shall use in slabs and walls only after "no objection" to the same has been obtained from the Engineer.

e. Any materials which have not been found to conform to the specifications and not approved by the Engineer shall be rejected forthwith and shall be removed from the site by the contractor at his own cost within the time stipulated by the Engineer. The Engineer shall have the powers to cause the contractors to purchase and use materials from any particular source, as may in his opinion be necessary for the proper execution of work.

f. Contractor shall also ensure that all constituents of exposed concrete shall be taken from same sources to achieve a uniform colour and texture.

g. Approved list of Manufacturer's/Suppliers is given in Section VII- 8:Tender Drawings and Documents. In case the Contractor desired to procure the material from any other supplier, it shall be got approved by the Engineer.

2. Cement

2.1 Product and Materials for Cement

a. Cement to be used in the works shall conform to 53-grade OPC (IS 269:2015) or blended cement such as Portland Pozzolana Cement (IS 1489:2015) or Portland Slag Cement (IS 455:2015).

b. The Contractor shall submit to the Engineer the Manufacturer's Certificate to affirm that the cement complies with the relevant standards.

c. Samples of the proposed cement shall be taken and forwarded to an independent laboratory for analysis before the source is approved.

d. Prior to ordering cement, the Contractor shall submit details of the proposed supplier or manufacturer and information on the proposed methods of transport, storage and certification for the Engineer's approval and show that the quantity and quality required can be attained and maintained throughout the construction period. In exposed concrete elements, the cement used in the concrete for entire element shall preferably be from a single manufacturer to ensure uniform colour.

e. Subsequent to obtaining the Engineer's approval, the Contractor shall not change the agreed arrangements without the prior approval from the Engineer. Each delivery of cement shall be accompanied by a certificate which shall be submitted to the Engineer immediately after the delivery showing the place of manufacture and the results of standard tests carried out by the manufacturer.

2.2 Testing for Cement

a. Samples shall be tested from every batch of cement delivered on site or once for every 1000 bags whichever is more frequent. The sampling from bulker shall be increased as decided by the Engineer.

b. Samples shall be taken immediately on receipt of cement at site. The methods and procedures for sampling shall be in accordance with IS: 3535.

c. Tests shall be carried out as per IS4031 for physical analysis as fineness, initial and final setting time and compressive strength and results approved by the Engineer before use. The contractor shall provide complete facilities at site for carrying out the following tests:

   i. Setting time by vicat's apparatus as per IS:5513 and IS:4031.

   ii. Compressive strength of cement as per IS: 4031, IS:650, IS:10080.

d. The Engineer may require any other form of sampling and tests including chemical analysis. Total chloride content in cement and total sulphur content calculated shall in no case exceed the requirements of Table 2 of IS 269. In case the cement supplied is of

doubtful quality, tests shall be done in accordance with IS 4032. The costs of such additional tests shall be borne by the Contractor.

3. Aggregates

3.1 General

Aggregates shall conform to the provisions specified in IS 383:2016. The contractor shall submit to the Engineer certificates of grading and compliance for all consignments of aggregate. In addition, at site from time to time, the contractor shall allow for carrying out tests and for supplying test records to the Engineer. Prior to commencing any concrete work, the Contractor shall obtain the Engineer's approval of the proposed types and sources of aggregate.

For fair faced concrete, the contractor shall ensure that aggregates are free from iron pyrites and impurities, which may cause discoloration. Aggregates shall be stored on paved areas in different compartments according to their nominal size.

Sampling of aggregates shall be as per IS 2430.

3.2 Fine Aggregates (Sand)

a. The grading of the sand shall conform to IS:2386(Part1). The grading of fine aggregate shall be within the grading zones I, II, III. Sand, if found too coarse, shall be suitably blended with finer sand obtained from approved sources to obtain the desired grading. The provision of two types of sand, their separate stacking and their mixing in the specified proportions shall be at the Contractor's own cost.

b. The sand shall not contain silt, shale, clay and other weak particles for more than a total of 3% by weight. In case of sand containing excess silt, clay and chlorides, the sand shall be washed in screw type mechanical washers in potable water to remove the same. The screening and washing of sand shall be completed at least one day before using it in concrete. The washed sand shall be stored on a sloping platform while ensuring that contamination is avoided.

c. Water absorption shall be less than 3% by weight (ASTM C 117)

d. The sand shall be screened on a 4.75 mm size screen to eliminate oversized particles. The Contractor shall carry out the following tests at Site and ensure that the appropriate provisions of Indian or other standards, as may be applicable, are complied with:

    i. Proportion of clay, silt and fine dust by sedimentation method as per IS 383:2016 and IS 2386 (Part II)

    ii. Moisture content in fine aggregate as per IS 2386(Part III)

    iii. Water absorption shall be worked out as per IS 2386(Part III)

    iv. Bulk Density or bulkage as per IS 2386(Part III)

v. Grading of fine aggregate asper IS 383:2016 and IS 2386(Part I)

3.3 Coarse Aggregates

a. All coarse aggregate shall conform to IS: 383 and tests for conformity shall be carried out as per IS: 2386, Parts I to VIII.

b. The maximum size of coarse aggregate shall be such that the concrete can be placed without difficulty so as to surround all reinforcement thoroughly and fill the corners of formwork. The grading of coarse aggregate shall be such that not more than 5% shall be larger than the maximum size and not more than 10% shall be smaller than the smallest size. Between these sizes the coarse aggregate shall be well graded. Unless otherwise permitted by the Engineer the nominal maximum size shall not exceed 20 mm.

c. Water absorption shall be less than 3% by weight (ASTM C 117)

d. Coarse aggregates used for the Works shall be crushed stone conforming to IS 383, obtained from approved sources by the Engineer. Only quarries having jaw crushers with choke feeding arrangements producing aggregates of nearly cubical shape shall be applied.

e. Coarse aggregate containing flat or flaky pieces or mica shall be rejected.

f. The Contractor shall carry out the following tests at site and ensure that the appropriate provisions of following Indian standards as may be applicable are complied with:

i. Moisture content in coarse aggregate asper IS 2386(Part III)

ii. Water absorption shall be worked out as per IS 2386(Part III)

iii. Bulk density and voids asper IS 2386(Part III)

iv. Grading of coarse aggregate as per IS 383:2016 and IS 2386(Part I)

4. Water

Water used in the works shall be potable water and free from deleterious materials. Water used for mixing and curing concrete as well as for cooling and/or washing aggregate shall be fresh and clean free from injurious amounts of oil, salts, acids, alkali, sugar other chemicals and organic matter. Mixing and curing with seawater shall not be permitted.

Water shall be from the source approved by the Engineer and shall be in accordance with IRS: CBC(Cl.4.3), IS: 456 (Cl. 5.4) and/or BS 3148.

Water samples from the intended source of supply shall be taken for analysis before any concrete work commences, and at regular intervals throughout the duration of the Works, as approved by the Engineer. Whenever the source of water changes, the water shall be tested for its chemical and other properties or impurities to ascertain its suitability for use

in concrete, subject to the approval of the Engineer. No water shall be used until tested and found satisfactory. Cost of all such tests shall be borne by the Contractor.

5. Chloride Content

The chloride content of aggregates shall be within the recommended limits stated in IS: 383 or BS 882 and the chloride content of the concrete mix shall be within the recommended limit of IS: 456 or BS 8110. Chloride levels shall be determined daily in accordance with the methods described in BS 812.

6. Alkali-Silica Reactivity

If aggregates contain any materials which are reactive with alkalis in any of the constituents of the concrete, or in water which will be in contact with the finished work, then the Contractor shall take samples of these materials every week. The Contractor shall ensure that the concrete mix complies with the requirements of this Specification regarding "Minimising risk of alkali-silica reaction in concrete". The results of the Contractor's weekly monitoring tests shall be submitted in writing to the Engineer-in-charge.

7. Sulphate Content

The total acid soluble sulphate content of the concrete mix, expressed as SO3, shall not exceed the recommended limit in IS: 456 or BS 8110.

8. Reinforcement Steel

The Contractor shall refer to Annexure - C of these Technical Specifications.

9. Binding Wire

GI wires of 1.6mm diameter shall be used for binding of reinforcements. It shall conform to the provisions laid down in IS 280.

10. Concrete Admixtures

a. Admixtures shall conform to the provision laid down in IRS: CBC (Cl. 4.4).

b. Concrete admixtures are proprietary items of the manufacturer and shall be obtained only from established manufacturers with proven track record, quality assurance and full- fledged laboratory facilities for the manufacture and testing of concrete. Naphthalene or melamine-based admixtures that are approved by the Engineer only shall be used in the Works. The admixture shall be non-air entraining type. The Contractor shall provide the following information concerning each admixture after obtaining the same from the manufacturer:

   i. Normal dosage and detrimental effects, if any, of under dosage and over dosage.

   ii. The chemical names of the main ingredients in the admixtures.

iii. The chloride content, if any, expressed as a percentage by weight of the admixture.

iv. Values of dry material content, ash content and relative density of the admixture which can be used for uniformity tests.

v. Whether or not the admixture leads to the entrainment of air when used as per the manufacturer's recommended dosage, and if so, to what extent.

vi. Where two or more admixtures are proposed to be used in any one mix, confirmation of their compatibility.

vii. Whether or not there would be an increase in risk of corrosion of the reinforcement or other embodiments as a result of using the admixture.

viii. Retardation achieved in initial setting time.

c. Physical and chemical requirements of admixtures shall conform to IS 9103. In addition, the following conditions shall be satisfied:

i. Plasticizers and superplasticizers shall meet the requirements indicated for "Water reducing Admixture".

ii. The air content of freshly mixed concrete, in accordance with the pressure method given in IS 1199, shall not be more than 1% higher than that of the corresponding control mix.

iii. There shall be no chloride content in admixture when tested in accordance with IS 6925.

iv. Uniformity tests on the admixtures are essential to compare qualitatively the composition of different samples taken from batch to batch or from the same batch at different times.

v. All tests relating to the concrete admixtures shall be conducted periodically at an independent laboratory and compared with the data given by the manufacturer.

vi. While qualifying the admixture, the infrared spectrograph plot shall be given. Each batch of the supply shall be tested for IR spectrograph and prove the consistency of supply.

11. Minimising the Risk of Alkali-Silica Reaction (ASR) in Concrete

a) Precautions against ASR in Concrete

Concrete mixes for use in the Permanent Works shall comply with one of the Subsections (b), (c) or (d). The Contractor shall notify the Engineer of his proposals for complying with this requirement.

b) The cementitious material shall have a reactive alkali content not exceeding a

maximum value of 0.6% by mass when defined and tested in accordance with Subsections 3.3.1 ((e) to (k) inclusive).

To combat the ASR, Microsilica shall be used in minimum 5% cement and shall not exceed 10% by the wt of cement in order to bind free alkalis early in plastic concrete and to reduce the permeability of concrete to prevent the moisture and external alkalis penetration.

OR

c) The total mass of reactive alkali in the concrete mix shall not exceed 3.0 kg/m^3 of concrete when defined, tested and calculated in accordance with Subsections 3.3.1 ((e) to (k) inclusive) and 3.3.1 ((l) to (o) inclusive).

OR

d) The aggregate shall be classed as non-reactive in accordance with the definition in Subsection (n).

e) Cementitious Material (Hydraulic and Latent Hydraulic Binders):

f) The term alkali refers to the alkali metals sodium and potassium expressed as their oxides. The reactive alkali content of Portland cements shall be defined as the percentage by mass of equivalent sodium oxide (Na_2O) calculated from:- % equivalent Na_2O = % acid soluble Na_2O + 0.658 x (% acid soluble K_2O)

g) The method used in determining the acid soluble alkali content of the materials shall be in accordance with BS 4550: Part 2: Subsection 16.2.

h) The Contractor shall make available the certified average acid soluble alkali content of Portland cement on a weekly basis.

i) The Contractor shall give immediate notice of any change which may increase the certified average acid soluble alkali content above the level used in the mix design for the concrete. A revised mix design for any concrete which would be affected by the increased alkali content shall be submitted for consent with notification of the change.

j) Minimising the Risk by Using Cementitious material Containing less than 0.6% Reactive Alkali

The requirements of Subsection (b) will be met by Subsection (k) provided that the contribution of alkalis from other sources does not exceed 0.2 kg/m3 (see Subsections and (u)). Where alkalis exceed 0.2 kg/m3 the requirements of Subsections (l) to (o) shall apply.

k) The cementitious material shall be Portland cement complying with Indian Standard and shall have additionally a certified maximum acid soluble alkali content not exceeding 0.6%.

l) The Contractor shall provide on request weekly certificates which name the source of the cement and confirm compliance with the Specification.

Minimising the Risk by Limiting the Reactive Alkali content of the concrete to 3.0 kg/m3. The requirements of Subsection (c) will be met provided that Subsections (m), (n) and are satisfied.

m) The reactive alkali content of the concrete contributed by the Portland cement to the concrete shall be calculated from:

Portland cement

$$A = \frac{C \times}{\frac{a}{100}},$$

Where,

A = reactive alkali content of the concrete to the nearest 0.1 (kg/m3) C = target mean Portland cement content of the concrete (kg/m3)

a = certified average acid soluble alkali content of the Portland cement (%).

n) Where reactive alkalis in excess of 0.2kg/m^3 are contributed to the concrete from sources other than the cementitious material the limit of 3.0 kg/m^3 from the cementitious material shall be reduced by the total amount so contributed.

The reactive alkali contributed by sodium chloride contamination of aggregates shall be calculated from:

$$H = 0.76x \frac{(NFxMF)+(NCxMC)}{100} \text{ (kg/m3)}$$

Where H = equivalent alkali contribution made to the concrete by the sodium chloride

NF = chloride ion content of the fine aggregate as a percentage by mass of dry aggregates and measured according to BS 812: Part 4

MF = fine aggregate content (kg/m3)

NC = chloride ion content of the coarse aggregate as a percentage by mass of dry aggregate and measured according to BS 812: Part 4: 1976 (now in draft as Part 117)

MC = coarse aggregate content (kg/m3).

The factor 0.76 is obtained from a consideration of the composition of sea water.

The chloride ion content of aggregate sources containing 0.01% of

chloride ion by mass or more shall be determined weekly in accordance with BS 812 or another approved method. When the chloride ion level is less than 0.01% it shall be regarded as nil.

o) The Contractor shall provide certificates on request confirming compliance with the Specification and stating:

i. The target mean cementitious material content of the concrete.

ii. The names of the works manufacturing the cement.

iii. A weekly report of the cement alkali determinations in accordance with Subsection (f).

iv. The certified average acid soluble alkali content of the Portland cement.

p) Minimising the Risk by Using Selected Aggregates

Fine and coarse aggregate material shall comply with the requirements of IS:383 (and/or AASHTO Standard Specifications M6 and M80 respectively) to be taken out to conform to 512(2).

q) Water

r) Water for use in the manufacture of concrete shall be obtained from a public utility undertaking supply or from a source approved by Engineer and shall be of potable quality, and comply with the requirement of IS:456 and or BS 3148

s) Where a potable mains supply is not available the Contractor shall obtain confirmation of the quality and reliability of the proposed source from the appropriate water authority and shall thereafter seek consent from the Engineer to use the proposed source.

t) Water other than from a public utility undertaking supply shall be sampled at a frequency to be determined by the Engineer and tested in accordance with the relevant provisions of IS:3025 or BS 3148. The sodium oxide and potassium oxide content shall be declared and expressed as equivalent Na_2O and shall be taken into account when calculating the total reactive alkali content of the concrete mix.

u) Admixtures and Pigments

Admixtures and pigments shall comply with the requirements of IS 9103 and IS:6925 or BS 5075 and BS 1014. The manufacturer's declared equivalent acid soluble alkali content and the dosage rate of any admixture or pigment to be incorporated shall be included with details of all concrete mixes submitted for consent.

v) The alkali content of admixtures shall be taken into account when determining the total equivalent alkali content of the concrete mix.

w) Micro silica (silica fume) shall be used in 5% by the weight of cement and shall not exceed 15% by the weight of cement.

12. Storage of Materials

12.1 General

a. Handling and storage of all material shall be as per IS 4082.

b. All materials shall be stored at proper places to prevent their deterioration or intrusion by foreign matter and to ensure their satisfactory quality and fitness for the work. The storage space shall also permit easy inspection, removal and restoring of the materials. All such materials even though stored in approved storage places, will be subjected to acceptance test prior to their immediate use.

c. The procedures to be adopted for transportation and storage of the materials shall obtain prior approval from the Engineer.

12.2 Cement

a. Cement shall be transported, handled and stored on the site in such a manner as to avoid deterioration or contamination. Cement shall be stored above ground level in perfectly dry and watertight sheds and shall be stacked not more than eight bags high. Wherever bulk storage containers are used, it shall be ensured that their capacity is adequate to cater to the requirement at Site and they are cleaned at least once every 3 months. Cement older than 3 months from the date of manufacture shall not be used.

b. Each consignment shall be stored separately so that it may be readily identified and inspected, and cement shall be used in the sequence in which it is delivered at Site. Any consignment or part of a consignment of cement which had deteriorated of any sort during storage, shall not be used in the Works and shall be removed from the Site by the Contractor, without adding any costs to the Employer.

c. The Contractor shall prepare and maintain proper records on site regarding delivery, handling, storage and use of cement. These records shall be available for inspection by the Engineer at all times.

d. The Contractor shall make a monthly return to the Engineer on the date corresponding to the interim certificate date, showing the quantities of cement received and issued during the month and in stock at the end of the month.

12.3 Aggregates

1. Storage areas for aggregates have to be covered, protected against any kind of contamination, avoid the possibility of mix among aggregates and protected also against any water inflow. The floor of the storage for aggregates has to be in concrete and has

to be drained. Storage areas for different size of aggregates have to be independent to avoid any possibility of mix.

2. During rainy and cold weather periods, the aggregates shall be stored undercover for at least 48 hours before being used and kept sufficiently dry.

3. The stockpiling of the processed aggregate and drawl there from shall be such as to ensure that the variation in the free moisture in the aggregate during anyone shift of working, does not exceed 1 percent.

4. The coarse aggregates shall, be stored as per the procedure of relevant IS: codes.

5. Care shall be taken in screening and stocking of the coarse aggregates so as to avoid intermixture of different gauge materials and inclusion of any foreign materials.

6. The stockpiles shall be built up in horizontal or gently sloping layers.

7. Trucks and bulldozers shall be kept off the stockpiles to prevent breakage and impairing the cleanliness of aggregate.

8. A hard base shall be provided to prevent contamination from underlying materials in storage areas in continuous use.

9. Overlap of different sizes of materials shall be prevented with suitable walls or by ample distance between storage piles.

10. Arrangement shall be made to store natural and manufactured sand in a way that shall protect it from being contaminated with dust, organic matter or other deleterious substances.

13. Design Mix Concrete

10.1 General

a. For all items of concrete, only design mix shall be used. Prior to the commencement of construction, the Contractor shall design the mix and submit the proportions of materials, including admixtures to be used to the Engineer for obtaining approval. Suitable water reducing admixtures or super-plasticizing admixtures shall be used for achieving desired workability and strength of the concrete only after obtaining prior approval from the Engineer. No extra payment shall be made for such admixtures.

b. Mix design shall conform to the provisions under IRS: CBC (Cl. 5.5 and 8.7) and IS 10262.

c. Drying shrinkage of concrete shall be 0.03% or less. Drying shrinkage of concrete shall be tested in accordance with IS 1199.

d. When non-bleeding high flow concrete is used, it shall be confirmed that no bleeding occurs under Concrete Bleeding Test specified in IS 9103. The Contractor shall submit

the test results to the Engineer prior to the commencement of concrete works for obtaining approval.

e. Mix design, once approved, must not be altered without obtaining prior approval of the Engineer. However, if the Contractor anticipates any change in quality and/or change in source of future supply of materials than that used for earlier mix design, the Contractor shall inform the Engineer well in advance and bring fresh samples sufficiently in advance, to carry out fresh trial mixes.

f. The total chloride content of all constituents of concrete in mix shall be limited to 0.43 kg/m3 for reinforced concrete works and prestressed concrete works as per IS:14959.

10.2 Workability of Concrete

a. The mix shall have the consistency which allows proper placement and consolidation in the required position. It shall be ensured that uniform consistency is maintained.

b. Workability of concrete shall conform to the provisions of IRS: CBC(Cl.5.3).

10.3 Durability of Concrete

a. Maximum water cement ratio for design mix shall conform to IRS: CBC(Clause5.4.3) as follows:

Plain Concrete	Reinforced Concrete
0.45	0.40

b. Minimum grade of concrete shall conform to IRS: CBC(Clause5.4.4) as follows:

Plain Concrete	Reinforced Concrete
M-20	M-35

c. Maximum and minimum permissible cementitious material shall conform to IRS: CBC (Clause5.4.5) as follows:

Minimum(kg/cum)		Max
Plain Concrete	Reinforced Concrete	
250	350	500

10.4 Trial Mixes

a. The Contractor is entirely responsible for the design of the concrete mixes. However, the design shall have approval from the Engineer. At least 8 weeks before

commencing any concreting in the Works, the Contractor shall make trial mixes using samples of coarse aggregates, sand, water, super plasticiser and cement, typical of those to be used in the Works, and which have been tested in an approved laboratory. A clean dry mixer shall be used, and the first batch shall be discarded.

b. The mix shall be designed to produce the grade of concrete having the required workability, durability and a characteristic strength not less than appropriate value given in IRS: CBC (CL. 5.1, 5.3 & 5.4). Trial mixes shall be prepared under full-scale site conditions and tested in accordance with IS 10262.

c. Whenever there is a significant change in the quality of any of the ingredients for concrete, the Engineer, at his discretion, may order the carrying out of fresh trial mixes. All costs for trial mixes and tests shall be borne by the Contractor's and held to be included in the rates quoted in the priced Bill of Quantities.

d. Before commencing the Works, the Contractor shall submit full details of the preliminary trial mixes and tests to the Engineer for approval.

10.5 Size of Coarse Aggregate

The nominal size of coarse aggregates for concrete shall be as per the Drawings. The proportions of the various individual size of aggregates shall be so adjusted that the grading produces densest mix and the grading curve corresponds to the maximum nominal size adopted for the concrete mix.

10.6 Mixing Concrete

10.6.1 General

a. Production and control of concrete shall conform to IRS: CBC(Cl.5.6).

b. Concrete shall be mixed in an automatic batching and mixing plant as per this Technical Specifications. Hand mixing shall not be permitted. The mixer or the plant shall be at an approved location that shall be selected considering the properties of the mixes and the transportation arrangements available with the Contractor. The mixer or the plant shall be approved by the Engineer. Unless permitted by the Engineer, all concrete shall be produced in computerised automatic weigh batching plant having printing facilities to printout records of each batch and installed at the Site.

c. Mixingshallbecontinuedtillmaterialsareuniformlydistributedandauniform colour of the entire mass is obtained, and each individual particle of the coarse aggregate shows complete coating of mortar containing its proportionate amount of cement.

d. Mixers which have been out of use for more than 30 minutes shall be thoroughly cleaned before putting in a new batch. Unless otherwise agreed by the Engineer, the first batch of concrete from the mixer shall contain only two thirds of the normal quantity of coarse aggregate for cleaning purpose only, and the same shall not be

used for concreting purpose. Mixing plant shall be thoroughly cleaned before changing from one type of mix to another.

10.6.2 Batching on site

a. Batching of concrete shall conform to the provision of IRS: CBC (Cl. 5.6.2) and IS 4925.

b. All weighing and measuring equipment shall be tested and calibrated as per IS 4926.The results of these tests and calibration shall be submitted to the Engineer.

c. Addition of water to compensate for slump loss shall not be resorted to nor shall the design maximum water content and maximum water-cement ratio be exceeded. If permitted by the Engineer, additional dose of retarder shall be used to compensate the loss of slump at the Contractor's cost. Re-tempering water shall not be allowed to be added to mixed batches to obtain desired slump.

10.6.3 Ready Mixed Concrete

The Contractor can use RMC, if approved by the Engineer. The source batching plant of RMC shall not change during the course of work. If RMC is used, it shall conform to the provisions laid down in IRS: CBC (CL. 5.7). The batching plant shall have consent to establish and consent to operate permit from Pollution Control Authority. The batching plant shall be operated by trained staff. The batching plant shall have suitable motorable road and a traffic plan to ensure free and safe passage of all vehicles. Waste water and sludge from batching plant shall be at the designated points.

a. Transporting, Placing and Compaction of Concrete

Transporting, placing, compacting and curing of concrete shall be in accordance with IRS: CBC(Cl.8), IS 456 and IS 5892.

i. Transporting

- The method of transporting and placing concrete shall have approval from the Engineer. Transportation of concrete shall conform to IRS: CBC (Cl. 8.1, 5.7), if not in contravention to the following provisions.
- The mix shall be transported by agitating transit mixers, buckets, pumps etc. or asper approval by the Engineer, without causing segregation and loss of cement slurry and without altering its desired properties with respect to water content, water cement ratio, slump, air content, cohesion and homogeneity.
- $1m^3$ of each mix shall be supplied to Site before it is required in the Works to enable the Contractor to carry out workability tests. Under no circumstances shall extra water be added to the concrete after the original mixing is completed.

ii. Pumping

- Pumping of concrete shall conform to IRS: CBC (Cl.8.9), if not in contravention to the following provisions.
- The type of concrete pump, the diameter of transporting pipe, the route of piping etc. shall be determined considering the pumpability of the concrete to obtain the required quality of concrete after pumping.
- The type and the number of concrete pumps shall be determined in consideration of the pumping pressure, the discharge amount, the pumping rate per hour, the environmental conditions of construction site etc.
- Prior to pumping design mix concrete, pumping of mortar with the same proportion as of design mix concrete shall be done to prevent loss of mortar in pump due to adherence.
- The mortar pumped prior to the concrete pumping shall not discharge into the formwork.

iii. Placing

a) Placing General

- Placing of concrete shall conform to the provisions laid down in IRS: CBC(Cl.8.2).
- Prior to concreting, detailed planning on the placing system, the arrangement and the number of pumping cars, the position of the inlet for concrete pump, lighting equipment and arrangements for power supply, the sequence and rate of placing, time interval between concrete lifts etc. shall be specified in the Method Statement and the same shall be submitted to the Engineer for approval. Due allowance shall be made to secure enough clear spacing of reinforcement bars which enables concrete to flow through the spaces between reinforcement bars.
- Concrete shall be transported by means which prevent contamination (by dust, rain etc.) segregation or loss of ingredients, and shall be transported and placed without delay.
- Concrete shall be placed directly in its final position without segregation or displacement of the reinforcement, embedded items and formwork. Concrete shall not be placed in water, except as specified. Concrete shall not be dropped through a height greater than 1.5 metres.

- All formwork shall be thoroughly cleaned to remove debris etc. before concreting. In addition, the Engineer shall inspect that there is no debris etc. in the formwork before concrete is cast. It shall be examined that there is no abnormality in the formwork and falsework before and during concreting.
- No concrete shall be placed in any part of the structure until approval of the Engineer has been obtained. If concreting did not commence within 24 hours of issuance of approval, then it shall be obtained again from the Engineer. Concreting then shall proceed continuously over the area between the construction joints.
- Except where otherwise agreed by the Engineer, concrete shall be deposited in horizontal layers to a compacted depth of not more than 300 mm.
- Concrete when delivered in the works shall be maintained at a temperature of not more than 35°C as far as possible.
- Clear spacing between reinforcements shall be secured adequately and lighting equipment shall be arranged adequately in order to visually check the position of inlet of the concrete pump and the filling situation of the concrete during concreting works. In addition, suitable measures shall be taken so that the reinforcement bars do not move and clear cover to the reinforcement bars does not change.
- The clear cover shall be uniform and as per the Drawings. Concrete cover blocks used shall be of the same concrete mix as the member and shall contain the binding wire to secure it to the reinforcement. All ends of binding wire shall be carefully turned inside so that they do not project out of concrete cover. Reinforcement bars shall be adequately secured by chairs/ties/hangers so that it maintains its position during casting and vibrating concrete. Ends of the wires used to tie bars shall be bent into the member.
- In case of concreting the horizontal member immediately after the concreting of vertical member is finished, the horizontal member shall be cast after any settlement of concrete of the vertical member ceases in order to prevent settling cracks.
- If bleeding water is present on the surface of concrete during concreting, the bleeding water shall be removed before the following concrete is placed.
- The Contractor shall ensure that the place where concreting is to be done shall be free of water.

b) Extent of Pours

For piers and pier heads, portal columns the concreting is to be carried out in single stage i.e. in first stage concreting will be from kicker to just below pier head bottom and second stage of concreting will be pier head including shear key and cross girder (in station zone stages as given in drawings for all heights by using tremie/ pumps at the rate not more than 1.5m / hr or as approved by the Engineer.

Floors, roofs and ground slabs shall be placed in a sequence of pours to the approval of the Designer and the consent of the Engineer.

If the use of slip-forms or paving trains is permitted, these limits may be revised. The sequence of pours shall be arranged to minimise thermal and shrinkage strains.

c) Placing Equipment

Concrete shall generally be placed without segregation by pumping or bottom-opening skips. If chutes are used their slopes shall not cause segregation and spouts or baffles shall be provided.

d) Time for Placing

Concrete and mortar must be placed and compacted within 30 minutes of water being added to the mix or otherwise included via damp aggregates, unless admixtures are in use. Partially-set concrete shall not be used in the Works.

e) Continuity of Placing

Placing in each section of work shall be continuous between construction joints. The Contractor shall make provision for standby equipment. If the placing of concrete is delayed due to breakdown then the Contractor shall erect vertical stop-ends and form a construction joint or remove the concrete already placed and restart after repair of the breakdown, as directed.

f) Placing in Inclement Weather

Placing shall not take place in the open during storms or heavy rains. If such conditions are likely to occur the Contractor shall provide protection for the materials, plant and formwork so that work may proceed. If strong winds are prevalent protection from driving rain and dust shall be provided.

g) Placing in High Temperature and Low Temperature

The temperature of concrete shall not exceed 32º nor below 5ºC or the

temperature stated in the table of Mixes whichever is the lower at the time of placing concrete. Also the maximum concrete temperature after placing shall not exceed temperature 50oC or 30oC above the concrete temperature at the time of placing whichever is the lower.

"Concrete in hot countries" published by FIP congress at New Delhi 1986 shall be complied with. The procedures the Contractor wishes to employ shall be subject to the Engineer consent

The Contractor shall supply suitable maximum/minimum thermometers and record the shade and sun temperatures at locations where concrete is being placed. Recommendations for cold weather concrete can be had from IS: 7861 (Part 2).

h) Placing at Night

If consent has been given for placing at night or in dark interiors, adequate lighting shall be provided where mixing, transportation and placing are in progress.

i) Placing Under Water

Underwater concrete shall be placed with minimum disturbance of the water. Running water and wave wash shall be controlled. The specified concrete grade shall be used and the mix design shall provide for good flowing ability.

Tremie pipes, bottom-dump skips or other approved placing equipment shall be used. Segregation shall be avoided.

Placing shall be commenced in approved sections and continued to completion.

The tremie pipe shall be buried in the concrete for at least 1.5m and the pipe must not be emptied until the pour is complete. If a bottom-dump skip is used, the contents shall be covered by canvas or similar before lowering into the water. The doors shall be opened when the skip is resting on the bottom with no tension in the support cable, and the skip shall be lifted gradually so that the concrete flows out steadily.

j) Preparation Before Placing

Before placing concrete for reinforced work on the ground, the formation shall be compacted as specified and a screed of blinding concrete shall be applied to form a surface for construction.

Before placing concrete on or against rock, masonry, brickwork or old concrete, loose material shall be removed and the surface washed down; water seepage

shall be stopped or channelled away from the work.

iv. Compaction

1. Compaction of concrete shall conform to the provisions laid down in IRS: CBC (Cl.8.3).

- Additional vibrators in serviceable condition shall be kept at site so that they can be used in the event of breakdowns. Concrete shall be compacted before setting commences and shall not be subsequently disturbed.

2. Internal (needle) and surface (screed board) vibrators of approved make shall be used for compaction of concrete. Internal vibrators shall be inserted in an orderly manner. The distance between insertions shall be 500 mm or less. The vibrator shall be made to operate at a regular pattern of spacing. The effective radii of action will overlap approximately half a radius to ensure complete compaction.

3. Internal vibrators shall be used for compaction of concrete in foundations, columns, buttresses arch section, slabs etc, and if required surface vibrators shall also be used. Depending on the thickness of layer to be compacted, 25 mm, 40 mm, 60 mm and 75 mm dia internal vibrators will be used. The concrete shall be compacted by use of appropriate diameter vibrator by holding the vibrator in position until:

a) Air bubbles cease to come to surface.

b) Resumption of steady frequency of vibrator after the initial short period of drop in the frequency, when the vibrator is first inserted.

- The vibration shall be done till the tone of the vibrated concrete becomes uniform. To achieve an even and dense surface free of aggregate pockets, vibration shall be supplemented by tamping or rodding by hand in the corners of forms and along the form surfaces while the concrete is plastic.

c) Flattened, glistening surface, with coarse aggregates particles blended into it appears on the surface.

d) Use of curing compounds may be permitted with specific approval of Engineer.

4. After the compaction is completed, the vibrator should be withdrawn slowly from the concrete so that concrete can flow in to the space previously occupied by the vibrator. To avoid segregation during vibration the vibrator shall not be dragged through the concrete nor used to spread the concrete. The vibrator shall be made to penetrate, into the layer of fresh concrete below if any for a depth of about 150mm. The vibrator shall be made to operate at a regular

pattern of spacing. The effective radii of action will overlap approximately half a radius to ensure complete compaction.

a) To secure even and dense surfaces free from aggregate pockets, vibration shall be supplemented by tamping or rodding by hand in the corners of forms and along the form surfaces while the concrete is plastic.

b) A sufficient number of spare vibrators shall be kept readily accessible to the place of deposition of concrete to assure adequate vibration in case of breakdown of those in use.

c) Form vibrators whenever used shall be clamped to the sides of formwork and shall not be fixed more than 450 mm above the base of the new formwork and concrete shall be filled not higher than 230mm above the vibrator. The formwork must be made specially strong and watertight where this type of vibrator is used.

d) Care must be taken to guard against over vibration especially where the workability of the concrete mix is high since this will encourage segregation of the concrete.

e) Plain concrete in foundations shall be placed in direct contact with the bottom of the excavation, the concrete being deposited in such a manner as not to be mixed with the earth. Plain concrete also shall be vibrated to achieve full compaction.

5. Construction Joints

a. Construction joints shall be avoided as far as possible and in no case the locations of such joints shall be changed or increased from those shown in the drawings, unless otherwise approved by the Engineer.

b. Where provision of construction joint is unavoidable, the location, direction and construction method of construction joint shall be determined in consideration of the structural strength, durability and appearance of the structure. Concreting shall be carried out continuously upto the construction joints. Construction joints shall conform to the provisions laid down in IRS: CBC (Cl. 8.5 and Annexure - B). The Contractor shall submit Method Statement on the construction joints which shall be subject to the consent of the Engineer prior to concreting works.

c. The location of the construction joints and their arrangement, procedure for surface preparation of construction joint and sequence of concreting shall be subject to the consent of the Engineer. Construction joints shall be located at locations where the shear force is minimum. The joints shall be provided in a direction perpendicular to the member axis. Sequencing of concrete placement shall be organized in such a

way that cold joints are totally eliminated. Properly designed reinforcement shall be provided prior to casting of the next lift for transfer of full tensile stress across the joints.

6. Expansion, Contraction and Movement Joints

Expansion, contraction and other movement joints shall be incorporated in the works as shown on the Drawings.

Where shown on the Drawings approved, expansion joint fillers shall be supplied and installed. Filler material shall be stored flat on a dry surface adequately protected from rain or moisture in such a way that the material does not deteriorate. Filler material which has been damaged or has started to deteriorate shall not be incorporated in the works.

Movement joints shall be sealed with an approved sealant applied in strict accordance with the manufacturer's instructions to the dimensions shown on the Drawings. The surface of the concrete to which the sealant is to adhere shall be straight and cleaned of all filler material, dirt, oil, grease and other matter. The sealant shall be applied by methods recommended by the manufacturer so that the sealant is brought flush to the surface of structure and a smooth surface is achieved. Excess material and spillage shall be properly cleaned off and removed.

Dowel bars shall be installed and cast in across the movement joint where shown on the Drawings. The bars shall be straight with clean cut ends of the diameters and lengths as

shown on the Drawings or in the Schedules. Cutting and cleaning of the dowel bars shall comply with the requirements of this Specification.

The bars shall be firmly supported in the positions shown on the Drawings so that they remain accurately parallel and are not displaced during the casting of the concrete in the first part of the structure. After the concrete has hardened and the formwork removed, the projecting ends shall be cleaned of all concrete spillage and painted with two coats of an approved bituminous paint and caps shall be fitted to the free ends of the bars. Dowel bar end caps shall be of cardboard or other material, of correct diameter for the dowel bar and of sufficient length to allow the specified movement of the two adjacent concrete structures. They shall be manufactured expressly for this purpose by an approved manufacturer.

The Contractor shall take care to protect the projecting ends of dowel bars from bending or other damage prior to concreting the succeeding bay. The bituminous paint shall be applied as soon as practicable, but end caps shall not be fitted until immediately prior to the succeeding concreting operations.

7. Bolts, Inserts and Openings

All fixing blocks, brackets, built in bolts, holes, chases, etc., shall be accurately set out and formed and carefully sealed prior to the concrete being placed. No cutting away of concrete for any of these items shall be done without the permission of the Engineer-in- Charge.

Bolts and other inserts to be cast into the concrete shall be securely fixed to the formwork in such a way that they are not displaced during the concreting operations, and that there is no loss of materials from the wet concrete through holes in the formwork.

Unless shown otherwise on the Drawings or the Engineer has given consent, reinforcement shall be locally moved so that the minimum specified cover is maintained at the locations of inserts, holes, chases, etc.

Temporary plugs shall be removed and the threads of cast in bolts shall be proved to be free and shall be greased before handing over any part of the Works. Construction joints in all concrete work shall be made as directed by the Engineer. Where vertical joints are required, these shall be shuttered as directed and not allowed to take the natural slope of the concrete.

8. Concreting under Special Conditions

Concreting under special conditions shall conform to the provisions laid down in IRS: CBC.

10.7 Concreting in Extreme Weather Conditions

Concreting in extreme weather conditions shall conform to the provisions laid down in IRS: CBC (Cl. 8.6.1).

10.8 Concreting under Water

a. Concreting underwater and seawater shall conform to the provisions laid down in IRS: CBC (Cl. 8.6.2 and Cl. 8.6.3), where not contravening to the following provisions.

b. When it is necessary to deposit concrete under water, the methods, equipment, materials and proportions of mix to be used shall obtain approval of the Engineer, prior to the commencement of any work.

c. Concrete shall not be placed in water having a temperature below 5°C. The temperature of the concrete, when deposited, shall neither be less than 16 °C nor more than 35°C.

d. All underwater concreting shall be carried out by tremie method as described in IRS: CBC (CL.8.6.2) only, using tremie of appropriate diameter. The number and spacing of the tremie shall be worked out to ensure proper concreting. The tremie concreting

when started shall continue without interruption for the full height of the member being concreted. The concrete production and placement equipment shall be adequate to enable the underwater concrete to be completed uninterrupted within the stipulated time. Necessary standby equipment shall be available for emergency situation.

e. In case of withdrawal of tremie out of the concrete either accidentally or to remove a choke in the tremie with the approval of the Engineer, the tremie shall be reintroduced in the following manner to prevent impregnation of laitance or scum lying on top of the concrete deposited in the bore. The tremie shall be gently lowered on to the old concrete with very little penetration initially. A vermiculite plug shall be introduced in the tremie. Fresh concrete of slump between 150 mm and 175 mm shall be filled in the tremie which will push the plug forward and will emerge out of the tremie displacing the laitance or scum. The tremie shall be pushed further in steps making fresh concrete sweep away the laitance or scum in its way. When tremie is buried in for about 0.60m to1.0 m, concreting may be resumed.

f. In case of concreting through tremie or such pipes which are subsequently withdrawn, the concrete shall be placed in adequate quantity to ensure that during withdrawal of the tube, a sufficient head of concrete is maintained to prevent the inflow of soil and water or bentonite slurry.

g. No concrete shall be allowed to come in contact with seawater within 72 hours of casting.

10.9 Concreting under Aggressive Soils and Water

Concreting under aggressive soils and water shall conform to the provisions laid down in IRS: CBC (Cl. 8.6.4).

11. Curing of Concrete

11.1 General

a. Concreting operations shall not commence until adequate arrangements for curing of concrete have been made by the Contractor. Curing and protection of concrete shall commence after the concrete has set hard enough, to with stand stresses due to curing work and does not get damaged, in order to protect it from the following:

i. Premature drying out, particularly by solar radiation and wind.

ii. High internal thermal gradients.

iii. Leaching out by rain and flowing water.

iv. Rapid cooling during the first few days after placing.

v. Low temperature.

vi. Vibration and impact which may disrupt the concrete and interfere with its bond to there reinforcement.

b. Where members are of considerable size and length, with high cement content, accelerated curing methods may be applied, as approved by the Engineer.

11.2 Curing Procedure

a. In order to ensure the required quality of concrete in terms of parametres such as strength, durability and permeability, concrete shall be cured adequately, being kept at a temperature and humidity necessary to be hardened within a certain period of time after concreting, in order not to be affected by harmful effects such as low or high temperature, rapid temperature change, drying, loading and impact loading.

b. Curing of concrete shall conform to the provisions laid down in IRS: CBC (Cl.8.4). Approved curing compounds shall be used in lieu of moist curing, with the approval of the Engineer, particularly for all vertical faces and inaccessible areas, conforming to IRS: CBC (CL. 8.4.2).

11.3 Finishing

Finishing shall conform to the provisions laid down in IRS: CBC (Cl. 6.2.4), if not in contravention to the following provisions:

a. Immediately after removal of forms, exposed bars or bolt, if any, shall be cut inside the concrete member to a depth of at least 50 mm below the surface of the concrete and the resulting holes shall be filled with cement mortar of dry pack consistency.

b. All construction and expansion joints in the completed work shall be left carefully tooled and free of any mortar and concrete. Expansion joint filler shall be left exposed for its full length with clean and true edges.

c. The finished surfaces of concrete after removal of form work shall be such that no touching up is required. All finsca used by form joints, if any, shall be ground using electric sur face grinder.

d. Immediate Lyon removal of forms, before any defects are rectified, the concrete work shall be examined by the Engineer.

i. Exposed concrete surfaces shall be smooth and even, originally as stripped, without any finishing or rendering. The Contractor shall exercise special care and supervision of formwork and concreting to ensure that the cast members are made true to their sizes, shapes and positions. The work that has sagged or contains honeycombing to an extent which is detrimental to structural safety or architectural appearance shall be rejected. Honeycombed parts of the concrete, including other surface defects in the concrete, shall be removed by the Contractor as per the methods which do not affect the strength of adjoining

concrete and as per approval of the Engineer. In the final finish, no honeycombing is allowed.

ii. Part of defective concrete thus removed shall be recast using fresh concrete of same grade, as approved by the Engineer without any additional cost. For that purpose, the Contractor shall prepare a comprehensive work procedure and obtain approval of the Engineer. No additional payment shall be made for repair of the concrete. The Contractor shall ensure that no air bubbles are formed on the exposed surface. Concrete pouring sequence, vibration methodology etc. shall be planned to ensure that air bubbles are not formed. All materials, sizes and layouts of formwork including the locations for their joints shall have approval from the Engineer prior to the commencement of the works.

iii. After the finishing works, cracks which occurred in the surface of concrete until the concrete starts to set shall be removed by refinishing or tamping.

e. The top face of a slab intended to be surfaced with other material shall be left with a spaded finish.

f. Chemical surface retarders, if approved by the Engineer, shall be used to produce an exposed aggregate finish, provided the Contractor demonstrates that the durability of the concrete surface is not reduced.

12. Inspection, Tests and Standards of Acceptance

a. The Contractor shall submit test certificates from the manufacturer or supplier of materials along with each batch of material(s) delivered to site.

b. The Contractor shall set up a field laboratory with necessary equipment for testing of all materials & finished products to be used in the construction. The laboratory must have riffle divider of adequate capacity as approved by the Engineer for preparation of lab sample for sieve analysis of aggregates.

c. The test in go falls the materials shall be carried out by the Contractor at the field laboratory or from the laboratory approved by the Engineer and in the presence of the Engineer. The Contractor shall make all the necessary arrangements and bear the entire cost for the same.

d. Tests which cannot be carried out in the field laboratory shall be done at the Contractor's cost at any recognized laboratory or testing establishments having NABL certification and duly approved by the Engineer.

e. If materials are brought from abroad, the cost of sampling or testing, whether in India or abroad, shall be borne by the Contractor. The Contractor shall provide and maintain on site, until the works are completed, at all times the equipment and staff required for carrying out these tests.

13. Quality Control of Concrete

a. The Contractor shall carry out the following tests for concrete, at the site of placing, and ensure that they comply with appropriate provisions of Indian and/or other standards, as may be applicable:

   i. Slump test for concrete: The frequency of slump test shall be as follows:

   ii. Case 1: If the site of placing is at the same area as the concrete plant installed, then it shall be conducted once in every hour, as per IS1199(Cl. 5.0) and IS7320.

   iii. Case2: Other than Case1, it shall be conducted once in each delivery of transit mixer, asper IS 1199 (CL. 5.0) and IS 7320.

   iv. Tolerance for slump shall conform to IS4926(Cl.6.2.1).

   v. Compressive and Flexural strength of concrete: Sampling, Strength tests and Acceptance criteria of concrete shall conform to IRS: CBC (Cl. 8.7) according to the type of concrete grade.

   vi. Chloride ion content test: It shall be conducted as per IS:15949 once a week. Chloride ion content shall be0.43kg/m3 or less.

   vii. Relative Density and pH value of plasticizer (if used): The test shall conform to IS9103(Cl.7.1, Cl.10.0, Annexure-E) and the tolerances shall be as specified in IS9103(Cl. 9.0, Table-2).

   viii. Temperature of concrete shall be verified once in each slump test.

   ix. The concrete shall be verified for permeability and the test procedure along with tolerances shall conform to IRS: CBC (Cl. 5.4.2, Appendix - G). The frequency of test shall depend up on the change in design mix or change in source of material used in the work. However, the Engineer shall select random batches of concrete for examination at his discretion, and any time during concreting. Sampling shall generally be done at the point of discharge from the mixer and at placing point. The concrete shall pass the permeability test if it is properly compacted and the water penetration depth in the broken core is less than 25mm.

b. It is the complete responsibility of the Contractor to redesign the concrete mixes as per the standard methods that have been approved and to produce there in forced concrete conforming to the specifications. The Contractor shall have competent staff to carry out this work.

c. After the completion of the quality control checks of concrete, the Contractor shall immediately report the test results to the Engineer by submitting quality control records of the concrete.

14. Inspection of Concrete

a. Inspection shall be carried out by the Contractor, after the removal of form work. Also, additional inspection shall be carried out if instructed by the Engineer.

b. Inspection shall be carried out as per approval of the Engineer for the Method Statement, incorporating the test procedures specified in Table below:

Table: Inspection of Concrete Surface Condition

Measurement Items	Inspection Method	Place to be Inspected
Presence or absence of honey combing, cold joint, discoloration, and cracking	Visual inspection at point-blank range	All parts
Presence or absence of cavity, float, and cracking	Hammering Inspection	As per approved Method Statement, and as directed by the Engineer
Clear cover to the outermost reinforcement	Non-destructive test using a probe	

c. Additional non-destructive tests (NDT) on the hardened concrete in the structure as a whole or any finished part of the structure where necessary, or directed by the Engineer, shall be carried out as laid down in IRS: CBC (CL. 18.3).

d. The Contractor shall report the inspection results along with the location to the Engineer immediately after the inspection. The forms generated from the probes during the inspection shall be attached to the records.

e. If defects such as deleterious cracking, spalling, deformation and finishing defects or damages caused by the Contractor are noticed from the results of the inspection, no repair work shall be commenced without prior permission taken from the Engineer.

f. Counter measures against the defects shall be subject to approval of the Engineer. In this case, "repair work" refers to all actions which make alterations to the surface of concrete after the removal of formwork (including plastering etc.). If repair work is required, the Contract or shall submit Method Statement on the repair work and shall obtain approval of the Engineer for the same, prior to the commencement of repair work. During the repair work, the Contractor shall record about the work, and shall report to the Engineer on the results of the work immediately after the repair work has finished.

g. If cracks develop in concrete construction, which in the opinion of the Engineer may be detrimental to the strength of the construction, the Contractor, at his own cost, shall dismantle the construction, carry away the debris, replace the construction and carry out all consequential work thereto.

h. If any cracks develop in the concrete construction, which in the opinion of the Engineer, are not detrimental to the stability of the construction, the Engineer shall decide whether such cracks are required to be grouted. The Contractor shall grout such cracks as decided by the Engineer with polymer cement grout of approved quality at his own risk and cost.

i. External crack width shall be restricted to 0.2mm or less on all concrete structures, unless otherwise specified in the Drawings/Design.

ADDITIONAL TESTS FOR CONCRETE:

As frequently as the Engineer may require, additional testing shall be carried out for concreting in addition to mandatory test specified in CPWD specifications 1996/2002 / relevant IS Code / MOST/MORTH Specifications.

15. Non-Destructive tests for concrete

1. Ultrasonic pulse velocity test

2. Rebound hammer test

In order to determine the following properties of concrete, non-destructive tests for concrete (ultra-sonic pulse velocity test and rebound hammer test) in accordance with IS 13311(Part 1 and Part 2) shall be carried out.

i. the homogeneity of concrete

ii. the presence of cracks, voids and other imperfections

iii. changes in the structure of the concrete which may occur with time

iv. the quality of the concrete in relation to the standard requirements

v. the quality of one element of concrete in relation to the another, and

vi. the values of dynamic elastic modulus of the concrete

In view of the limitations of each method of the non destructive testing of the concrete, it is essential that the results of tests obtained by one method should be complemented by other tests and each method should be adopted very carefully.

16. Permeability test for Concrete:

The concrete will be verified for permeability by the following procedure and shall confirm to IS: 3085-1965 – „Permeability of Cement Mortar & Concrete", Section

1717.7..5 of MOST Specification and DIN 1048.

a) The Engineer shall select random batches of concrete for examination at his discretion and sampling will generally be done at the point of discharge from the mixer and at placing point.

b) From the batches thus selected two concrete cylinders shall be made in accordance DIN 1048.

c) All cylinders shall be made, cured, stored, transported and tested in accordance with clause 1717.7..5 of MOST Specifications. The tests shall be carried out in a laboratory approved by the Engineer.

d) At least two cylinders shall be made on each day"s concreting until 60 cylinders have been made for each grade of concrete. The cylinders will be tested as per the procedure, given in Clause (e) next.

e) Test Procedure:

The permeability of concrete will be verified by the following procedure:

i. Prepare a cylindrical test specimen 150 mm dia and 160mm high.

ii. After 28 days of curing, test specimen will be fitted in a machine such that the specimen can be placed in water under pressure up to 7 bars. The typical machine shall be similar to one shown in Appendix 1700/II of MOST.

iii. At first a pressure of one bar is applied for 48 hours, followed by 3 bars for 24 hours and 7 bars for next 24 hours.

iv. After the passage of the above period, the specimen is taken out and split in the middle by compression applied on two round bars on opposite sides above and below.

v. The water penetration in the broken core is measured with scale and the depth of penetration assessed in mm (max permissible limit 25 mm).

f) Acceptability Criteria:

The concrete shall pass the permeability test if it is properly compacted and is not considered permeable when tested as per DIN, and the water penetration in the broken core is less than 25mm.

No extra payment shall be made for this test and cost of the same will be included in his rate for concrete work.

17. Chlorides in Concrete

The levels of equivalent acid-soluble chlorides as NaCl (Cl x 1.65 = NaCl) in the constituents of concrete as stated elsewhere are indicative and are subject to the over-riding limits for the mixes.

The total estimated content as a percentage by weight of the cement in the mix shall not exceed the following limits: -

(a) For reinforced concrete

0.5% if made with Ordinary Portland Cement (OPC)

0.1% if made with Sulphate Resistant Portland Cement (SRPC)

(b) For mass concrete

1.0% if made with OPC

0.2% if made with SRPC

The Contractor shall test the constituents of the concrete to establish these contents as provided for elsewhere in this Specification.

In addition, regular tests to BS 1881: Part 6 for chloride content shall be made on the hardened concrete. The following values are acceptable: -

(i) For reinforced concrete made with OPC

95% of the test results less than 0.40% NaCl by weight of cement and no result greater than 0.50% NaCl by weight of cement.

(ii) For reinforced concrete made with SRPC

95% of the test results less than 0.1% NaCl by weight of cement and no result greater than 0.14% NaCl by weight of cement.

(iii) For mass concrete made with OPC

95% of the test results less than 1.0% NaCl by weight of cement, and no result greater than 1.30% NaCl by weight of cement.

(iv) For mass concrete made with SRPC

95% of the test results less than 0.2% NaCl by weight of cement and no result greater than 0.25% NaCl by weight of cement.

In the event that the SRPC used contains a proportion by weight of tri-calcium aluminate which approaches 4 - 8%, then consent may be sought for an appropriate adjustment of the relevant chloride content limits.

18. Sulphates in Concrete

The level of acid-soluble sulphates (SO_3) in the mix shall be no greater than: Coarse aggregate 0.4% by weight

Fine aggregate 0.4% by weight

Water500 mg/l

The total estimated sulphate content (SO_3) of the mix including that present in the cement shall not exceed 3.7% by weight of cement in the mix.

In addition, regular tests to BS 1881: Part 6 shall be made on the hardened concrete to determine the total sulphate content, which shall not exceed 4% by weight of cement in the mix.

Permissible Level of Chloride and Sulphates

The permissible level of chlorides and sulphates quoted in the above Subsections shall not be considered as mean values for the whole of the Works, but shall apply to any concrete.

Concrete for water-retaining structures shall in addition be as per IS: 3370.

19. CRACKS:

If cracks, which in the opinion of the Engineer may be detrimental to the strength of the construction, develop in concrete construction, the Contractor at his own expense shall test the structure as specified in "Loading Tests" of these Specifications.

If under such test loads the cracks develop further, the Contractor shall dismantle the construction, carry away the debris, replace the construction and carry out all consequential work thereto.

If any cracks develop in the concrete construction, which in the opinion of the Engineer- in-Charge, are not detrimental to the stability of the construction, the Contractor at his own expense shall grout the cracks with neat cement grout or with other composition as directed by Engineer-in-Charge and also at his own expense and risk shall make good to the satisfaction of the Engineer all other works such as plaster, moulding, surface finish, which in the opinion of the Engineer have suffered damage either in appearance or stability owing to such cracks. The Engineer's decision as to the extent of the liability of the Contractor in the above matter shall be final and binding.

External crack width shall be as per IRS: CBC with latest addendums.

20. DEFECTIVE CONCRETE:

Should any concrete be found honeycombed or in any way defective, such concrete shall be cut out partially or wholly by the Contractor and made good at his own

expense. If Engineer feels that repaired structure will not be having same strength or shape or uniformity with other exposed surface as original desired structure / original structure, the same shall be rejected by Engineer and required to be dismantled and disposed by contractor at his own cost as instructed by Engineer-in-Charge. Decision of the Engineer shall be final and binding in this regard.

21. EXPOSED FACES, HOLES AND FIXTURES:

On no account shall concrete surfaces be patched or covered up or damaged concrete rectified or replaced until the Engineer or his representative has inspected the works and issued written instructions for rectification. Failure to observe this procedure will render that portion of the works liable to rejection.

Holes for foundation or other bolts or for any other purposes shall be moulded, and steel angles, holdfasts or other fixtures shall be embedded, according to the drawing or as instructed by the Engineer.

22. FINISHES:

Unless otherwise instructed the face of exposed concrete placed against formwork shall be rubbed down immediately on removal of the formwork to remove irregularities. The face of concrete for which formwork is not provided other than slabs shall be smoothed with a float to give a finish equal to that of the rubbed down face, where formwork is provided. The top face of a slab which is not intended to be covered with other materials shall be leveled and floated to a smooth finish at the levels or falls shown on the drawings or as directed. The floating shall be done so as not to bring an excess of mortar to the surface of the concrete. The top face of a slab intended to be surfaced with other material shall be left with a spaded finish. Faces of concrete intended to be plastered shall be roughened by approved means to form key.

23. CONCRETE FOR FLOORING ON GRADE:

Concrete for flooring on grade shall be placed in alternate bays not exceeding more than 4m x 6m or as specified in the drawings including forming the joints or adjacent bays. The stiff mix shall be thoroughly vibrated and finished to receive the floor finish.

24. GROUTING OF BASE PLATES & BOLT HOLES:

a) Mixing :

Dry grout should be mixed in a mechanical mixer: the conventional 200/400-litre capacity concrete mixer can be used to mix four bags of dry grout; alternatively, paddle type mortar mixers can be used. The quantity of grout to be mixed at one time should not exceed that amount which can be placed in approximately 10 to 15 minutes.

b) Batching :

Batching of grout by fraction of a bag is not allowed. The quantity of mixing water should be the minimum commensurate with workability, compaction, and filling of the grout in all corners and crevices. Mixing should be done for a minimum of three minutes to obtain a fluid grout of uniform consistency.

c) Cleaning and preparation of the surface :

The base concrete should be clean and strong, and its surface should be properly hacked; all dust should be removed suction or compressed air. The surface should be thoroughly wetted with water for several hours. Before the grout is poured, all free water should be removed and the flat surfaces coated with a thin cement slurry.

d) Restraint :

Heavy back-up blocks of timber or concrete should be fixed on all sided of the base plate to prevent escape of the grout, when poured through the openings provided in the base plate. Adequate restraint must be ensured on all the sides for a period of 7 days to obtain effective expansion and shrinkage compensation.

e) Curing :

The grout should not dry out where external restraint is provided in the form of form- work, the top opening and all stray openings should be covered with wet sack for at least 7 days.

f) Placing and Compaction :

The grout should be placed quickly and continuously either through the holes in the base plates or from one side only to ensure complete filling without entrapment of air. Grout should be properly spread and compacted by rodding. Excessive vibration should be avoided.

Below the bed plates the grout should be compacted using long pieces of doubled-over flexible steel strapping or chains. The forward and backward movement of the strap or chain will assist in the flow of the grout into place. Steps must be taken to keep the grout in full contact with the underside of the bedplate until the grout sets; maintaining a small head of fresh grout in the forms.

g) Shrinkage Compensated Grout:

Shrinkage compensated grout or non-shrinkable grout of Associated Cement Companies Limited or any other approved manufacturer (Fosroc, Roff, Sikka) should be used. The batching shall be as per the manufacturer's specifications,

other procedures being as above.

25. Tolerance

Tolerances for the finished concrete structures shall be as specified in the Contract.

26. Mass Concrete

a) Any concrete having minimum dimension of more than 1 m shall be considered mass concrete.

b) In mass concrete core temperature shall not exceed 75^0C and differential temperature between core and surface of concrete shall not exceed 20^0C.

c) For each grade of mass concrete mock up trial shall be carried out of size 2m x 2m x thickness of mass concrete. Mock up trial shall use thermocouples to measure concrete temperature both near surface and at the core. Thermocouples shall be located centrally along the length and width of the mock up. Thermocouple shall be rigidly suspended so that they do not move out of position during casting. The Contractor shall monitor and document the conformance of the trial with the maximum allowable temperature requirement as given above. Result shall be automatically locked at the minimum of hourly intervals and logging shall continue for at least 72 hours or until the core reached ambient temperature, which ever is longer.

d) The scheme of mock up trial shall be submitted by the Contractor to the Engineer for approval. If there is change in brand/ factory of cement, mock up trial will be required again.

e) The Contractor shall carry out temperature monitoring of core temperature and surface temperature of 1st structure of mass concrete to confirm the results of mock up trial.

f) Ply shuttering will be preferred. However, if steel plate shuttering is used, insulation will be provided with thermocol.

g) No water curing should be carried out for 07 days. Concrete top surface shall be covered with plastic sheets after initial setting of concrete and insulation of plastic sheets by thermocol after final setting of concrete. Vertical shuttering shall remain intact till 07 days or as per directions of the Engineer.

h) Detailed report shall be submitted by the Contractor to the Engineer after mock up and 1st structure casting.

i) The contractor shall submit pour plan to the Engineer for approval for each structure of mass concreting. The pour plan shall include pour sequence, infrastructure required (RMC plant, TM, Concrete pump, placing boom), logistic plan, manpower (duties and responsibilities), lab equipment. Mass concrete shall

preferably use PPC to reduce core temperature. Concrete placement temperature shall be decided by the results of mock trial and the same shall be followed.

27. Precast Concrete

27.1 Manufacture Off-Site

a. Casting of members shall not begin until a NONO has been given by the Engineer to the shop drawings, required computation and method of manufacture.

b. When the drawings and method of manufacture have been noticed, no changes shall be made without NONO from the Engineer

c. The Contract or shall in form the Engineer in advance of the date of commencement of manufacture and casting of each type of member.

d. Concrete reinforcement and work man ship shall be asper IS: 456.

e. A copy of all cube test results for the precast concrete works shall be sent to the Engineer as soon as these are available.

f. No members to which the tests relate shall be dispatched to the Site until the tests have been satisfactorily completed and noticed by the Engineer.

27.2 Forms

The design and fabrication of the forms and false work as well as their construction shall be the responsibility of the Contractor. Forms shall be inspected prior to authorizing casting operations. Details shown on the Drawings shall be built into the forms. Worn, damaged, or otherwise unacceptable forms shall be repaired be forecasting of any member is authorized. The forms may be made either of steel or of plywood. If the Contractor elects to use plywood forms, it shall be high quality plywood, 19mm minimum thickness marine grade subject to NONO from the Engineer. Forms shall be structurally adequate to support the members within permissible tolerances. Forms shall be coated with a noticed form-release agent prior to use. Anchor devices may be cast into the concrete for later use in supporting forms provided the arrangement has Notice from the Engineer. Bottom/base should be true level without offsets and kinks of designed supports and shutterings over required PCC base with proper drainage arrangement for proper working and curing.

27.3 Curing

a) Steam curing with approved methodology can be adopted if required, for precast components subject to the approval of Engineer-in-Charge. No extra payment will be made for adopting steam curing. Before concrete products are subjected to any accelerated method of curing, the cement to be used shall be tested in accordance with accepted standards (relevant IS codes) especially for soundness, setting time and suitability for steam curing. In the case of elements

manufactured by accelerated curing methods, concrete admixtures to reduce the water content may be allowed to be as permitted by applicable codes of practice subject to the approval of the Engineer-in- Charge. The normal aeration agents used to increase the workability of concrete shall not be allowed. The steam curing of concrete products shall take place under hoods, under chambers or in tunnels. Use of insulated tarpaulin may be permitted. The steam shall have a uniform quality throughout the length of the member. The precast elements shall be stacked with sufficient clearance between each other and the bounding enclosure, so as to allow proper circulation of steam. The surrounding walls, the top cover and the floor of steam curing chamber or tunnel or hood shall be so designed as not to allow more than 1 kcal/m2/h/ deg C. The inside face of the steam curing chamber, tunnel or hood shall have a damp-proof layer to maintain the humidity of steam. Moreover, proper slope shall be given to the floor and the roof to allow the condensed water to be easily drained away. At first, when steam is let into the curing chambers, the air inside shall be allowed to go out through openings provided in the hoods or side walls which shall be closed soon after moist steam is seen jetting out. Preferably, steam should be let in at the top of the chamber through perforated pipelines to allow uniform entry of steam throughout the chamber. In no case shall steam impinge directly on concrete products. The fresh concrete in the moulds shall be allowed to get the initial set before allowing the concrete to come into contact with steam. The regular heating up of fresh concrete product from 20 °C to 35 °C shall start only after a waiting period ranging from 2 to 5 hours depending on the setting time of cement used. The second stage in steam curing process shall be to heat up the concrete elements, moulds and the surroundings in the chamber. The air-space around the member shall be heated up to a temperature maximum to 70°C at a gradual rate, not faster than 10° per hour. This process shall continue 1 1/2 to 2 1/2 hours depending upon the outside temperature. The third stage of steam curing shall be to maintain the uniform temperature and pressure for a duration depending upon thickness of the section. This may vary from 3 to 5 1/2 hours. The fourth stage of steam curing shall be the gradual cooling down of concrete products and surroundings in the chamber and normalization of the pressure to bring it at par with the outside air. The maximum cooling rate, which is dependent on the thickness of the member, shall not exceed 30° per hour. In all these cases, the difference between the temperature of the concrete product and the outside temperature shall not be more than 60°C for concrete up to M 30 and 75°C for concrete greater than M 45. In the case of light weight concrete, the difference in temperature shall not be more than 60°C for concrete less than M 25. For concrete greater than M 50, the temperature differences may go up to 75°C. After the steam curing is completed, the elements shall be further water cured for about 3 to 7 days.

The curing shall be carried out as per approved Method Statement.

27.4 Storage

When members are stored, they shall be firmly supported only at the points specified.

a. The accumulation of trapped water and deleterious matter in the units shall be prevented.

b. Care shall be taken to avoid rust staining and efflorescence.

c. The area intended for the storage of pre-cast units should be surfaced in such a way that no unequal settlement can occur.

d. To prevent deformation of slender units, they should be provided with supports at fairly close intervals and should also be safeguarded against tilting. Lifting and hand ling positions should conform to the Engineer's directions and drawings. In addition, location and orientation marks shall be put on the members, as and where necessary.

27.5 Handling and Transport

a. Members shall be lifted or supported only at points specified or otherwise given a NONO from the Engineer and shall be handled and placed without impact.

b. The Contractor shall define the method of lifting, the type of equipment and transport to be used, and the minimum age of the members to be handled and shall submit to obtain approval from the Engineer.

27.6 Protection

At all stages of construction, pre-cast concrete units and other concrete associated there with shall be properly protected to prevent damage to permanently exposed concrete surfaces, specially arises and decorative features.

28. Falsework and Formwork

28.1 General

Falsework and formwork shall conform to the provisions laid down in IRS: CBC (CL. 6.1 to6.4) and IRC: 87, if not in contravention to the following provisions.

a. Falsework shall be designed in consideration of appropriate raising (camber) against sinking and deformation due to the weight of the concrete during construction and after completion. Furthermore, the Contractor shall submit the plan of the camber to the Engineer prior to the commencement of works for obtaining approval.

b. Ties shall not be welded to the reinforcement bars. Clear cover to the end of the ties shall not be less than 25mm. Filling of tie locations after removal of form work shall be carried out with dry pack cement mortar.

c. The form work shall be of steel plates of proper thickness to give good finish.

28.2 Design of Formwork

a. The Contractor shall submit the design and drawing of complete formwork (i.e. the forms as well as their supports) to the Engineer, before any erection work commences. If proprietary system of formwork is used, the Contractor shall furnish detailed information to the Engineer. However, the Contractor shall be entirely responsible for the adequacy and safety for formwork.

b. The foundation of all supports shall be designed to suit the bearing capacity of soil to support the designed loads without settlement.

c. The Contractor shall prepare detailed shop drawing showing the arrangement of form work for structural members including shoring system, horizontal and diagonal bracing system, details of foundation etc. The sizes of individual members shall be as per the design calculations.

28.3 Finishing of Formwork

a. Finishing shall conform to IRS: CBC (Cl.6.2.4 and Cl.6.2.5).

b. Formwork shall be made to produce a finished concrete true to shape, line, levels and dimensions.

c. Chamfers shall be provided at all angles of the formwork to avoid sharp corners. The chamfers, bevelled edges and mouldings shall be made in the form work itself, conforming to the Drawings.

28.4 Cleaning and Treatment of Forms

Cleaning and treatment of forms shall conform to IRS: CBC(Cl.6.3).

28.5 Specialized Formwork

a. Specialized form work shall conform to the provisions laid down in IRC:87(Cl.10).

b. Specialized formwork may be required in the case of slip formwork, underwater concreting etc. Such specialized formwork shall be designed and detailed by competent agencies and a set of complete working drawings and installation instructions shall be supplied to the Engineer. The site personnel shall be trained in the erection and dismantling as well as operation of such specialized formwork. If proprietary equipment is used, the supplier shall supply drawings, details, installation instructions, etc. in the form of manuals along with the formwork. Where specialized formwork is used, close coordination with the design of permanent structure is necessary.

c. For slip form, the rate of slipping the formwork shall be designed for each individual case considering various parametres including the grade of concrete, concrete strength, concrete temperature, ambient temperature and concreted mixtures.

d. In order to verify the time and sequence of striking or removal of specialized formwork, routine field tests for the consistency of concrete and strength development are mandatory and shall be carried out before adoption.

28.6 Inspection of Formwork

a. The Contractor shall inspect the formwork and shall submit inspection results by "Formwork Assembly Inspection Record" prior to concreting works.

"Formwork Assembly Inspection Record" describes the results of verification of inspection results of the formwork with design documents in which the shape and dimensions of the formwork, clear cover to the outermost reinforcement, effective height etc. are verified. The proposed form of "Formwork Assembly Inspection Record" shall be submitted by the Contractor for approval of the Engineer.

b. Concreting shall not be allowed unless approved for the formwork by the Engineer.

28.7 Stripping and Removal of Formwork

a. Stripping time shall conform to the provisions laid down in IRS: CBC(Cl.6.4).

b. The scheme for removal of formwork (i.e., de-shuttering and decentring) shall be planned in advance and submitted to the Engineer for scrutiny and approval. No form work or any part there of shall be removed without prior approval of the Engineer.

c. The formwork shall be removed in such a manner that does not cause any damage to concrete. Centring shall be gradually and uniformly lowered in such a manner that it permits the concrete to take stresses due to its own weight uniformly and gradually to avoid any shock or vibration.

d. Where the rear ere- entrant angles in the concrete sections, the formwork shall be removed at these sections as soon as possible after the concrete has set to avoid cracking due to shrinkage of concrete.

28.8 Reuse of Forms

The Contractor shall not be permitted reuse of timber facing formwork brought new on the works for more than 5 times for exposed concrete formwork and 8 times for ordinary formwork.5 or 8 uses shall be permitted only if forms are properly cared for, stored and repaired after each use. Use of different quality boards or the use of old and new boards in the same form work shall not be allowed. If any other type of special or proprietary form work is used, the number of times they can be used shall begiven a NONO from the Engineer.

Annexure – OCS 2

REINFORCEMENT STEEL

1 General

a) High strength deformed steel bars for concrete reinforcement used in the works shall be Fe 500D TMT, conforming to IS 1786 and manufactured by SAIL/TATA STEEL /JSW STEEL/RINL/*JSPL* . No rerolled steel shall be used. The Contractor shall produce copy of original challan or voucher as a proof of having purchased the steel reinforcement from manufacturers or their authorized distributors having approval of the Engineer. Reinforcement steel shall be stored as per IS 4082.

b) Any steel specified for reinforcement shall conform in every respect to the latest relevant Indian Standard Specifications and shall be of tested quality under the ISI Certification Scheme.

c) All reinforcement work shall be executed in conformity with the drawings supplied and instructions given by the Engineer and shall generally be carried out in accordance with the relevant Indian Standard Specifications IS: 2502- Bending and Fixing of Bars for Concrete Reinforcement.

d) No work shall be commenced without the Engineer's approval for reinforcement bar bending schedule. The reinforcement bars shall be bent to conform to the dimensions and shape shown in the Drawings in a manner that will not damage the parent material. Bars shall be bent cold. Any reinforcement, which is bent, shall not be re-bent. However, when it is unavoidable to re-bend the reinforcement, the same shall have approval from the Engineer.

e) Placement of reinforcement shall conform to the provisions laid down in IRS: CBC (Cl. 7.1.3). Cover and spacing of steel shall be uniform and as specified in the specifications and as shown in the Drawings.

f) Uncoated reinforcement steel shall be protected from rusting or chloride contamination. Reinforcements shall be free of rust, mortar, loose mill scale, grease, oil or paint.

g) Procurement of reinforcement steel shall be so phased by the Contractor that the storage period before its actual use in the works is limited to the bare minimum as directed by the Engineer.

h) Steel shall be stored in a rebar yard having proper workflow or a hard surface i.e.100 mm thick concrete over compacted base so that the surface of the rebar yard is not damaged during handling of bars. The yard should enable easy and efficient handling of the reinforcement bar for various stages i.e; receipt of material, cutting and bending stacking and dispatch to site.

2 Inspection and Testing

a) Manufacturer's test certificate shall be submitted for each lot of supply brought at the Site by the Contractor. Physical tests shall conform to IS1387, IS1599, IS1608 and IS1786. Independent test on quality of steel from each lot shall be carried out as per IRS: CBC (Cl.4.5.2).

b) The frequency of tests on reinforcement consignments delivered at site from one manufacturer should be as per IS 1786:2008 (Cl. 11.1).

c) Specimens required for three tensile tests for each of the different size of bar for each consignment delivered shall be sampled and tested by the Contractor before use at Site. Test results shall be duly supported by graph with respect to stress and strain. If first test of three test samples does not give the specified results, two additional tests shall be carried out. Both retests shall conform to the requirements as specified in IS 1786. The steel shall be rejected otherwise.

d) Reinforcement steel shall be inspected prior to the commencement of works and assembly on Site. Defective, brittle, excessively rusted or burnt bar shall be discarded. Cracked ends of bars shall be cut out. All reinforcement steel shall be free of loose small scales, rust and coats of paint, oil, mud etc.

e) The Contractor shall inspect the reinforcement works and submit inspection results by "Reinforcement Assembly Inspection Record". "Reinforcement Assembly Inspection Record" describes the results of verification of inspection results of the reinforcement work with the Drawing in which the diameter, number and length of the reinforcements, position of splices and joints, position and interval of the bent reinforcement bar, type and disposition of cover blocks are verified. The form of "Reinforcement Assembly Inspection Record" shall be proposed by the Contractor for approval of the Engineer.

f) The Contractor shall obtain approval of the Engineer for reinforcement work prior to the commencement of concrete work.

3 Tolerances and Criteria

a) Unless otherwise specified by the engineer, reinforcement shall be placed within the following tolerances:

   i. For overall depth 200 mm or less : ±10mm

   ii. For overall depth more than 200mm : ±15mm

   The cover shall, in no case, be reduced by more than one third of specified cover or 5mm whichever is less.

4 Lapping and Joints

a) Lapped Splices: No splicing of bars shall be permitted without prior approval of the Engineer. Lengths of splice, wherever required, shall be as indicated on the drawings and

approved by the Engineer. Lapped splices shall be staggered and located at points along the span where shear stresses are low.

b) Mechanical Joints: Mechanical coupler shall be used for jointing of reinforcement bars of diameter 25 mm and above. Mechanical coupler shall conform to laid down specification given in Clause 6 below.

c) Welded Joints : Not permitted

5 Coupler Specifications

a) Introduction

Only cold-forged, parallel threaded mechanical coupler system shall be used. All mechanical couplers shall be of Type 2 (or Class H as specified in IS-16172) and should be simple to install and which can be confirmed by quick visual inspection to have been correctly installed and to have achieved the required full strength connection. Any other types of mechanical coupler systems are not permitted.

The couplers shall be of standard parallel thread type. Ends of the reinforcement bars, which are to be joined, shall be enlarged by cold forging, threaded in such a way that root thread diameter is not lesser than the parent bar to be joined. The coupler shall be of TYPE – II and qualified/Certified as per UK CARES, IS code 16172:2014, ACI 318, ASME, Section III, and Div.2, Caltrans.

Couplers shall be installed strictly in accordance with the manufacturer's recommendations. Couplers shall be located away from high stress zones in the various structural elements and shall be staggered and shall conform to provision of IRS: CBC

All the couplers shall be manufactured in a factory which is ISO 9001:2008 (or higher revision) certified for "Manufacturing of Mechanical Steel Rebar Couplers & Accessories" and also be certified for "Site Management of Threading & Processing of Rebar including Sales and Distribution". All the couplers shall undergo quality checks on uniformity of threads, dimensional accuracy etc. Each coupler shall be clearly stamped indicating batch number and diameter. This number shall be traceable to the original cast. The relevant material mill certificate shall be submitted with supply of a particular lot. The certificate shall give salient material properties. The coupler manufacturer shall operate at least an ISO 9000 approved quality assurance programme or equivalent for the manufacture of couplers.

b). Threading of ends of the reinforcing bars:

The threading activity shall preferably be done at Site. The various stages involved in threading are as given below:

i. **Cutting (Rebar End Preparation):**

The ends of reinforcement bars shall be cut by mechanical means to get a perfect

plane surface perpendicular to the axis of the bar.

ii. Cold forging & threading:

After cutting the ends of the bar shall be enlarged by cold forging such that the area of cross section after threading shall not be less than the area of cross section of the parent bar. The length of cold forging shall be adequate for proposed thread length as per manufacturer's design. Threading shall be done on threading machine. The threads shall be square parallel type to suit the couplers. The thread length and depth shall be as per manufacturer's design. After threading is completed, the threaded length of the bars shall be protected by providing plastic end caps before taking the bars out of the shop.

a) Quality control in making of threads:

Double forging of bars is not permitted. In case of improper cold forging the forged of the bar shall be square cut and fresh cold forging shall be undertaken. 100% threading at threaded rebars shall be checked with 'go' and 'no go' gauges for the correctness of the thread profile on the rebar. A proper record for same shall be maintained at site.

b) Qualification tests

The coupler shall be qualified as per IS code 16172:2014, ACI 318, ASME - Section III, and Div.2, Caltrans and must have conducted & qualified for the following tests:

i. Static tensile test

Mechanical connections shall be tested for all reinforcing rebar sizes. For each rebar size, a minimum of three connections (3 joints + 1 Parent bar) in each load direction shall be tested in accordance with ASTM A370 test method to meet code requirement. A tensile test on an unsliced specimen from the same bar used for the spliced specimens shall be performed to establish actual tensile strength. The tensile strength of an individual splice system shall not be less than the 125% of the specified minimum yield strength (fy of rebar) of the spliced bar.

ii. Cyclic tension and compression test

Mechanical connections shall be tested in all reinforcing rebar sizes. For each rebar size, a minimum of three connections shall be tested for cyclic tension & compression test. Each specimen shall withstand cycles of stress variation of the specified minimum yield strength of the reinforcing bar. The test should be carried out as per the table mentioned below:

Loading Stages and Cycles per stage for cyclic load test

Stage	Tension	Compression	Cycles
1	0.95 fy	0.5 fy	20cycles
2	2 εy	0.5 fy	4cycles
3	5 εy	0.5 fy	4cycles

Note:

fy is specified yield strength of the reinforcing bar.

εy is the strength of reinforcing bar at actual yield stress

iii. **Cyclic tensile test**

Mechanical connections shall be tested in all reinforcing rebar sizes. For each rebar size, a minimum of three connections shall be tested for low cyclic tensile test. Each specimen shall withstand 100 cycles of stress variation from 5% to 90% of the specified minimum yield strength (fy) of the reinforcing bar. One cycle is defined as an increase from the lower load to the higher load & return.

iv. **Low cycle fatigue test (for 10,000 cycles)**

Fatigue test shall be conducted on splice sample from +173 Mpa to -173 Mpa for 10,000 cycles. A sine wave form @ 0.5 Hz shall be followed for bar dia 36 mm & above and 0.35 Hz shall be followed for bar dia less than 36 mm. Test shall be conducted confirming to IS 16172:2014 & Caltrans specifications. Past certificates for low cycle fatigue test shall be accepted. However these should not be more than 3 years old.

v. **High cycle fatigue test (for 2,000,000 cycles)**

In high cycle fatigue test, the test specimen is subjected to an axial tensile load which varies cyclically according to the sinusoidal wave form of constant frequency in the elastic range, as accordance with IS-16172. Past certificates for high cycle fatigue test shall be accepted. However these should not be more than 3 years old.

vi. **Slip test**

Slip Test Shall be performed on each diameter coupler specimen as per ASTM A 370 section 10. Test shall be conducted conforming to IS 16172:2014 & Caltrans specifications. Total slip shall not exceed the max value of 0.1 mm.

vii. **Proof loading test**

Every cold-forged, threaded bar end shall undergo a proof load test prior to leaving

system supplier's workshop. Every threaded bar must be subjected to proof load testing to a minimum test loading of 75% of the characteristic strength (theoretical fy). The system supplier shall essentially install a proof load tester equipment within its threading workshop premises and ensure to test each and every threaded bar. A positive indication shall be marked on the rebar to indicate that this operation has been carried out.

Note: All three steps involved in the preparation of mechanical joints i.e end cutting of reinforcement, cold forging and threading shall be performed by the coupler manufacturer at site/supplier's workshop. Alternatively, these three steps can also be carried out at site by the Contractor in which case all required machinery shall be procured from the manufacturer and work carried out under the guidance of manufacturer. The manufacturer shall supervise complete operation at site in the initial stage. The manufacturer shall train staff of the Contractor in all activities. However, the manufacturer shall oversee the quality of threading activities through periodical audits and shall give guarantee for the overall quality of preparation of mechanical joints. Contractor shall submit the test certificates of joint strength of samples for static tensile test carried out at NABL approved lab duly certified by the manufacturer.

6 INSTALLATION OF COUPLERS IN THE FIELD:

The installation of couplers in the field, for joining reinforcing bars shall be undertaken by trained manpower and as per manufacturer's instructions. Threads of both the couplers and the bars shall be thoroughly cleaned just before installation. Where couplers are cast-in the concrete, but connection is not to be completed immediately, the couplers shall be internally greased and plastic capped to a protection detail acceptable to the engineer. This cap shall be removed only when next bar is to be attached, then the same to be cleaned before joining the next bar.

The contractor shall arrange for a suitably qualified manufacturer's representative experienced in mechanically connecting reinforcement to be present at site before the start of work for initial training of personnel, and also to demonstrate the equipment and techniques as necessary. The threading workshop is to be fully supervised by the manufacturer's representative.

The contractor shall submit to the Engineer, for his approval a method statement duly approved by the manufacturer for mechanically connecting the reinforcement and for the installation and verification in the field. All activities of manufacture of mechanical joint i.e. cutting, forging and threading shall be carried out under the overall guidance of the manufacturer at the rebar yard with necessary machines and equipment supplied by the manufacturer. The Contractor shall also submit certificate for satisfactory performance of the mechanical joint from the manufacturer for all the coupled bars. This shall take into account any special requirements for horizontal, vertical and inclined couplers and shall include a rectification procedure, if the connection is

incorrectly made. It shall also cover the correct methodology for handling of tools and equipment for mechanical connection on site. The following information shall also be included:

1 Requirements for cleanliness

2 Equipment for threading bars

3 Method of locking the connections on both rebars

4 Method of verification of final rebars alignment and coupler integrity

Each coupler shall be visually examined prior to use to ensure the absence of rust and of any foreign material on the inside surface. All completed couplers shall be inspected and verified in accordance with the approved QAP. The Contractor shall ensure the acceptance of the Engineer for a procedure for documenting the inspection of the couplers. The contractor shall retain inspection records and shall submit copies to the Engineer-in-Charge within 7 days. The Couplers that do not meet the acceptance shall be completely removed and the bars re-connected as required.

7 BAR BENDING AND BAR BENDING SCHEDULE:

All bars will be carefully and accurately bent by approved means in accordance with IS: 2502, and relevant drawings. It shall be ensured that depth of crank is correct as per the bar cutting and bending schedule and bent bars are not straightened for use in any manner that will injure the material.

Prior to starting bar bending work, the Contractor shall prepare bar bending schedule from the structural drawings supplied to him and get the same approved by Engineer. Any discrepancies and inaccuracies found by the Contractor in the drawings shall be immediately reported to the Engineer whose interpretation and decision there to, shall be accepted.

8 SPACING, SUPPORTING AND CLEANING:

a) All reinforcement shall be placed and maintained in the positions shown on the drawings to be prepared by contractor.

b) The Contractor shall provide approved types of supports for maintaining the bars in position and ensuring required spacing and correct cover of concrete to the reinforcement as specified on the drawings. Cover blocks of required shape and size, Chairs and spacer bars shall be used to ensure accurate positioning of reinforcement. Spacers or chairs should be placed at a maximum spacing of 1m and closer spacing sometime be necessary. Cover blocks of approved proprietary should be pre-packaged free flowing mortars (Conbextra HF of Fosroc or equivalent). Cover blocks of concrete (not sand cement mortar) should be of the same strength as that of the surrounding concrete and properly compacted and vibrated on a vibrating table. They shall be cured for a minimum period of 14days

before they are used in the works. The cost of cover block shall be deemed to have been included in the rates.

Cover blocks shall be firmly placed at appropriate intervals to maintain specified concrete cover to the reinforcement. The number of cover blocks to be provided shall generally be about 4 pieces per m2 for the bottom surface of the member and about 2-4 pieces per m2 for the side surface of the member. Cover blocks shall be made of concrete or mortar having quality equal to or higher than that of the parent concrete.

c) Bars must be cleaned, before concreting commences, of all scale, rust or partially set concrete which may have been deposited there during placing of previous lift of concrete. On no account shall the bars be oiled or painted nor shall mould oil used on the formwork be allowed to come in contact with the bars. Cement wash to bars will not be permitted.

d) Only Fe500D TMT bars complying to IS:1786 shall be provided.

e) 1.6mm dia. G.I. wire shall be used for binding reinforcement.

Annexure OCS-3

FABRICATION AND ERECTION OF STEEL BRIDGE GIRDER

1. General

Fabrication of all Steel Bridge Girders shall be performed within the plants and by fabricators having the experience, knowledge, trained manpower, quality controls, equipment and other facilities required to produce the steel work to desired quality. The plants where fabrication works are proposed to be performed shall be duly approved by RDSO for fabrication of OWG. The tenderer shall submit complete details of the plants along with his tender for the approval of the Engineer. Inspection and passing of fabricated elements/girder shall be done by the RDSO/Employer as per codal provisions and specifications.

Fabrication and erection of steel girder bridges shall be in accordance with IRS fabrication specifications (B1).

2. Material

a. Steel: Mild steel for welded/riveted bridge girders subjected to railway loading shall conform to IS: 2062, Quality "B0" Grade Designation E250, fully killed and with normalizing/ normalizing rolling/ controlled rolling. Plates less than 12mm thick need not be with normalizing/ normalizing rolling/ controlled rolling.

b. In case Rolled Steel Standard Sections conforming to IS:2062 Quality "B0" are not available in market, Engineer may permit use of steel conforming to IS:2062 Quality "BR" / "A" on case to case basis.

c. Steel shall have smooth and uniform finish and shall be free from rolling defects such as cracks, flaws, seams, laps, imperfect edges etc. and other defects such as loose mill scale, rust, pitting, or other defects affecting its strength and durability.

d. High Strength Friction Grip (HSFG) bolt assembly including Direct Tension Indicator (DTI)washers shall conform to EN: 14399 series.

e. All the steel sections used in the fabrication must have mill test certificate clearly indicating the specification to which the steel conforms and whether steel is killed and normalized.

f. The materials, on receipt, shall be carefully unloaded, examined for defects, checked, sorted, and stacked securely on a level bed, out of danger from flood or tide and out of contact with water or ground moisture. They will be supported on timber or concrete plinths so that they do not touch the ground.

3. Fabrication of steel work

a. The records of fabrication shall be maintained in the registers as per the formats given in the Appendix I of IRS: B1-2001.

b. The greatest accuracy shall be observed in the design, fabrication, and erection of every part of the work to ensure that all parts will fit accurately together on erection. Components of all the spans shall be fully interchangeable. Same jigs and assembly fixtures duly approved shall be used. The tolerances in manufacture shall be in accordance with as shown in Appendix II of IRS: B1-2001.

c. There should be level, finished concrete floor of sufficient dimensions in the fabrication yard, on which the fabricator will precisely set out the outline of the structure (to full scale) as per drawings for the purpose of preparing templates. Only steel tapes shall be used for all measurements, and they will be held tight and level on the floor while measuring or marking.

d. Steel tapes used for marking out the work shall be calibrated at a temperature of 20° C.

e. The templates throughout the work shall be of steel bushed.

i. Flattening and straightening

All steel materials, plates, bars and rolled sections shall have straight edges, flat surfaces and be free from twist. If necessary, they shall be cold straightened or flattened by pressure before being worked or assembled unless they are required to be of curvilinear form.

ii. Cutting of Steel

Cutting of steel for fabrication may be done by shearing, sawing, or by gas using mechanically controlled torch/torches. All flame cut edges shall be ground to obtain reasonably clean square and true edges. Plasma-arc cutting method may also be employed. This process offers less heat input causing less distortion.

iii. Making of Holes

Marking and drilling of holes in members shall preferably be done with the use of templates/jigs. All bolt holes in members built up by welding shall be drilled after welding.

Holes for turned bolts, should be 1mm under drilled in shop and should be reamed at site to suit the diameter of turned bolt. Jigs shall be periodically checked for tolerances from master plates.

iv. Welding

Welded construction work shall be carried out generally in accordance with the provisions of Indian Railway Standard Welded Bridge Code and subject to further specifications as given below:

i. All welds shall be done by submerged arc welding process in shop. Site welding should not be undertaken except in special circumstances with the approval of the Engineer. Site welding should be confined to connections having low stresses, secondary members, bracings etc.

ii. Suitable jigs and fixtures shall be used to avoid distortion during welding. Components which are mass fabricated in the shop should be proved in master templates.

iii. Class and size of electrode for welding shall conform to IRS Specification M-28. For fabrication of steel bridge girder following class of electrode shall be used-

Class of Electrode as per IRS Specification No. M.28.66	**Type of work to be welded**	**I.S. Specification No.**	**Code (as per IS:815- 66)**
Class B2 (Moderately high ductility)	For welding of mild steel to IS:2062-1962 (Fusion welding quality) or equivalent, for service conditions where the weldment is rigid and subjected to relatively high dynamic stresses	814-63	M 110 to M 997-H, J, K or P.

Brand and make of electrode on approved list of M&C wing of RDSO should be used.

i. No welding operator shall be employed on the work until he has, in the presence of the Engineer, passed the appropriate tests laid down in relevant codes.

ii. All main butt welds shall have complete penetration and shall comply with the requirements of IRS Welded Bridge Code. They shall be made between prepared fusion faces. Where possible they shall be welded from both sides. The ends of the welds shall have full throat thickness. This shall be obtained on all main welds by the use of extension pieces adequately secured on either side of the main plates. Additional metal remaining after the removal of the

extension pieces shall be removed by machining, or by other approved means and the ends and surfaces of the welds shall be smoothly finished.

iii. In the fabrication of built-up assemblies all butt welds in the component parts shall be complete before the final assembly.

iv. A record of butt welds shall be kept to enable it to be identified with the welders responsible for the work but material shall not be marked by hard stamping for this purpose.

The welding techniques and sequence, quality, size of electrodes, voltage and current required shall be as prescribed by manufacturers of the material and welding equipment. The Contractor shall submit full details of welding procedure in proforma given at Appendix V of IRS: B1-2001 for approval of the Engineer.

v. Welding of Stud Shear Connectors:

i. The welding of stud shear connectors shall be done by "DRAWN ARC STUD WELDING WITH CERAMIC FERRULE" technique. The shear stud and ceramic ferrules shall conform to type SD1/UF as per BS EN ISO 13918-2008.

ii. The stud and the surface to which studs are welded shall be free from scale, moisture, rust and other foreign material. The stud base shall not be painted, galvanized or cadmium plated prior to welding. Welding shall not be carried out when temperature is below 10 degrees Celsius or surface is wet or during periods of strong winds unless the work and the welder are adequately protected. The welds shall be visually free from cracks and shall be capable of developing at least the nominal ultimate strength of studs. The procedural trial for welding the stud shall be carried out when specified by the Engineer.

iii. Testing of Stud Shear Connectors:

(A) Appearance Test

1) The weld to a shear stud connector should form a complete collar around the shank and free from cracks, excessive splashes of weld material, free from injurious laps, fins, seams, twist, bends or other injurious defects.

2) Weld material should have a 'steel blue' appearance.

(B) Test to check the fixing of shear studs

1) Ring Test: Involves striking the side of the head of stud with a 2 kg hammer. A ringing tone achieved after striking indicates good fusion whereas dull tone indicates a lack of fusion (BS 5400-6) All studs shall be checked by Ring test.

2) Bend Test: Test requires the head of a stud to be displaced laterally by approximate 25% of its height using 6kg hammer.

* The weld should then be checked for sign of cracking or lack of fusion.

* Stud should not be bent as back as this is likely to damage the weld.

* The testing rate should be 1 in 50 (BS 5400-6).

vi. Making of Joints

i. Joints shall normally be made by filling not less than 50 per cent of holes with service bolts and barrel drifts in the ratio 4:1. Only barrel drifts shall be used in erection. Drifts may be used for drawing light members in position; but their use on heavy members shall be restricted to securing them in their correct position. Any error in the shop fabrication or deformation resulting from handling and transportation which prevents proper assembling and fitting up of parts shall be reported immediately to the Engineer. No reaming shall be undertaken without the written authority of the Engineer.

ii. The erection of OWG shall be done in accordance with Appendix III of IRS: B1-2001. However, if the Contractor desires to adopt any other method of erection, they shall submit the scheme and obtain the approval of the Engineer. It shall be ensured that when in position, the girder has the camber as per drawing.

vii. High Strength Friction Grip (HSFG) bolting assembly

The HSFG bolting assembly shall conform to EN 14399 Series (High strength structural bolting assemblies for preloading):

- EN 14399-1:2015- General requirements.
- EN 14399-2:2015- Suitability for preloading.
- EN 14399-3:2015- System HR- Hexagonal bolt and nut assemblies.
- EN 14399-5:2015- Plain washers.
- EN 14399-6:2015- Plain chamfered washers.
- EN 14399-9:2009- Direct Tension Indicator for bolt and nut assembly.

HSFG bolting assemblies are very sensitive to differences in manufacture and lubrication. Therefore, complete HSFG bolting assembly (i.e. bolt, nut, washers & DTI) including galvanizing shall be procured from single manufacturer. Use of Direct Tension Indicator (DTI) washers shall be mandatory in the HSFG bolting assemblies.

Grade and size of bolts shall be as per the Drawings. The surface preparation, tightening procedures and other details for HSFG bolts shall be as per RDSO standard Drawing No. RDSO/B-11760/R1.

Table: Composition of high strength structural bolting assembly and its component marking

Type of bolting assembly		System HR	
General requirements		EN 14399-1	
Suitability for preloading		EN 14399--2 and, if any, additional testing specified in the product standard	
Bolt & Nut		EN 14399-3	
Marking	Bolt	HR8.8	HR10.9
	Nut	HR8 or HR10	HR10
Washers		EN 14399-5[a] or EN 14399-6	
Marking		H or HR[b]	
Direct tension indicator and nut face washer or bolt face washer		EN 14399-9	
Marking	Direct Tension Indicator	H8	H10
	Nut Face Washer	HN	
	Bolt Face Washer	HB	

[a] EN 14399-5 can only be used under the nut.
[b] At the choice of the manufacturer.

The bolt length shall be chosen such that after tightening the following requirements are met for bolt end protrusion beyond the nut face and the thread length:

a) the length of protrusion shall be at least the length of one thread pitch measured from the outer face of the nut to the end of bolt

b) at least four full threads (in addition to the thread run out) shall remain clear between the bearing surface of the nut and unthreaded part of the shank.

Holes for HSFG bolts- The holes shall be made by drilling only. The actual diameter of hole shall be 1.5 mm more than the bolt diameter for less than 25mm diameter bolts and 2mm more than nominal diameters of HSFG bolts for diameters 25mm and above.

Surface preparation of steel interface before providing HSFG bolts–Wherever property class 8.8 bolts are used these should be hot dip galvanized as per ISO: 10684(latest version). Property class 10.9 bolts should not be hot dip galvanized since this may cause hydrogen embrittlement. So these bolts should be coated with zinc flakes as per ISO: 10683 (latest version). However, depending on the site conditions, locations of these bolts in the

structure and corrosion proneness, use of zinc flake spray coating as per ISO: 10683(latest version) can be adopted even for property class 8.8 bolts as well.

Installation of HSFG bolting assembly- Installation /tightening of preloaded bolting assemblies shall be carried out as per clause 8.3 & 8.5 of EN 1090-2 and clause 5.2 of EN 14399-9. The following steps shall be followed for tightening of bolts:

i. The holes shall be brought in alignment by using drifts etc. such that bolt threads are not damaged/enlarged during insertion of bolts.

ii. The members being joined shall be held in position by insertion of few HSFG bolts (tightened to first stage only i.e. snug tight condition).

iii. After the alignment/geometry of members is verified to be correct as per drawings, balance bolts shall be inserted and tightened upto first stage of tightening. The drifts inserted as above shall also be replaced by HSFG bolts one by one.

iv. After first stage of tightening, the joint shall be checked to see if the plies are in close contact and clearances are not exceeded.

v. Second stage tightening shall be done with torque wrench. Bolts shall be tightened until indentation on the DTI indicate full tightening. In order to minimize loosening of already tight bolts, tightening in both the stages shall be done starting from the stiffest part to free edges.

vi. 100% bolts shall be checked for proper tightening using feeler gauge of 0.4/0.25 mm.

vii. Fully tensioned bolt, opened for any reason whatsoever, shall be rejected and removed from the site of work along with washers, nut and DTI.

4. Bearing and Expansion Gear

All bearings and expansion gears shall be procured from a reputed and experienced manufacturer qualified to undertake precision fabrication of this type and shall be approved by the Engineer.

5. Trial Shop erection

Trial shop erection shall be done in accordance with Cl.614 of IRBM.

6. Field erection

Field erection shall be done in accordance with Cl.616 of IRBM.

7. Erection in contractor's Works

The whole of the work shall be completely interchangeable. First span (of each type) shall be temporarily erected complete at the Contractor's Works for inspection by the Inspecting Officer to test the accuracy of the templates. Further spans or part span assemblies built from

parts selected at random by the Inspecting Officer shall be erected from time to time to check the accuracy of the work as the Inspecting Officer may require.

8. Launching

Before taking up launching, the Contractor shall prepare and submit launching scheme along with design and methodology of launching including details of equipment proposed to be used for the approval of the Engineer.

a) Rail Flyovers (RFO)

After approval of the Engineer, launching scheme shall be got approved from Chief Bridge Engineer/Northern Railway. CRS application shall be prepared by the Contractor and submitted to the Commissioner of Railway Safety (CRS) through the Engineer, HRIDC and CBE/NR. Work of launching shall be started only after receipt of sanction of CRS.

b) Road Under Bridges

After approval of the Engineer, launching scheme shall be got approved from concerned road authorities. Work of launching shall be started only after receipt of approval of concerned road authority.

During erection of plate/composite steel girder by crane special care shall be taken to support the girder by wooden blocks & temporary bracing to ensure stability against toppling till permanent bracings are provided."

9. Track work for OWG:

Track work for open web girder bridge on H-beam sleepers shall be done as per IRPWM, relevant RDSO drawings and codal provisions.

10. Camber

In order to eliminate secondary stresses in a span under loaded condition, the nominal length (i.e. the lengths which will give no camber) of member shall be increased or decreased by the amount shown on the camber diagram supplied by the Employer. Frequent checks shall be made of the camber of girders during erection and care taken to see that the camber as per drawing is obtained when the girder is completely assembled. When span is supported on ends and intermediate supports are removed the dead load camber shall be recorded and entered in bridge register. This will provide the reference to compare the camber checked during technical inspection to ascertain the loss of camber.

11. Test certificates & testing

All materials for the work shall pass Mechanical test, Charpy test, Chemical Analysis, etc. prescribed by the relevant IS specifications or such other equivalent specifications.

For all materials including HSFG bolts, the contractor shall furnish copies of test certificates from the manufacturers including proof sheets, mill test certificates, etc. showing that the materials have been tested in accordance with the requirements of various specifications and codal provisions.

If any further testing of materials is required by Engineer in respect of these and other items, it shall be arranged for by the contractor at a reputed laboratory/National test house as approved by Engineer. For this, nothing extra shall be payable.

Even satisfactory outcome of such tests or analysis shall in no way limit, dilute or interfere with the absolute right of the Engineer to reject the whole or part of such materials supplied, which in the judgement of the inspecting authority does not comply with the conditions of the contract. The decision of the Engineer in this regard shall be final, binding and conclusive for all purposes.

The Engineer shall be empowered, at his/her discretion to make or have made under the supervision, any of the tests specified in the specifications mentioned herein in addition to such other tests as he/she may consider necessary, at any time up to the completion of the contract and to such an extent as he/she may think necessary to determine the quality of all materials used therein. In doing so, he/she shall be at liberty under any reasonable procedure, he/she may think fit to select, identify, have cut-off and take possession of test pieces from the material either before, during or after its being worked up into the finished product.

The Engineer shall also be empowered to call for a duly authenticated series of mechanical tests to be obtained from the maker for this materials used in the work and to accept the same in lieu of other tests to the extent he/she deems fit. The Contractor shall supply the material for the test pieces and shall also prepare the test pieces necessary.

The test shall be carried out by the Contractor, for which Contractor shall provide all facilities including supply of labour and plant. Engineer may at his/her discretion direct the Contractor to despatch such tests pieces as he/she may require to the National Test House or elsewhere as he/she may think fit for such testing purposes. The Engineer may at his/her discretion, check test results obtained at Contractor's work by independent tests at National Test House.

The Engineer shall at all times be empowered to examine and check the working of the Contractor's plant before and after using it. Should the Contractor's plant be found, in the Engineer's opinion, unreliable, he/she is empowered to cancel any tests already carried out in this contract and have these tests carried out at any National Test House or elsewhere, as he/she may think fit.

12. Fabrication drawings

The contractor shall prepare detailed shop drawings including drawing office dispatch lists (DODL's) on the basis of design drawings supplied by Engineer in such size and in such details as may be specified by Engineer. The shop drawings shall be submitted to Engineer in triplicate.

No work of fabrication will be started without such approval being obtained. Contractor has to arrange the proof checking of the working fabrication drawings from the nominated Institution / Consultant. The cost will be borne by the contractor.

13. Painting

a. Fabricated steel work shall not be painted over except to the extent specified in para (b) until it has been inspected and passed by the Engineer or his representative and any defect, pointed out by him has been rectified.

b. All surfaces which shall be in permanent contact and any others which will not be accessible for painting later on shall be cleaned thoroughly and given one coat of Zinc Chrome Red Oxide Priming to IS 2074 or other approved composition in the prescribed number of coats immediately prior to assembly.

c. Steel girders (including all components) shall be provided with protective coating by metalizing with sprayed aluminum as given in the Appendix-VII of IRS: B1-2001, followed by painting as per painting schedule given below-

i. One coat of etch primer to IS:5666

ii. One coat of zinc chrome primer to IS: 104 with the additional proviso that zinc chrome to be used in the manufacture of primer shall conform to type 2 of IS:51.

iii. Two coats of aluminum paint to IS: 2339 brushing or spraying as required. One coat shall be applied before the fabricated steel work leaves the shop. After the steel work is erected at site, the second finishing coat shall be applied after touching up the primer and the finishing coat if damaged in transit.

14. All third Party (RDSO/RITES/Any other nominated agency) Inspections charges for Open Web Girders and Composite Girders etc. shall be paid by the Employer."

Annexure OCS-4

PRESTRESSING

1 GENERAL

The work shall be carried out in accordance with the drawing and these specifications or as approved by the Engineer.

Concrete and un-tensioned steel for the construction of prestressed concrete members shall conform to the requirements of respective sections so far as the requirements of these Sections apply and are not specifically modified by requirements set forth herein.

Contractor shall ensure that different components of prestressing such as jacks, bearing plates, wedges, anchorages, strands, and HDPE ducts etc. are compatible to each other and the same shall be exchanged in between all the suppliers to ensure the same.

2 MATERIALS

a. Sheathing

i. The sheathing ducts shall be of the spiral corrugated type. Unless otherwise specified, the material shall be Cold Rolled Cold Annealed (CRCA) Mild Steel conforming to IS: 513 intended for mechanical treatment and surface refining but not for quench hardening or tempering.

ii. The material shall normally be bright finished. However, where specified, as in case of use in aggressive environment, galvanized or lead-coated mild steel strips shall be used. The thickness of sheathing shall be as shown on the drawing, but shall nevertheless not be less than 0.3mm, 0.4mm and 0.5mm for sheathing ducts having internal diameter of 50mm, 75mm and 90 mm respectively. For larger diameter of ducts, thickness of sheathing shall be based on recommendations of prestressing system supplier or as directed by the Engineer.

iii. For major projects, the sheathing ducts should preferably be manufactured at the project site utilising appropriate machines. With such an arrangement, long lengths of sheathing ducts may be used with consequent reduction in the number of joints and couplers. Where sheathing duct joints are unavoidable, such joints shall be made slurry tight by the use of corrugated threaded sleeve couplers which may be tightly screwed onto the outer side of the sheathing ducts.

iv. The length of the coupler should not be less than 150mm but should be increased upto 200mm wherever practicable. The joints between the ends of the coupler and the duct shall be sealed with adhesive sealing tape to prevent penetration of cement slurry during concreting. The couplers of adjacent ducts should be staggered wherever practicable. As far as possible, couplers should not be located in curved zones. The corrugated sleeve couplers are being conveniently manufactured using the sheath making machine with the next higher size of die set.

v. The internal diameter of the sheathing duct shall be in accordance with the recommendations of the system manufacturer and shall be about three times the area of the tendons. In case of 6T13, 12T13 and 19T13 sizes of tendons comprising 12/13mm dia strands, the inner diameter of the sheathing shall not be less than 50mm, 75mm and 90mm respectively or those shown in the drawing, whichever is greater.

b. Anchorages

i. Anchorages shall be procured from authorized manufacturers only. Anchorages shall conform to BS 4447. Test certificates from a laboratory fully equipped to carry out the tests shall be furnished to the Engineer. Such test certificates shall not be more than 12 months old at the time of making the proposal for adoption of a particular system for the project.

ii. No damaged anchorages shall be used. Steel parts shall be protected from corrosion at all times. Threaded parts shall be protected by greased wrappings and tapped holes shall be protected by suitable plugs until used. The anchorage components shall be kept free from mortar and loose rust and any other deleterious coating.

iii. Swages of prestressing strand and button heads of prestressing wire, where provided shall develop a strength of at least 95 per cent of the specified breaking load of the strand or wire as the case may be. Where swaging / button-heading is envisaged, the Contractor shall furnish details of his methodology and obtain approval of the Engineer, prior to his taking up the work.

c. Prestressing Steel

i. 12.7mm nominal dia stress relieved low relaxation high tensile steel strand (CLASS-II) conforming to IS: 14268 with ultimate tensile strength 1861 N/mm2 shall be used. Various test as recommended in IS: 14268 shall be conducted before transporting the lot to site. Apart from 1000 hrs relaxation test conducted by manufacturer, at least two such tests are required to be conducted by independent agency in the beginning of project.

d. Prestressing strands/Wires storage

i. All high tensile steel for prestressing work shall be stored about 30cm above the ground in a suitably covered and closed space to protect it from dampness. It shall also be invariably wrapped in gunny cloth or tar paper or any other suitable materials, as per approval of Engineer. Even if it is to be stored in an area at the site for short time during transit it shall be suitably covered. Protection during storage and repacking or application of washable protective coating to the H.T. steel shall be given by the contractor at no extra cost if the packing of H. T. Strand/wire during unloading and storage / handling in the stores gets damaged.

ii. Stock piling of H. T. Steel on the work site shall not be allowed any time, especially before and during the monsoon.

iii. The Engineer or his authorized representative shall always have an easy access to the store-yard for inspecting the H. T. Wire/strands/Bars and satisfying themselves regarding the condition thereof. Any modifications regarding storage suggested by the Engineer shall scrupulously be followed by the contractor. During monsoon days, H.T wires/strands shall be kept in reasonable airtight store, if required by the Engineer, at no extra cost.

e. Testing of Prestressing steel and Anchorages

i. All materials specified for testing shall be furnished free of cost and shall be delivered in time for tests to be made well in advance of anticipated time of use.

ii. All wire, strand or bars to be shipped to the site shall be assigned a lot number and tagged for identification purposes. Anchorage assemblies to be shipped shall be like-wise identified.

iii. All samples submitted shall be representative of the lot to be furnished and in the case of wire or strand, shall be taken from the same master roll. The Contractor shall furnish samples of at least 5.0m length selected from each lot for testing. Also, two anchorage assemblies, complete with distribution plates of each size or types to be used, shall be furnished along with short lengths of strands as required.

3 WORKMANSHIP

a. **Cleaning**

i. Tendons shall be free from loose rust, oil, grease, tar, paint, mud or any other deleterious substance.

ii. Cleaning of the steel may be carried out by immersion in suitable solvent solutions, wire brushing or passing through a pressure box containing carborandum powder. However, the tendons shall not be brought to a polished condition.

b. **Straightening**

i. High tensile steel wire and strand shall be supplied in coils of sufficiently large diameter such that tendons shall retain their physical properties and shall be straight as it unwinds from the coil. Tendons of any type that are damaged, kinked or bent shall not be used.

ii. The packing of prestressing wire / strand shall be removed only just prior to making of cable for placement. Suitable stands shall be provided to facilitate uncoiling of wires / strands without damage to steel. Care shall be taken to avoid the possibility of steel coming into contact with the ground.

c. **Positioning**

i. Post-Tensioning

Prestressing tendons shall be accurately located and maintained in position, both vertically and horizontally, as per drawings.

Tendons shall be so arranged that they have a smooth profile without sudden bends or kinks.

The location of prestressed cables shall be such as to facilitate easy placement and vibration of concrete in between the tendons.

Sheathing shall be placed in correct position and profile by providing suitable ladders and spacers. Such ladders may be provided at intervals of approximately 1.0 m. Sheathing shall be tied rigidly with such ladders/spacer bars so that they do not get disturbed during concreting.

The method of supporting and fixing shall be such that profile of cables is not disturbed during vibrations, by pressure of wet concrete, by workmen or by construction traffic.

- Each anchorage device shall be set square to the line of action of the corresponding prestressing tendon and shall be positioned securely to prevent movement during concreting.
- The anchorage devices shall be cleaned to the satisfaction of the Engineer prior to the placing of concrete. After concreting, any mortar or concrete which adheres to bearing or wedging surfaces shall be removed immediately.

d. **Cutting**

i. Cutting and trimming of wires or strands shall be done by suitable mechanical or flame cutters. When a flame cutter is used, care shall be taken to ensure that the flame does not come in contract with other stressed steel. The location of flame cutting of wire or strand shall be kept beyond 75mm of where the tendon will be gripped by the anchorage or jacks.

ii. In post-tensioning the ends of prestressing steel projecting beyond the anchorages, shall be cut after the grout has set.

e. **Protection of Prestressing steel**

i. Prestressing steel shall be continuously protected against corrosion, until grouted. The corrosion protector shall have no deleterious effect on the steel or concrete or on the bond strength of steel to concrete. Grouting shall conform to these specifications or as directed by the Engineer or specified in Contract Specifications.

f. **Sheathing Joints and Couplings**

i. Joints in sheathing shall, if so, instructed be sealed with a heat shrink tape.

ii. Special attention should be paid to its junction at the anchorage. It should tightly fit on the trumpet end of anchorage and the junction should be sealed, preferably, with heat shrink tape.

iii. The heat shrink tape is supplied in the form of bandage rolls which can be used for all diameters of sheathing ducts. The bandage is coated on the underside with a heat sensitive adhesive so that after heating the bandage material shrinks on the sheathing duct and ensures formation of a leak-proof joint. The heating is affected by means of a soft gas flame.

iv. The sheathing and all joints shall be watertight. Any temporary opening in the sheathing shall be satisfactorily plugged and all joints between sheathing and any other part of the prestressing system shall be effectively sealed to prevent entry of mortar, dust, water or other deleterious matter. Sheathing shall be neatly fitted at joints without internal projection or reduction of diameter.

v. Enlarged portions of the sheathing at couplings or anchorages shall be of sufficient length to provide for the extension of the tendons.

g. **Grout Vents**

i. Grout vents of atleast 20mm diameter shall be provided at both ends of the sheathing and at all valleys and crests along its length. Additional vents with plugs shall also be provided along the length of sheathing such that the spacings of consecutive vents do not exceed 20m. Each of the grout vents shall be provided with a plug or similar device capable of withstanding a pressure of 1.0MPa without the loss of water, air pressure or grout.

h. **Anchorages**

i. All bearing surfaces of the anchorages shall be cleaned prior to concreting and tensioning. Anchor cones, blocks and plates shall be securely positioned and maintained during concreting such that the centre line of the duct passes axially through the anchorage assembly.

ii. The anchorages shall be recessed from the concrete surface as per drawings.

iii. After the prestressing operations are completed and prestressing strands are cut, the surface shall be painted with two coats of epoxy of suitable formulation having a dry film thickness of 80 microns per coat and entire recess shall be filled with concrete or non-shrink/pre-packaged mortar or epoxy concrete.

i. **Handling and Storage**

i. Care shall be taken to avoid mechanically damaging, work-hardening or heating prestressing tendons while handling. All prestressing tendons shall be stored clear of the ground and protected from the weather, from splashes from any other materials, and from splashes from the cutting operation of an oxy-acetylene torch, or arc-welding processes in the vicinity.

ii. In no circumstances shall prestressing tendons after manufacture be subjected to any welding operation, or 'on-site' heat treatment or metallic coating such as galvanizing. This does not preclude cutting as specified.

iii. All wires, strands or bars stressed in one operation shall be taken, where possible, from the same parcel. Each cable shall be tagged with its number from which the coil numbers of the steel used can be identified. Cables shall not be kinked or twisted. Individual wires and strands for which extensions are to be measured shall be readily identifiable at each end of the member. No strand that has become unraveled shall be used.

j. **Supervision**

i. All prestressing and grouting operations shall be undertaken by trained personnel only. A representative of supplier of the prestressing system shall be present during all tensioning and grouting operations and shall ensure, monitor and certify their correctness.

4 Tensioning Equipment

All tensioning equipment shall be procured from authorized manufacturers only and be approved by the Engineer prior to use. Where hydraulic jacks are used, they shall be power driven unless otherwise approved by the Engineer. The tensioning equipment shall satisfy the following requirements:

a. The means of attachments of the prestressing steel to the jack or any other tensioning apparatus shall be safe and secure.

b. Where two or more wires / strands constitute a tendon, a single multiple stressing jack shall be used which is capable of tensioning simultaneously all the wires / strands of the tendon. Suitable facilities for handling and attaching the multi-pull jack to the tendons shall be provided.

c. The tensioning equipment shall be such that it can apply controlled total force gradually on the concrete without inducing dangerous secondary stresses in steel, anchorage or concrete; and

d. Means shall be provided for direct measurement of the force by use of dynamometres or pressure gauges fitted in the hydraulic system itself to determine the pressure in the jacks. Facilities shall also be provided for the linear measurement of the extension

of prestressing steel to the nearest mm and of any slip of the gripping devices at transfer.

e. Any indication in the loss of strength in tendons during the tensioning operation shall be brought to the attention of the Engineer. Any corrective measures which may be required in procedures and/or material shall be approved by the Engineer.

f. When friction must be reduced, water soluble oil may be used subject to the approval of the Engineer. This oil may be flushed from the duct as soon as possible after stressing is completed by use of water pressure. These ducts shall be flushed again just prior to the grouting operations. Each time the ducts are flushed, they shall be immediately blown dry with oil-free air.

5 Testing by the Contractor

For the purpose of accurately determining the tendon elongations while stressing, the Contractor shall bench test two samples of each size and type of strand tendon to determine the modulus of elasticity prior to stressing the initial tendon. The bench should be at least 6metres long, with concrete anchorage blocks having a constant area end section of at least four times that of the anchorage assembly area. The tendon shall be straight and centered on the cross-sectional area of the bench. The test procedure shall consist of stressing the tendon at an anchor assembly with the dead end consisting of a load cell. The test specimen shall be tensioned to 80 percent of ultimate in 10 increments. For each increment, the gauge pressure, elongation and load cell force shall be recorded. The data shall be furnished to the Engineer. The theoretical elongations shown on the post-tensioning working drawings shall be re-evaluated by the Contractor using the results of the tests and corrected as necessary. Revisions to the theoretical elongations shall be submitted to the Engineer for approval.

Apparatus and methods used to perform the tests shall be proposed by the Contractor and be subject to the approval of the Engineer. After the initial testing, five more tests shall be performed. These tests shall be spaced evenly throughout the duration of the Contract.

a. Post Tensioning Procedure

i. Tensioning force shall be applied in gradual and steady steps and carried out in such a manner that the applied tensions and elongations can be measured at all times. The sequence of stressing applied tensions and elongations shall be in accordance with the approved drawing or as directed by the Engineer.

ii. It shall be ensured that in no case, the load is applied to the concrete before it attains the strength specified on the drawing or as stipulated by the prestressing system supplier, whichever is more.

iii. After prestressing steel has been anchored, the force exerted by the tensioning equipment shall be decreased gradually and steadily so as to avoid shock to the prestressing steel or anchorage.

iv. The tensioning force applied to any tendon shall be determined by direct reading of the pressure gauges or dynamo metres and by comparison of the measured elongation with the calculated elongation. The calculated elongation shall be invariably adjusted with respect to the modulus of elasticity of steel for the particular lot as given by the manufacturer.

v. The difference between calculated and observed tension and elongation during prestressing operations shall be regulated.

vi. **Grouting of Prestressed Tendons:** Grouting shall conform to provisions in **Annexure D** of "IRS Concrete Bridge Code: 1997". A record of grouting operations shall be maintained in a format given by Engineer.

6 Safety Precautions during Tensioning

These are applicable for both pre-tensioning and post tensioning operations.

a. Care shall be taken during tensioning to ensure the safety of all persons in the vicinity.

b. Jacks shall be secured in such a manner that they will be held in position, should they lose their grip on the tendons.

c. No person shall be allowed to stand behind the jacks or close to the line of the tendons while tensioning is in progress.

d. The operations of the jacks and the measurement of the elongation and associated operations shall be carried out in such a manner and from such a position that the safety of all concerned is ensured.

e. A safety barrier shall be provided at both ends to prevent any tendon, which might become loose from recoiling unchecked.

f. During actual tensioning operation, warning sign shall be displayed at both ends of the tendon. No person will stand behind in line with jacks while tendon / wire are being stressed.

g. After prestressing, concrete shall neither be drilled nor any portion cut nor chipped away nor disturbed, without express approval of the Engineer.

h. No welding shall be permitted on or near tendons nor shall any heat be applied to tendons. Any tendon which has been affected by welding, weld spatter or heat shall be rejected.

7 Transportation and Storage of Units

a. Precast girders or elements shall be transported in an upright position. Points of support and the direction of reactions with respect to the girder shall approximately be the same during transportation, and storage as when the girder is placed in final position.

b. When members are to be stacked, they shall be firmly supported at such bearing positions as will ensure that the stresses induced in them are always less than the permissible design stresses. Further, inclined side supports shall be provided at the ends and along the length of a precast girder to prevent lateral movements or instability.

c. Care shall be taken during storage, hoisting and handling of the precast units to prevent their cracking or being otherwise damaged. Units worked or damaged by improper storing or handling or transport shall be replaced by the Contractor at his expense.

8 Tolerances

a. Permissible tolerances for positional deviation of prestressing tendons shall be limited to the following:

i. Variation from the specified horizontal profile: 5 mm
ii. Variation from the specified vertical profile: 5 mm
iii. Variation from the specified position in member: 5 mm

Section VII: Employer's Requirements

Section VII-7: General Electrical Services

CHAPTER – 1 SCOPE OF WORK

1.1 GENERAL

A general description of the broad scope of work, relating to works covered in this Contract under Schedule 'C', is given below. It shall, however, be clearly understood that the description is for the purpose of general guidance only and is not exhaustive. For complete appreciation of the Scope, the specifications, drawings and other relevant paragraphs of the Tender documents shall be referred to. *Contractor shall obtain all relevant RDSO Standards/drawing from RDSO at its own cost.*

1.2 ITEMS OF WORK

The following items of work are within the Scope of this Tender:

i. Electrification of Dhalawat, Chandla Dungerwas, Pachgaon, New Patli and Sultanpur Station Building and Yard area with allied facilities, *FOB/Subway etc*. and complete power supply arrangement as per Standard Railway Practice and guideline issued by Railway Board/ RDSO/ CPWD specification in Package C-23 for HORC Project.

ii. Supply, Installation, testing and commissioning of substation (11/0.44 kV, 2x250 kVA CSS with DRY type transformer (250 kVA) and silent type DG of 125 kVA capacity including AMF, APFC Panel of 100kVAR & LT Panel) including earthing system and all Safety equipment with complete power supply arrangement at New Patli station. The Location of Compact Sub Station (CSS) with all accessories shall be proposed by contractor in Station Area for approval of Engineer.

iii. *Deleted*

iv. Supply, Installation, testing and commissioning of High Mast Towers (16 mtrs) and octagonal poles (5 mtrs) with luminaries at yards, platform and circulating area with complete cabling arrangement to meet standard LUX level as per guideline issued be RDSO/ Railway Board.

v. Supply, Installation, testing and commissioning of CLS PANEL with cabling arrangement of suitable size and rating at each station as per RDSO specification.

vi. Supply, installation, testing and commissioning of Single sided and Double sided LED signage board with pictogram/symbol at each station as per specification.

vii. Supply, Installation, Testing and Commissioning of 3 Nos Lifts(G+1) (13 Passenger ,884 Kg) at New Patli Station. with all safety equipment and 02-year or warranty given by OEM whichever is higher including all schedule maintenance as per OEM, attending breakdown with in prescribed time.

viii. All equipment testing, system acceptance test, integrated testing, and Commissioning of all erected equipment.

ix. Provision of all the construction drawings, documents and as-built drawings required to supply, install, test and commission the above installations.

x. Deal and resolve in co-ordination with the Engineer the Interface with other Contractors to ensure timely completion of the Works.

xi. Space for Escalator (Future) at New Patli station to be kept.

xii. New 11kV HT connection at New Patli station and New connection/Load Augmentation at LT at Dhulawat, Chandla Dungerwas, Pachgaon and Sultanpur Station shall be arranged and availed by the contractor.

xiii. Provision of Submersible pumps at all stations.

xiv. Provision of water cooler, Inverter and cabling etc.

xv. Provision of LT panel for distribution of LT supply for lighting, fans, air conditioners, Yard Lighting, Fob/Sub Way Lighting, signalling and Telecom Load, SCADA RTU load, Lift load, submersible pump load, Tower Wagon shed, Power supply for operation of OHE motorised isolator/Interrupter etc. Twenty percent (20%) spare capacity shall be kept in LT panel for future loads.

xvi. All Nuts, bolts, Studs, washers, Pins etc. shall be of GI or stainless steel. All earthing strips shall be of GI.

1.3 SCOPE

1.3.1 General

In general, The Contractor is responsible for all electrical works relating to electrification of station building/Yard with allied facilities including provision of lifts and (11/0.44 kVA) substation of rated capacity in this Section.

Table -2.1 Scope of work

S.NO	NAME OF SECTION	SCOPE
1	Dhulawat Station	Various Electrical General Services Work
2	Chandla Dungerwas Station	Various Electrical General Services Work
3	Panchgaon Station	Various Electrical General Services Work
4	New Patli Station	Various Electrical General Services Work including SITC of Passenger Lifts
5	Sultanpur Station	Various Electrical General Services Work
6	Design	All General Services Work

NOTE: - The Contractor shall arrange *inspection test plan of all required items. Contractor shall obtain approval of* lay out plan of Complete HT/LT power supply arrangement from Engineer before commissioning of work.

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CHAPTER 2 — DESIGN AND PERFORMANCE REQUIREMENTS

2.1 General

2.1.1 The design, supply, installation, testing and commissioning of General Services work including Power supply system etc. shall meet the design and performance requirements within the design environments specified in this PS.

2.1.2 Design Environment

Adequate Margin shall be built in Design, particularly to take care of Climate Conditions/Operating Environment. Wherever the equipment is installed in open at the surface level or inside service buildings at surface level, the same shall be designed for working in the tropical conditions existing here and the ambient temperature and humidity levels pertaining to HORC Project area.

2.2 Basic Design Philosophy and Requirements

2.2.1 Proven Design

The Contractor shall develop the design based on specification and on proven and reliable Engineering Practices. The design details shall be submitted with technical data and calculations to the Engineer for review. *The Design shall include complete Single line Diagram indicating Local, DG set and AT supply*.

The contractor shall submit drawings in such a form as the Engineer will require them for approval, copies as required of all drawings, diagrams and details of all equipment in part or in whole. The contractor shall make any drawings available to the Engineer at all reasonable times. Wiring diagrams and other drawings as the Engineer deems shall not be finally settled until satisfactory installation and testing has been made, this shall be approved in principle.

The contractor shall submit a schematic block diagram of the equipment showing the manner, in which the functional requirements of this specification shall work together. The contractor shall submit a schedule including details of numbering, categories and drawing registers / indexes for the production, submission and approval during the period of the contract of drawings and also of any information, required for the Engineer in connection with the design of the contract works.

This schedule shall be suited to the requirements of manufacture, delivery and installation of the contract works to meet the requirements of the contract and shall allow reasonable time (approx. 8 weeks) for study and approval by the Engineer of all drawings, calculations and graphics submitted (and, as necessary, resubmitted) by the contractor.

No approval by the Engineer of any drawing shall relieve the contractor of any of his obligations of liabilities under the contract or of his responsibility for ensuring that the work is satisfactory done and that all operational requirements shall be met.

The contractor shall provide final drawings without undue delay, and in any case within twelve weeks of the award of the contract, these drawings shall include dimensions, capacity of equipment and complete power supply arrangement with all associated items of each station. *Incomplete submission of documents and Drawings shall not be considered as submission. by contactor.*

2.2.2 The design philosophy should meet the following criteria:

a) Application of state-of-the-art Technology
b) Service proven design
c) Design life *20* years *(However the individual equipment shall have different design life.*
d) Minimum life cycle cost
e) Low maintenance cost
f) Use of interchangeable, modular components
g) Extensive and prominent labelling of parts, cables and wires
h) High reliability
i) Low energy loss
j) System safety
k) Adequate redundancy in system
l) Fire and smoke protection
m) Use of fire retardant materials and fire survivals cables
n) Environment friendly
o) Adherence to operational performance requirements
p) Maximum utilization of indigenous materials and skills, subject to quality conformity.

Adequate margin shall be built into the design particularly to take care of the higher ambient temperatures, dusty conditions, and high seasonal humidity, etc. prevailing in HORC Project area.

2.3 AS-BUILT DRAWINGS

Preparation of the as-built drawings shall be part of these specifications. As-built drawings will be Final Design Drawings of the project showing the actual work done. The contractor shall provide the as-built drawings in one original and one reproducible negative produced from the original, with the names of the signature authorities of the Engineer and the contractor. After they are signed for approval, prints shall be taken from the signed original of each drawing. Also, *Hard Disc Drive (1 TB)* with all as-built drawings shall be handed to the Engineer. Together with the as-built drawings, the contractor shall provide reduced size (e.g. A3 size) booklets of the as-built drawings as per the Engineer requirement.

All details, dimensions, texts, etc., on the reduced size drawings shall be clearly recognizable and readable. The contractor shall complete and obtain the Engineer's approval on the as-built drawings and make the final submission of the as-built drawings together with the A3 size booklets latest within three months following the date of the Certificate of Completion. All costs associated with the provisions mentioned above shall be deemed to be included in the contract price.

As-built drawings shall cover in general (but not limited to):

a) For mechanical equipment:

i. Construction drawings,
ii. Instruction drawings,
iii. Functional block diagrams with set-point range of process parameters depicted

thereon.

b) For electrical installation:

i. Installation drawings with circuit numbers and exact type-assignation of all installed equipment,
ii. Distribution diagrams with circuit numbers,
iii. Fault analysis and protection co-ordination settings the of protection system,
iv. Power consumption,
v. Precise type numbering
vi. Earthing systems

c) For distribution panels:

i. Construction drawings,
ii. Circuit drawings as operating diagrams,
iii. Additional current flow-charts where required,
iv. Accurate lists of any installed equipment with precise description of this equipment,
v. Adjustment tolerances of circuit-breakers, switches, etc.

d) For equipment:

i. Construction drawings,
ii. Circuit diagrams,
iii. Functional block diagrams with set-point range of process
iv. parameters depicted thereon,
v. List of quantities with detailed break-down of the bill of materials comprising the equipment.

e) For cabling:

i. Diagrams with dimensions, type of cables and power requirements with regular cross- section area and measured cable values shall be used for these diagrams.

2.4 System Requirements :

2.4.1 Conformity with Governing Specifications and other Statutory Requirements: -

The work shall be carried out in accordance with the following governing specifications and other statutory rules:

i. Indian Electricity Act 2003 with latest amendments.
ii. CEA Regulations 2010
iii. Central Safety regulations, 2010
iv. Regulations laid down by Chief Electrical Inspector to the government.
v. Regulations laid down by EIG Indian Railways.
vi. National Building Code.
vii. Rules and Regulations prescribed by local authorities as applicable.
viii. Relevant, Indian Standards, IEC Standards, CENELEC, British Standards and

other National/ International standards as applicable.

ix. The Contractor shall furnish information asked for by a statutory body (e.g., Government of India, Ministry of Railways, Commissioner of Railway Safety, Government of Haryana etc.) in particular format as directed by Engineer. Any documents, studies, test reports, compliances required for getting safety clearances from any authority shall be submitted by the contractor

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CHAPTER –3 INSTALLATION AND CONSTRUCTION

3.1 REQUIREMENTS

3.1.1 General Requirements

i. The Contractor shall comply with all Enactments in executing the Works, including but not limited to all statutory provisions on occupational health and safety.

ii. The Contractor shall co-ordinate with Other Contractors in the execution of the Works.

iii. The Contractor shall also co-operate with all Relevant Authorities in the execution of the Works.

iv. The installation of all equipment shall be undertaken at all times by suitably trained and competent employees of the Contractor, to the satisfaction of the Engineer.

v. Only appropriate tools, plant, equipment and vehicles shall be used.

vi. Installation of all equipment shall be in accordance with the Construction and Installation Plan described in the drawing/plans as approved by Engineer before commissioning of work.

vii. Installation of all equipment shall conform to the best industry practices.

viii. Precautions shall be undertaken to ensure the safety of personnel and equipment for all installation works.

ix. The Contractor shall, prior to starting any installation and construction work, identify any possible hazards, and implement measures of eliminating and/or controlling such potential hazards, in line with safe working practices.

x. The Contractor shall ensure that all areas of work are sufficiently illuminated for the works to be undertaken and that a safe system of work is employed for all activities.

xi. The Contractor shall operate a robust system for the control of persons entering or working upon the site.

xii. The Contractor shall co-operate, always, with the Engineer and Other Contractors to ensure that the Site is protected from unauthorised admission, either wilfully or otherwise.

xiii. The Contractor shall make due provision for the safe access and egress to the Site of Works for its staff and subcontractors.

xiv. This access shall be maintained such that it is free of all hazards and is in a safe condition throughout the duration of the Works.

xv. Contractor shall submit method statement for (a). Erection of equipment, (b).Equipment testing and commissioning and (c). Performa and checklist for recording during equipment testing.

xvi. The contractor shall set up at least one main store/ depot for receiving and storing materials & other equipment at his own cost.

3.1.2 Specific Requirements

The installation and construction work pertaining to this Contract shall include, but not be limited to the following: -

i. Finalisation of the Construction and Installation Programme provided by contractor and duly approved by Engineer.
ii. Survey on Site and review the technical requirements shown in this Specification and the Engineer's Drawings (if any).
iii. Production of the calculation sheets and installation drawings for Site installation.
iv. Production of specific site designs and drawings based on typical designs and drawings supplied.
v. Installation in accordance with the finalised installation drawings.
vi. Co-ordination with Other Contractors;
vii. Submission of the installation reports and records.
viii. Testing and commissioning, as per finalised protocol and programme.

3.2 Construction and Installation Plan

The Contractor shall undertake installation work in stages as shown in the detailed installation programme. Installation, testing and commissioning of later stages shall not impact revenue operation of earlier stages.

As a minimum, the detailed Construction and Installation Plan shall include but not be limited to all the activities, installation details and methods of all activities, equipment and tools to be used for installation, safety issues, supervision, temporary land occupation needed and the vehicles to be used for installation.

3.2.1 *Material* Handling

To facilitate handling of equipment during installation and maintenance thereafter, the Contractor shall closely co-ordinate and interface with other contractors travelling hoists and unloading jib cranes for sub-stations. The entire material handling plan for movement of bulky item such as Transformers, Panels, DG sets, and cables etc. shall be carefully planned. Crane of adequate capacity with a jib of requisite length will be arranged by the Contractor at his own cost. Road crane for handling heavy materials at the contractor's depot for loading and unloading of material will be arranged by the contractor who will also arrange his own crew for its operation and maintenance. All charges including pay and allowances of the crew and all running expenditure will be borne by the contractor.

3.3 Site Supervision/ Deployment of Technical Staff: -

3.3.1 The Contractor shall set up a Site supervision system, which shall be part of the overall safety, system assurance and quality management system.

i. The Contractor shall provide sufficient number of experienced Engineer, Supervisors and skilled workers to ensure progress and quality of the work at Site and in the Contractor's workshops (if any), are maintained to the satisfaction of the Engineer. The minimum number of Engineers required to be deployed is shown in table below: -

No	Post	Minimum Eligibility	Minimum Requirements in nos.
1	Sr. Engineer (Overall in charge of all type of General Services work)	Graduate in Electrical Engineering with 10 or more- year experience in Electrical General Services work or HT & LT works.	1
2	Electrical Engineer (Site Engineer)	Graduate in Electrical Engineering with 7 or more-year experience in General Services work or HT & LT works. **Or** Diploma in Electrical Engineer with 10 or more years experience in General Services work or HT & LT works.	2

ii. The contractor shall submit to the Engineer, not later than 60 days from the date of award of contract, the organization chart showing following key positions, and CV's of the incumbents and the brief job descriptions. The Engineer shall issue Notice of "No-objection" or otherwise for the appointment of "key positions" within stipulated working days of such submission.

iii. The performance of personnel shall be under observation by Engineer. In case the performance of any personnel is not up to the mark, as decided by Engineer. In case replacement is required, contractor shall be responsible for replacement of such personnel.

iv. In case the contractor fails to employ the technical staff as aforesaid to the satisfaction of the Engineer-in-charge, the recovery shall be as mentioned below per each calendar month or part thereof of default.

Sl. No.	Post	Amount to be recovered per person per each calendar month or part thereof of default. (Rs)
1	Sr. Engineer	1.0 Lakhs
2	Electrical Engineer	50,000 /-
3	E&M Engineer	50,000/-

v. Contractor is to abide by the provisions of Payment of Wages act & Minimum wage act.

vi. The Contractor's supervision system shall be responsible not only for the supervision of the concerned system installation but also for the supervision of the installation of the primary fixing system, earth mats and systems, etc. The supervisors shall work on a full-time basis during the entire installation process.

vii. The Contractor shall maintain a set of drawings at each system which accurately reflect the current status of field changes. The Contractor shall obtain letter of no objection from the Engineer for any such changes. The Contractor shall prepare final drawings showing the as built configuration. These drawings shall be developed in a logical format to facilitate routine system maintenance and troubleshooting. All drawings and details shall be endorsed by the Contractor.

viii. The Engineer reserves the right to undertake, at any time, checks on the proficiency of the Contractors staff, licensing and all associated documentation. If any of the Contractors staff be found incompetent or unlicensed he shall be removed from the site until their Competency has been established.

3.4 Workmanship

All the installation shall be carried out according to the instructions shown in these specifications and Drawings (as approved).

All assemblies of equipment and their components and parts shall be completely interchangeable if they are of similar type

The style and procedure of the workmanship shall be consistent throughout the Works. Unless otherwise specified, the Engineer shall decide the final colours for all paint work and other finishes to be applied to any part of the Works.

All parts, which are subject to, wear or damage by dust, shall be completely enclosed in dust proof housings.

3.4.1 Installation of Cables

The Contractor shall co-ordinate with the Civil Contractors wherever necessary, for the installation of cables in cable galleries, trenches, ducts, trays, risers and other locations. The cable system shall, during installation, be fully protected from mechanical damage and be generally accessible at all points for inspection along its entire route. Suitable cable markers shall be provided for covered cables upon completion of installation Should it prove necessary to cut any cable during installation, all cut ends shall be properly sealed.

The maximum pulling force of any cable during installation shall not exceed the design force of cables.

All cables shall be installed in the formed cable trenches, shafts, hangers, trays and brackets. The minimum recommended bending radius of the cables shall be adhered to during installation.

All materials used for termination, jointing and installation of cables in confined spaces shall have flame retardant, low smoke, halogen free characteristics.

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CHAPTER – 4 TESTING AND COMISSIONING

4.1 TESTING

This Chapter describes the testing & commissioning related to the Various General Services works in conformity with the requirements of RDSO/Railway Board Standards and standard Railway practices.

Testing constitutes an essential obligation to satisfy the Railway System.

4.2 Testing Conditions and Equipment Acceptance

The Contractor will have to carry out all the tests and checks required guaranteeing the Engineer of the good construction and the satisfactory operation of all power supply installation. Also, the contractor shall co-ordinate & arranges testing equipment etc. required for testing facilities.

The various high, medium and low voltage equipment will be subjected to all the tests required under equipment test sheets, (lists are not exhaustive) as per the relevant IEC or other standards mentioned in the technical specification of each equipment or otherwise.

It is reminded that the contractor is totally entrusted with full responsibility of assembly and installation of all pieces of equipment mentioned in this specification, with supplying the maintenance equipment and the special tooling which shall be delivered as soon as equipment installation will be completed and with the various duties he is bound to regarding witnessing of tests at commissioning and supervision after energising.

4.2.1 **In-plant testing**: -

In plant testing concern type, routine tests and factory acceptance test.

i. Type tests are tests performed on one or two of an equipment series
ii. Routine test are tests performed on each equipment
iii. Factory acceptance tests are tests on a sample size as per standards.
iv. These tests will enable checking the quality of the equipment and its compliance with the specifications.
v. Following equipment, if desired by the Engineer shall be tested at third-party (duly approved by the Engineer)/ RITES during Factory Acceptance Test.:
    1. DG sets *and AMF Panel.*
    2. Transformer of any capacity
    3. Switch gears
    4. Different size of cables (LT/HT)
    5. LED light fittings
    6. Different types of HT/LT panels and APFC panel etc.
    7. Earthing material.
    8. *16 mtr and 5 mtr High Mast.*
    9. *Submersible Pumps*
    10. Any other material decided by Engineer

Employer/Engineer representative shall also witness the testing of materials as decided by Employer. Once the equipment will have passed the in-plant acceptance tests, it shall be delivered and installed under the contractor responsibility.

Concerning some type tests, test certificates issued by recognised agencies will be able to

be supplied if the contractor cannot carry out these tests himself and if the test certificates are related to a similar equipment of same capacity and design.

The final factory tests will be carried out on the fully assembled equipment as specified. Thereafter, if required and permitted by the technical features of the equipment, the equipment may be dis-assembled for transportation purposes. The dis-assembly should not, however, cause any deterioration of the technical performance of the equipment.

These tests will be carried out by the contractor, under his responsibility and in the presence of the Engineer and of the consulting Engineer. The cost of Factory Inspection/Site Inspection/Lab Test/Documentations will be borne by contractor.

Each of these tests will be subjected to a certificate. Provisional acceptance will be granted only after execution of the both sets of tests.

NOTE: For type tests, the contractor can provide test reports performed according to the corresponding IEC standard, on similar equipment of same capacity and design.

4.2.2 Third Party Tests

i. During execution stage Engineer may conduct the Test on any type of equipment from third party independent lab at its own cost, to ensure the quality of material supplies. If any of the samples fail in the test, the cost of the Test along with the complete replacement of whole lot shall be borne by the Contractor.
ii. If contractor represents, two random samples from the failed Lot shall be collected by the contractor in the presence of Engineer duly sealing the samples and send to two different NABL accredited labs (as approved by Engineer) for conducting all those tests, which were conducted on the failed sample. Cost of the testing including the collection of sample and transportation of sample will be borne by the contractor.
iii. If both the samples pass all the Tests, the Lot will be deemed as accepted by HRIDC, but in the case of failure of any of the samples collected by the contractor, complete Lot will be deemed as rejected and contractor will replace the whole Lot.
iv. The delay, if any for the procurement of the material due to failure, shall be considered as non-compliance and applicable penalty shall be imposed on the contractor.

4.2.3 System Acceptance Tests

At least six weeks in advance of any particular site testing, the contractor shall submit details of tests and details for the teste equipment the proposes to use for that testing to the Engineer for his approval.

All tests for statutory requirements and insurances including arrangements for such tests, inspections by Authorized bodies, persons or insurers, as necessary and the provision of certificates in the prescribed and approved forms necessary to enable plant and equipment to be put into service, shall be made by the contractor.

If each section of plant is installed, commissioning tests for each section shall be carried out on site. At least six weeks in advance of any particular site testing, the contractor shall submit details of tests and details for the test equipment he proposes to use for that testing

to the Engineer for his approval. As installation proceeds, the insulation resistance of cables shall be checked and recorded.

The identification of the cores shall be confirmed from end to end of each cable end, in the case of communication, alarm- and control-cabling, from end to end of each circuit. Tests on cables shall be completed and accepted by the Engineer before the testing of the associated equipment starts.

All tests for statutory requirements and insurances including arrangements for such tests, inspections by authorized bodies, persons or insurers, as necessary and the provision of certificates in the prescribed and approved forms necessary to enable plant and equipment to be put into service, shall be made by the contractor.

4.2.3.1 On-site commissioning tests being subject of acceptance by the Engineer shall include:

a) All equipment, cabling, distribution etc. is electrically and mechanically safe.
b) All interlocks, isolators and door and cover securing mechanisms shall be properly fitted and adjusted.
c) All exposed metal work is properly bonded and grounded and that all connections and points required to be grounded for a safe and satisfactory operation shall be properly grounded in accordance with the manufacturer's requirements.
d) All cables, cores and terminations shall be secure, properly fitted and correctly identified and coloured.
e) All phases, polarities, neutral and common connections shall be correctly switched / connected as required, so that the power is correctly available at all points and that the voltage and frequency at all equipment is correct and in accordance with the requirements for correct work.
f) All supplies shall be properly fused or otherwise protected, to give successfully discrimination and safe disconnection under fault conditions.
g) All contacts shall be properly aligned / adjusted and not subject to excessive wear or corrosion.
h) Batteries shall be correctly installed, connected and fitted and checked that the battery chargers are working correctly.
i) The insulation-resistance of all cabling and equipment shall not be less than specified.
j) During the commissioning of major item like HT panel, Transformer, DG sets etc. the contractor shall arrange expert Engineer of OEM of such item at respective sites. The expenditure for charges for the same including transport, lodging, shall be borne by the contractor at no extra cost.
k) All instruments and meters shall be energized with correct polarity and working properly.
l) All fault indications and alarms shall be working correctly.
m) In addition to all operational tests, required for a successful hand-over, the operation of all interlocks, sequences and protections which are not utilized in normal operations shall be subject of acceptance by the engineer.
n) The on-site commissioning tests shall be conducted under the supervision of the engineer.

4.2.3.2 (a) The final acceptance tests shall begin after all on-site commissioning tests have been successfully completed and all defects detected during those tests have been rectified / corrected, which is accepted by the Engineer. The tests shall include full operation tests on the works as a whole and selected technical tests on some or all of the equipment.

(b) On completion of the site acceptance tests, the contractor shall forward the test results certified by him to the Engineer. When the Engineer has received the results and deems that the plant has successfully passed the tests, he will write to the contractor to that effect. During the site acceptance tests the Engineer shall inform the contractor of minor faults detected and which of these minor faults shall be corrected before the beginning of the tests on completion.

4.2.4 TRIAL OPERATION

The trial operation shall occur with full responsibility of the contractor. The trial operation shall take place after finishing the tests on completion. For starting the trial operation, it is required, that all tests on completion are finished positive for the entire installation and shall occur within 21 days.

The trial operation shall show the evidence of a fully functional operation of the electrical system and that security is given during operation. Therefore, the trial operation shall occur without significant malfunctions. The contractor shall test different operation cases during the trial operation (e.g. loss of different equipment etc.).

The contractor shall make organizational measurements during the trial operation, so that malfunctions can be rectified as soon as possible (within max. 2 days).

The results of the different tests during trial operation shall be shown in a protocol. This protocol shall be signed by the contractor and the Engineer.

4.2.5 Energization: -

The Contractor shall prepare operation safety rules and procedures for the review of the Engineer before Energization.

The Contractor shall carry out all necessary checks to ensure safe Energization.

All power equipment shall be subject to inspection by inspectors from the Electrical Inspectorate of Engineer before Energization. The Contractor shall ensure all Engineer requirements are met. Contractor shall be responsible for reliable operation of all Electrical equipment.

4.3 COMMISSIONING

4.3.1 General

The Commissioning description, based on the following frame, will have to be defined by the contractor and submitted to the Engineer.

Once the contractor will have completed the above tests, and the various pieces of equipment installation, the assignment should include:

i. Putting into service tests

ii. After energising

The Engineer will be empowered to ask for any additional testing they may deem necessary. The contractor will have to supply the testing installations and measuring apparatuses required to this effect in accordance with the stipulations, provisional acceptance will then take place, followed by final acceptance at the end of the guarantee time.

4.3.1.1 Putting into Service Tests

It should be performed at this stage the tests verifying that the different equipment is acting correctly when energised.

4.3.1.2 Integrated Testing and Commissioning

The general testing having shown proper operation, an overall integrated test of the installations, should be performed, after the first 15 days of operation, during which the various actuation and operation situation (putting into service, normal actuation, failure tripping) will be simulated.

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CHAPTER – 5 MAINTENANCE AND TRAINING

5.1 INTRODUCTION

This Chapter describes the maintenance philosophy and training of maintenance staff for Electrical system considering RDSO/ Railway board standards and Railway practices.

The Contractor shall provide comprehensive training and documentation to the Engineer staff in accordance with the requirement of this chapter and the chapter of General Specifications.

This training shall enable all the installations, to be operated and maintained in the most efficient and safe manner, to achieve the maximum reliability and economy required by such System.

Note: - All type of Routine, Preventative and Schedule Maintenance work will be carried out at regular intervals, based on latest SMI's/ Instructions/Guidelines issued by RDSO/Railway Board and equipment manufacturers' recommendations.

5.1.1 Maintenance Management

The management of the maintenance process entails defining various levels of responsibility and enabling them to implement the strategic orientations defined by the directing authority:

i. By defining their respective missions,
ii. By setting objectives for each person,
iii. By translating these objectives into action plans,
iv. By implementing the means required to carry out action plans,
v. By diagnosing the causes of any deviation from the set objectives,
vi. By taking corrective measures concerning the action plans or the objectives.

This management process requires a global approach and helps to improve the performance of the maintenance work of different components with quality, on time and at low cost. It must be implemented at three levels:

i. At the level of human resources and management in the context of the scheduling of work, the allocation of human resources and the training of personnel.
ii. At the skills level to ensure quality, safety and suitable working conditions.
iii. At an economic and financial level to ensure responsible management of production, spare parts, purchasing and miscellaneous costs.

The quality of this management depends on the capability of those entrusted with operation and maintenance responsibilities:

i. To exploit the results of management within their field of responsibility.
ii. To react in the event of any deviation from the action plans defined with a view to achieving the set objectives.

Within the context of this approach, the management control function ensures timely advice to be given to those with operational and maintenance responsibility:

i. By placing at their disposal, the tools and information required for piloting and diagnosis.

ii. By participating in carrying out this diagnosis.

iii. By participating in the task of defining the objectives to be achieved.

In conclusion, the process of maintenance management must incorporate two major components:

i. the management of human resources and the study of the most suitable means of achieving the set objectives.
ii. This is one of the first guidelines of maintenance organisation in the various relevant centres.

5.1.2 Determining Requirements in Terms of Facilities and Tools

The achievement of the objectives assigned to the maintenance division about quality, safety and regularity for the lowest possible overall cost requires the implementation of a number of resources which must be perfectly tailored to the requirements.

The facilities and tools are part and parcel of the resources placed at the disposal of the maintenance division to achieve the set objectives.

Owing to the cost of these facilities, the number of maintenance centres to be equipped and the necessity of keeping the maintenance actions consistent and uniform, the main choices of facilities and tools are integral part of the System maintenance policy and program.

When determining these requirements, in-depth knowledge in the dedicated maintenance plan is needed while taking due account of the experience acquired in similar fixed installation which has been in service for several years.

5.2 SUPERVISION AND PLANNING OF MAINTENANCE

5.2.1 General

The following outlines the Engineer maintenance strategy, various levels of maintenance, the Maintenance Management System and the arrangement for maintenance.

The Contractor shall make use of all relevant information to provide supervision of maintenance.

5.2.2 Engineer's Maintenance Strategy

According to the maintenance strategy, all equipment and infrastructure supplied for the 'Project' must be such as to ensure for minimum or no maintenance. Maintenance activities required must be capable of being performed with little or no impact on the train service. In addition, the maintenance work systems shall ensure safety of personnel and equipment.

The Contractor shall ensure that to supervise maintenance during the DNP (Defects Notification Period) personnel are always available with the relevant skills and level of competence.

The Contractor, upon noticing any defects, deficiency in quality and quantity of spares and materials shall without delay, arranges for alternative source of supply and submit his proposal to the Engineer for review.

5.2.3 Planned Maintenance

Routine preventative maintenance will be carried out at regular intervals based on condition, reliability, usage, and service history, SMI 's issued by Railway Board/ RDSO and equipment manufacturers' recommendations. The Operating and Maintenance Manual shall describe the different levels of planned maintenance.

5.2.4 Supervisory Staff

The Contractor shall provide supervisory Maintenance staffs who are expert in all the different levels of fault finding, maintenance and repair of the various relevant systems supplied under the Contract:

i. Electrical system
ii. Switch gear/power supply arrangement
iii. Other works

5.2.5 Maintenance requirements

I. Testing and Re-commissioning of System and Equipment

In the event of a failure requiring modifications to the System, the Contractor shall undertake any testing and re-commissioning required.
Any such modification shall be submitted for Engineer review.

II. Temporary Alterations to Restore Service

The Contractor shall undertake any temporary modifications necessary to maintain service.
Any such modification shall be submitted for Engineer review.

III. Discrepancies between Installation and Design Records

Should the Contractor discover inconsistencies between the maintenance drawings and documentation and the installed equipment, the Contractor shall correct all such errors within two weeks.

IV. Communications

The Contractor shall ensure that adequate communication facilities are provided to its staff during the DNP and maintenance period as per approval of Engineer.

V. Location of Staff

The Contractor shall be responsible for locating staff such that the Contractor meets its contractual obligations and as per approval of Engineer.

VI. Maintenance Regimes

The Contractor shall provide documented maintenance regimes to be followed by the Engineer upon substantial completion of various components of the work until the end of the DNP.

The Contractor shall produce a maintenance regime for the equipment that shall comprise two constituent parts, corrective and routine/preventative maintenance.

Routine/preventative maintenance shall be non-intrusive to the day-to-day operation of the train service and be capable of being pre-planned in advance of the work.

Corrective maintenance shall be available 24 hours per day, able to respond to all foreseeable circumstances**.**

The maintenance regime shall cover all parts and equipment of the system designed, installed and commissioned by the Contractor.

The Contractor shall take into account the requirements of the operations and maintenance when determining and proposing its maintenance regime.

VII. Scope and Hours of Coverage

The regime and structure of corrective maintenance shall be robust in design.

The Contractor shall provide full 24 hour On-Call coverage and shall be such that initial response and rectification of failure are in accordance with the following:

i. Assistance to first level and corrective maintenance within 30 minutes, upon request of first line maintainer.

ii. All elements of preventative maintenance shall be carried out and completed during non-traffic hours without interrupting train services.

VIII. Routine and Corrective Maintenance Procedures

Routine and corrective maintenance procedures shall be supplied for all equipment. The format shall be as follows:

i. Uniform format and layout irrespective of equipment supplier.

ii. Colour coding for each activity.

iii. Cross referenced to the Operation and Maintenance Manuals.

iv. Document control information.

IX. Maintenance Manuals

The Contractor particulars of operating parameters, tools for dismantling and testing, methods of assembly and disassembly, tolerances, repair techniques and all other information necessary to set up a repair and servicing programme as per satisfaction of Engineer.

The Contractor shall provide documentation for all hardware and software for computer systems and other associated electronic equipment to meet the following requirements.

Such documents shall include but not be limited to:

i. manufacturers' documentation supplied as standard with the equipment;

ii. hardware configuration with details of expansion capabilities and options;

iii. programme loading instructions, including runtime environment configuration;

iv. programme listing including comprehensive 'comment statements' in hard copy and soft format for source code, compilers and development tools necessary to modify and recompile software;

v. flow charts, data flow diagrams and state diagrams as appropriate;

vi. description of software modules including purpose, linkage with other modules, error routines and any special considerations;

vii. memory maps for both internal and peripheral memory showing description of all programmes, data files, overlay areas, memory available for expansion and the like;

viii. loading and operating instructions for diagnostic programmes and specifically developed debugging tools; and

ix. Programming manuals relevant to operating systems, languages, development tools, etc.

The manual shall also include inspection/overhaul procedure and periodicity of various inspection/overhaul schedules in detail including the tools, special tools/plants, and facilities required.

5.3 TRAINING:

During the contract period, the contractor shall provide training manuals, as well as onsite training and training courses to ensure that the Engineer staff associated with this project may acquire full knowledge and appreciation / understanding of all aspects of the design, day to day operation, breakdown and routine maintenance and fault diagnosis of the power supply, the surveillance and control equipment as well as the belonging hard- and software. The contractor shall train the Engineer personnel about all equipment in theoretical and practical way. Also, the maintenance staff shall be trained. The Engineer will nominate members of his staff, who are attending the training courses.

The contractor shall nominate qualified instructors. It shall be essential that prior approval of the Engineer is obtained for the instructor and the instructor's qualifications in each case.

The contractor shall provide all relevant and necessary facilities which are needed for complete and effective staff training (such as video, TV, slide- and film-projectors and others) and venue. The contractor shall provide all facilities including accommodation, transport and catering of all trainees. Within three months after the signing of the contract, the contractor shall submit a detailed syllabus for the training courses for approval by the Engineer.

5.3.1 General Requirements

The Contractor keeping the above aspect in view shall provide comprehensive training to the Engineer's staff in accordance with the requirements contained in this Particular specification and general specification. The training courses and/or sessions shall include system performance requirements and all major equipment and works designed, by the Contractor.

The specific objectives of each course, training facilities to be used, the qualification and experience of the training instructors and the assessment criteria shall be developed by the

Contractor and submitted to the Engineer for review at least three months before any course is conducted.

The Contractor shall provide full-time on-Site management and co-ordination of the entire training programme to ensure the continuity of classes, and proper distribution of training materials, and be responsible for interfacing with the instructors.

The training courses shall be delivered to all relevant Engineer's staff, including instructors, operation and maintenance Engineering staff.

5.3.2 Mock-Up for Training

The Contractor shall install mock-up equipment for system and any such facility(s) considered necessary for the training of Engineer's staff in the training school.

The training mock-up shall include but not limited to the following: -

i. Clear Cut Section drawings / photographs of various power supply equipment's such as Circuit Breakers, HT/LT panel, Power supply arraignment, Current Transformers and Potential Transformers.

ii. Cut Section drawings / photographs of HT/LT cables.

iii. Cut Section drawings / photographs of Gas Insulated Switchgear and other types of panels.

iv. Clear photographs of transformers, their windings, bushings etc.

v. Samples of various item used in substations.

vi. Clear drawings and photographs of Control panel, protection schemes, earthing and complete power supply arrangement system.

The Contractor shall submit full details of the training span and other mock up equipment, photographs etc. including proposed training activities and objectives.

5.3.3 Training of Engineer's Training Instructors (ETI)

The objective of the training is to enable the Engineer's Training Instructors to be competent to deliver future training courses for other employees of the Engineer.

The Contractor shall provide training to the Engineer's Training Instructors on the various Systems. Aspects covered shall include, but not be limited to, the following:

i. Configuration of the entire System, including interface with the DHBVNL supply system at the feeding points;

ii. Feature and functional principles of the entire System;

iii. System design aspects including but not limited to design standards, design criteria and parameters, short-circuit and other calculations, insulation and protection co-ordination;

iv. Details of major equipment and material including but not limited to voltage and current transformers, Electrical fittings, assemblies and protection relays, and cables of different types and their joints used in the system;

v. System operation and maintenance management and procedures;

vi. Earthing arrangement, covering safety aspects of touch and step potential, safety to personnel, passengers and outsiders;

5.3.4 Operations Staff Training

The objective of the training is to enable the Engineer's operations staff to be familiar with the Systems, with focus on the operational aspects under normal and emergency conditions.

The training shall also enable the trainee to acquire full capability for identification, trouble shooting and rectification of faults in the specified duration. After classroom training which includes mock ups of equipment, the staff shall be trained in actual operation.

5.3.4.1 Maintenance Staff Training

The objective of the training is to enable the Engineer's maintenance staff and Engineering staff to be familiar with the Systems focus on the maintenance aspects of the System including but not limited to the following: -

i. Full understanding of all the equipment, sub-systems and system, their function, maintenance and overall requirements.
ii. Procedures to be followed for unscheduled maintenance and repair.
iii. Identification of failed components and sub-systems in electronic equipment by use of special test kit as necessary.
iv. Modification in the software to extend or modify the control, monitoring and protection functions.

5.3.4.2 Training Requirements

Man weeks of contractor's Training Instructors for training Engineer's maintenance personnel in India.

S. No	Training	Man-Weeks
1	HT/LT panels, Transformer, Circuit Breakers, DG set , Switchgear and cables	2
2	Other General services Equipment/Electrical wiring	2
3	Electrical safety & Earthing system	1

5.4 Defects Notification Period (DNP)

The Contractor shall be responsible for all the Defects and deficiencies, till the expiry of a **period of 01 (One) year**. The Contractor shall repair or rectify all Defects and deficiencies observed by the Authority Engineer during the Defects Notification Period within time period as may be determined by the Engineer in accordance with Good Industry Practice.

5.4.1 Warranty Certificates from OEM:

i. All Original Warranty Certificates of OEMs of all Electrical system or equipment including contract spare, Commissioning spare, DNP spares and Special tools & Test and Measuring equipment shall be valid for three years or as specified in RDSO Specification of the equipment whichever is later and registered in the name of Engineer. These warranty certificates received from the OEMs should be passed on to Engineer before final Taking over.

ii. Validity of period of Warranty Certificates shall start from date of Commissioning.

iii. Original invoice shall also be submitted with the OEM warranty certificates in a booklet form before Commissioning.

iv. Warranty period and defect liability support shall start from the date of Commissioning.

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CHAPTER – 6 TECHNICAL SPECIFICATION

6.1 TECHNICAL SPECIFICATION OF GENERAL SERVICES WORKS: -

S.No	Description of work	Work to be Done	Relevant IS Code/Standards	Reference Make
1.	Wiring for light/ceiling fan/exhaust fan/call bell etc. points including circuit wiring, sub-main wiring with Fire Retardant (FR), PVC insulated, multistranded, copper conductor, single core cable on surface/in recessed conduits, distribution boards, sub distribution boards, earthing and suitable number of modular switch and socket. *Surface Conduits shall be of GI and concealed conduit may be of GI/PVC. All PVC conduit shall be fire resistant Low smoke (FRLS).*	1. The point/ circuit wiring is to be done by 03 x 1.5 sqmm insulated multi-strand copper wire for phase, neutral and earth inside pvc duct/ conduit 19/20 mm. 2. Wiring of sub-main with single core insulated, multi-stranded 3x2.5/3x4.0/3x6.0 sqmm PVC CU cable in conduit 19/20mm concealed in stone/ bricks masonry wall separate conduit & 2.5/4.0/6.0 sqmm PVC CU cable insulated multi-stranded for earth wire respectively. 3. Wire for phase, neutral and earth shall be laid/done in concealed conduit pipe, minimum 19/20 mm dia and thickness 1.5 mm along with bend / junction. 4. SITC of 5/6 and 15 Amp plug 5-pin 230V or above modular type switch socket of standard size on existing board and connection with 2.5sqmm and 4.0 sqmm PVC CU cable respectively. 5. Supply and fixing of *GI* cable duct 40 x 60 *mm* (w x h) 1 M STD slot greenish grey. 6. SITC of Double Pole MCB of 32 Amp, 10 kA C series is to be provided in the metal enclosure. 7. SITC of 02/04/08/12 Module modular Plate MS Box (GI) for fixing of switches and sheet metal box of thickness 2/3 mm, of good quality and standard size. 8. SITC of Double Door MCB DB SP 12 way (10+ 2 module), neutral and earth link and suitable IP protection, with one no DP MCB 40amp, one no DP RCCB 40 amp 30 mA and eight no SP MCB 32/25/16/10/6 amp. 'C' series.	i. IS: 694-2010 for PVC conductor. ii. IS: 3854/1997 for switches iii. IS: 1293/2005 For Plugs & socket iv. IS: 371/1999 for celling rose. v. IS: 8828/1996 for MCB vi. IS 13947 (Part -1) 1993 for MCCB vii. IS:9537/2000 for PVC conduit The Electricity Act- 2003 or Latest. All CPWD Norms for electrical wiring	PVC CU conductor- Finolex / Polycab / KEI / Havells or similar as approved by Engineer. i. Modular switch/ socket – Anchor /Roma / Schneider / Legrand / Havells or similar as approved by Engineer. ii. MCCB/RCCB/ MCB/DB – Legrand, ABB, Schneider and similar. iii. PVC conduit – BEC / AKG / Poly pack or similar as approved by Engineer.

S.No	Description of work	Work to be Done	Relevant IS Code/Standards	Reference Make
		9. SITC of Double Door MCB TPN DB 8 modules 4 row, neutral and earth link, and suitable IP protection with one no 4 pole MCB 40 amp, one no FP RCCB 40 amp 30 mA and twenty-four no SP MCB 40/32/25/16/10/6 amp. Min 02 Nos of DB should be installed at each floor of station building or as per requirement.		
2	Supply, installation, testing and commissioning of pre-wired 22 watt energy efficient Tube light fitting (4 feet) on wall bracket connections from junction box/light point etc. to luminary with 1.5 sq.mm FRLS PVC insulated multistranded copper conductor single core/three cable & earthing etc.	1.SITC of LED tube light (22 Watt) suitable for IP-20 for indoor application operating voltage (140-270) V minimum 2000 Lumens, Colour temperature 6500ºK, CRI>65, CRCA steel sheet type enclosure. **2.** SITC of rechargeable batten type Emergency light 60 LEDs, 4 watt or higher with one-hour minimum backup.	CEE Spec No:CEE/NR/121-Elect/PS/2019(REV-04) Dated-04.11.2019 or latest for LED light.	Bajaj, Philips, Crompton or similar as approved by Engineer.
3	Supply, installation, testing and commissioning of 230V A.C. ceiling fan (1200/1400MM)/ Exhaust fan and fan Regulator.	1. SITC OF ceiling fan 230V A.C. 1200/1400 mm ISI mark 5-star energy rating issued by BEE. 2. SITC of heavy duty exhaust fan 300mm sweep with louver shutter. 3. SITC of modular type electronic fan regulator, 5 step type on existing board.	i. IS: 374/1979 for ceiling fan ii. 2312/1967 for Exhaust fan. iii. IS:11037/1984	i. Crompton Greaves / Usha / Bajaj /Havells / Schneider or similar as approved by Engineer. ii. Anchor /Roma / North-West / Schneider / Legrand / Havells Crabtree or similar as approved by Engineer for fan regulator.
4	Provision of High Mast Tower (16 Mtrs) with LED Flood	**1.** SITC of hot dipped galvanised (inside & outside), 16m high mast system (in two sections), complete	i. IS:875(Part-3)/1987 for High Mast Structure,	Bajaj, Philips, Crompton or similar

S.No	Description of work	Work to be Done	Relevant IS Code/Standards	Reference Make
	Light fitting (200 Watt) complete in all respect and as per requirement. Minimum 6 Nos of LED light fitting at each HMT.	with accessories, foundation bolts with nuts, washers, anchor plates & templates etc. manufactured from special steel, head frame, 2-point suspension system with steel wire rope 6mm dia (7/19 construction), double drum winch, galvanised lantern carriage arrangement suitable for required luminaries symmetrically arranged & control gear boxes and lighting finial etc. The mast shall have integral type power tool at the base compartment for its raising and lowering operation, twin dome LED aviation obstruction lights. construction of foundation as per recommendation of manufacturer and approved drawing and its fixing arrangements etc. 2. SITC of Control Panel consist of - (a) 1X63 A TPN MCB for incoming supply (b) 3X32 A SPN MCB for outgoing (50% lighting, 100% lighting, motor) (c) Automatic timer with Power contactor for controlling above lights of suitable capacity. (d) 1 no multi plug socket 16A 1. High mast shall be provided with fencing panel of size 2Mx2Mx1.5M in square shape for protection of erected high mast tower wherever required as directed by Engineer. **2.** SITC of LED flood light fitting (200 Watt) pre die cast aluminium, IP-66 protection, with high power LED lamp complete with all accessories. 3. Provision of Pipe Earthing system of each HMT. (Minimum 02 earth is required for each high mast tower).	ii. BSTN-10025/1993 for High Mast Shaft, iii. IS:2026 for other component IS: 2629 / 1985, BSEN ISO-1461 for Galvanization. *iv. IS 1367 for Fastener* v. RDSO specification No. ETI/OHE/13(4/84or latest) vi. CEE Spec No:CEE/NR/121-Elect/PS/2019(REV-04) Dated-04.11.2019 or latest for LED light.	

S.No	Description of work	Work to be Done	Relevant IS Code/Standards	Reference Make
5	Provision of Octagonal poles (5 metres) with street light fitting (40 Watt) and 70-30% arrangement with complete accessories.	1. SITC of 5 mtrs. long octagonal pole made with 3 mm thick GI sheet, Top Dia 70 mm, Bottom dia 130 mm with single /double arm hot dip galvanized steel octagonal Poles with galvanized base plate of 220 x 220x 12 mm (as per IS 2062) and GI bolt size M20 X 600mm X4 no in position including excavation of pit and filling the same with concrete M-20 including supply of material as required or recommended by pole manufacturer. 2. SITC of 40-Watt LED Energy efficient LED based street light fitting with pressure die cast aluminium housing with driver &suitable fixing arrangement, IP-65 for outdoor application, operating voltage (140-270) V, System efficacy more than 100 lm/W, colour temperature 6500K, CRI>65. Complete with all accessories. 3. SITC of modular digital timer for automatic operation of platform, circulating area, street light etc. complete with required power Contact, digital timer and MCB etc. in enclosure of suitable size and power Contact.	i. IS:2629/1985, BESN ISO-1461 for Galvanization. ii. CEE Spec No:CEE/NR/121-Elect/PS/2019(REV-04) Dated-04.11.2019 or latest for LED light. iii. IS 1367 for *Fastener*. iv. RDSO specification No. ETI/OHE/13(4/84or latest)	Bajaj, Philips, Crompton or similar as approved by Engineer.
6	Provision of Passenger Lifts (13 Passengers, 884 Kg) (G+1) with complete accessories at New Patli Staion.	1. Supply, installation, testing and commissioning of passenger Lifts (13 Passanger,884 Kg) gearless machine room less, single landing (GF&FF), Minimum load 13 persons speed 1m/s to 1.5 m/s, Automatic door with two side opening, microprocessor base variable frequency, variable voltage derive controller with ARD, Stainless Steel Hairline Finish Car and Car Door, 1.00 MPS. Simplex Collective, Selective Control, Emergency Light, Fireman's switch, Alarm Button, Phase Failure & Phase Reversal Protection, Automatic Rescue Device, Vacuum fluorescent display in Car	i. IS-14665/2000 for Lift ii. RDSO/2013/EM/SPEC/0016 Rev (0) for Lift iii. All CPWD Norms for installation of Lifts.	OTIS, KONE, Mitsubishi, Jonson or similar as approved by Engineer.

S.No	Description of work	Work to be Done	Relevant IS Code/Standards	Reference Make
		and other safety device with minimum guarantee/ warranty of 02 years. 2. Contractor should provide all the safety parameters/ License/ Insurance certificate and other required clearness issued by state authorities. 3. During Warranty period contractor will ensure all Preventive and Schedule maintenance/checks will be done by OEM only with in time interval as decided by Engineer. 4. During warranty period all the Breakdowns like defective/ broken of lifts Light, Fan, Batteries ARD and various electronic cards with in 3 hrs otherwise penalty may be imposed as per decision of Engineer. (Detail Technical specification of LIFT is also given at Para 6.2)		
7	Supply, Installation, Testing and Commissioning of *Compact* Sub-Station (11/0.440 KV) including CSS-1 and CSS-2. Each CSS Shall be consisting of 11KV Compact VCB/SF6 CB panel (1 incoming isolator + 2 outgoing ACB with air insulated BUS PT metering module) + DRY type Transformer (250 kVA) Capacity + L.T. Switchgear with all HT & LT inter-connections, accessories,	*1.* Each CSS comprising of 11 kV compact substation suitable for outdoor installation with natural cooling, having type tested equipment comprising of dry-type (CRT) distribution transformer and SF-6 insulated compact switchgear enclosed in robotically sealed stainless steel tank, low – voltage switchboard, interconnection between HT switchgear and transformer using cables and transformer to LT-switchgear using aluminium bus bars, factory built ready for connection type, internal GI earthing provided complete with other associated equipment etc. complete as required as regards to design, manufacturing, type-testing, route-testing, pedestrian and operator safety (IAC AB 21ka/1-sec). The enclosure shall have modular	IEC 62271-202, *IS: 7098 Part-2: 2011*	ABB/Raychem/Voltamp/Schneider/Siemens/CG or similar as approved by Engineer.

S.No	Description of work	Work to be Done	Relevant IS Code/Standards	Reference Make
	fittings & auxiliary equipment inside GI Enclosure as per technical specification. CSS also include 1 RMU 11kVA 630 Amp 21 KA, LT panel as per spec., APFC panel 100 kVAR MPP type heavy duty, all HT *copper Cable* and LT cable with proper termination arrangement of suitable size and length, Suitable H-pole arrangement with GO/DO switch (if required) supply, fixing and commissioning of silent type 125 kVA DG set with AMF panel, Provision of Copper Plate earthing as per requirement and CT/PT for Metering system as per technical specification and supply & fixing of all safety items required as per rules.	construction using G.I. Sheet and shall be power-coated from exterior. The transformer compartment will have IP-54 protection. *Connection from 11kV HT meter of DISCOM in HORC premises to incomer of CSS.* 2. HT SWITCHGEAR shall comprise of 03-Way Ring Main Unit having 01nos. Fixed-Type VCBs feeding to transformer in CSS, all enclosed in common tank, made of robotically welded non-magnetic/non-ferritin Stainless Steel Sheets, and filled with SF6 gas acting as insulating medium to suitable pressure, the tank design meeting IP-67 criteria with SF6 gas leakage rate less than 0.1% per annum, whereas it shall be Arc-Proof design with internal Arc classification IAC 20ka/1-sec individually. The complete Ring Main Unit should be a front-accessible design with associated Capacitive Voltage LED Indicators for each arc-proof cable box, along with associated Terminal Protector boots and front-facia semaphore mechanical indication for isolator/breaker ON/OFF/EARTH. The breaker will have provided with integrated Self-Powered 30C +1EF relay with low and high set for over current and earth fault. Relay should have facility to display the maximum loaded phase current also. Relay shall record minimum 5 fault records with time stamping, and shall be actuated via Resin cast Ring Core Protection CTs of suitable ratio and burden installed in the cable box.		

S.No	Description of work	Work to be Done	Relevant IS Code/Standards	Reference Make
		3. 01no. 250 KVA 11KV/433V Dyn11 Dry Type Distribution transformer having cast resin design Bushings for HT and LT with Off load tap switch of rating +5% to -5% @2.5% and WTI scanner. Temp Rise – 115 deg C, Class 'H' insulation, Losses = 2.2 kW (NLL/7.25KW(FLL) (Subject to IS Tol.), Impedance 5% (Subject to IS Tol.) and 01no. WTI Alarm/Trip Scheme and Surge arrestor in the HV side. 4. LV-PANEL shall be a totally enclosed, floor/Wall mounted, dead-front access, min IP2X protected panel which has a type tested design, aluminium busbars, suitable switchgear configuration and indication scheme as describe below 01no. 433V, 400 Amp, Aluminium Busbar Arrangement with suitable colour coding scheme for identification for each phase.01no. 800A, 433V, 50Ka, 4P Fixed, Manual ACB with microprocessor based over current, short circuit and earth fault release acting as IC-OG arrangement 01set. LED based ON/OFF/TRIP Indication for mains ACB. 01no. Multifunction Meter for measurement of various parameters like Voltage, Amp, kVA, kw, PF etc. of reputed make for mains ACB. (along with associated CT where applicable) 5.OUTDOOR ENCLOSURE shall comprise of having construction of Galvanised Sheet Steel of thickness at least 1.5mm. The Enclosure shall have IP54 degree of protection for HT & LT switchgear compartment . The enclosure shall be *Powder* coated. Each compartment will be provided with the door and pad locking arrangement. The compartment illumination lamp with the door		

S.No	Description of work	Work to be Done	Relevant IS Code/Standards	Reference Make
		operated switch shall be provided for HV and LV compartment. The successful tenderer shall submit the arrangement GTP and other relevant drawings for approval as per standard make prior to supply and execution of work.		
8	Provision of Inverter type Split AC (1.5 Ton, Heavy duty, 5 Star Rating with Stabilizer) and other accessories as per site requirement	1. SITC of 1.5 Ton heavy duty, 5-star inverter type split air conditioner with required suitable size nuts, bolts, fasteners, cu pipe & petty hard ware in all respect. Top up the required refrigerant & maintain the pressure (If required) as per company recommendation or latest Eco-friendly refrigerant. 2. SITC of Metal Clad Plug Socket 20A single phase with 32A MCB 10kA ,c series including fixing and sheet metal enclosure box with one 20A plug top (Ray roll type) to be supplied with board for each AC.	IS:1391/1992 for Air conditioning	Voltas, Blue Star, Carrier, Hitachi, O -General, Mitsubishi or similar as approved by Engineer.
9	Provision of LED Signage Board & LED Station Name Board (Single Sided/Double Sided) with all accessories	1. Design, SITC of LED back lit single & double-sided signage boards with IP-65 CRCA housing, vinyl print on acrylic sheet which is back lit with high grade, high brightness LED modules inbuilt SMPS driver, without battery backup. Operating voltage 80-270VAC. LED with L70 life of minimum 50,000 hours, LPM technology, including fabrication and supply of clamping arrangements as desired. 2. The pictogram and letter of desired colour and size made by translucent vinyl sheet cut through computerized machine shall be pasted on acrylic sheet. Acrylic sheet with pictogram shall be fixed on CRCA/GI sheet powder coated box with suitable arrangement. Subject matter and pictogram	IS:16101-2012 and 16102-2012 part 1 and 2.	PHILIPS, NICHIA, OSRAM and SEOUL or similar as approved by Engineer.

S.No	Description of work	Work to be Done	Relevant IS Code/Standards	Reference Make
		can be seen in the standard book of signage available in office. 3. Depth of box shall be approximately 3.5 inches (for single sided) 5.5 inches (for double sided) and made by 0.8 mm thick CRCA/GI sheet with powder coated having louvers for ventilation on two sides having suitable gaskets for protection against water and vermin ingress.		
10	Supply and laying of different sizes 1.1 kV grade LT XLPE insulated armoured, aluminium conductor cable, in trench/ air/ HDPE pipe. making good the damages, end terminations with aluminium crimping sockets/lugs, provision of cable route markers, etc.	1. Supply of 1.1 KV grade 4x16,4x35,4x50,4x70,4x95,4x120 and 4x185 sqmm LT XLPE insulated armoured aluminium conductor cable, making good the damages, end terminations with aluminium crimping sockets/lugs, gland, testing and meggering etc. as per required Technical specifications. Note: -The contractor shall arrange inspection of cable at manufacture's works before dispatch at his own cost if required by the Engineer. 2. Supply & laying of HDPE pipe in already excavated trench under road/ground/floor/railway track etc. as per site requirement size 75/80 and 50 mm Dia wall thickness 3mm PN-4 conforming to IS 4984:1995 or latest as per site requirement. Pipe should be laid in trench such that It shall be possible to withdraw the cables for repair or replacement without disturbing the work. 3. Supply & laying of HDPE pipe in already excavated trench under road/ground/floor/railway track etc. with technical specification 160 mm dia (OD), wall thickness between 6.2 mm to 7.1 mm, material grade PE-80 and class of pipe should be PN-4. 4. Laying of underground cable under the road/Railway track, recessing in platform /wall	i. *IS: 7098 Part- 1: -1988 for cable* ii. IS: 8130-1984 for cable iii. IEC-502 standards with latest amendment. iv. IS 4984:1995 or latest for HDPE pipe	i. KEI, Finolex, Havells and Universal or similar as approved by Engineer for cable. ii. Duraline/Godavari/Rex Polyextrusion/ Eflex or similar as approved by Engineer for HDPE pipe. iii. Comet / Dowells / Lapp Kabel/Hummel or similar as approved by Engineer for Lugs and glands.

S.No	Description of work	Work to be Done	Relevant IS Code/Standards	Reference Make
		along with Railway Track. in laid HDPE /GI pipe as required 1.1 KV grade LT XLPE insulated armoured, aluminium conductor cable including making chase & plastering after laying of cable/digging of cable trench, sand cushioning, protective covering with second class bricks, provision of cable route marker (200x150x3mm thick M.S. Plate and welded to MS rod of min 5 mm dia including bending and fixing) as per tech. spec. 5. Excavation & Refilling of 0.5 Mtr Width 1.20 Mtr Deep trench in all kinds of soil for laying of HDPE/GI pipe for underground cable crossing. Contractor will clear all metallic parts & stones etc. in trench. 6. Drilling of horizontal bore below Rly track by pushing method for laying of HDPE/SPUN/DWC/CI/GI pipe up to 450 mm by pushing method. Horizontal boring will be done at minimum 1.5 Mtr. Below or as per site requirement from ground level. 7. SITC of LT heat shrinkable straight through joint with required accessories complete in all respect suitable for LT XLPE 4 core cable as per site requirement. *8. Cable Route Marker: Cable Route Marker size 200X150X3 mm thick GI plate for HT/LT electrical underground cables. The plate shall be provided with 250X50X6 mm flat whose one portion shall be welded to the route marker plate and another antiskid end shall be embedded suitably in 150X150X 150 mm M-20 grade concrete and concrete block shall be minimum 100 mm below the ground.*		

S.No	Description of work	Work to be Done	Relevant IS Code/Standards	Reference Make
11	SITC of Water Cooler (150 Ltrs) capacity with MS Cage & suitable protection arrangement as per site requirement.	1. SITC of self-contained drinking water cooler 150 litres capacity (cooling capacity 150 Lts. per hour), ISI marked, min 3 star rated, suitable for operation on 230 volts+/-10%, 50Hz, AC supply system complete with all connected standard fittings, accessories etc. and 5KVA, wall mounted, I.C. controlled electronic auto-voltage corrector.	i. IS:1475/2005 ii. IS: 1475 Part-1/2001	Blue Star, Kelvinator, Shriram, Voltas or similar as approved by Engineer.
12	*Provision of Water Pumping Arrangement system with 10 HP Submersible Pump set, 10000 LPH or Above; Head range: 160M or above; Phase: 3 Phase;* *Submersible pump set ,2 HP Head Range 20-25 mtr,5000 LPH capacity* *Submersible pump 5 HP Monoblock Head Range 20-25 mtr, 15000 LPH capacity*	1.SITC The pump set 10 HP shall be Energy Efficient Pumps (3 star or above) confirm to latest relevant IS and shall be guaranteed for the pump discharge range of head between +25% and - 10% of the specified head. The pump set shall be suitable for 8" dia bore well. Rotor dynamically balanced suitable for operation on 3-phase 50 Cycles 415Volts -10% +5% AC Supply. Motor squirrel cage induction type and shall be adequate capacity to provide the pump discharge within the range as specified. The Electric motor shall be water-cooled and water lubricated sealed against pollution from outside water. The thrust bearing shall be hydrodynamic Mitch well type preferably and provided with tilting thrust pads de-signed to make up all outward loads at the most unfavourable conditions. The motor shall be of ISI 410grade material; starter of motor should be impregnated with superior quality epoxy paint having type it thermal insulation as per IS5831-1970 or latest the rotor shall be dynamically balanced. All nut-bolts in contact with water of bore well should be of stainless steel. 2.Supply, *Installation*, testing and commissioning *(SITC)* of single stage Mono-block open well submersible pump set with control panel rating 2 HP/1.5KW, Head range (M) :26 meters and above,	i. IS:8034/2002 for submersible pump set. ii. IS: 9283/1995 for Motor of submersible pump set. iii. IS: 14220/1994 for open well submersible pump set. iv. IS 694 Part-I 1964 or latest for CU cable.	i. ABB / BBL / Crompton Greaves / Kirloskar or similar as approved by Engineer. ii. Finolex / Polycab / KEI / Havells / Lapp or similar as approved by Engineer for CU cable.

S.No	Description of work	Work to be Done	Relevant IS Code/Standards	Reference Make
		size (MM) suction X delivery 50X40, Discharge (LPH):5000 or above at 26-meter head suitable for single phase 50Hz AC supply. 3. Supply, *Installation ,Testing & Commissioning of* Three phase, mono block Horizontal/Sump pump *submersible* 5 HP, 3.75 KW (dia 150 mm), 20-25 mtrs. Head, discharge *1500 LPH with control panel and* complete with all accessories. *4. Supply and laying of flat submersible cable copper 3Cx6/3Cx10 sq.mm for pump set ISI mark as per requirement.*		
13	Supply, Installation Testing and Commissioning of Earthing System	1. The earthing shall be done with 3 meters long 50 mm dia. 'B' class G.I. Pipe earth electrode with l2 mm dia. holes around the pipe at distance of 30 cm, down side tapered. Earth electrode to be put vertically 3-meter-deep with alternate layer of salt & charcoal approx. 50 kg charcoal and l0 kg salt. 8 SWG hot dip G.I. or 7/4 mm dia. galvanized steel stranded earth wire shall be connected from earth electrode top with l2 mm dia. G.l. nut bolt to main board / equipment with masonry / RCC earth enclosure of size 300x300x300 mm (ln side to inside) with I25 mm wall thickness & suitable size *CI* /RCC pull out cover. The G.l. wire shall run in l2 mm 'B'class G. I. Pipe along with wall / pole up to height of 1.5 meter. The depth of 8 SWG hot dip G. I. or 7/4 mm dia galvanized steel stranded earth wire including connections from earth pipe to main board / equipment /H pole/Tower in ground shall be 30 cms.	i. IS:1239 or latest IS: 3043 ii. RDSO specification No. iii. RDSO/PE/SPEC/PS/0109 (REV-0)-2008	1) TATA, Jindal, Prakash, Surya Sail or similar as approved by Engineer for MS pipe for earthing. 2) Erico / Indlec / Duvalmession or similar as approved by Engineer for maintenance free earth.

S.No	Description of work	Work to be Done	Relevant IS Code/Standards	Reference Make
		2 Supply and providing of Maintenance Free Earthing with primary *GI* conductor 40 mm dia 3000 mm long and secondary *GI* Electrode 80 mm dia 3000 mm long includes digging pit of size 5ft.x5ft.x10ft. And using earth enhancement chemical compound minimum 75 kg. Per pit suitable for 40 KA current capacities. 3. supply of Copper earthing of size (600x600x3 mm) thick copper earth plate & suitable size of 40 X 5 mm copper strip. The price shall also cover erection including digging of earth pit in any kind of soil at the specified location. The work shall also cover the earth treated to obtain earth resistance of less than 1 ohm. Connection of earth electrode should be made by providing Copper clamps nuts, bolts.		
14	Supply and fixing of suitable size feeder pillars and Junction Box	1. Supply, erection, testing and commissioning of feeder pillar size 900x600x300 mm fabricated from 16 SWG *CRCA* sheet suitable for outdoor installation, powder coated *7 tank process* complete enclosed type dust and vermin proof, with gland plate in bottom as required including connecting incoming & outgoing cables with aluminium lugs and brass glands, with 63 amp MCCB and 4 nos. aluminium bus bars suitable for 200A, complete with locking arrangement with *GI* angle stand 2 feet height angle size 40 x40 x6 mm Grouted in cement concrete mixture 1:3:6. 2. Supply and fixing of junction box size 390x305x170mm comprising of SMP/FRP material with rubber gasket, padlock arrangement, zinc pas- sivated earth bolt, etc. similar to Sintex model no. GSJB 3525 or similar with 4 no. aluminiums bus bar cap 200 Amp. Suitable for 415-	Relevant IS code	Popular make of ISI mark

S.No	Description of work	Work to be Done	Relevant IS Code/Standards	Reference Make
		volt supply requirement. The box shall be fixed robustly with clamps at pole/ wall as per requirement.		
15	Supply and fixing of CLS panel suitable for 25 kVA/10 KVA capacity AT supply with complete accessories and protection system as per RDSO specification	1.SITC of CLS panel including automatic changeover complete as per connections as required.	RDSO specification No.TI/SPC/PSI/CLS/0020 (12/02) with A&C slips No. 1 to 4 or latest,	RDSO approved make.
16	Supply and fixing of Phase selector of size (610x450x190mm) with I/P MCCB- 100/ 63 amp and O/P MCCB- 63 Amp	1. SITC of 1.6 mm thick CRCA powder coated box of size 610 x 450 x 190 mm approximate with Din rail. The distribution board shall be indoor type dust vermin proof Knock out/glands plates as applicable shall be provided in the box for incoming and outgoing cables. Earth terminals shall be provided. Danger notice shall be provided at appropriate place. The complete internal wiring for each phase selector is to be done with copper wire of size 10 sqmm. 2. It consists of 01 no. 100 amp TPN MCCB as incomer,01 no. 100/63 amp (as per requirement) SPN MCCB as outgoing, 04 nos. integrated LED pilot lamp (3 incoming+1 outgoing),01 no. 63-amp selector switch (phase selector switch) without OFF Three pole three ways (Three phase incoming & only one phase outgoing.	Relevant IS code	
17	Design, supply, testing Erection and commission of	1. SITC of 1.5 mm CRCA sheet steel fabricated, cubicle, having outdoor type LT panel distribution	IS: 2147-1952 IS:2675-1966	Rittal / ABB / Schneider or similar as approved by Engineer.

S.No	Description of work	Work to be Done	Relevant IS Code/Standards	Reference Make
	Indoor type LT panel with one incoming MCCB of suitable rating and Min 6 Nos of Output MCCB of suitable rating.	board, having suitable IP protection, floor mounted front operated, mounted on *GI* base channel of suitable size, with top / bottom removable cable gland plate as required, earth bus, hinged and lockable doors, dust and vermin proof, complete with all inter connections, small wiring by min 2.5 sq mm copper wires. The panel should consist of(A) incoming 2x250 amp 4 pole MCCB's with changeover provision (if required) with microprocessor release having integral overload, short circuit, earth fault and neutral protection and breaking capacity 60 KA (Ics=100%Icu). (B)outgoing 2x125 amps, 2x100 amps and 2x63 amp 4 poles MCCB's with adjustable overload and adjustable short trip unit and breaking capacity 36KA (Ics=100%Icu). the panel is to be provided with over voltage protection with suitable relay. The bus bar shall be insulated by heat shrinkable sleeves. The instrument shall be of flush type ammeter, voltmeter, and selector switches with CTs, feeder name & danger board.		
18	*Supply, Installation, Testing and Commissioning of 2 kVA, 240 volt AC, pure sine wave online inverter cum UPS consist of intelligent battery charging mechanisms with adaptive battery charging and 150 AH, 24 Volt tubular battery (2 nos 12 volt batteries to be connected in series) suitable for heavy duty application. Warranty of invertors is 24 months and for Battery -36 months*	1.SITC of 2 kVA, 24-volt pure sine wave Online UPS cum inverter. 2. SITC of 150 AH 24 volt heavy duty tubular Battery with 3 year warranty.	IS:13314/1992 for Inverter	Luminous, Microtek, Exide, Amaron or similar as approved by Engineer.

S.No	Description of work	Work to be Done	Relevant IS Code/Standards	Reference Make
19	Supply, *Installation, Testing and Commissioning* of Perforated Cable Tray of size 150x50 mm made out of MS sheet and hot dip galvanized (85 microns) 1.6 mm thick with suitable fixing Arrangements.	SITC of 150x50 mm and 1.6 mm tick galvanised cable tray for laying of cable with all accessories.	Relevant IS code	Adarsh / Indiana / Mahesh Wari or similar as approved by Engineer.
20	Fresh connection / Load Augmentation complete in all respect and as per specification.	*Application for New 11kV HT connection at new Patli station and New connection/Load Augmentation at LT at Dhulawat, Chandla Dungerwas, Pachgaon and Sultanpur Station and availing connection in HORC premises shall be arranged by the contractor. Necessary coordination and liaisoning with DISCOM shall be made by contractor including payment of all charges for bringing the power supply HT/LT from DISCOM terminal to HORC HT/LT Panel.*	-	-

6.2 DETAILED SPECIFICATION FOR PASSANGER LIFTS (FOR 13 PERSONS)

1	Type of Lift	Passenger lift
2	Number of lift required	As per requirement
3	Load: no. of person	13 Person
4	Related speed	1.0 metre per second
6	Number of floor served	2
7	a) Inside size of lift well	Approx. size 2500 mm x 1900 mm deep or as Per site feasibility
	b) Pit depth	1600 mm or as per site feasibility
	c) Head room	4800 mm or as per site feasibility
8	Clear inside size of lift car	Approximate size : 2000x1100x2200(H) mm or as per site feasibility
9	Dimension of machine room	Not Applicable(No machine room is being provided)
10	Position of counter weight	At the back / side of the car
11	Position of machine room	Not applicable
12	a) Type of control	Microprocessor based AC variable voltage variable frequency
	b) Type of operation	Simplex selective – collective without attendant
	c) Potential free contacts	Yes potential free contacts for each floor position and up and down movement of the lift shall be provided in the controller which can be used for the building automation system at later
13	Car entrance door	
	a) Number	1 No. center/side opening stainless steel
	b) Size	Approx. size900x2000 mm high or as per site feasibility
	c) Type of doors	Horizontal sliding-center / side opening
	d) Car open in front only or open through	Open in front at ground floor and opposite / reverse opening at first floor
14	Construction design and finish of car body work	Stainless steel Hairline finish with stainless steel drop ceiling and led lights fittings for lightning inside the car and axial flow fan, 5 mm thick antiskid PVC flooring. All other item as per CPWD general specification for lifts 2003 with up to date amendments.
15	Type of signal system	(a) Digital floor position indicator in the car and all landings (to be provided above the car/ landing doors).
		(b) Travel direction indicator in the car and at all landings. (to be provided above the car/ landing doors).
		(c) Gongs & visual indication through directional arrows on all landings pre arrival of the car at all floors.
		(d) Over load warning audio & visual indica-tor , inside the car (lift should not start on overload)
		(e) Battery operated alarm bell and emergency light.
		(f) Car operating panel with fade proof luminous buttons in in the car and with intercom. Braille switches to be provided in the lift.
		(g) Luminous hall buttons at all landings with Braille switches.

		(h) Fireman's switch at ground floor.
		(i) Voice annunciation system. This will announce the position of the car landing in Hindi & English facilities for any other announcement to be made from the central control room / reception of the building.
		(j) Protection against over – voltage, under voltage and single phasing should be provided.
16	Landing entrance	
	a) Location of landing entrance in different floors	Front at ground floor and opposite / reverse at first floor
	b) Number	2 pairs
	c) Size	Approx. size 900 mm wide x 2000 mm high or as per site feasibility
	d) Type of doors	Horizontal sliding – canter / side opening
	e) Lift in use / lift out of order sign	Suitable box above the landings with LED illuminated bilingual (in English & Hindi) sign of "LIFT OUT OF ORDER" coming up simultaneously on all floors.
17	Electric supply	a) Power 415 V, AC, 50 Hz, 3 Phase, 4 Wire system.
		b) Lighting : 230 V, AC, 50 Hz, 1 Phase
18	Is neutral wire available for control circuits	Yes
19	Proposed date for commencement of site	-
20	Proposed date for completion	-
21	Environmental condition at site of installation	Summer condition Winter condition Monsoon condition Height above sea level
22	Storage space provided	_
23	Additional item, if any	
	a) Firemen's switch	Required for all lifts
	b) Emergency power supply	Available
	c) The firm's offer should include beam and all structural steel required for work	
	d) Automatic Rescue Device (ARD)	Provisions of automatic rescue device for the purpose of bringing the lift car to the nearest floor should be provided, one each for individual lift. ARD's are to be provided. The each shall consist of 1. Control panel with necessary interface /integration of device with main controller 2.Invertor of required capacity 3. Maintenance free batteries of Ampere –hours 4. Battery charging unit 5. "Rescue Operation On "indicator in the lift car.

S.NO.	**Particulars of detail**	
A	General	
1	Name of manufacture	As per CPWD approved 'A' category manufacture
2	Capacities (Persons/Weight)	13 Person/884 kg
3	Service	Passenger
4	Speed of travel	1.0 MPS
6	No. of floor served	02
7	No. of openings	02
8	Position of counterweight	At the back / side of the car or as per site feasibility
9	Type of levelling method	Automatic +/- 5 mm
B	**Machine**	
1	Position of machine	Top of lift shaft in hoist way / Machine room less
2	Motor	Permanent magnet synchronous Motor, Gear less machine
3	Electric supply particulars for which it is suitable for operation	3 PH 415 V 50 HZ 4 wire system
C	**Brake**	
1	Type	Electromagnetic brake
D	**Car & Doors**	**Horizontal sliding, centre / side opening**
1	Outside dimension of car	AS PER SITE CRITERIA
2	Inside clear dimension	Approximate size : 2000x1100x2200 (H) mm or as per site feasibility
3	Construction of car	Stainless steel Hairline finish with stainless steel drop ceiling and LED lights fittings for lighting inside the car and axial flow fan. 5 mm thick antiskid PVC flooring. All other item as per CPWD general specification for lifts 2003 with up to date amendments.
4	Design/ type of enclosure of car	Rectangular / as per site condition, stainless steel scratch proof (HAIR LINE FINISH)

S.NO.	**Particulars of detail**	
5	Details of flooring	6 mm thick aluminium/5 mm SS Chequered plate
6	Attachment and fitting inside the car	Axial flow fan & LED light fittings with anti – theft arrangement (As per requirement)
7	Car doors	HORIZONTAL SLIDING, CENTRE/SIDE - OPENING
	a) Size	Approx. size 900mm x 2000 mm or as per site feasibility
	b) Operation	Power operated automatic door
	c) Construction, design & finish	Stainless steel scratch proof (HAIR LINE FINISH)
8	**Landing Doors**	
	a) size	Approx. size 900 mm x 2000 mm high or as per site feasibility
	b) operation	Power operated automatic door
	c) Construction, design & finish	Stainless steel scratch proof (HAIR LINE FINISH)
E	**SAFETY DEVICE**	
1	Car safety type	Progressive / instantaneous type
2	Counter weight safety- type	-
3	Door inter locks in car- type	Electrical type
4	Door locks in landing- type	Electromechanical type
F	**For physically challenged**	Note below
	Voice Response System.	Required in Hindi, English / local language if needed
	Luminous Push Button with Brail script.	Required
	Hand Rails	Stainless steel hair line finish, SS - 304

Note: -

a) All materials used in the work shall be procured from RDSO approved sources or ISI marked only and of the best quality and of the class suited for the purpose

specified.

b) Design codal life of all type of material/equipments should be as per RDSO codal life standard.
c) The contractor shall be solely responsible for the correctness of the position, levels and dimensions of the works according to approved drawings, notwithstanding that he may have been assisted by the Engineer or his men in setting out the same.
d) Notwithstanding anything given anywhere else all work execution shall be as per latest design and drawing of RDSO and latest guideline issue by Railway Board.
e) The contractor should follow all the clearances as per latest CEA regulation.
f) Meet the all protective provisions relating to electrical safety.

XXXXX

Section VII-8: Tender Drawings and Documents

A- Tender Drawings
B- Tender Documents

Section VII-8
A: Tender Drawings

Tenderer shall download Tender drawings from HRIDC website. Tender Drawings are available for downloading under Active Tender Section on HRIDC website (https://hridc.co.in/active-tender.php). Tender drawings uploaded on HRIDC website for Package C-23 shall be deemed to form part of Final Tender Documents. List of Tender Drawings are enclosed hereunder.

List of Tender Drawings

	-Black colour shows Tender drawings which have not been revised
	-Blue colour shows Tender drawings which have been revised
	-Red colour shows New additional Tender drawings

S. No.	TITLE	REVISED/NEW DRAWING NO.
1. ALIGNMENT PLAN & L-SECTION		
1.	Conceptual Plan & longitudinal section (29KM to 33.0KM)	GC-HRIDC-ALL-DRW-ALN-P&P-29-33KM_A1
2.	Conceptual Plan & longitudinal section (33.0KM to 35.0KM)	GC-HRIDC-ALL-DRW-ALN-P&P-33-35KM_A1
3.	Conceptual Plan & longitudinal section (35.0KM to 40.0KM)	GC-HRIDC-ALL-DRW-ALN-P&P-35-40KM_A1
4.	Conceptual Plan & longitudinal section (40.0KM to 45.0KM)	GC-HRIDC-ALL-DRW-ALN-P&P-40-45KM_A1
5.	Conceptual Plan & longitudinal section (45.0KM to 50.0KM)	GC-HRIDC-ALL-DRW-ALN-P&P-45-50KM_A1
6.	Conceptual Plan & longitudinal section (55.0KM to 61.5KM)	GC-HRIDC-ALL-DRW-ALN-P&P-55-61.5KM_A1
7.	Conceptual Plan & longitudinal section connectivity towards Patli	GC-HRIDC-C2-DRW-ALN-P&P-03001_A2
8.	Conceptual Plan and longitudinal section connectivity towards Sultanpur	GC-HRIDC-C2-DRW-ALN-P&P-04001_A2
9.	Re-grading of Garhi Harsaru-Farukhnagar main line of Sultanpur station yard (conceptual)	GC-HRIDC-C23-DRW-ALN-P&P-06001_A0
2. ESP/YARD PLAN		
1.	Conceptual Engineering scale plan of New Patli Junction CH:58135.513 f/Prithala	GC-HRIDC-C23-DRW-STN-ESP-NPA01_A2
2.	Conceptual Engineering scale plan Sultanpur Kaliawas junction CH: 3674.74m f/Badsa KM:6/375	GC-HRIDC-C23-DRW-STN-ESP-SUL01_A2

S. No.	TITLE	REVISED/NEW DRAWING NO.
3.	Conceptual Engineering scale plan Dhulawat Station CH: 32767m F/Prithala	GC-HRIDC-C23-DRW-STN-ESP-DHU01_A0
4.	Conceptual Engineering scale plan Chandla Dungerwas station yard CH:42606.159m F/Prithala	GC-HRIDC-C23-DRW-STN-ESP-CDU01_A1
5.	Conceptual Engineering scale plan Pachgaon Station yard Ch:46279.352m F/Prithala	GC-HRIDC-C23-DRW-STN-ESP-PCG01_A1
3. STATION BUILDING AND SUBWAY		
1.	Conceptual Architectural drawing New Patli Station & Subway Br.No 144A	GC-HRIDC-C23-DRW-STN-SAD-NPA01_A1 (Sheet 1 of 3)
		GC-HRIDC-C23-DRW-STN-SAD-NPA01_A1 (Sheet 2 of 3)
		GC-HRIDC-C23-DRW-STN-SAD-NPA01_A1 (Sheet 3 of 3)
2.	Conceptual Architectural drawing Sultanpur station building	GC-HRIDC-C23-DRW-STN-SAD-SUL01_A1
3.	Conceptual Architectural drawing Dhulawat station & subway Br.No 79	GC-HRIDC-C23-DRW-STN-SAD-DHU01_A1 (Sheet 1 of 2)
		GC-HRIDC-C23-DRW-STN-SAD-DHU01_A1 (Sheet 2 of 2)
4.	Conceptual Architectural drawing Chandla Dungerwas station & subway Br.No 104	GC-HRIDC-C23-DRW-STN-SAD-CDU01_A1
5.	Conceptual Architectural drawing Pachgaon station & subway Br.No 113	GC-HRIDC-C23-DRW-STN-SAD-PCG01_A1
4. BRIDGES		
4.1 MINOR BRIDGES		
4.1.1 MAIN LINE		
1.	Conceptual general arrangement drawing proposed ROB Br. No. 073 Span 1×11.5×11 RCC box (at Ch: 30155.000)	GC-HRIDC-C23-DRW-BRD-GAD-01073_A1
2.	Conceptual general arrangement drawing proposed Br. No. 074 span 2×3.0×2.0 RCC box (syphon) at Ch: 30528.000	GC-HRIDC-C23-DRW-BRD-GAD-01074_A1
3.	Conceptual general arrangement drawing proposed Br. No. 075 span 2×5.0×2.5 RCC box (syphon) at Ch: 30839.000	GC-HRIDC-C23-DRW-BRD-GAD-01075_A1
4.	Conceptual general arrangement drawing proposed RUB no. 076 span 2×6.2×5.650 RCC box at Ch: 31145.000	GC-HRIDC-C23-DRW-BRD-GAD-01076_A1

S. No.	TITLE	REVISED/NEW DRAWING NO.
5.	Conceptual general arrangement drawing proposed RUB no. 077 span 1×6.0×4.0 RCC box at Ch: 31365.000	GC-HRIDC-C23-DRW-BRD-GAD-01077_A1
6.	Conceptual general arrangement drawing proposed RUB no. 078 span 1×6.0×4.0 RCC box at Ch: 32022.000	GC-HRIDC-C23-DRW-BRD-GAD-01078_A1
7.	Conceptual general arrangement drawing proposed RUB no. 080 Span 1×6.0×4.50 RCC box at Ch: 33155.000	GC-HRIDC-C23-DRW-BRD-GAD-01080_A1
8.	Conceptual general arrangement drawing balancing culvert bridge no. 81, 1x2x2 RCC box at CH:33269.230	GC-HRIDC-C23-DRW-BRD-GAD-01081_A1
9.	Conceptual general arrangement drawing bridge no. 82, 90, 96, 99 &122 pipe Culvert 1x1.8 span	GC-HRIDC-C23-DRW-BRD-GAD-PIPE_A1
10.	Conceptual general arrangement drawing for proposed RUB no. 083 span 2×7.0×5.650 RCC box at Ch: 33673.045	GC-HRIDC-C23-DRW-BRD-GAD-01083_A1
11.	Conceptual general arrangement drawing for proposed RUB no. 084 span 1×6.0×5.0 RCC box at Ch: 33976.50	GC-HRIDC-C23-DRW-BRD-GAD-01084_A1
12.	Conceptual general arrangement drawing for proposed RUB no. 085 span 2×5.5×5.650 RCC box at Ch: 34280.218	GC-HRIDC-C23-DRW-BRD-GAD-01085_A1
13.	Conceptual general arrangement drawing for road under bridge no 87 Span 1.0x5.0x3.0 RCC box at Ch: 35371.018m	GC-HRIDC-C23-DRW-BRD-GAD-01087_A1
14.	Conceptual general arrangement drawing for road under bridge no 88 Span 1.0x5.0x3.0 RCC box at Ch: 35916.064m	GC-HRIDC-C23-DRW-BRD-GAD-01088_A1
15.	Conceptual general arrangement drawing for proposed RUB no. 089 span 2×7.0×5.65 RCC box at Ch: 36984.118	GC-HRIDC-C23-DRW-BRD-GAD-01089_A1
16.	Conceptual general arrangement drawing for proposed RUB no. 091 span1×5.0×3.15 RCC box at Ch: 37804.099	GC-HRIDC-C23-DRW-BRD-GAD-01091_A1
17.	Conceptual general arrangement drawing proposed RUB no. 092 span 2×5.5×5.650 RCC box at Ch: 38456.750	GC-HRIDC-C23-DRW-BRD-GAD-01092_A1
18.	Conceptual general arrangement drawing for balancing culvert bridge no.	GC-HRIDC-C23-DRW-BRD-GAD-01093_A1

S. No.	TITLE	REVISED/NEW DRAWING NO.
	093 Span 1×3.0×2.0 RCC box at Ch: 39155.000	
19.	Conceptual general arrangement drawing for road under bridge no. 094 span 1.0x5.0x3.0 RCC box at Ch: 39552.508	GC-HRIDC-C23-DRW-BRD-GAD-01094_A1
20.	Conceptual general arrangement drawing proposed RUB no. 095 span 2×5.5×5.650 RCC box at Ch: 40003.467	GC-HRIDC-C23-DRW-BRD-GAD-01095_A1
21.	Conceptual general arrangement drawing for proposed RUB no. 097 span 1×4.0×2.5 RCC box at Ch: 40671.025	GC-HRIDC-C23-DRW-BRD-GAD-01097_A1
22.	Conceptual general arrangement drawing for road under bridge no. 098 span 1.0x4.0x3.0 RCC box at Ch: 41312.174	GC-HRIDC-C23-DRW-BRD-GAD-01098_A1
23.	Conceptual general arrangement drawing for balancing culvert bridge no. 100 Span 1.0x2.0x2.0 RCC box at Ch: 41925.899	GC-HRIDC-C23-DRW-BRD-GAD-01100_A1
24.	Conceptual general arrangement drawing proposed RUB no. 101 span 2×7.0×5.650 RCC box at Ch: 41962.645	GC-HRIDC-C23-DRW-BRD-GAD-01101_A1
25.	Conceptual general arrangement drawing for balancing culvert bridge no 102 Span 1.0x2.0x2.0 RCC box at Ch: 42238.900	GC-HRIDC-C23-DRW-BRD-GAD-01102_A1
26.	Conceptual general arrangement drawing for proposed RUB no. 103 span 1×5.0×3.0 RCC box at Ch: 42578.906	GC-HRIDC-C23-DRW-BRD-GAD-01103_A1
27.	Conceptual general arrangement drawing proposed RUB no. 105 span 2×7.0×5.650 RCC box at Ch: 43506.883	GC-HRIDC-C23-DRW-BRD-GAD-01105_A1
28.	Conceptual general arrangement drawing for road under bridge no 106 Span 1.0x4.0x3.1 RCC box at Ch: 43758.291	GC-HRIDC-C23-DRW-BRD-GAD-01106_A1
29.	Conceptual general arrangement drawing for balancing culvert bridge no 108 Span 1.0x4.0x5.0 RCC box at Ch: 44281.401	GC-HRIDC-C23-DRW-BRD-GAD-01108_A1
30.	Conceptual general arrangement drawing for balancing culvert bridge no 109 Span 1.0x4.0x5.0 RCC box at Ch: 44401.641m	GC-HRIDC-C23-DRW-BRD-GAD-01109_A1

S. No.	TITLE	REVISED/NEW DRAWING NO.
31.	Conceptual general arrangement drawing proposed RUB no. 110 span 1×6.0×5.0 RCC box at Ch: 44420.238	GC-HRIDC-C3-DRW-BRD-GAD-01110_A1
32.	Conceptual general arrangement drawing for balancing culvert bridge no 114 span 1.0x6.0x6.0 RCC box at Ch: 46635.175	GC-HRIDC-C23-DRW-BRD-GAD-01114_A1
33.	Conceptual general arrangement drawing for road under bridge no 115 Span 1.0x6.0x6.0 RCC box at Ch: 46768.341	GC-HRIDC-C23-DRW-BRD-GAD-01115_A1
34.	Conceptual general arrangement drawing for balancing culvert bridge no 116 span 1.0x5.0x5.0 RCC box at Ch: 46915.023	GC-HRIDC-C23-DRW-BRD-GAD-01116_A1
35.	Conceptual general arrangement drawing for road under bridge no 117 Span 2.0x5.0x5.0 RCC box at Ch: 47300.018	GC-HRIDC-C23-DRW-BRD-GAD-01117_A1
36.	Conceptual general arrangement drawing for balancing culvert no 118 Span 1.0x4.0x4.0 RCC box at Ch: 47500.360	GC-HRIDC-C23-DRW-BRD-GAD-01118_A1
37.	Conceptual general arrangement drawing for balancing culvert bridge no 119 Span 1.0x4.0x3.0 RCC box at Ch: 47824.336	GC-HRIDC-C23-DRW-BRD-GAD-01119_A1
38.	Conceptual general arrangement drawing for balancing culvert bridge no 120 Span 1.0x4.0x4.0 RCC box at Ch: 48093.515	GC-HRIDC-C23-DRW-BRD-GAD-01120_A1
39.	Conceptual general arrangement drawing for road under bridge no 121 Span 1.0x4.0x4.0 RCC box at Ch: 48231.618	GC-HRIDC-C23-DRW-BRD-GAD-01121_A1
40.	Conceptual general arrangement drawing for road under bridge no 124 Span 1.0x4.0x4.0 RCC box at Ch: 48794.629	GC-HRIDC-C23-DRW-BRD-GAD-01124_A1
41.	Conceptual general arrangement drawing for road under bridge no 125 Span 2.0x5.0x3.6 RCC box at Ch: 49167.307	GC-HRIDC-C23-DRW-BRD-GAD-01125_A1
42.	Conceptual general arrangement drawing for bridge no. 126 Pipe culvert 1x1.2 span, at Ch: 49583.348	GC-HRIDC-C23-DRW-BRD-GAD-01126_A1
43.	Conceptual general arrangement drawing for balancing culvert bridge no	GC-HRIDC-C23-DRW-BRD-GAD-01137_A1

S. No.	TITLE	REVISED/NEW DRAWING NO.
	137 Span 1.0x5.0x4.0 RCC box at Ch: 56117.426	
44.	Conceptual general arrangement drawing for road under bridge no 138 Span 1.0x5.0x4.0 RCC box at Ch: 56290.652	GC-HRIDC-C23-DRW-BRD-GAD-01138_A1
45.	Conceptual general arrangement drawing for balancing culvert bridge no 139 Span 1.0x5.0x4.0 RCC box at Ch: 56465.029	GC-HRIDC-C23-DRW-BRD-GAD-01139_A1
46.	Conceptual general arrangement drawing for balancing culvert bridge no 140 Span 1.0x5.0x4.0 RCC box at Ch: 56755.035	GC-HRIDC-C23-DRW-BRD-GAD-01140_A1
47.	Conceptual general arrangement drawing For Road + Balancing culvert bridge no 141/ 141A 1x2x2+1x5x4 RCC box at Ch: 57154.991/57167.991	GC-HRIDC-C23-DRW-BRD-GAD-01141_A1
48.	Conceptual general arrangement drawing for balancing culvert bridge no 142 1x5.0x4.0m RCC box at Ch:57520	GC-HRIDC-C23-DRW-BRD-GAD-01142_A1
49.	Conceptual general arrangement drawing for road under bridge no. 143, 2x7x5.25 RCC box at CH: 57670.809	GC-HRIDC-C23-DRW-BRD-GAD-01143_A1
50.	Conceptual general arrangement drawing for balancing culvert bridge no. 144, 1x2x2 RCC box at CH: 57987.046	GC-HRIDC-C23-DRW-BRD-GAD-01144_A1
51.	Conceptual general arrangement drawing for road under bridge no. 145, 1x5x3 RCC box at CH: 58203.149	GC-HRIDC-C23-DRW-BRD-GAD-01145_A1
52.	Conceptual general arrangement drawing for balancing culvert bridge no. 146, 1x2x2 RCC box at CH: 58564.993	GC-HRIDC-C23-DRW-BRD-GAD-01146_A1
53.	Conceptual general arrangement drawing for bridge no.146A - 5 m clear span inverted U over GAIL pipe line crossing at Ch. 58720.513	GC-HRIDC-C23-DRW-BRD-GAD-01146A_A0
54.	Conceptual general arrangement drawing for balancing culvert bridge no 147A 1x2.0x2.0m RCC box at Ch. 59587.000	GC-HRIDC-C23-DRW-BRD-GAD-01147A_A0
55.	Conceptual general arrangement drawing for road under bridge no. 148, 2x5x5.25 RCC box at CH: 59884.954	GC-HRIDC-C23-DRW-BRD-GAD-01148_A1
56.	Conceptual general arrangement drawing for Road+Balancing culvert bridge no 149/149A 1x5x3 + 1x2x2	GC-HRIDC-C23-DRW-BRD-GAD-01149_A1

S. No.	TITLE	REVISED/NEW DRAWING NO.
	RCC box at Ch. 60161.343m/ 60171.264m	
57.	Conceptual general arrangement drawing for balancing culvert bridge no. 154, 1x2x2 RCC box at CH: 61163.504	GC-HRIDC-C23-DRW-BRD-GAD-01154_A1
4.1.2 CONNECTING LINE		
A. NEW PATLI TO PATLI		
1.	Conceptual general arrangement drawing for road under bridge no. 1, 1x5x3.25 RCC box at CH: 1046.562 (connecting line New Patli to Patli)	GC-HRIDC-C23-DRW-BRD-GAD-03001_A1
2.	Conceptual general arrangement drawing for balancing culvert bridge no. 2, 1x2x2 RCC box at CH: 1277.958 (connecting line New Patli to Patli)	GC-HRIDC-C23-DRW-BRD-GAD-03002_A1
3.	Conceptual general arrangement drawing for road under bridge no. 3, 1x4x3.25 RCC box at CH: 1986.847 (connecting line New Patli to Patli)	GC-HRIDC-C23-DRW-BRD-GAD-03003_A1
4.	Conceptual general arrangement drawing for road under bridge no. 4, 1x5x5.25 RCC box at CH: 2518.489 (connecting line New Patli to Patli)	GC-HRIDC-C23-DRW-BRD-GAD-03004_A1 (Sheet 1 of 2) GC-HRIDC-C23-DRW-BRD-GAD-03004_A1 (Sheet 2 of 2)
5.	Conceptual general arrangement drawing for balancing culvert bridge no. 5, 1x2.5x3 RCC box at CH: 2687.006 (connecting line New Patli to Patli)	GC-HRIDC-C23-DRW-BRD-GAD-03005_A1
B. NEW PATLI TO SULTANPUR		
1.	Conceptual general arrangement drawing for balancing culvert bridge no. 2, 1x2x2 RCC box at CH: 1548.996 (connecting line New Patli to Sultanpur)	GC-HRIDC-C23-DRW-BRD-GAD-04002_A1
2.	Conceptual general arrangement drawing for bridge no.3A - 5 m clear span inverted U over GAIL pipe line crossing at Ch. 1785m (connecting line New Patli to Sultanpur)	GC-HRIDC-C23-DRW-BRD-GAD-04003A_A0
3.	Conceptual general arrangement drawing for balancing culvert bridge no.4, 1x2x2 RCC box at CH: 2189.831 (connecting line New Patli to Sultanpur)	GC-HRIDC-C23-DRW-BRD-GAD-04004_A1
4.	Conceptual general arrangement drawing for road under bridge no. 5, 1x5x4.25 RCC box at CH: 2823.679 (connecting line New Patli to Sultanpur)	GC-HRIDC-C23-DRW-BRD-GAD-04005_A1

S. No.	TITLE	REVISED/NEW DRAWING NO.
5.	Conceptual general arrangement drawing for bridge no.5A - 5 m clear span inverted U over GAIL pipe line crossing at Ch. 3733m (connecting line new Patli to Sultanpur)	GC-HRIDC-C23-DRW-BRD-GAD-04005A_A0
4.2	**MAJOR BRIDGES**	
4.2.1	**MAIN LINE**	
1.	Conceptual general arrangement drawing for PSC U Slab bridge no. 86, 2x12.2 RCC box at CH:34899.045	GC-HRIDC-C23-DRW-BRD-GAD-01086_A1
2.	Conceptual general arrangement drawing for proposed major bridge no.107 at Ch: 44246.344m 1 x 18.3 m Composite girder	GC-HRIDC-C23-DRW-BRD-GAD-01107_A1
3.	Conceptual general arrangement drawing for proposed major RUB no.111 at Ch:44570.310m as 1 x 18.3 m PSC I Girder	GC-HRIDC-C23-DRW-BRD-GAD-01111_A1
4.	Conceptual general arrangement drawing for prop. major RUB no.112, at Ch: 45495.969m 4x18.3(CG) + 1x30.5(CG) + 8x24.4 (CG) + 1x76.2(OWG) + 2x24.4(CG) + 1x61(OWG)	GC-HRIDC-C23-DRW-BRD-GAD-01112_A1 (Sheet 1 of 2) GC-HRIDC-C23-DRW-BRD-GAD-01112_A1 (Sheet 2 of 2)
5.	Conceptual general arrangement drawing for proposed viaduct br no.123 at Ch: 48663.628m as 1 x 18.3 m PSC I girder	GC-HRIDC-C23-DRW-BRD-GAD-01123_A1
6.	Conceptual general arrangement drawing for proposed major ROR bridge no.136, 18.3(CG) + 76.2(OWG) + 18.3 (CG) at Ch: 55724.752m	GC-HRIDC-C23-DRW-BRD-GAD-01136_A1
7.	Conceptual general arrangement drawing for proposed major RUB no.147 at Ch:59106.085m 1 x 45.7m, Open Web Girder	GC-HRIDC-C23-DRW-BRD-GAD-01147_A1 (Sheet 1 of 2) GC-HRIDC-C23-DRW-BRD-GAD-01147_A1 (Sheet 2 of 2)
8.	Conceptual general arrangement drawing for proposed major RUB no. 150, 1x30.5 Composite Girder at CH: 60457.614	GC-HRIDC-C23-DRW-BRD-GAD-01150_A1 (Sheet 1 of 2) GC-HRIDC-C23-DRW-BRD-GAD-01150_A1 (Sheet 2 of 2)
9.	Conceptual general arrangement drawing for proposed major RUB no. 151, 1x24.4 Composite Girder at CH: 60563.367	GC-HRIDC-C23-DRW-BRD-GAD-01151_A1 (Sheet 1 of 2) GC-HRIDC-C23-DRW-BRD-GAD-01151_A1 (Sheet 2 of 2)
10.	Conceptual general arrangement drawing for proposed major RUB no. 152, 1x24.4 Composite Girder at CH: 60642.669	GC-HRIDC-C23-DRW-BRD-GAD-01152_A1 (Sheet 1 of 2) GC-HRIDC-C23-DRW-BRD-GAD-01152_A1 (Sheet 2 of 2)

S. No.	TITLE	REVISED/NEW DRAWING NO.
11.	Conceptual general arrangement drawing for proposed major RUB no. 153, 1x30.5 Composite Girder at CH: 60754.591	GC-HRIDC-C23-DRW-BRD-GAD-01153_A1 (Sheet 1 of 2)
		GC-HRIDC-C23-DRW-BRD-GAD-01153_A1 (Sheet 2 of 2)
4.2.2 CONNECTING LINE		
A. NEW PATLI TO SULTANPUR		
1.	Conceptual general arrangement drawing for proposed major RUB no. 1 at Ch:951.499 m 1 x 45.7m, Open Web Girder (connecting line new patli to sultanpur)	GC-HRIDC-C23-DRW-BRD-GAD-04001_A1
2.	Conceptual general arrangement drawing for proposed major RUB no. 3, 1x12.2 PSC U Slab at CH: 1767.989 (connecting line New Patli to Sultanpur)	GC-HRIDC-C23-DRW-BRD-GAD_04003_A1
5. MISCELLANEOUS DRAWINGS (CONCEPTUAL PLANS)		
1.	Conceptual Plan Typical embankment/cutting profile	GC-HRIDC-SK-GEN-001_A1
2.	Conceptual Plan S&T hut	GC-HRIDC-SK-GEN-002_A1
3.	Conceptual Plan Mini platform shelter	GC-HRIDC-SK-GEN-003_A1
4.	Conceptual Plan R.C. pre-cast fencing for end platform	GC-HRIDC-SK-GEN-004
5.	Conceptual Plan Station name board	GC-HRIDC-SK-GEN-005_A1
6.	Conceptual Plan Proposed toilet block on island platforms	GC-HRIDC-SK-GEN-006_A1
7.	Conceptual Plan Proposed toilet block on end platforms	GC-HRIDC-SK-GEN-007_A1
8.	Conceptual Plan Drains for Embankment	GC-HRIDC-SK-GEN-008_A1
9.	Conceptual Plan Steel barricade	GC-HRIDC-SK-GEN-009
10.	Conceptual Plan Water booth with one side taps arrangement (end platform)	GC-HRIDC-SK-GEN-010_A1
11.	Conceptual Plan Water booth with both side taps arrangement (island platform)	GC-HRIDC-SK-GEN-011_A1
12.	Conceptual Plan Ticket counter for New Patli station	GC-HRIDC-SK-GEN-013
13.	Conceptual Plan CC Toe wall	GC-HRIDC-SK-GEN-014_A1
14.	Conceptual Plan Typical details of protection work	GC-HRIDC-SK-GEN-015_A1
15.	Conceptual Plan Barbed wire fencing	GC-HRIDC-SK-GEN-016_A1

S. No.	TITLE	REVISED/NEW DRAWING NO.
16.	Conceptual Plan Rain –Water Harvesting	GC-HRIDC-SK-GEN-018
17.	Conceptual Plan for Transition system of bridge approaches	GC-HRIDC-SK-GEN-019
18.	Conceptual Plan for Self-Supporting roof covering Shed	GC-HRIDC-SK-GEN-020
19.	Conceptual Plan for formation details below subway, lift well and building	GC-HRIDC-SK-GEN-021
20.	Conceptual plan for Trolley Refuge in embankment	GC-HRIDC-SK-GEN-022
21.	Conceptual plan for Trolley Refuge in cutting	GC-HRIDC-SK-GEN-023
22.	Conceptual sketch for RCC platform wall	GC-HRIDC-SK-GEN-024
23.	Conceptual Plan for single lane and double lane road	GC-HRIDC-SK-GEN-025
24.	Conceptual Plan for reinforced earth wall geogrid reinforcement	GC-HRIDC-SK-GEN-026
25.	Conceptual Plan for sump	GC-HRIDC-SK-GEN-027
26.	Conceptual sketch for NP4 pipe of 450mm Dia	GC-HRIDC-SK-GEN-028
27.	Conceptual sketch for precast RCC box 500 x 500 mm size	GC-HRIDC-SK-GEN-029
28.	Jurisdictional Sketch for civil works C-23 package	GC-HRIDC-C23-SK-CIVIL-001_A1
29.	Conceptual Plan Drainage arrangement (New Patli)	GC-HRIDC-C23-SK-CIVIL-002_A1
30.	Conceptual Plan Drainage arrangement (Sultanpur)	GC-HRIDC-C23-SK-CIVIL-003_A1
31.	Conceptual Plan Drainage arrangement (Dhulawat)	GC-HRIDC-C23-SK-CIVIL-004_A1
32.	Conceptual Plan Drainage arrangement (Chandla Dungerwas)	GC-HRIDC-C23-SK-CIVIL-005_A1
33.	Conceptual Plan Drainage arrangement (Pachgaon)	GC-HRIDC-C23-SK-CIVIL-006_A1
34.	Conceptual Plan Bank/cutting benching at interface locations	GC-HRIDC-C23-SK-CIVIL-009_A1
35.	Type plan powder toilet for divyangs	N.R.H.Q.E PLAN NO. HQ/20/11-2021

Section VII-8
B. Documents

List of Documents

-Black Colour shows Tender documents which have not been revised

-Blue Colour shows Tender documents which have been revised

-Red Colour shows New Additional Tender documents

List of Documents		
S.NO.	Existing Documents Title	Revised/New Documents Title
1	List of Curve and Gradients	List of Curve and Gradients
2	List of Control Points	List of Control Points
3	List of Charted Utilities	List of Charted Utilities
4	Geotechnical Investigation Reports	Geotechnical Investigation Reports
	1. Chainage 55.6 to Chainage km 69.5	1. *Old Ch. 52+518 to Old Ch. 59+270 ((New CH: 55+719 to 62+546)*
	2. Chainage 29.487 to Old Ch. 46.400 (New	2. *Old Ch. 29+487 to Old Ch. 46+400 (New CH: 30+155 to 49+584)*
	–	3. Major Bridge Old Ch. 42+256 (New Ch: 45+497)
	a. Patli to New Patli	4. Patli to New Patli
	b. New Patli to Sultanpur	5. New Patli to Sultanpur
5	Approved Manufactures/Suppliers List	Approved Manufacturers/Suppliers List
6	–	List of Existing Structures to be Dismantled

1. List of Curve and Gradients

1. List of Curve and Gradients

PKG-C23 Gradient Details (km 29.200- km 49.700)							
S. No.	Chainage KM		Length	Gradient	RISE/FALL	PFL	
	From	upto	metre	1 in		From	To
1	28420.000	29960.000	1540.000	160	R	247.78	257.405
2	29960.000	31080.000	1120.000	152	R	257.405	264.774
3	31080.000	31940.000	860.000	175	R	264.774	269.688
4	31940.000	32200.000	260.000	LEVEL		269.688	269.739
5	32200.000	33399.509	1199.509	1200	F	269.739	268.74
6	33399.509	33699.509	300.000	3000	F	268.74	268.64
7	33699.509	33939.509	240.000	LEVEL		268.64	268.64
8	33939.509	34524.257	584.748	220	F	268.64	265.89
9	34524.257	34879.509	355.252	750	R	265.89	266.336
10	34879.509	35034.415	154.906	LEVEL		266.336	266.336
11	35034.415	35519.509	485.094	5000	R	266.336	266.428
12	35519.509	35914.509	395.000	195	F	266.428	264.403
13	35914.509	36364.509	450.000	165	F	264.403	261.675
14	36364.509	36824.509	460.000	165	R	261.675	264.463
15	36824.509	37064.510	240.001	LEVEL		264.463	264.463
16	37064.510	37744.506	679.996	165	F	264.463	260.342
17	37744.506	38384.506	640.000	200	R	260.342	263.542
18	38384.506	38524.506	140.000	LEVEL		263.542	263.542
19	38524.506	39564.506	1040.000	200	F	263.542	258.342
20	39564.506	39924.506	360.000	552	R	258.342	258.994
21	39924.506	40064.506	140.000	LEVEL		258.994	258.994
22	40064.506	40544.506	480.000	200	F	258.994	256.594
23	40544.506	41084.512	540.006	900	R	256.594	257.194
24	41084.512	41954.506	869.994	155	R	257.194	262.807

PKG-C23 Gradient Details (km 29.200- km 49.700)							
S. No.	Chainage KM		Length	Gradient	RISE/FALL	PFL	
	From	upto	metre	1 in		From	To
25	41954.506	43264.506	1310.000	1200	R	262.807	263.899
26	43264.506	43584.506	320.000	155	R	263.899	265.963
27	43584.506	44129.344	544.838	330	R	265.963	267.315
28	44129.344	44804.344	675.000	165	R	267.315	271.706
29	44804.344	45088.261	283.917	200	R	271.706	273.181
30	45088.261	45776.311	688.050	LEVEL		273.181	273.181
31	45776.311	45899.352	123.041	200	F	273.181	272.566
32	45899.352	46649.347	749.995	400	F	272.566	270.691
33	46649.347	46784.347	135.000	150	F	270.691	269.791
34	46784.347	48184.184	1399.837	163	F	269.791	261.202
35	48184.184	48685.184	501.000	200	F	261.202	258.697
36	48685.184	49452.301	767.117	400	R	258.697	260.614
37	49452.301	51047.000	1594.699	155	F	260.614	257.081

Horizontal Curve Details												
S. No.	Curve No.	SIDE	DEGREE	RADIUS	DEF. ANGLE (Delta)	CANT {SE) (mm)	TANGENT LENGTH	CCL	TRANSITION LENGTH	CH. TPTC-1	CH. TPTC-2	TOTAL LENGTH
1	14	*LHS*	0.438	4000.000	19°57'37"	30.000	743.900	**1313.500**	**80.000**	28486.954	29960.434	1473.480
2	15	*LHS*	1.966	890.000	26°31'44"	145.000	284.500	**260.900**	**150.000**	31126.993	31687.918	560.925
3	16	*RHS*	0.499	3505.400	03°03'35"	30.000	143.600	**87.200**	**100.000**	32479.484	32766.658	287.174
4	17	*RHS*	0.875	2000.000	14°15'45"	80.000	315.200	**367.700**	**130.000**	34420.023	35047.728	627.705
5	18	*LHS*	0.530	3300.000	7°52'53"	35.000	277.300	**353.900**	**100.000**	36868.221	37422.137	553.916
6	19	*LHS*	0.610	2870.000	20°14'07"	40.000	567.100	**903.600**	**110.000**	39689.383	40812.944	1123.561

Horizontal Curve Details

S. No.	Curve No.	SIDE	DEGREE	RADIUS	DEF. ANGLE (Delta)	CANT {SE) (mm)	TANGENT LENGTH	CCL	TRANSITION LENGTH	CH. TPTC-1	CH. TPTC-2	TOTAL LENGTH
7	20	*LHS*	0.350	5000.000	1°43'10"	20.000	115.000	**70.000**	***80.000***	41377.845	41607.887	230.042
8	21	*LHS*	0.350	5000.000	1°30'05"	20.000	105.500	**51.000**	**80.000**	42467.917	42678.945	211.028
9	22	*LHS*	1.795	975.000	19°35'28"	160.000	257.700	**151.700**	**180.000**	43622.056	44133.762	511.706
10	23	*RHS*	0.972	1800.000	4°48'48"	100.000	140.600	**21.000**	**130.000**	44260.050	44541.086	281.036
11	24	*LHS*	3.500	500.000	16°34'33"	150.000	132.000	**22.700**	**120.000**	44851.854	45114.616	262.762
12	25	*RHS*	4.000	437.500	20°21'27"	105.000	113.400	**85.000**	**70.000**	45243.401	45468.362	224.961
13	26	*RHS*	4.000	437.500	15°28'23"	80.000	84.400	**68.000**	**50.000**	45698.954	45866.928	167.974
14	27	*RHS*	0.625	2800.000	4°3'14"	45.000	154.100	**88.100**	**110.000**	45935.763	46243.832	308.069
15	28	*RHS*	1.400	1250.000	8°29'50"	120.000	162.700	**44.900**	**140.000**	46294.845	46619.755	324.910
16	29	*LHS*	1.129	1550.000	13°5'40"	130.000	262.700	**183.700**	**170.000**	46818.226	47341.914	523.688
17	30	*LHS*	1.151	1520.000	16°50'33"	135.000	314.800	**266.100**	**180.000**	47564.307	48190.444	626.137
18	31	*RHS*	1.167	1500.000	10°5'29"	110.000	202.300	**123.900**	**140.000**	49037.443	49441.304	403.861
19	26	*RHS*	0.500	3500.000	19°57'37"	30.000	665.900	**1119.300**	**100.000**	28468.502	29787.983	1319.481
20	27	*RHS*	2.000	875.000	26°31'44"	150.000	280.900	**253.900**	**150.000**	*31110.614*	31664.553	*553.939*
21	28	*LHS*	0.500	3500.000	3°03'35"	30.000	143.500	**86.900**	**100.000**	32460.925	32747.810	286.885
22	29	*LHS*	0.854	2050.000	14°15'45"	75.000	321.400	**380.200**	***130.000***	34394.257	35034.415	640.158
23	30	*RHS*	0.547	3200.000	7°52'53"	35.000	275.400	**330.200**	***110.000***	36850.244	37400.394	550.150
24	31	*RHS*	0.614	2850.000	20°14'07"	40.000	563.600	**896.500**	**110.000**	39674.412	40790.909	1116.497
25	32	*RHS*	0.437	4005.300	1°43'10"	30.000	100.100	**40.200**	**80.000**	41375.332	41575.520	200.188
26	33	*RHS*	0.437	4005.300	1°30'05"	30.000	92.500	**25.000**	**80.000**	42463.663	42648.620	184.957
27	34	*RHS*	1.832	955.300	19°35'28"	165.000	254.300	**144.900**	**180.000**	43609.185	44114.083	504.898
28	35	*LHS*	0.854	2050.000	4°48'48"	75.000	151.100	**42.100**	**130.000**	44233.970	44536.050	302.080
29	36	*RHS*	3.844	455.300	16°34'33"	150.000	120.600	**19.900**	**110.000**	44848.326	45088.261	239.935
30	37	*LHS*	3.889	450.000	20°21'27"	100.000	115.600	**89.400**	**70.000**	45217.729	45447.158	229.429
31	38	*LHS*	3.889	450.000	15°28'23"	80.000	86.100	**71.400**	**50.000**	45690.412	45861.772	171.360

Horizontal Curve Details

S. No.	Curve No.	SIDE	DEGREE	RADIUS	DEF. ANGLE (Delta)	CANT {SE) (mm)	TANGENT LENGTH	CCL	TRANSITION LENGTH	CH. TPTC-1	CH. TPTC-2	TOTAL LENGTH
32	39	*LHS*	0.699	2505.300	4°3'14"	45.000	138.700	**77.200**	**100.000**	45932.932	46210.151	277.219
33	40	*LHS*	1.250	1400.000	8°29'50"	125.000	178.800	**57.200**	**150.000**	46260.238	46617.404	357.166
34	41	*RHS*	1.163	1505.300	13°5'40"	135.000	262.500	**163.300**	**180.000**	46800.129	47323.459	523.330
35	42	*RHS*	1.168	1498.000	16°50'33"	140.000	311.500	**259.600**	**180.000**	47550.700	48170.350	619.650
36	43	*LHS*	1.129	1550.000	10°5'29"	105.000	201.800	**142.700**	**130.000**	49021.483	49424.232	402.749

Gradient Details PKG-C23 (km 55.600- km 61.500)

S. No.	Chainage KM		Length	Gradient	RISE/FALL	PFL		Remarks
	From	upto	metre	1 in		From	To	
1	*55585.806*	*55804.097*	*218.291*	LEVEL		235.902	235.975	**Main Line**
2	*55804.097*	*56329.075*	*524.978*	165	F	235.984	232.856	
3	*56329.075*	*57026.475*	*697.4*	155	F	232.863	227.185	
4	*55206.475*	*58999.075*	*3792.6*	1004	F	226.619	225.335	
5	*58999.075*	*59219.075*	*220*	LEVEL		225.154	225.335	
6	*59219.075*	*59839.075*	*620*	170	F	225.152	221.723	
7	*59839.075*	*59979.075*	*140*	LEVEL		221.708	221.708	
8	59979.075	60524.075	545	155	R	221.708	225.188	
9	60524.075	60704.075	180	LEVEL		225.224	225.224	
10	60704.075	60894.075	190	155	F	225.224	223.998	
11	60894.075	61184.746	290.671	165	F	223.968	223.239	
12	61184.746	61595.051	410.305	265	R	222.178	223.761	
1	0	700	700	1004	R	226.217	226.914	**New Patli -Patli**

Gradient Details PKG-C23 (km 55.600- km 61.500)

S. No.	Chainage KM		Length	Gradient	RISE/FALL	PFL		Remarks
	From	upto	metre	1 in		From	To	
2	700	1847.724	1147.724	230	F	226.914	221.927	
3	1847.724	2418.056	570.332	LEVEL		221.927	221.927	
4	2418.056	2968.371	550.315	220	R	221.927	224.428	
5	2968.371	3247.861	279.49	4692	R	224.428	224.428	
6	3247.861	3760.79	512.929	585	R	224.428	225.365	
1	*0*	*830*	*830*	1004	F	226.217	225.221	**New Patli -Sultanpur**
2	*830*	1250	*420*	LEVEL		225.221	225.221	
3	1250	2310.92	1060.92	170	F	225.221	218.98	
4	2310.92	2881.479	570.559	5632	R	218.98	219.251	
5	2881.479	3840.926	959.447	200	F	219.251	214.454	
6	3840.926	4114.38	273.454	400	F	214.454	213.77	

Horizontal Curve Details

S. No.	Curve No.	SIDE	DEGREE	RADIUS	DEF.ANGLE (Delta)	CANT {SE) (mm)	TANGENT LENGTH	Circular Curve Length (CCL)	TRANSITION LENGTH	CH. TPTC-1	CH. TPTC-2	TOTAL LENGTH	Remarks
1	47	*LHS*	1.171	1494.700	11°47'23"	125.000	231.700	152.100	155.000	55849.683	56311.801	462.118	**Main Line UP line**
2	48	RHS	0.250	7005.300	1°02'52"	15.000	94.100	68.100	60.000	59280.924	59469.034	188.110	
3	49	LHS	0.648	2700.000	3°07'27"	40.000	138.600	17.100	130.000	60907.606	61184.746	277.140	
4	50	*RHS*	2.481	705.300	9°16'39"	120.000	107.000	13.700	100.000	61381.500	61595.160	213.660	

Horizontal Curve Details

S. No.	Curve No.	SIDE	DEGREE	RADIUS	DEF.ANGLE (Delta)	CANT {SE) (mm)	TANGENT LENGTH	Circular Curve Length (CCL)	TRANSITION LENGTH	CH. TPTC-1	CH. TPTC-2	TOTAL LENGTH	Remarks
1	35	RHS	1.167	1500.000	11°47'23"	140.000	*244.600*	128.000	180.000	*55838.456*	56326.415	*487.959*	**Main Line DN line**
2	38	*LHS*	0.250	7000.000	1°02'52"	15.000	94.000	68.000	60.000	59444.976	59632.989	188.013	
3	39	*RHS*	0.700	2500.000	3°07'27"	45.000	133.100	6.200	130.000	60929.518	61195.740	266.222	
4	40	LHS	2.500	700.000	9°16'39"	120.000	111.500	2.600	110.000	61376.441	61599.049	222.608	
1	1	RHS	1.795	975.000	5°05'30"	45.000	58.300	56.600	30.000	163.031	279.67	116.639	**New patli to patli**
2	2	RHS	1.795	975.000	5°05'30"	45.000	58.300	56.800	29.900	279.675	396.188	116.513	
3	3	*LHS*	2.917	600.000	42°05'15"	65.000	250.900	400.700	40.000	622.495	1103.186	480.691	
4	4	*RHS*	2.961	591.000	115°38'57"	85.000	969.700	1132.700	60.000	1471.172	2723.916	1252.744	
5	5	*LHS*	1.000	1750.000	2°21'07"	50.000	60.900	21.800	50.000	3119.295	3241.119	121.824	
6	6	*LHS*	1.000	1750.000	1°34'27"	35.000	39.000	18.100	30.000	3364.032	3442.113	78.081	
1	1	*LHS*	1.795	975.000	5°05'30"	45.000	58.300	56.600	30.000	163.031	279.676	116.645	**New patli to Sultanpur**
2	2	*RHS*	1.795	975.000	5°05'30"	45.000	58.300	56.800	*29.900*	279.676	396.118	116.442	
3	3	*RHS*	3.889	450.000	7°32'22"	55.000	44.600	29.200	30.000	786.182	875.36	89.178	
4	4	*RHS*	1.944	900.000	18°45'31"	60.000	168.700	254.600	40.000	1058.681	1393.319	334.638	
5	5	*LHS*	3.804	460.000	65°57'46"	55.000	313.600	499.500	30.000	2956.77	3516.32	559.55	
6	6	*LHS*	3.977	440.000	43°00'17"	60.000	188.400	300.200	30.000	3550.337	3910.537	360.2	

2. LIST OF CONTROL POINTS

LIST OF CONTROL POINTS

CH 55.000 KM TO CH 70.000 KM GCP'S DETAIL'S					
GCP"S	WGS84 Latitude	WGS84 Longitude	Grid Northing (m)	Grid Easting (m)	Elevation
SCP-34	28°26'27.1660"N	76°53'03.9408"E	3147488.043	684540.453	215.911
SCP-35	28°25'30.7392"N	76°50'25.8913"E	3145684.543	680266.856	219.896
SCP-36	28°28'09.7293"N	76°52'43.6735"E	3150636.520	683939.677	213.146
SCP-37	28°27'18.7550"N	76°50'07.4498"E	3149001.770	679714.292	220.146
SCP-38	28°29'42.9174"N	76°52'07.7145"E	3153489.785	682916.938	214.025
SCP-39	28°28'50.9803"N	76°49'32.4323"E	3151826.102	678718.550	213.476
SCP-40	28°31'23.0046"N	76°51'19.5862"E	3156550.370	681560.510	215.268
SCP-41	28°30'47.1215"N	76°48'49.0457"E	3155383.233	677484.549	215.147
TCP-121	28°24'44.9666"N	76°52'05.2477"E	3144317.248	682992.383	219.192
TCP-122	28°24'43.9123"N	76°52'08.2088"E	3144286.044	683073.473	218.608
TCP-123	28°25'12.0360"N	76°51'58.2550"E	3145147.538	682789.158	216.629
TCP-124	28°25'12.2561"N	76°52'01.6202"E	3145155.733	682880.630	216.485
TCP-125	28°25'44.3761"N	76°51'51.2001"E	3146140.046	682581.747	215.537
TCP-126	28°25'44.5441"N	76°51'55.0849"E	3146146.859	682687.377	215.975
TCP-127	28°26'14.6158"N	76°51'43.6273"E	3147067.689	682361.278	217.239
TCP-128	28°26'12.3380"N	76°51'47.4057"E	3146999.166	682465.168	218.938
TCP-129	28°26'52.0371"N	76°51'34.8424"E	3148215.885	682104.440	214.765
TCP-130	28°26'53.6477"N	76°51'38.0460"E	3148266.810	682190.830	213.613
TCP-131	28°27'22.0923"N	76°51'27.8475"E	3149138.096	681899.839	213.026
TCP-132	28°27'23.6537"N	76°51'29.6618"E	3149186.920	681948.452	212.382
TCP-133	28°27'36.8392"N	76°51'38.4657"E	3149596.499	682181.669	213.633
TCP-134	28°27'37.9196"N	76°51'45.7131"E	3149632.812	682378.301	213.769
TCP-135	28°27'59.5240"N	76°51'23.4804"E	3150288.477	681763.240	212.754
TCP-136	28°27'58.2345"N	76°51'26.5012"E	3150250.052	681846.023	213.531
TCP-137	28°28'36.0083"N	76°51'16.7447"E	3151408.700	681562.683	212.211
TCP-138	28°28'35.7799"N	76°51'20.2138"E	3151403.127	681657.146	212.179
TCP-139	28°28'57.6830"N	76°51'05.8799"E	3152071.330	681256.893	212.880
TCP-140	28°28'57.1481"N	76°51'10.2363"E	3152056.693	681375.628	212.816
TCP-141	28°29'18.8721"N	76°50'53.4692"E	3152718.372	680909.323	212.975
TCP-142	28°29'19.3493"N	76°50'57.6049"E	3152734.791	681021.569	212.681
TCP-143	28°29'54.7526"N	76°50'31.4879"E	3153813.651	680294.586	214.680
TCP-144	28°29'57.1221"N	76°50'30.5123"E	3153886.183	680266.936	214.588
TCP-145	28°30'22.3772"N	76°50'20.6217"E	3154659.458	679986.076	214.211
TCP-146	28°30'22.6226"N	76°50'23.7880"E	3154668.329	680072.053	214.134
TCP-147	28°30'53.1741"N	76°50'08.1171"E	3155602.235	679631.563	213.177
TCP-148	28°30'54.2896"N	76°50'11.2711"E	3155637.887	679716.790	212.908
TCP-149	28°31'22.3387"N	76°49'56.0802"E	3156494.973	679290.586	213.433
TCP-150	28°31'25.2632"N	76°49'57.6593"E	3156585.651	679332.140	213.002
TCP-151	28°31'59.1200"N	76°49'43.5444"E	3157621.968	678932.518	212.454
TCP-152	28°31'59.1272"N	76°49'46.9756"E	3157623.614	679025.787	212.229

MANSI CONSULTANTS PVT LTD NAGPUR

Pramod Rehpade
Asst.Technical Manger

LIST OF CONTROL POINTS-Continued					
GCP's DATA OF CH: -12KM TO 18 KM					
Name	**WGS84 Latitude**	**WGS84 Longitude**	**Grid Northing (m)**	**Grid Easting (m)**	**Elevation**
SCP'S					
SCP-009	28°12'25.3731"N	77°09'09.6978"E	3122015.079	711280.047	194.380
SCP-010	28°14'42.9312"N	77°08'00.6765"E	3126216.341	709323.220	199.402
SCP-011	28°11'39.2352"N	77°07'12.9607"E	3120538.658	708121.475	193.529
SCP-012	28°14'07.9269"N	77°06'12.5381"E	3125087.181	706394.085	199.346
SCP-013	28°10'47.0640"N	77°05'43.5348"E	3118890.253	705710.322	193.408
SCP-014	28°13'39.4318"N	77°03'49.0236"E	3124142.674	702496.512	206.820
TCP'S					
TCP-031	28°13'32.7210"N	77°08'15.0757"E	3124061.929	709753.912	196.424
TCP-032	28°13'34.4235"N	77°08'10.2582"E	3124112.021	709621.637	196.726
TCP-033	28°13'24.1071"N	77°07'33.5187"E	3123776.815	708625.507	195.883
TCP-034	28°13'26.0676"N	77°07'28.5870"E	3123834.806	708489.981	195.888
TCP-035	28°13'06.1224"N	77°07'04.0268"E	3123209.091	707831.072	196.092
TCP-036	28°13'08.4893"N	77°07'01.1748"E	3123280.594	707752.032	196.182
TCP-037	28°12'46.0137"N	77°06'30.9154"E	3122574.323	706939.003	196.105
TCP-038	28°12'48.2184"N	77°06'28.5920"E	3122641.090	706874.466	195.849
TCP-039	28°12'26.9901"N	77°06'02.1892"E	3121975.106	706165.842	195.179
TCP-040	28°12'28.5366"N	77°06'00.3063"E	3122021.822	706113.673	195.220
TCP-041	28°12'02.1341"N	77°05'38.0417"E	3121198.560	705520.574	194.986
TCP-042	28°12'05.5195"N	77°05'35.9737"E	3121301.798	705462.378	194.676
TCP-043	28°11'41.1865"N	77°05'25.8750"E	3120547.998	705199.897	196.170
TCP-044	28°11'42.7878"N	77°05'22.1513"E	3120595.539	705097.490	194.453
TCP-045	28°11'09.1126"N	77°05'11.8430"E	3119554.071	704834.200	192.723
TCP-046	28°11'10.7340"N	77°05'08.4153"E	3119602.374	704739.851	192.474
GCP's DATA OF CH: -29.200 KM TO 49.700KM					
SCP'S					
SCP-016	28°14'24.9297"N	77°00'38.4942"E	3125455.819	697278.697	293.012
SCP-017	28°12'09.7271"N	76°59'49.0726"E	3121271.671	696000.073	285.465
SCP-018	28°15'19.2876"N	76°59'11.9851"E	3127090.138	694892.969	273.709
SCP-019	28°12'36.4995"N	76°58'28.9449"E	3122059.974	693801.589	267.623
SCP-020	28°16'14.8549"N	76°57'40.0201"E	3128759.717	692358.624	265.112
SCP-021	28°13'47.9549"N	76°57'05.9422"E	3124222.828	691502.865	255.562
SCP-022	28°16'55.1346"N	76°56'08.4654"E	3129959.400	689843.726	263.025
SCP-023	28°15'13.5971"N	76°54'58.7895"E	3126803.659	687994.658	251.916
SCP-024	28°18'24.4724"N	76°55'12.5797"E	3132685.086	688277.200	269.222
SCP-025	28°17'16.6389"N	76°52'57.2887"E	3130539.057	684624.084	247.585
SCP-026	28°19'55.3848"N	76°54'39.3566"E	3135469.180	687327.824	274.734
SCP-027	28°18'49.3740"N	76°52'18.0110"E	3133376.943	683509.660	248.185
SCP-028	28°21'34.0782"N	76°54'03.4730"E	3138491.703	686302.627	280.255
SCP-029	28°20'24.3860"N	76°51'42.8468"E	3136286.731	682506.665	247.017
SCP-030	28°23'07.8703"N	76°53'32.8386"E	3141365.673	685423.154	233.634
SCP-031	28°22'08.1544"N	76°51'03.7859"E	3139464.494	681393.875	237.072

LIST OF CONTROL POINTS-Continued

TCP'S					
TCP-067	28°13'06.4061"N	77°00'21.6871"E	3123031.074	696860.575	271.034
TCP-068	28°13'10.1973"N	77°00'24.0409"E	3123148.838	696922.820	267.933
TCP-069	28°13'18.2988"N	76°59'48.3517"E	3123382.138	695945.625	266.631
TCP-070	28°13'19.9142"N	76°59'51.8013"E	3123433.416	696038.857	267.836
TCP-071	28°13'30.9119"N	76°59'07.9414"E	3123752.284	694837.477	268.041
TCP-072	28°13'34.8089"N	76°59'10.8492"E	3123873.541	694914.788	265.898
TCP-073	28°13'52.9970"N	76°58'45.2818"E	3124421.995	694208.575	268.496
TCP-074	28°13'56.2575"N	76°58'46.5997"E	3124522.949	694242.866	265.104
TCP-075	28°14'13.3161"N	76°58'21.1823"E	3125036.739	693541.378	264.634
TCP-076	28°14'16.1903"N	76°58'23.6378"E	3125126.302	693606.877	263.697
TCP-077	28°14'37.2068"N	76°57'55.7443"E	3125760.863	692835.976	265.078
TCP-078	28°14'39.8343"N	76°57'57.5805"E	3125842.554	692884.717	261.528
TCP-079	28°14'57.9545"N	76°57'26.5372"E	3126386.614	692029.490	267.744
TCP-080	28°15'01.0976"N	76°57'26.4793"E	3126483.340	692026.347	263.061
TCP-081	28°15'15.1912"N	76°56'53.7368"E	3126902.765	691126.892	262.110
TCP-082	28°15'18.2916"N	76°56'54.8506"E	3126998.690	691155.712	260.056
TCP-083	28°15'32.5066"N	76°56'21.7602"E	3127421.762	690246.788	259.226
TCP-084	28°15'34.3650"N	76°56'24.1917"E	3127480.027	690312.141	257.216
TCP-085	28°15'52.5120"N	76°55'53.0335"E	3128025.036	689454.013	259.620
TCP-086	28°15'55.2536"N	76°55'55.6864"E	3128110.581	689524.965	258.329
TCP-087	28°16'11.0478"N	76°55'26.5575"E	3128584.097	688723.376	258.667
TCP-088	28°16'13.5955"N	76°55'27.8330"E	3128663.075	688756.888	257.003
TCP-089	28°16'33.0663"N	76°54'57.7123"E	3129249.383	687926.545	256.936
TCP-090	28°16'35.3419"N	76°54'59.4766"E	3129320.192	687973.514	252.996
TCP-091	28°16'58.1919"N	76°54'38.4368"E	3130014.477	687389.057	256.735
TCP-092	28°16'59.1606"N	76°54'42.0278"E	3130045.843	687486.435	254.180
TCP-093	28°17'27.8720"N	76°54'20.4598"E	3130920.345	686884.805	255.939
TCP-094	28°17'29.7514"N	76°54'21.8008"E	3130978.772	686920.431	256.329
TCP-095	28°17'57.4427"N	76°54'00.7114"E	3131822.106	686332.417	263.020
TCP-096	28°17'59.4644"N	76°54'04.6478"E	3131886.023	686438.683	258.503
TCP-097	28°18'28.6195"N	76°53'47.4042"E	3132776.079	685954.805	253.132
TCP-098	28°18'29.6459"N	76°53'49.6679"E	3132808.641	686015.977	252.571
TCP-099	28°19'00.8854"N	76°53'42.2393"E	3133767.067	685798.517	267.264
TCP-100	28°19'01.2164"N	76°53'44.2060"E	3133778.095	685851.931	264.187
TCP-101	28°19'36.3274"N	76°53'25.5125"E	3134850.886	685325.802	258.351
TCP-102	28°19'39.8222"N	76°53'26.5136"E	3134958.888	685351.382	258.279
TCP-103	28°20'00.9454"N	76°53'07.5761"E	3135601.025	684825.425	255.750
TCP-104	28°20'01.9312"N	76°53'09.9570"E	3135632.384	684889.796	256.456
TCP-105	28°20'26.6062"N	76°52'58.9299"E	3136387.228	684577.617	254.448
TCP-106	28°20'26.6381"N	76°53'00.7694"E	3136388.992	684627.698	254.540
TCP-107	28°21'02.7798"N	76°52'53.2526"E	3137498.297	684405.637	259.513
TCP-108	28°21'05.0330"N	76°52'55.7444"E	3137568.714	684472.409	260.368
TCP-109	28°21'33.4984"N	76°52'42.2721"E	3138439.205	684091.900	250.940
TCP-110	28°21'33.7066"N	76°52'45.7096"E	3138447.074	684185.399	251.315

3. List of Charted Utilities

3. List of Charted Utilities

(Ref. Sub-Clause 10.45 & 10.46, Appendix 10, Section VII-9: Appendices, Part 2 Employer's Requirements)

3.1.1 Type A-Overground Electrical Crossings

a) Overhead Electrical Crossings: LT and HT (up to 33 KV)

C23 Section: Type A-Overhead Electrical Crossings: LT and HT (up to 33 KV)					
S. No.	**HORC CH.**	**FEEDER**	**Description**	**Utility Owner**	**Remarks**
From Ch: km 29.68 to km 49.70					
1.	28900	Dhulawat AP	HT Crossing 11 KV (UG)	DHBVN	Near Tall Road
2.	28900	Dhulawat AP	LT Line	DHBVN	
3.	28900	Dhulawat AP	LT Line	DHBVN	
4.	29500	Indu VSM Food	HT Crossing 11 KV (UG)	DHBVN	Sohana Road
5.	29500	Salaka RDS	HT Crossing 11 KV (UG)	DHBVN	Sohana Road
6.	29700	Salaka RDS	HT Crossing 11 KV (UG)	DHBVN	Janun Farm
7.	30200	Padheni AP	HT Line shifting with Pole	DHBVN	5 No Pole shifting
8.	30300	Padheni AP	HT Crossing 11 KV (UG)	DHBVN	Jungle
9.	30500	Salaka RDS	HT Crossing 11 KV (UG)	DHBVN	Padheri Gaon
10.	30500		LT Line	DHBVN	
11.	30900	Padheni AP	HT Crossing 11 KV (UG)	DHBVN	Jungle
12.	31000		HT Line shifting with Transformer	DHBVN	1 Transformer, 5 Pole shifting
13.	31000		LT Line	DHBVN	
14.	31150	Padheni AP	LT Line	DHBVN	Tubewell
15.	31550	Padheni AP	LT Line	DHBVN	Tubewell
16.	31800	Padheni AP	LT Line	DHBVN	Tubewell
17.	32500	Sarai AP	HT Crossing 11 KV (UG)	DHBVN	
18.	32520	Gogjaka AP	HT Crossing 11 KV (UG)	DHBVN	
19.	33450	Gogjaka AP	HT Crossing 11 KV (UG)	DHBVN	
20.	33300		2 Nos. LT Line	DHBVN	Tokas farm
21.	33600	Golagaon	HT Line shifting with 2 Nos Transformer	DHBVN	Kothi
22.	33800	Bissar RDS Feeder	HT Crossing 11 KV (UG)	DHBVN	2 cable Gaon k liye
23.	33880	Gogjaka AP	LT Line	DHBVN	
24.	34100	Bissar RDS Feeder	HT Crossing 11 KV (UG)	DHBVN	
25.	34690	DRDO Feeder	HT Crossing 11 KV (UG)	DHBVN	Near Mohammadpur KMP Bridge
26.	34700	Tarudhan Feeder	HT Crossing 11 KV (UG)	DHBVN	Near Mohammadpur KMP Bridge
27.	34710	MES Feeder	HT Crossing 11 KV (UG)	DHBVN	Near Mohammadpur KMP Bridge
28.	34720	Mohammadpur AP	HT Crossing 11 KV (UG)	DHBVN	Near Mohammadpur KMP Bridge

C23 Section: Type A-Overhead Electrical Crossings: LT and HT (up to 33 KV)					
S. No.	**HORC CH.**	**FEEDER**	**Description**	**Utility Owner**	**Remarks**
29.	3550	Mohammadpur AP	HT Crossing 11 KV (UG)	DHBVN	Mohammadpur Ahil Village
30.		Mohammadpur	LT Line	DHBVN	Tubewell
31.	35800	Mohammadpur	LT Line	DHBVN	House
32.	36000	Mohammadpur	LT Line	DHBVN	Tubewell
33.	36500	Mohammadpur	LT Line	DHBVN	Tubewell
34.	36700	Hasanpur RDS	HT Crossing 11 KV (UG)	DHBVN	Sabras Village
35.	36750		LT Line	DHBVN	Tubewell
36.	36750	Sabras AP	HT Crossing 11 KV (UG), Pole shifting with Transformer	DHBVN	Sabras Village
37.	37120	Sabras	HT Crossing 11 KV (UG), Pole Shifting	DHBVN	Sabras Village
38.	37450	Sabras	LT Line	DHBVN	Tubewell
39.	38100	Sabras	LT Line	DHBVN	Tubewell
40.	38760	Sabras AP	LT Line	DHBVN	Sabras Village
41.	38900	Kalwadi Feeder	2 Nos. LT Line	DHBVN	Tubewell
42.	39220	Kalwadi AP	HT Line Shifting with Transformer	DHBVN	Kalwari Village
43.	39800	Rathiwas Feeder	HT Crossing 11 KV (UG)	DHBVN	Udaipuri (Pandu ka Mandir)
44.	39900	Kalwadi Feeder	HT Crossing 11 KV (UG)	DHBVN	Udaipuri (Pandu ka Mandir)
45.	40000	Kalwadi Feeder	LT Line	DHBVN	Tubewell
46.	40750	Kalwadi Feeder	HT Line with Transformer	DHBVN	Langra Village
47.	41250	Kalwadi Feeder	LT Line	DHBVN	Langra Village
48.	41830	Kalwadi Feeder	LT Line	DHBVN	Langra Village
49.	42820	Taudu-Rathiwas	HT Crossing 33 KV (UG)	DHBVN	Near Chandladungerwas village
50.	43000	Sohna - Manesar	HT Crossing 33 KV (UG)	DHBVN	Near Chandladungerwas village
51.	42850	Sohna - Manesar	HT crossing 11 KV (UG)	DHBVN	Near Chandladungerwas village
52.	43140	Sohna - Manesar	HT Crossing 11 KV (UG)	DHBVN	Near Chandladungerwas village
53.	43240	Sohna - Manesar	HT Crossing 11 KV (UG)	DHBVN	Near Chandladungerwas village

C23 Section: Type A-Overhead Electrical Crossings: LT and HT (up to 33 KV)					
S. No.	**HORC CH.**	**FEEDER**	**Description**	**Utility Owner**	**Remarks**
54.	43388	Sohna - Manesar	HT Crossing 11 KV (UG)	DHBVN	Near Chandladungerwas village
55.	43625	Sohna - Manesar	HT Crossing 11 KV (UG)	DHBVN	Near Chandladungerwas village
56.	46600	Manesar	HT Crossing 11 KV (UG)	DHBVN	near mandir
57.	47170	Manesar	HT Crossing 11 KV (UG)	DHBVN	village road
58.	47300	Manesar	HT Crossing 11 KV (UG)	DHBVN	village road
59.	48450	Manesar	HT Crossing 11 KV (UG)	DHBVN	Near KMP Toll
From Ch: km 55.60 to km 61.50					
60.	56000	Dhani site	HT Crossing 11 KV (UG)	DHBVN	Near telecom Tower
61.	56170	Dhani site	LT Crossing	DHBVN	Near telecom Tower
62.	56525	Transformer Site	Transformer Shifting	DHBVN	Near Bargad tree
63.	57769	Pig Farm	HT Crossing 11 KV (UG)	DHBVN	College road
64.	58960	Store front Side	HT Crossing 11 KV (UG)	DHBVN	Farukhnagar Road
65.	59060	Store front Side	HT Crossing 11 KV (UG)	DHBVN	Farukhnagar Road
66.	59110	Store Back Side	HT Crossing 11 KV (UG)	DHBVN	Farukhnagar Road
67.	61545	Sultanpur Main Line 1	HT Crossing 11 KV (UG)	DHBVN	Near Farukhnagar line
68.	61555	Sultanpur Main Line 2	HT Crossing 11 KV (UG)	DHBVN	Near Farukhnagar line
69.	61565	Sultanpur Main Line 3	HT Crossing 11 KV (UG)	DHBVN	Near Farukhnagar line
70.	1320	Sultanpur loop Line 1	HT Crossing 11 KV (UG)	DHBVN	Near Store
71.	1760	Sultanpur loop Line 2	HT Crossing 11 KV (UG)	DHBVN	GAIL
72.	2650	Sultanpur loop Line 3	HT Crossing 11 KV (UG)	DHBVN	
73.	3270	Sultanpur loop Line 4	HT Crossing 11 KV (UG)	DHBVN	GAIL
74.	3345	Sultanpur loop Line 5	HT Crossing 11 KV (UG)	DHBVN	GAIL
75.	3630	Sultanpur loop Line 6	HT Crossing 11 KV (UG)	DHBVN	GAIL
76.	2050	Patli To New Patli	HT Crossing 11 KV (UG)	DHBVN	Near Aam Tree

1.1.1 Type A-Overground Electrical Crossings

b) **Overground Electrical Crossings**: EHT (above 33 KV)

C-23 Section: Type A-Overground Electrical Crossings: EHT (above 33 KV)					
S. No.	**Feeder**	**kV**	**Utility Owner**	**HORC CH**	**Remarks**
From Ch: km 56.60 to km 61.50					
1.	Harsaru-Farukhnagar line	66 kV	HVPNL	59+195	EHT Modification work is in progress
2.	Dadri-Samaypur-bahadurgarh line	220 kV	BBMB	59+280	
3.	Dhanonda-Daulatabad line	400 kV	HVPNL	60+210	
4.	Sec 95-Mau line	220 kV	HVPNL	01+860 (Patli - New Patli Connecting Line)	
5.	Agra - Jhatikra Line	765 KV	PGCIL	60+020	Not Required to be modified
6.	Sec-95 - Mau Line	220 KV	HVPNL	2+590	
7.	Agra - Jhatikra Line	765 KV	PGCIL	2+000 (New Patli to Sultanpur connecting Line)	
8.	Dhanonda - Daulatabad Line	400 KV	HVPNL	3+800 (New Patli to Sultanpur connecting Line)	
From Ch: km 29.68 to km 49.70					
9.	Tauru - Mohammadpur Ahil Line	66 KV	HVPNL	33+340	EHT Modification work is in progress
10.	Badshahpur - Rewadi Line	220 KV	HVPNL	41+200	
11.	Manesar - Neemranan Line	400 KV	PGCIL	44+030	
12.	66 KV Panchgaon - Farukhnagar Line on 220 KV Multicircuit Tower	66 KV	HVPNL	44+270	
13.	Agra - Jhatikra Line	765 KV	PGCIL	36+070	Not Required to be modified

4. GEOTECHNICAL(GT) REPORTS

-Black colour shows Tender documents which have not been revised

-Blue colour shows Tender documents which have been revised

-Red colour shows New additional Tender documents

CONTENTS

Geotechnical Investigation Report

Old Ch. 52+518 to Old Ch. 59+270 (New CH: 55+719 to 62+546)

SR NO. : 544_21-22

CONDUCTING GEOTECHNICAL INVESTIGATION, PREPARATION OF GEOTECHNICAL REPORT FOR DESIGNING OF BRIDGES AND FOR EMBANKMENT IN CONNECTION WITH CONSTRUCTION OF HARYANA ORBITAL RAIL CORRIDOR (HORC) PROJECT FROM PALWAL TO HARSANA KALAN INCLUDING CONNECTIVITY TO EXISTING IR NETWORK IN THE STATE OF HARYANA

CLIENT

M/S. HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LTD. (HRIDCL)

PROGRAMME

APRIL - 2022

SR. No.	Report No.	Revision No.	Date
544_21-22	CEGTH/HRIDCL/SR-544/2022-23/808_(48 BHs)	04	07.09.2022
544_21-22	CEGTH/HRIDCL/SR-544/2022-23/262_(44 BHs)	03	05.05.2022
544_21-22	CEGTH/HRIDCL/SR-544/2022-23/97_(44 BHs)	02	18.04.2022
544_21-22	CEGTH/HRIDCL/SR-544/2021-22/1685_(44 BHs)	01	30.03.2022
544_21-22	CEGTH/HRIDCL/SR-544/2021-22/1544_(38 BHs)	00	22.03.2022

CEGTH
CEG TEST HOUSE
AND RESEARCH CENTRE PVT LTD

B-11(G), Malviya Industrial Area, Jaipur-302017
Tel. : 91-141-4046599, Fax : 91-141-2751806
E-mail : info@cegtesthouse.com., www.cegtesthouse.com

CEGTH/HRIDCL/SR-544/2022-23/808 Date:- 07.09.2022

To,

Haryana Rail Infrastructure Development Corporation Ltd. (HRIDCL)
SCO No.-17-19, 3rd & 4th Floor,
Sector - 17-A,
Chandigarh - 160017
Tele:- 0172-2715644
Email: hridc2017@gmail.com

Subject :- Geotechnical investigation work for Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan in the state of Haryana.

Dear Sir,

We are pleased to submit this report of the subject work based on 48 boreholes carried out at Old Ch. 52+518 (New ch. 55+719) to Old ch. 59+270 (New ch. 62+546) for the proposed project site.

The accompanying report presents results of various field tests and laboratory tests conducted on selected soil samples and their interpretation.

Should there be any clarifications regarding the contents please contact us at your most convenient time.

We value the opportunity to participate in this project and look forward a pleasant association on future projects.

Very truly yours,
CEG Test House & Research Centre Pvt. Ltd.

Nehal Jain
General Manager - Geotechnical
Authorized Signatory

Prepared By:-

Ankur Mudgal
Sr. Manager

SR. No.	Report Ref. No.	Revision No.	Date
544_21-22	CEGTH/HRIDCL/SR-544/2022-23/808_(48 BHs)	04	07-09-2022
544_21-22	CEGTH/HRIDCL/SR-544/2022-23/262_(44 BHs)	03	05-05-2022
544_21-22	CEGTH/HRIDCL/SR-544/2022-23/97_(44 BHs)	02	18.04.2022
544_21-22	CEGTH/HRIDCL/SR-544/2021-22/1685_(44 BHs)	01	30.03.2022
544_21-22	CEGTH/HRIDCL/SR-544/2021-22/1544_(38 BHs)	00	22.03.2022

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LIST OF FIGURES / TABLES

CHAPTER 1 GENERAL

1.0 INTRODUCTION:

The work of conducting "**Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana"** was awarded to "**CEG Test House & Research Centre Pvt. Ltd., Jaipur" by M/S.** "**Haryana Rail Infrastructure Development Corporation Ltd. (HRIDCL)"** as per work order no. HRIDC/ HORC/ GT/ CEG/ 237/ 2021/ 577-M dated 29th July 2021.

Field work including drilling of boreholes, conducting field tests such as Electrical Resistivity Test, & Plate Load Test and sample collection was carried out in the presence of representative of Client. Laboratory tests were conducted on selected soil samples to determine the design parameters, confirming to relevant IS specifications and the guidelines received from time to time from representative of Client.

This report includes the details of Methodology of Investigation, collection of samples (soil/ rock), field test results, laboratory test results, analysis of results and recommendations for proposed structure carried out at Old Ch. 52+518 (New ch. 55+719) to Old ch. 59+270 (New ch. 62+546) based on soil sample collected from the locations of 48 boreholess.

2.0 SITE LOCATION & GENERAl GEOLOGICAL HISTORY:

The details of the site & test locations for the proposed project are shown in location plan attached vide **Appendix A-1**. The site of proposed project is located from Palwal to Harsana Kalan (Sonipat) in the State of Haryana falls in seismic zone – IV (Zone factor=0.24) of India.

Soil of the Haryana Sub-Region have been classified and described under the following major soil types as shown below:-

- Typic Ustochrepts : Soil of old alluvial plains
- Typic Ustipsamments : Soil of Aravali plains
- Typic Ustifluvents : Soil of recent alluvial plains and flood plains
- Typic Torripsamments : Soil of Aeofluvial plains
- Rocky Outcrops : Aravali rocky hills

The district wise details of soil characteristics are described below:-

Panipat: The soils are well drained, Sandy loam to clay loam/silty clay loam in plains and loam to clay loam/ silty/ loose clay loam in relic channels/depressions/basins.

Sonipat: The district comprises of recent flood plains, young meander plains, old meander plains and old alluvial plains. Recent flood plains occur along the Yamuna River and clearly show fluvial features. The soils are loamy sand to sandy loam on the surface and sandy loam to clay loam in the sub surface.

Rohtak: The district mainly comprises of old alluvial plains. The soils are loamy sand to sandy loam on the surface and sandy loam to clay loam in the sub surface. Old meander plains are almost flat with loamy sand to silty clay loam soils. Oldest among all the land forms are old alluvial plains, which cover major areas in the district. These soils are sand to loamy sand/sandy loam (surface) to silt loam/silty clay loam (sub-surface).

Jhajjar: The district mainly comprises of old alluvial plains and some parts of the district also have soil belonging to Aravali plains.

Rewari: The soils of the district fall under Entisols and Inceptisols orders. The surface soil texture varies from sand to fine loamy sand.

Gurgaon: The district comprises of sand dunes, sandy plains, alluvial plains, salt affected areas,

low lands, lakes, hills and pediments. The soil varies from sand to loamy sand in sand dunes and sandy plain areas, sandy loam to clay loam / silty clay loam in alluvial plains, calcareous, loamy sand to loam in salt affected plains, silty loam to loam in low lands and calcareous, loamy sand to loam in hills.

Mewat: The soils of the area are generally sandy loam to loam. In parts of the low-lying areas, they are clayey and saline. The upper hills are mostly barren.

Faridabad and Palwal: The district comprises of recent Yamuna flood plains, low lying plains, depressions, sand dunes and hills. The texture of the soil is sand to loamy sand in recent Yamuna flood plains, sandy loam in plains, sandy loam to clay loam in alluvial plains, sandy loam to loam

(surface), clay loam/silty clay (sub-surface) in low lying plains and depressions.

3.0 SCOPE OF WORK:

The stipulated scope of work involved carrying out the following operations:-

a) Mobilisation of necessary plant equipment, men and materials for the complete Geotechnical investigation work as per specifications, drawings and instructions of the Engineer and to complete the same within the stipulated time schedule and demobilisation after completion of field work.

b) Shifting of Equipments from one structure location to another including Ereaction, installation of rigs at site and dismantling of the same after completion of field work. Shifting of setup for each borehole location and associated preparation for borehole under water

c) Making 150 mm nominal diameter boreholes at various locations in all types of soils except hard rock and large boulders using suitable approved method of boring including chiselling, cleaning, providing casing pipe as required; performing Standard Penetration Test at every 3.0m interval and at change of strata; collection of water samples and disturbed soil samples, observation such as ground water, etc., collection of undisturbed soil samples at every 3.0 m interval and at change of strata; transportation of all the collected samples to the laboratory and back filling of boreholes on completion of the same, complete as per specification and instructions of the Engineer, for depths below natural ground level.

d) Conducting Electrical resistivity tests at various locations all complete as per specification and directions of the Engineer.

e) Conducting plate load test at various locations, all complete as per specification and directions of the Engineer.

f) Drilling of Nx size boreholes (75mm dia.) in all types of hard rock, collection of core samples, maintaining continuous record of core recovery/ RQD, keeping the cores in wooden core boxes, transporting to laboratory, backfilling on completion of the same, all complete as per specification and instructions of the EIC.

g) Conducting various laboratory tests on soil samples at an approved laboratory including preparation of soil samples to determine the following properties of soil, all complete as per specification.

<u>On soil Samples</u>

- Dry density test
- Bulk Density and Moisture Content.
- Sieve Analysis
- Hydrometer Analysis
- Liquid Limit and Plastic Limit
- Specific gravity
- Shrinkage Limit

- Free Swell Index
- Direct Shear Test
- Triaxial Shear Test
- One Dimensional consolidation test
- Chemical Analysis of soil samples (pH, chloride, Sulphate)

h) Conducting laboratory tests on rock samples including preparation of the samples to determine the following properties, all complete as per specification

<u>On Rock Samples</u>

- Moisture content, porosity & Density
- Specific gravity
- Hardness
- Unconfined compression test
- Point load strength index
- Modulus of Elasticity and Poission's Ratio
- Abrasion Test

i) Conducting chemical tests on water samples to determine the Sulphate, chloride and pH value all complete as per specification.

j) Submitting draft report in soft copy including all field records and laboratory test results, graphs, etc., all complete as per specifications.

k) Submitting final report in three hard copies in after the approval of the draft report including all field records and laboratory test results, graphs, etc., all complete as per specifications.

4.0 FIELD INVESTIGATION IN SOIL STRATA:

The investigation was planned to obtain the subsurface stratification in the proposed project site and collect soil / rock core samples for laboratory testing to determine the engineering properties such as shear strength, along with basic engineering classification of the subsurface stratum.

For geotechnical investigation work, required equipements along with rotary drilling rigs and manpower were mobilized at site to carry out various field activities as per the scope of work. These were shifted from one test location to another location during execution of field work and were demobilized on satisfactory completion of field work.

For conducting the field investigations the following practices were followed at site:

- The locations of 48 boreholes carried out at Old Ch. 52+518 to ch. 59+270 (New ch. 55+719 to ch. 62+546) were marked at site at specified locations. These locations are shown in **Appendix A-1** attached subsequently.

The details of various boreholes along with their coordinates are provided herein below:

Table 1.1: Details of Borehole Locations

S. No.	Chainage Old	Chainage New	Structure	BH.No.	Depth of Water Table below EGL (m)	Depth of Borehole below EGL (m)	Co-ordinates (m)		(+) R.L. (m)
							E	N	
1.	52+518	55+719	MJB	BH-A1	22.80	40.00	683091.771	3143671.170	213.216
				BH-A2	23.50	40.00	683092.392	3143783.105	220.511
2.	52+934	56+118	MNB	BH-CL	NE	10.00	683069.549	3144133.557	217.658
3.	53+107	56+291	MNB	BH-CL	NE	15.00	683034.675	3144302.971	218.950
4.	53+282	56+466	MNB	BH-CL	NE	10.00	682995.864	3144473.609	218.087
5.	53+572	56+756	MNB	BH-CL	NE	10.00	682931.500	3144756.380	217.532
6.	53+982	57+169	MNB	BH-CL	NE	10.00	682840.528	3145156.160	217.050
7.	54+363	57+547	MNB	BH-CL	NE	10.00	682755.991	3145527.663	216.014
8.	54+496	57+672	MNB	BH-CL	NE	15.00	682726.480	3145657.348	217.393
9.	55+020	58+204	MNB	BH-CL	10.00	13.00	682610.214	3146168.286	215.845
10.	55+044	58+228	Station	BH-PLT-04	NE	12.00	682575.147	3146175.461	215.725
11.	55+910	59+107	MJB	BH-A1	16.00	40.00	682418.856	3147009.213	218.101
				BH-A2	15.60	40.00	682407.318	3147059.917	217.474
12.	56+403	59+587	MNB	BH-CL	NE	10.00	682303.349	3147516.813	215.389
13.	56+701	59+886	MNB	BH-CL	NE	15.00	682237.228	3147807.384	215.273
14.	56+978	60+162	MNB	BH-CL	NE	10.00	682175.767	3148077.480	212.389
15.	57+400	60+603	MJB	BH-A1	10.90	30.00	682111.171	3148361.347	217.941
				BH-P2	11.85	30.00	682104.781	3148389.429	213.893
				BH-P3	11.50	31.00	682101.808	3148402.495	214.414
				BH-P4	11.80	30.00	682098.835	3148415.561	214.498
				BH-P5	12.00	30.00	682095.861	3148428.627	214.548
				BH-P6	11.40	30.00	682092.888	3148441.693	214.417
				BH-P7	11.00	30.00	682089.915	3148454.759	214.599
				BH-P9	12.00	35.00	682083.968	3148480.891	214.330
				BH-P10	11.85	30.00	682080.995	3148493.957	214.021
				BH-P11	11.80	30.00	682078.022	3148507.023	213.946
				BH-P12	12.10	30.00	682075.049	3148520.089	214.402
				BH-P13	12.30	30.00	682072.075	3148533.155	214.579
				BH-P15	11.80	30.00	682066.129	3148559.287	213.460
				BH-P16	11.20	30.00	682063.156	3148572.353	212.949
				BH-P17	10.80	30.00	682060.182	3148585.419	213.184
				BH-P18	10.50	30.00	682057.209	3148598.485	213.517
				BH-P19	11.50	30.00	682054.236	3148611.551	213.504
				BH-A2	10.90	35.00	682050.819	3148626.567	213.090
16.	57+980	61+164	MNB	BH-CL	9.28	10.00	681950.308	3149053.752	213.055
17.	58+191	61+376	MNB	BH-CL	NE	10.00	681895.083	3149257.396	212.823
18.	58+497	61+676	MJB	BH-A1	11.50	40.00	681858.380	3149467.024	213.216
				BH-P1	11.60	40.00	681844.488	3149495.176	214.371
				BH-P2	10.70	40.00	681840.419	3149522.156	213.108
				BH-P3	11.00	40.0	681840.00	3149565.000	214.145
				BH-P4	11.90	40.00	681837.920	3149594.593	214.312

S. No.	Chainage Old	Chainage New	Structure	BH.No.	Depth of Water Table below EGL (m)	Depth of Borehole below EGL (m)	Co-ordinates (m)		(+) R.L. (m)
							E	N	
	58+497	61+676	MJB	BH-P5	12.00	40.00	681834.868	3149620.114	213.726
				BH-P6	11.00	40.00	681836.405	3149645.522	213.711
				BH-A2	12.00	40.00	681833.809	3149673.452	214.044
19.	58+837	62+026	MNB	BH-CL	NE	10.00	681823.952	3149897.982	213.610
20.	59+071	62+256	MNB	BH-CL	NE	10.00	681817.835	3150131.892	213.832
21.	59+206	62+400	MNB	BH-CL	12.65	15.00	681807.000	3150266.000	213.360
22.	59+270	62+546	MNB	BH-CL	NE	10.00	681801.000	3150330.000	212.593

***Not Encountered:-NE**

- In soil, boreholes of 150mm dia. were drilled as per the standard procedure laid in IS: 1892.
- Borehole was properly cleaned before taking any sample in soil.
- Casing was used as per the prevailing soil conditions, to stabilize the borehole.
- Standard Penetration Tests were conducted in bore holes at regular intervals or at every change of strata as per Technical specification.
- Undisturbed were collected wherevery feasible as per the requirements and at specified depths. The same has been discussed in detail in soil characteristics sheets attached with the report.
- Water table was met at depths varying from 10.5m to 23.5m below EGL.

The detailed procedure adopted for conducting various field tests is given here in below:

(i) Standard Penetration Test:

The Standard Penetration Test was conducted in boreholes as per IS 2131. The test was carried out using the standard split spoon sampler to measure the number of blows 'N'.

Standard split spoon sampler was attached to an 'A' rod. It was driven from borehole bottom to a distance of 45 cm using a standard hammer of 63.5 kg falling freely from a height of 75 cm to the required depth. While driving, the number of blows required to penetrate every 15 cm are recorded. The total number of blows required for the last 30 cm is taken as 'N' value at that particular depth of the borehole. Wherever the total penetration was less than 45cm, the no. of blows & the depth penetrated is recorded in the respective borelog.

SPT 'N' values were correlated with relative density of non-cohesive stratum and with consistency of cohesive stratum as given below:-

Table 1.2: Soil compactness as per SPT N values (cl. 9.7, table 9.3 & 9.4, page 330_text book of V.N.S. Murthy)

Correlation for Clay / Plastic silt		Correlation for Sand / Non-Plastic silt	
Consistency	**SPT "N" Value**	**Compactness**	**SPT "N" Value**
Very Soft	0 - 2	Very Loose	0 - 4
Soft	2 - 4	Loose	4 - 10
Medium	4 - 8	Medium	10 - 30
Stiff	8 - 15	Dense	30 - 50
Very Stiff	15 - 30	Very Dense	> 50
Hard	> 30		

The field SPT N values obtained were further corrected as per the guidelines given in IS: 2131 as follows:

(a) For overburden: - The N value for cohesionless soil is corrected with the help of fig. 1 given in IS-2131.

(b) Due to dilatancy :- Wherever N values observed below water table in fine sand, silty sand or silt was greater than 15, then corrected N values were corrected as under:

$$N' = 15 + ½ (N-15)$$

(ii) Undisturbed Sampling (Soil) in boreholes:

Undisturbed samples were collected using MS tubes of suitable diameter and length with Area ratio as per clause 4.1.1 (c) of IS: 1892 (latest) fitted to an adopter with ball and socket arrangement. Before taking any sample, sampling tube was properly greased. Immediately after taking on undisturbed sample in a tube, the adopter head was removed along with the disturbed material. The visible ends of the sample were trimmed off any wet disturbed soil. The ends were coated alternately with four layers of just molten wax. More molten wax was added to give a total thickness of min. 25 mm. The samples were carefully labeled and transported to the laboratory for testing. Undisturbed samples wherever slipped during lifting were duly marked in the field logs as well as in the soil profile.

(iii) Collection of Ground Water Samples from bore holes:

Water table was met at depths varying from 10.5m to 23.5m below EGL.

5.0 LABORATORY TESTS ON SOIL SAMPLES:

The following laboratory tests were conducted on selected soil samples:

Table 1.3: Description of Tests

Description of Test	Reference	Undisturbed (UDS) Soil Samples	Disturbed (DS/SPT) Soil Samples
Grain Size Analysis / Hydrometer	IS: 2720 (Part - 4)	√	√
Natural Moisture Content / Bulk / Dry density	IS : 2720 (Part – 2)	√	-

Description of Test	Reference	Undisturbed (UDS) Soil Samples	Disturbed (DS/SPT) Soil Samples
Atterberg Limits • Liquid Limit • Plastic Limit	IS: 2720 (Part - 5) IS: 2720 (Part - 5)	√ √	√ √
Specific Gravity	IS : 2720 (Part – 3)	√	-
Direct Shear Test	IS : 2720 (Part – 13)	√	-
Triaxial compressive shear test	IS : 2720 (Part – 11 & 12)	√	-
Chemical Analysis of Soil Samples	IS : 2720 (Part – 26, 27)	√	-

Note:- The detailed procedure adopted for conducting various laboratory tests is described in the following paragraphs:

5.1.1 Dry density and Bulk density

For determination of bulk density and dry density, a sample of known volume 'V' was extracted from the undisturbed sampling tube and it's bulk weight 'W' was noted down.Moisture content 'Wn' was determined by oven drying method.

The bulk density and dry density were determined by following equation-

Bulk density (γ_b) = W/V

Dry density (γ_d) = γ_b/ (1+Wn)

5.1.2 Natural water content

For this test, the soil sample of known quantity (Wm) was taken in a container.The container with soil sample was placed into an oven for drying at 105-110°c temperature for 16-24 hours. After drying, the dry sample was again weighted to determine the dry weight of sample (Wd).

The natural water content was computed by the following equation-

Wn = (Wm-Wd)*100/Wd

5.1.3 Grain Size Analysis (IS: 2720- Part-4)

Wet sieve analysis:

For determination of particle sizes finer than 75 micron, wet sieve analysis test was conducted. For this test, oven dried sample of known quantity was taken in a container and soaked with dispersing agent. The soaked soil sample was washed thoroughly over 75 micron IS sieve until the water passing sieve was substantially clean.

Fraction retained on 75 micron IS sieve was carefully collected in a container without any loss in material and placed into oven for drying.

Dry sieve analysis:

For this test, the oven dried soil sample after wet sieving was sieved through the set of IS sieves 20 mm, 10 mm, 4.75 mm, 2.0 mm, 1.0 m , 425 micron , 300 micron, 150 micron and 75micron. The amounts of soil retained on each sieve were noted down. The % retained, cumulative % retained and % passing were computed accordingly. Wherever the soil sample % passing 75 micron sieve was significant, Hydrometer method was used to find the percentage of silt and clay fraction.

Grain size analysis for the fraction passing 75 micron IS Sieve (Hydrometer method)

Calibration of Hydrometer

Hydrometer was calibrated to determine a relationship (an equation) between the effective depth H_R and corresponding hydrometer reading R_h (obtained during test).

50 to 100 gm of soil sample passing through 75 micron IS Sieve was taken. It was mixed with 100 ml of sodium hexametaphesphate solution and the mixture was warmed for about 10 minutes. It was then transferred to the cup of the mechanical mixer and the soil suspension was stirred for 15 minutes. The soil suspension was transferred into 1000 ml measuring cylinder and distilled water was added to make 1000ml solution. This solution was mixed vigorously. The measuring cylinder was then allowed to stand and the stopwatch was started. Hydrometer was immersed in the solution and reading were taken after half, one, two and four minutes. The hydrometer was then removed slowly and kept in distilled water at the same temperature as the soil suspension. Readings were taken after the periods of 8, 15 and 30 minutes, and one, two and four hours. Hydrometer was removed, rinsed and placed in the distilled water after each reading. After 4 hours reading was taken once or twice within 24 hours. Finally a reading was taken at the end of 24 hours. The temperature of the suspension was observed and recorded.

Calculations

Diameter of the particles (D):

$$D = \sqrt{\frac{30\mu}{980(G-1)}} \times \sqrt{\frac{H_R}{t}} = M\sqrt{\frac{H_R}{t}}$$

Where,

D = diameter of particle in suspension, in mm;

μ = co-efficient of viscosity of water at the temperature of the suspension at the time of taking the hydrometer reading, in poise;

G = specific gravity of the soil fraction used in the sedimentations analysis;

H_R = effective depth corresponding to R_n, in cm.

t = time elapsed between the beginning of sedimentation and taking of hydrometer reading in minutes

$M = \sqrt{\frac{30\mu}{980(G-1)}}$ = a constant factor for given values of μ and G at the temperature of the suspension.

Percentage finer than diameter D:

The percentage by mass (w) of particles smaller than corresponding equivalent particle diameters (D) was calculated from the formula:

$$w = \frac{100G_s}{W_b(G_s - 1)} \times R_h$$

Where

w = percentage finer

G_s = specific gravity of soil particle

W_b = weight of soil

R_h = Hydrometer reading

5.1.4 Specific Gravity (IS: 2720-Part-3 Sec-1)

The specific gravity of soil sample was determined by density bottle method. For this test 5-10g oven dried and cooled soil sample was taken in 50ml capacity density bottle and its weight was noted down as W_2 .The soil was covered with distilled water and left for sufficient period for suitable soaking. The entrapped air was removed by vacuum. The bottle with soil was filled fully with water and its weight was noted down (W_3). The mass of empty bottle and bottle filled with distilled water were noted down as W_1 and W_4 respectively.

The Specific Gravity was determined by using following equation :

$G=W_2-W_1/[(W_2-W_1)-(W_3-W_4)]$

5.1.5 Liquid Limit (IS: 2720- Part-5)

By Cone Penetrometer Method

The 'Cone Penetrometer Apparatus' is a variant of the fall-cone and consists of a cone with a smooth polished surface and angle of 30° ± 1/2°. The weight of the cone, together with its associated shaft is 80g ± 0.5g. A support assembly with an automatic cone release mechanism and cone height adjustment mechanism used to hold the cone vertically. The angle and weight of the cone were calibrated at regular intervals, and the sharpness of the cone tip was checked daily.

Distilled water was added and thoroughly mixed with the soil sample to produce a homogeneous paste. The paste was then placed in a cup with a diameter of at least 55mm and a depth of at least 40mm. The surface of the soil was smoothed off level and parallel to the base. The support assembly was used to position the tip of the cone so that it was just touching the top surface of the soil, and the automatic tripping mechanism was released. The cone was allowed to penetrate into the soil for a period of 5 (± 1) s, then the cone was locked off to stop further movement and the penetration was recorded. The cup was refilled and the test was repeated. The two recorded penetrations need to be within 0.5mm of each other, otherwise a third test is performed. when the three test vary by more than 1mm the test was repeated.

Further tests were conducted, at varying water contents, in order to produce a series of cone penetrations (usually 4) in the range 15mm to 25mm. The resulting cone penetrations were plotted verses the water content of the test specimens. The Liquid Limit (W_L) was read off the graph, being the water content at which the line of best fit through the test points crosses 20mm penetration.

5.1.6 Plastic Limit (IS: 2720-Part-5)

For this test, soil sample was prepared in the same way as for liquid limit test. A ball of soil sample weighed about 5 gm was formed. The ball was rolled between the fingers of one hand and the glass plate with pressure sufficient to reduce the mass into a thread of about 3 mm in 5 to 10 complete forward and back movements. When a diameter of 3 mm was reached, soil was again remolded into a ball. The process of rolling and remolding was repeated until the thread started just crumbing at a diameter of 3 mm. The crumbled thread was immediately transferred to an airtight container for determination of its moisture content by oven drying method.

This water content has been termed as plastic limit. (W_P)

5.1.7 Plasticity Index (IS: 2720-Part-5)

The plasticity index Ip was given by

$I_p=W_L-W_P$ (in percent)

5.1.8 Direct Shear Test (IS:2720-Part-13):

For this test shear box test apparatus was used. The prepared specimen from remolded/undisturbed sample was placed carefully in the box. The plain grid was kept on top of the specimen with its directions at right angles to the direction of shear. The upper porous stone was placed on the grid and loading pad on the stone. The box with specimen was gently placed in the container (water jacket). The specimen was submerged with water. The container was mounted with the shear box and the specimen inside, on the shearing machine. The upper part of the box was so adjusted that it

touchéd the proving ring. The jack was brought forward to bear up against the box container. The proving ring dial gauge was set to read zero.

The steel ball was placed in the recess of the loading pad. The loading yoke was set in contact with the steel ball on the loading pad. Vertical displacement dial gauge to read zero in contact with the top of the yoke. The normal load was applied and any change in thickness of specimen was recorded. Shear displacement dial gauge was also set to read zero. The locking screw was now removed and two parts of the shear box were separated by advancing the spacing screws.

The specimen was sheared at constant rate of strain. The readings of the proving ring dial gauge were noted down every 15 seconds for the first one-minute and then every 30 seconds thereafter. The reading of change in the thickness dial gauge and shear displacement dial gauge were also recorded at the same time interval. The test was continued until the specimen fails. The specimen was assumed to fail when the proving ring dial gauge started receding or at shear displacement of approximately 15% of the length took place.

The soil was removed from the box and test was repeated on the identical specimen under increased normal load.

The rate of strain for conducting Direct Shear Test is kept as 0.25 mm/min as per codal/literature provision based on strata.

5.1.9 Triaxial Shear Test_UUT (IS: 2720-Part-11)

For this test, Triaxial Shear Test apparatus was used. The plain disc was placed on the pedestal of the triaxial cell. The specimen was placed centrally on the disc. A correct size rubber membrane was fitted inside the stretcher with ends of membrane folded over those of the stretcher. Vacuum was applied to stretch the membrane to the inside surface of the stretcher which was carefully slipped around the specimen kept on the pedestal. The vacuum on the membrane was released. Its bottom part was rolled down into the pedestal. plain disc was placed on the top of the specimen and then loading pad was placed. The top part of membrane was rolled on to the loading pad. Then the stretcher was removed and ends were sealed with ‘O’ rings. With the properly sealed specimen placed centrally on the pedestal, the cell was assembled, keeping the loading piston initially clear of the loading pad of the specimen, the assembly was placed in the loading frame.

For unconsolidated undrained test, the bottom drainage value (BDV) and top drainage value (TDV) of cell, was closed and air release valve (ARV) was opened. The cell was filled with water through the cell water value CWV. ARV was closed when water begins to escape through it. The cell pressure was raised to the desired value and kept constant till the end of the test.

When the cell pressure was applied, the load piston rises upward, the loading machine was operated at the anticipated rate to bring the load piston slightly above the loading pad of the specimen and the load measuring dial gauge on proving ring was set to zero.

The piston was brought just in contact with loading pad by hand operation of the machine. The

axial compression dial gauge was mounted and set to read zero.

The axial loading was started at 1.25 mm/min rate of strain. Simultaneous readings on the load and compression dial gauges were noted down. The test was continued until a recession of the axial load is observed or 20% of strain.

After failure, the specimen was unloaded by reversing the loading machine, cell pressure was reduced and cell water was drained out through BRV. The cell was dismantled and the specimen was taken out, rubber membrane was removed and weight of the failed sample and its water content was determined. The test was repeated on two more identical specimens with increasing cell pressure.

The rate of strain for conducting UUT is kept as 1.25 mm/min as per codal/literature provision based on strata.

5.1.10 Chemical Testing

Chemical Testing was generally performed in accordance with IS: 2720, but the different parts of method as described below:

a) Total Sulphate Content Of Soil

Samples were tested according to IS 2720 (Part 27). The dried soil was extracted with a 10% solution of hydrochloric acid. The extract was adjusted to slightly alkaline pH with ammonia, and then barium chloride solution was added to precipitate the sulphate. The barium sulphate precipitate was collected by filtration, and it was washed, dried and weighed. The mass of barium sulphate recovered was used to calculate the sulphate content of the original soil.

b) pH Value

Samples were tested according to IS: 2720 (Part 26). The soil sample (30 ± 0.1g) was extracted with 75 ml of distilled water and the pH of the resulting suspension was measured with a calibrated (by means of Standard buffer solution) pH meter.

c) Chloride Content

For the water soluble content, soil samples were extracted with a volume of water equal to twice the mass of the soil. The extract was filtered and acidified with a small amount of nitric acid. Standardized silver nitrate solution was then added to precipitate the chloride as its silver salt. The amount of precipitated silver remaining in solution was then determined by titration.

An acid-soluble version of the test was also available, with the initial extraction being with nitric acid instead of water.

CHAPTER 2 ANALYSIS OF TEST RESULTS AND INTERPRETATION

6.0 STRATIFICATION

From the study of the 47 boreholes carried out at Old Ch. 52+518 (New Ch.55+719) to Old ch. 592+70 (New ch. 62+546), it is revealed that:-

At location of O.C. 52+518 & N.C. 55+719 :-

The sub strata mainly consist of sandy silt of low plasticity (ML-CL)/ silty Clay of low plasticity (CL).

At location of Old Ch:- 52+934 New Ch:- 56+118

The sub strata of BH A2 mainly consist of Silty sand (SM)/Silty Clay of low plasticity (CL).

At location of O.C. 53+107 & N.C. 56+291:-

The sub strata mainly consist of sandy silt of low plasticity (ML-CL)/ silty Clay of low plasticity (CL).

At location of O.C. 53+282 & N.C. :-56+466

The sub strata mainly consist of sandy silt of low plasticity (ML-CL)/ silty Clay of low plasticity (CL).

At location of O.C. 53+572 & N.C. :-56+756

The sub strata mainly consist of Silty Clay of low plasticity (CL).

At location of O.C. 53+982 & N.C. :-57+169

The sub strata mainly consist of sandy silt of low plasticity (ML-CL)/ silty Clay of low plasticity (CL).

At location of O.C. 54+363 & N.C. :-57+547

The sub strata mainly consist of sandy silt of low plasticity (ML-CL)/ silty Clay of low plasticity (CL)/Clayey sand (SM-SC).

At location of O.C. 54+496 & N.C. :-57+672

The sub strata mainly consist of sandy silt of low plasticity (ML-CL)/ silty Clay of low plasticity (CL).

At location of O.C. 55+020 & N.C. :-58+204

The sub strata mainly consist of silty Clay of low plasticity (CL)/Clayey sand (SM-SC).

At location of O.C. 55+044 & N.C. :-58+228

The sub strata mainly consist of sandy silt of low plasticity (ML-CL)/ Silty Clay of low plasticity (CL).

At location of O.C. 55+910 & N.C. 59+107 :-

The sub strata mainly consist of sandy silt of low plasticity (ML-CL)/ silty Clay of low plasticity (CL)/Silty sand (SM).

At location of O.C. 56+403 & N.C. 59+587:-

The sub strata mainly consist of sandy silt of low plasticity (ML-CL)/ silty Clay of low plasticity (CL)/Silty sand (SM).

At location of O.C. 56+701 & N.C. 59+886:-

The sub strata mainly consist of sandy silt of low plasticity (ML-CL)/ silty Clay of low plasticity (CL)/Silty sand (SM).

At location of O.C. 56+978 & N.C. :-60+162

The sub strata mainly consist of sandy silt of low plasticity (ML-CL)/ silty Clay of low plasticity (CL)/Clayey sand (SM-SC).

At location of O.C. 57+400 & N.C. 60+603:-

The sub strata mainly consist of sandy silt of low plasticity (ML-CL)/ silty Clay of low plasticity (CL)/Silty sand (SM).

At location of O.C. 57+980 & N.C. 61+164:-

The sub strata mainly consist of silty Clay of low plasticity (CL)/ silty Clay of Medium plasticity (CI).

At location of O.C. 58+191 & N.C. 61+376:-

The sub strata mainly consist of sandy silt of low plasticity (ML-CL)/ silty Clay of low plasticity (CL).

At location of O.C. 58+497 & N.C. 61+676:-

The sub strata mainly consist of sandy silt of low plasticity (ML-CL)/ silty Clay of low plasticity (CL)/Clayey sand (SM-SC).

At location of O.C. 58+837 & N.C. 62+026:-

The sub strata mainly consist of sandy silt of low plasticity (ML-CL)/ Silty sand (SM).

At location of O.C. 59+071 & N.C. 62+256:-

The sub strata mainly consist of sandy silt of low plasticity (ML-CL).

At location of O.C. 59+206 & N.C. 62+400:-

The sub strata mainly consist of sandy silt of low plasticity (ML-CL).

At location of O.C. 59+270 & N.C. 62+546:-

The sub strata mainly consist of sandy silt of low plasticity (ML-CL).

6.1 GROUND WATER TABLE DEPTH

The Ground Water Table was met at depths varying from 9.28 m to 23.5m below EGL, it may rise up during heavy rains / rainy season. Therefore, for the analysis of various foundations, the water table has been considered to rise by about 3.0m at the locations of boreholes, however at the locations of 13 BHs water table was not encountered, for the analysis of foundation the water table has been considered well below the depth of influence zone.

6.2 RESULTS OF CHEMICAL ANALYSIS

Results of chemical analysis of soil samples (as per **Appendix – B2**) indicates that the soil sample falls under Class I for sulphates and chlorides concentration (As per IS 456-2000 and CIRIA Sp. Publication No. 31). The results are summarized here in below :-

Summary of chemical analysis of soil samples

Chemical Property	Findings (Min. to Max.)	Remarks (Required limits as per IS 456-2000)
pH	8.06 to 9.87	> 6.0
Sulphite as SO_3^{2-} (%)	0.0017 (%) to 0.0025 (%)	< 0.2% (Class I)
Chlorides as Cl^- (%)	0.0055 (%) to 0.0097 (%)	No limit specified in IS 456. However, a limit of 0.10% specified for class I in CIRIA Sp. Publication No. 31)

Note :- All the chemical contents are within permissible limit hence no special precautions are required.

6.3 COMPUTATION OF LIQUEFACTION POTENTIAL

Liquefaction is the sudden loss of shear strength of the sub soil strata due to earthquake-induced vibration under saturated conditions.

Assessment of liquefaction potential of foundation strata is made by simplified approach proposed as per IS: 1893 (Part-1)-2016, from the SPT data and peak ground acceleration likely to occur at the site. In this method, cyclic shear stress likely to be induced in the foundation strata by Design Basis Earthquake (DBE) is first evaluated.

Next threshold cyclic shear stress, which is good enough to cause liquefaction, is determined from SPT data and the empirical relations. Finally, comparison of these two stresses is used in the estimation of liquefaction susceptibility of the foundation strata.

Unsaturated soils are not subjected to liquefaction because vibratory forces from earthquakes do not cause any increase in pore water pressure in such soils.

The area of site from Palwal to Harsana Kalan (Sonipat) in the State of Haryana falls in seismic zone – IV of India as per IS: 1893. Further as per the provisions of IS: 1893 in soil deposits consisting of submerged loose sands & soils falling under classification of SP with standard penetration N value less than 15, the shaking caused by earthquake ground motion may cause liquefaction or excessive total and differential settlements.

For the analysis of liquefaction potential, following constant parameters are considered:

EQ Zone	IV
Earthquake Magnitude (Mw)	7.0
Peak Horizontal Ground Acceleration (amax /g)	0.24

The ground water table was encountered at depths varying from 9.28 m to 23.50m below EGL at 33 boreholes locations and not encountered at 14 borehole locations. For the analysis of liquefaction potential, the water table has been considered to rise by about 3.0m at the location of all boreholes. Since, water table is either very deep or not encountered, the boreholes are not likely to liquefy, as tabulated below below:-

Table 2.1: Liquefaction Analysis

S. No.	Chainage Old	Chainage New	Structure	BH.No.	Depth of Water Table below EGL (m)	Water Table Depth considered for analysis below EGL (m)	Liquefiable Depth (m)
1.	52+518	55+719	MJB	BH-A1	22.80	19.80	Non-Liquefiable
				BH-A2	23.50	20.50	Non-Liquefiable
2.	52+934	56+118	MNB	BH-CL	NE	-	Non-Liquefiable
3.	53+107	56+291	MNB	BH-CL	NE	-	Non-Liquefiable
4.	53+282	56+466	MNB	BH-CL	NE	-	Non-Liquefiable
5.	53+572	56+756	MNB	BH-CL	NE	-	Non-Liquefiable
6.	53+982	57+169	MNB	BH-CL	NE	-	Non-Liquefiable
7.	54+363	57+547	MNB	BH-CL	NE	-	Non-Liquefiable
8.	54+496	57+672	MNB	BH-CL	NE	-	Non-Liquefiable
9.	55+020	58+204	MNB	BH-CL	10.00	-	Non-Liquefiable
10.	55+044	58+228	Station	BH-PLT-04	NE	-	Non-Liquefiable
11.	55+910	59+107	MJB	BH-A1	16.00	13.00	Non-Liquefiable
				BH-A2	15.60	12.60	Non-Liquefiable
12.	56+403	59+587	MNB	BH-CL	NE	-	Non-Liquefiable
13.	56+701	59+886	MNB	BH-CL	NE	-	Non-Liquefiable
14.	56+978	60+162	MNB	BH-CL	NE	-	Non-Liquefiable
15.	57+400	60+603	MJB	BH-A1	10.90	7.90	Non-Liquefiable
				BH-P2	11.85	8.85	Non-Liquefiable
				BH-P3	11.50	8.50	Non-Liquefiable
				BH-P4	11.80	8.80	Non-Liquefiable
				BH-P5	12.00	9.00	Non-Liquefiable
				BH-P6	11.40	8.40	Non-Liquefiable
				BH-P7	11.00	8.00	Non-Liquefiable
				BH-P9	12.00	9.00	Non-Liquefiable
				BH-P10	11.85	8.85	Non-Liquefiable
				BH-P11	11.80	8.80	Non-Liquefiable
				BH-P12	12.10	9.10	Non-Liquefiable
				BH-P13	12.30	9.30	Non-Liquefiable
				BH-P15	11.80	8.80	Non-Liquefiable
				BH-P16	11.20	8.20	Non-Liquefiable
				BH-P17	10.80	7.80	Non-Liquefiable
				BH-P18	10.50	7.50	Non-Liquefiable
				BH-P19	11.50	8.50	Non-Liquefiable
				BH-A2	10.90	7.90	Non-Liquefiable

S. No.	Chainage Old	Chainage New	Structure	BH.No.	Depth of Water Table below EGL (m)	Water Table Depth considered for analysis below EGL (m)	Liquefiable Depth (m)
16.	57+980	61+164	MNB	BH-CL	9.28	-	Non-Liquefiable
17.	58+191	61+376	MNB	BH-CL	NE	-	Non-Liquefiable
18.	58+497	61+676	MJB	BH-A1	11.50	8.60	Non-Liquefiable
				BH-P1	11.60	8.60	Non-Liquefiable
				BH-P2	10.70	7.70	Non-Liquefiable
				BH-P3	11.00	8.00	Non-Liquefiable
				BH-P4	11.90	8.90	Non-Liquefiable
				BH-P5	12.00	9.00	Non-Liquefiable
				BH-P6	11.00	8.00	Non-Liquefiable
				BH-A2	12.00	9.00	Non-Liquefiable
19.	58+837	62+026	MNB	BH-CL	NE	-	Non-Liquefiable
20.	59+071	62+256	MNB	BH-CL	NE	-	Non-Liquefiable
21.	59+206	62+400	MNB	BH-CL	12.65	9.65	Non-Liquefiable
22.	59+270	62+546	MNB	BH-CL	NE	-	Non-Liquefiable

***Not Encountered:-NE**

Note: To identitfy the Soil sheet, Shear curves and Log profiles, old chainages of respective bore holes are mentioned.

6.4 INTERPRETATION OF LAB TEST RESULTS

Grain Size Analysis

- **Clay content:** It generally varies from 4 to 14%.
- **Silt content:** It generally varies from 15 to 59%.
- **Sand content:** It generally varies from 23 to 85%.
- **Gravel content:** It generally varies from 1 to 12%.

Atterberg's Limit

- **Liquid limit:** The test results of liquid limit of the soil samples reveal that it generally varies from 26 to 28% in ML-CL type of soil, 30 to 34% in CL type of soil.
- **Plastic Limit*:*** The plastic limit of the soil sample varies from 19 to 21% in ML-CL type of soil, 20 to 23% in CL type of soil. However ML-CL type of soil is considered as non-plastic.
- **Plasticity index*:*** The plasticity index of the soil samples generally varies from 6 to 7% in ML-CL type of soil, 10 to 11% in CL type of soil whereas ML-CL and SM/ SM-SC/ SC type of soil are non-plastic.

Natural moisture content & Bulk density

The bulk density of soil samples generally varies from 1.63gm/cc to 1.97gm/cc whereas natural moisture content varies from 10.21% to 18.26%.

Direct shear tests:

Direct shear test under drained condition have been conducted in sandy silty (ML-CL) / sandy stratum (SM/ SM-SC/ SC) type of soil.

For Sandy strata (SM/ SM-SC/ SC), the value of angle of internal friction varies from 25^{o} to 32^{o}, whereas cohesion varies from 0.00 kg/cm^2 to 0.11 kg/cm^2.

For Silty strata (ML-CL), the value of angle of internal friction varies from 22^{o} to 27^{o}, whereas cohesion varies from 0.19 kg/cm^2 to 0.22 kg/cm^2.

Triaxial shear tests:

Triaxial shear test under undrained condition have been conducted in silty clay (CL) type of soil.

For silty clay (CL) strata, the value of angle of internal friction varies from 4^{o} to 5^{o}, whereas cohesion varies from 1.42kg/cm^2 to 2.24kg/cm^2.

CHAPTER 3 TYPE AND DEPTH OF FOUNDATION WITH ANALYSIS

7.0 TYPE & DEPTH OF FOUNDATION:

Based on the nature & strength characteristics of the substrata and requirement of the project, the following type of foundation have been analyzed as given below:

Table 3.1 : Shallow Foundation

Type of foundation	Depth of Foundation below E.G.L. (m)	Size of Foundation (m x m)
Shallow Foundation	1.0,1.5,2.0	6.2 X 6.2 3.7 X 3.7 4.9 X 4.9 4.7 X 4.7 11.35 X 11.35 2.7 X 2.7 3.7 X 3.7 4.7 X 4.7 2.7 X 2.7
	2.0, 3.0, 4.0	7.2 X 7.2

Table 3.2 : Pile Foundation

Type of foundation	Length of Pile below E.G.L. (m)	Dia. of Pile (m)
Normal Bored Cast in-situ RCC Pile	16.0, 18.0, 20.0, 22.0, 24.0, 26.0, 28.0	1.0 & 1.2

The details of foundation analysis are given in the subsequent paragraph.

7.1 Analysis of SHALLOW foundation

7.1.1 From Shear Failure Criteria

Net Safe Bearing capacity from Shear Failure consideration has been computed in accordance with IS: 6403-1981, which is based on, modified Terzaghi's classical approach. The weighted average of shear strength parameters for various strata upto depth equal to 0.5*B*Tan (45+Ø/2) (where B = Width of the Foundation, Ø = Angle of internal friction) is used in the analysis. A factor of safety of 2.5 to estimate the net safe bearing capacity from ultimate net bearing capacity.

For soils, containing both coarse grained (gravels & sands) and fine grained (clays), c and Φ are used to determine the soil strength. In case of predominantly fine grained soils, c and Φ are determined by the Triaxial Compression test as per IS: 2720 pt XI. For predominantly coarse grained soils, c and Φ are determined by Direct Shear test as per IS: 2720 pt XIII. These c and Φ values were used for determining the SBC of soil as per shear failure criteria.

The ultimate net bearing capacity in case of general shear failure is given by following expression,

$q_d = c\, N_c\, s_c\, d_c\, i_c + q\,(N_q\text{-}1)\, s_q\, d_q\, i_q + (1/2)\, B\, \gamma\, N_\gamma\, s_\gamma\, d_\gamma\, i_\gamma\, W'$

The ultimate net bearing capacity in case of local shear failure is given by following expression,

$q'_d = (2/3)\, c\, N'_c\, s_c\, d_c\, i_c + q\,(N'_q\text{-}1)\, s_q\, d_q\, i_q + (1/2)\, B\, \gamma\, N'_\gamma\, s_\gamma\, d_\gamma\, i_\gamma\, W'$

Where,

$d_c = 1 + 0.2\,(D_f/B)*SQRT(N_\phi)$

$d_q = d_\gamma = 1$ for $\phi < 10^o$

$d_q = d_\gamma = 1 + 0.1\,(D_f/B)*SQRT(N_\phi)$ for $\phi > 10^o$

$N_\phi = \tan^2(\pi/4 + \phi/2)$

ϕ' for local shear failure $= \tan^{-1}(0.67 \tan\phi)$

7.1.2 From Settlement Failure Criteria

Allowable Bearing Pressure from Settlement Failure consideration has been computed in accordance with IS: 8009 (Part-I). The magnitude of settlement, when foundation loads are applied, depends upon the compressibility of the underlying strata and rigidity of the substructure.

The total permissible settlement in cohesion-less soil is estimated using SPT value as per IS: 8009 (Part-I). While using this approach, the N value was corrected, wherever applicable, below the footing base to at least 1.5B below the base to account for the effects of energy ratio, adopted bearing pressure, dilation for submerged silty fine sands / fine sands as well as that due to the overburden pressure.

Further for settlement Calculation in cohesive soil the following equation has been used.

$S_t = \Delta P\, M_v\, H$

Where,

M_v = Coefficient of volume compressibility, cm^2/kg

ΔP = Pressure increment, kg/cm^2

H = Thickness of layers

Note: - Value of Coefficient of volume compressibility (Mv) has been calculated by using the following co-relation [Ref. Stroud and Butler, 1975] :-

Coefficient of Volume Compressibility derived from SPT N-Value (after Stroud and Butler, 1975)

Plasticity Index (%)	Conversion Factor (f_2)	m_v (10^{-3} kPa^{-1}) based on N-Value: $m_v = 1/(f_2 N)$				
		N=10	N=20	N=30	N=40	N=50
10	800	0.12	0.06	0.04	0.03	0.02
20	525	0.19	0.09	0.06	0.05	0.04
30	475	0.21	0.10	0.07	0.05	0.04
40	450	0.22	0.11	0.07	0.06	0.04

$Mv = 1/(f_2 N_{corr.})$

Where f_2 = factor based on $N_{corr.}$ Value & plasticity index of soil

$N_{corr.}$ = corrected SPT 'N' value

For analysis of shallow foundation the total permissible settlement has been considered as 25mm, & 50mm as per IS 1904.

Zone of influence below foundation has been considered up to 1.5 times the width of the foundation.

For the determination of the SBC from settlement criteria, the corrected SPT N values within the influence zone are given in the table below.

NOTE:-

- Lower of the two values obtained from settlement and shear criteria is used in arriving at allowable bearing capacity of the soil.
- Structural foundations are designed based on the minimum of Safe Bearing Capacity obtained from Shear Failure Criteria and Allowable Bearing Pressure corresponding to the permissible settlement. The permissible Settlement that can be allowed for the foundation depends on the strata at the location and type of foundation (whether Isolated or Raft).
  Settlement occurs with the application of loads on foundations. It has two components, Immediate Settlement and Long Term Settlement. The immediate settlement takes place immediately as the loading is imposed on the structure and long term settlement arises due to the consolidation of the sub-soil with time under the load. Hence, the total settlement allowed for a foundation is the sum of the immediate and consolidation settlement that is expected to occur. The cohesionless strata (predominantly sandy) is primarily subjected to immediate settlement and cohesive strata (clayey) undergoes settlement in long time with the compression of the strata due to consolidation. Settlement of the foundation is determined from the relation provided in Indian standards (IS: 8009 (part-1) &/or various literatures (Bowles, BM Das, etc.).

  From the Geotechnical investigation conducted on our site along with subsequent laboratory tests on soil samples, it is observed that predominantly the strata is silty with sand (SM/SC/SM-SC/ML-CL i.e. predominantly cohesionless) with the presence of small patches of silty clay of low plasticity (CL). Since the Settlement that takes place in cohesionless strata is mostly immediate, it takes place immediately after the imposing of load, initially during construction with the application of Dead Load and further during Live Load. The live load usually is many times lesser than the dead load, and correspondingly the post construction settlement is very less for live loads. As an example, if dead load is three times that of live load, then the settlement corresponding to

live load (i.e. the post construction settlement) will be one-third of the settlement due to dead load which is comparatively lesser than 25mm for permissible settlement of 50mm.

According to the IS 1904, the permissible settlement for concrete structure having raft foundation is allowed upto 75mm, and the permissible settlement is 25mm post construction as per IRS code (Code of Practice for The Design of Sub-Structures and Foundations of Bridges). As discussed above, the settlement post construction is directly proportional to the allowable settlement. Therefore, given the importance of structure to be constructed and considering mostly cohesionless strata encountered at site, it is recommended that the maximum permissible settlement shall be restricted to 50mm for the design purpose on conservative side so that the post construction settlement can be constraint to lesser than 25mm.

As per IS- 8009 part 1 clause 9.2.2.1, If the clay layer is sandwitched between cohesionless soil layers, the immediate settlement is zero. Hence, even though the immediate settlement has been calculated during analysis, however it is ignored in the calculation of total settlement.

The sample calculations for computation of allowable bearing capacity of sub-strata for shallow foundation vide **Appendix – C-1.**

7.2 Analysis of PILE foundation

(A) Deep foundation

The safe Load Carrying Capacity of normal bored cast in-situ RCC pile is determined in compression, uplift and lateral as per IS: 2911 (Part-1/sec-2) – 2010. The axial capacity of a pile depends upon the soil skin friction along the shaft and end bearing at it's tip.

Thus Axial load = Skin Friction + End-bearing

a) For piles in granular soils (using the static formula)

$$\mathbf{Q_u = (0.5*D*\gamma*N_\gamma + P_D*N_q)*A_p + (\Sigma K_i*P_{Di}*\tan\delta_i)*A_{si}}$$

Where,

Q_u = Ultimate load capacity of pile in KN

D = dia. of pile shaft in m

γ = effective unit weight of the soil at pile tip in kN/m^3

N_γ & N_q = bearing capacity factors depending upon the angle of internal friction Φ at pile tip (N_γ from IS 6403 for general shear failure case & N_q from Fig. 1, IS 2911)

P_D = effective overburden pressure at pile tip in kN/m^2 limited to 15-17 times diameter of pile (as per the Phi value at end bearing)

Σ = Summation for layers (1 to n) in which pile is installed and which contribute to (+ve) skin friction

K_i = coefficient of earth pressure applicable for the i^{th} layer

P_{Di} = effective overburden pressure for the i^{th} layer in kN/m^2 limited to 15-17 times diameter of pile (as per the Phi value at end bearing)

δ_i = angle of wall friction between pile and soil for i^{th} layer, and

A_{si} = surface area of pile shaft in the i^{th} layer in m^2

b) For piles in cohesive soils (using the static formula)

$$\mathbf{Q_u = cp*Nc*A_p + \Sigma\alpha_i*c_i*A_{si}}$$

Where,

Q_u = Ultimate load capacity of pile in KN

A_p = cross-sectional area of pile tip in m^2

N_c = bearing capacity factor (= 9)

Σ = Summation for layers (1 to n) in which pile is installed and which contribute to (+ve) skin friction

α_i = adhesion factor for the i^{th} layer depending on the consistency of soil

c_i = average cohesion for i^{th} layer in kN/m^2

A_{si} = surface area for pile shaft in the i^{th} layer in m^2

c) For computation of safe load carrying capacity of pile in lateral, the following equation has been used:

i. <u>Fixed Head Condition</u>

$$\mathbf{Q = (12 * E * I * Y) / (L_1 + L_f)^3}$$

ii. <u>Free Head Condition</u>

$$\mathbf{Q = (3 * E * I * Y) / (L_1 + L_f)^3}$$

Where,

Q = Lateral Load (in kg)

Y = Permissible lateral deflection taken as 5mm

E = Modulus of Elasticity of concrete

I = Moment of Inertia of the pile cross-section

L_1 = Length of pile above cut-off level

L_f = Length of fixity

The effective length of the pile has been considered below the cut-off level taken as 2.0m below the EGL. Normal Bored cast in-situ RCC piles having stem diameter equal to 100cm & 120cm and of effective length varying from 16.0m to 28.0m were selected.

For the analysis of the pile foundations the soil parameters used for computation of safe load carrying capacity of pile is tabulated below:-

Table 3.3 : Design Soil Parameter

Chainage Old & New	Chainage New	BH Ref.	Layer depth below EGL (m)		Thickness of strata (m)	Strata description	SPT 'N'		Bulk Density (gm/cc)	Cohesion (C) (kg/cm^2)	Angle of internal Friction (Φ) (°)
			From	To			Observed	Corrected			
52+518	55+719	BH-A1	0.00	4.00	4.00	Sandy Silt	12	15	1.70	0.20	29
			4.00	7.00	3.00	Sandy Silt	22	22	1.76	0.21	29
			7.00	11.50	4.50	Silty Clay	36	36	1.85	1.22	4
			11.50	16.00	4.50	Sandy Silt	44	32	1.86	0.21	30
			16.00	40.00	24.00	Sandy Silt	83	34	1.92	0.15	30
		BH-A2	0.00	5.50	5.50	Sandy Silt	13	17	1.72	0.19	29
			5.50	13.00	7.50	Silty Clay	24	24	1.78	0.74	5
			13.00	16.00	3.00	Silty Clay	39	39	1.85	1.12	4
			16.00	25.00	9.00	Sandy Silt	59	34	1.87	0.21	30
			25.00	34.00	9.00	Sandy Silt	43	18	1.84	0.23	29
			34.00	40.00	6.00	Sandy Silt	75	25	1.89	0.17	30
52+934	56+118	BH-CL	0.00	5.25	5.25	Silty Sand	19	23	1.77	0.09	28
			5.25	8.25	3.00	Silty Clay	21	21	1.92	0.81	6
			8.25	10.00	1.75	Silty Clay	-	-	1.94	0.98	7
53+282	56+466	BH-CL	0.00	5.25	5.25	Sandy Silt	14	19	1.74	0.20	28
			5.25	8.25	3.00	Silty Clay	32	32	1.89	1.02	5
			8.25	10.00	1.75	Silty Clay	25	25	1.90	1.02	5
53+572	56+756	BH-CL	0.00	3.00	3.00	Silty Clay	9	9	1.68	0.26	5
			3.00	8.25	5.25	Silty Clay	32	32	1.91	1.09	4
			8.25	10.00	1.75	Silty Clay	47	47	1.97	1.65	4
53+982	57+169	BH-CL	0.00	2.25	2.25	Silty Clay	8	8	-	-	-
			2.25	5.25	3.00	Silty Clay	22	22	1.89	0.39	5
			5.25	7.50	2.25	Silty Clay	24	24	1.97	0.85	4
			7.50	10.00	2.50	Sandy Silt	32	25	1.90	0.20	28
54+363	57+547	BH-CL	0.00	5.25	5.25	Silty Sand	21	27	1.82	0.11	30
			5.25	8.25	3.00	Silty Clay	33	33	1.99	1.09	4
			8.25	10.00	1.75	Sandy Silt	38	28	1.90	0.20	30
54+496	57+672	BH-CL	0.00	5.25	5.25	Sandy Silt	15	19	1.79	0.21	28
			5.25	8.25	3.00	Silty Clay	32	32	1.98	1.09	5
			8.25	11.25	3.00	Silty Clay	37	37	1.99	1.26	4
			11.25	15.00	3.75	Silty Clay	44	44	2.00	1.42	4
55+020	58+204	BH-CL	0.00	5.25	5.25	Silty Sand	14	17	1.75	0.09	30
			5.25	7.50	2.25	Silty Sand	20	20	1.76	0.00	31
			7.50	13.00	5.50	Silty Clay	23	22	1.95	0.85	8
55+044	58+228	BH-PLT-04	0.00	2.25	2.25	Silty Sand	7	10	1.63	0.00	29
			2.25	4.50	2.25	Sandy Silt	16	20	1.75	0.18	27
			4.50	7.50	3.00	Sandy Silt	28	28	1.75	0.18	27
			7.50	9.00	1.50	Sandy Silt	-	-	1.78	0.18	27

Chainage Old & New	Chainage New	BH Ref.	Layer depth below EGL (m)		Thickness of strata (m)	Strata description	SPT 'N'		Bulk Density (gm/cc)	Cohesion (C) (kg/cm^2)	Angle of internal Friction (Φ) (°)
			From	To			Observed	Corrected			
			9.00	12.00	3.00	Silty Clay	24	21	1.82	0.82	5
55+910	59+107	BH-A1	0.00	7.00	7.00	Silty Sand	13	14	1.68	0.00	30
			7.00	13.00	6.00	Silty Clay	28	28	1.81	0.85	4
			13.00	19.00	6.00	Sandy Silt	43	25	1.83	0.20	30
			19.00	25.00	6.00	Sandy Silt	53	24	1.85	0.18	30
55+910	59+107	BH-A1	25.00	31.00	6.00	Sandy Silt	67	27	1.87	0.20	30
			31.00	40.00	9.00	Sandy Silt	85	30	1.89	0.18	30
		BH-A2	0.00	5.50	5.50	Silty Sand	19	24	1.75	0.00	32
			5.50	8.50	3.00	Silty Sand	26	24	1.76	0.00	32
			8.50	16.00	7.50	Silty Sand	36	27	1.77	0.00	32
			16.00	20.50	4.50	Silty Clay	39	39	1.99	1.34	4
			20.50	26.50	6.00	Sandy Silt	56	25	1.86	0.20	30
			26.50	40.00	13.50	Sandy Silt	73	28	1.95	0.16	30
56+978	60+162	BH-CL	0.00	2.25	2.25	Sandy Silt	14	20	-	-	-
			2.25	3.00	0.75	Sandy Silt	-	-	1.86	0.22	28
			3.00	10.00	7.00	Silty Clay	27	27	1.95	0.85	5
57+400	60+603	BH-A1	0.00	8.50	8.50	Silty Sand	17	19	1.73	0.10	31
			8.50	13.00	4.50	Silty Clay	32	32	1.86	1.06	5
			13.00	17.50	4.50	Silty Sand	57	29	1.86	0.00	32
			17.50	30.00	12.50	Silty Clay	74	43	2.01	1.66	4
		BH-P2	0.00	5.50	5.50	Sandy Silt	20	26	1.78	0.21	30
			5.50	8.50	3.00	Silty Clay	32	32	1.83	1.10	4
			8.50	14.50	6.00	Sandy Silt	40	27	1.84	0.20	30
			14.50	20.50	6.00	Silty Clay	67	67	2.01	2.22	4
			20.50	26.50	6.00	Sandy Silt	90	35	1.90	0.21	30
			26.50	30.00	3.50	Sandy Silt	-	-	1.94	0.20	32
		BH-P3	0.00	4.00	4.00	Sandy Silt	12	15	1.71	0.16	29
			4.00	10.00	6.00	Sandy Silt	31	28	1.81	0.18	30
			10.00	19.00	9.00	Silty Sand	40	25	1.82	0.00	32
			19.00	25.00	6.00	Sandy Silt	53	25	1.88	0.21	30
			25.00	31.00	6.00	Sandy Silt	61	26	1.90	0.20	30
		BH-P4	0.00	7.00	7.00	Silty Sand	16	20	1.73	0.00	31
			7.00	11.50	4.50	Sandy Silt	51	43	1.84	0.25	32
			11.50	17.50	6.00	Sandy Silt	59	29	1.90	0.21	30
			17.50	23.50	6.00	Sandy Silt	73	32	1.93	0.22	30
			23.50	30.00	6.50	Sandy Silt	80	32	1.94	0.19	30
		BH-P5	0.00	4.00	4.00	Silty Sand	11	14	1.69	0.00	31
			4.00	10.00	6.00	Silty Sand	26	24	1.75	0.00	32

Chainage Old & New	Chainage New	BH Ref.	Layer depth below EGL (m)		Thickness of strata (m)	Strata description	SPT 'N'		Bulk Density (gm/cc)	Cohesion (C) (kg/cm^2)	Angle of internal Friction (Φ) (°)
			From	To			Observed	Corrected			
			10.00	16.00	6.00	Sandy Silt	49	31	1.85	0.23	30
			16.00	22.00	6.00	Sandy Silt	65	30	1.88	0.22	30
			22.00	30.00	8.00	Sandy Silt	85	33	1.91	0.18	30
		BH-P6	0.00	5.50	5.50	Silty Sand	13	17	1.71	0.00	31
57+400	60+603	BH-P6	5.50	8.50	3.00	Silty Sand	20	18	1.73	0.00	31
			8.50	11.50	3.00	Silty Clay	26	26	1.84	0.90	4
			11.50	14.50	3.00	Silty Clay	32	32	1.96	1.03	5
			14.50	20.50	6.00	Sandy Silt	52	26	1.90	0.19	30
			20.50	26.50	6.00	Sandy Silt	62	27	1.90	0.22	30
			26.50	30.00	3.50	Sandy Silt	73	30	1.92	0.24	30
		BH-P7	0.00	4.00	4.00	Silty Sand	14	18	1.71	0.00	31
			4.00	10.00	6.00	Silty Sand	26	24	1.74	0.00	32
			10.00	16.00	6.00	Silty Clay	38	38	1.99	1.15	4
			16.00	22.00	6.00	Sandy Silt	51	25	1.88	0.22	30
			22.00	25.00	3.00	Sandy Silt	63	28	1.91	0.20	30
			25.00	30.00	5.00	Sandy Silt	80	32	1.94	0.23	30
		BH-P9	0.00	5.50	5.50	Sandy Silt	16	20	1.74	0.22	29
			5.50	8.50	3.00	Sandy Silt	19	18	1.75	0.22	29
			8.50	11.50	3.00	Silty Clay	33	33	1.86	1.02	4
			11.50	14.50	3.00	Silty Clay	30	30	1.89	1.02	4
			14.50	17.50	3.00	Sandy Silt	66	31	1.88	0.20	30
			17.50	23.50	6.00	Silty Clay	45	45	1.98	1.42	4
			23.50	31.00	7.50	Sandy Silt	77	31	1.92	0.17	30
			31.00	35.00	4.00	Sandy Silt	97	35	1.95	0.16	30
		BH-P10	0.00	7.00	7.00	Silty Sand	26	30	1.78	0.00	32
			7.00	10.00	3.00	Silty Clay	27	27	1.83	0.92	5
			10.00	16.00	6.00	Sandy Silt	34	22	1.84	0.21	29
			16.00	22.00	6.00	Sandy Silt	46	23	1.88	0.18	29
			22.00	30.00	8.00	Sandy Silt	68	28	1.91	0.21	30
		BH-P11	0.00	5.50	5.50	Sandy Silt	14	17	1.72	0.16	29
			5.50	11.50	6.00	Sandy Silt	25	22	1.78	0.21	29
			11.50	23.50	12.00	Sandy Silt	27	17	1.83	0.21	28
			23.50	25.00	1.50	Silty Clay	45	45	1.97	1.47	4
			25.00	30.00	3.00	Sandy Silt	85	33	1.94	0.19	30
		BH-P12	0.00	7.00	7.00	Silty Sand	26	29	1.77	0.11	32
			7.00	13.00	6.00	Sandy Silt	31	25	1.81	0.22	30
			13.00	23.50	10.50	Sandy Silt	36	20	1.83	0.21	29
			23.50	30.00	6.50	Sandy Silt	53	24	1.87	0.22	29

Chainage Old & New	Chainage New	BH Ref.	Layer depth below EGL (m)		Thickness of strata (m)	Strata description	SPT 'N'		Bulk Density (gm/cc)	Cohesion (C) (kg/cm^2)	Angle of internal Friction (Φ) (°)
			From	To			Observed	Corrected			
		BH-P13	0.00	4.00	4.00	Silty Sand	9	14	1.68	0.00	30
			4.00	11.50	7.50	Sandy Silt	38	36	1.82	0.21	31
			11.50	17.50	6.00	Sandy Silt	42	23	1.85	0.23	29
			17.50	20.50	3.00	Silty Clay	51	51	2.00	1.67	4
57+400	60+603	BH-P13	20.50	30.00	9.50	Sandy Silt	64	27	1.93	0.22	30
		BH-P15	0.00	10.00	10.00	Silty Sand	19	22	1.76	0.09	31
			10.00	17.50	7.50	Sandy Silt	56	34	1.86	0.19	31
			17.50	25.00	7.50	Sandy Silt	63	29	1.87	0.22	30
			25.00	30.00	5.00	Sandy Silt	83	33	1.92	0.23	30
		BH-P16	0.00	4.00	4.00	Sandy Silt	16	20	1.75	0.21	29
			4.00	10.00	6.00	Sandy Silt	20	19	1.76	0.19	29
			10.00	16.00	6.00	Silty Sand	28	18	1.78	0.00	30
			16.00	19.00	3.00	Silty Sand	39	21	1.81	0.00	31
			19.00	26.50	7.50	Sandy Silt	77	34	1.94	0.17	30
			26.50	30.00	3.50	Silty Sand	-	-	1.94	0.17	33
		BH-P17	0.00	4.00	4.00	Silty Clay	5	5	1.66	0.20	4
			4.00	14.50	10.50	Sandy Silt	24	19	1.75	0.23	27
			14.50	17.50	3.00	Sandy Silt	36	21	1.83	0.20	28
			17.50	29.50	12.50	Sandy Silt	-	-	1.94	0.18	29
		BH-P18	0.00	4.00	4.00	Sandy Silt	15	19	1.74	0.21	29
			4.00	7.00	3.00	Sandy Silt	20	20	1.77	0.21	29
			7.00	10.00	3.00	Sandy Silt	26	22	1.80	0.19	29
			10.00	17.50	7.50	Silty Clay	32	32	1.93	1.07	30
			17.50	30.00	12.50	Sandy Silt	-	-	1.95	0.21	33
		BH-P19	0.00	8.50	8.50	Sandy Silt	15	17	1.72	0.22	29
			8.50	16.00	7.50	Sandy Silt	28	21	1.77	0.19	29
			16.00	20.50	4.50	Silty Clay	33	33	1.94	1.02	5
			20.50	30.00	9.50	Silty Sand	100	36	1.94	0.00	34
		BH-A2	0.00	4.00	4.00	Sandy Silt	14	18	1.72	0.16	29
			4.00	7.00	3.00	Silty Clay	26	26	1.80	0.88	4
			7.00	10.00	3.00	Silty Clay	27	27	1.82	0.88	4
			10.00	13.00	3.00	Sandy Silt	30	19	1.80	0.20	29
			13.00	22.00	9.00	Sandy Silt	34	20	1.82	0.20	29
			22.00	35.00	13.00	Sandy Silt	88	31	1.95	0.19	29
57+980	61+164	BH-CL	0.00	3.00	3.00	Silty Clay	11	11	1.80	0.61	5
			3.00	8.25	5.25	Silty Clay	23	23	1.93	1.17	7
			8.25	10.50	2.25	Silty Clay	-	-	1.89	0.68	7

Chainage Old & New	Chainage New	BH Ref.	Layer depth below EGL (m)		Thickness of strata (m)	Strata description	SPT 'N'		Bulk Density (gm/cc)	Cohesion (C) (kg/cm^2)	Angle of internal Friction (Φ) (°)
			From	To			Observed	Corrected			
58+497	61+676	BH-A1	0.00	5.50	5.50	Sandy Silt	21	27	1.76	0.19	29
			5.50	8.50	3.00	Sandy Silt	32	30	1.80	0.22	29
			8.50	20.50	12.00	Silty Clay	48	48	1.86	1.52	5
			20.50	28.00	7.50	Sandy Silt	72	37	1.86	0.21	30
			28.00	40.00	12.00	Sandy Silt	78	36	1.89	0.17	30
58+497	61+676	BH-P1	0.00	4.00	4.00	Sandy Silt	17	22	1.75	0.23	29
			4.00	7.00	3.00	Sandy Silt	30	30	1.81	0.19	29
			7.00	10.00	3.00	Silty Clay	40	40	1.86	1.34	5
			10.00	13.00	3.00	Silty Clay	45	45	1.91	1.48	4
			13.00	16.00	3.00	Silty Clay	49	49	1.97	1.65	5
			16.00	19.00	3.00	Silty Clay	54	54	2.02	1.80	4
			19.00	28.00	9.00	Sandy Silt	70	29	1.88	0.20	30
			28.00	40.00	12.00	Sandy Silt	82	30	1.91	0.16	30
		BH-P2	0.00	4.00	4.00	Silty Sand	19	30	1.74	0.09	30
			4.00	11.50	7.50	Silty Clay	28	28	1.81	0.93	4
			11.50	20.50	9.00	Sandy Silt	49	25	1.83	0.20	30
			20.50	26.50	6.00	Sandy Silt	61	28	1.88	0.21	30
			26.50	40.00	13.50	Sandy Silt	100	36	1.95	0.17	33
		BH-P3	0.00	7.00	7.00	Silty Sand	15	17	1.69	0.00	31
			7.00	13.00	6.00	Sandy Silt	36	26	1.80	0.21	30
			13.00	19.00	6.00	Sandy Silt	47	25	1.85	0.19	30
			19.00	28.00	9.00	Sandy Silt	88	36	1.89	0.22	30
			28.00	40.00	12.00	Sandy Silt	105	36	1.94	0.18	33
		BH-P4	0.00	5.50	5.50	Sandy Silt	22	29	1.77	0.18	30
			5.50	13.00	7.50	Sandy Silt	42	34	1.82	0.20	31
			13.00	26.50	13.50	Sandy Silt	62	28	1.84	0.19	30
			26.50	31.00	4.50	Sandy Silt	78	30	1.87	0.19	30
			31.00	40.00	9.00	Sandy Silt	82	30	1.91	0.22	30
		BH-P5	0.00	4.00	4.00	Silty Sand	8	13	1.66	0.00	31
			4.00	8.50	4.50	Silty Sand	28	29	1.76	0.00	32
			8.50	17.50	9.00	Silty Clay	37	37	1.92	1.26	4
			17.50	23.50	6.00	Sandy Silt	54	25	1.86	0.20	30
			23.50	28.00	4.50	Sandy Silt	67	28	1.89	0.22	30
			28.00	40.00	12.00	Sandy Silt	96	33	1.96	0.17	31
		BH-P6	0.00	4.00	4.00	Sandy Silt	16	20	1.74	0.24	29
			4.00	7.00	3.00	Sandy Silt	27	27	1.79	0.19	30
			7.00	10.00	3.00	Silty Clay	36	36	1.87	1.22	5

Chainage Old & New	Chainage New	BH Ref.	Layer depth below EGL (m)		Thickness of strata (m)	Strata description	SPT 'N'		Bulk Density (gm/cc)	Cohesion (C) (kg/cm^2)	Angle of internal Friction (Φ) (°)
			From	To			Observed	Corrected			
			10.00	13.00	3.00	Silty Clay	43	43	1.90	1.36	5
			13.00	16.00	3.00	Silty Clay	51	51	1.99	1.65	4
			16.00	19.00	3.00	Silty Clay	54	54	2.02	1.79	4
			19.00	28.00	9.00	Sandy Silt	73	30	1.87	0.18	30
58+497	61+676	BH-P6	28.00	40.00	12.00	Sandy Silt	100	36	1.95	0.20	32
		BH-A2	0.00	4.00	4.00	Sandy Silt	13	21	1.74	0.22	29
			4.00	11.50	7.50	Sandy Silt	29	28	1.80	0.20	30
			11.50	20.50	9.00	Sandy Silt	34	19	1.81	0.18	29
			20.50	32.50	12.00	Sandy Silt	57	25	1.87	0.19	30
			32.50	40.00	7.50	Sandy Silt	99	34	1.91	0.17	30

Design parameter have been obtained from the laboratory test results however various depth where the shear parameter seems on the lower side with respect to SPT 'N' values those shear parameter have been judicially improved based on the SPT 'N' for the analysis purpose.

The sample calculation for computation of safe load carrying capacity of normal bored cast-in-situ RCC pile in compression & uplift are attached vide **Appendix C-2.**

The sample calculation for computation of safe load carrying capacity of normal bored cast-in-situ RCC pile in lateral are attached vide **Appendix C-3.**

CHAPTER 4 FOUNDATION RECOMMENDATIONS

8.0 FOUNDATION RECOMMENDATIONS

- Based on the nature & strength characteristics of the substrata and requirement of the project, shallow foundation and normal bored cast in-situ RCC pile foundation have been analyzed.
- Based on the method of analysis & design parameters given under Para 7.1 above, the recommended net allowable bearing capacity values are given in Table 4.1 to 4.4.

Table 4.1: Recommended Net Allowable Bearing Capacity for shallow foundation for allowable settlement 25mm

Sr. No.	Old Chainage	New Chainage	BH. No.	Depth of foundation below EGL (m)	Foundation Size (m x m)	Net Safe Bearing Capacity from Shear Failure (t/m^2)	Net Allowable Bearing Pressure from settlement failure (t/m^2)	*Recommended Net Allowable Bearing Capacity (t/m^2)
1.	52+518	55+719	BH-A1	2.0	7.2 X 7.2	32.9	20.1	20.1
				3.0		38.8	23.5	23.5
				4.0		44.9	28.1	28.1
			BH-A2	2.0	7.2 X 7.2	36.1	14.1	14.1
				3.0		42.6	15.4	15.4
				4.0		49.4	16.8	16.8
2.	52+934	56+118	BH-CL	1.0	6.2 X 6.2	28.0	8.3	8.3
				1.5		31.8	8.6	8.6
				2.0		35.7	9.0	9.0
3.	53+107	56+291	BH-CL	1.0	6.2 X 6.2	23.9	18.4	18.4
				1.5		26.3	19.6	19.6
				2.0		28.8	21.1	21.1
4.	53+282	56+466	BH-CL	1.0	3.7 X 3.7	25.3	17.0	17.0
				1.5		28.8	18.5	18.5
				2.0		32.5	20.5	20.5
5.	53+572	56+756	BH-CL	1.0	3.7 X 3.7	6.3	7.5	6.3
				1.5		6.6	8.7	6.6
				2.0		6.9	10.4	6.9
6.	53+982	57+169	BH-CL	1.0	4.9 X 4.9	9.2	5.1	5.1
				1.5		9.5	5.7	5.7
				2.0		9.9	6.6	6.6
7.	54+363	57+547	BH-CL	1.0	4.7 X 4.7	34.0	23.2	23.2
				1.5		39.1	24.6	24.6
				2.0		44.4	26.5	26.5

Sr. No.	Old Chainage	New Chainage	BH. No.	Depth of foundation below EGL (m)	Foundation Size (m x m)	Net Safe Bearing Capacity from Shear Failure (t/m^2)	Net Allowable Bearing Pressure from settlement failure (t/m^2)	*Recommended Net Allowable Bearing Capacity (t/m^2)
8.	54+496	57+672	BH-CL	1.0	11.35 X 11.35	39.5	13.4	13.4
				1.5		42.6	13.5	13.5
				2.0		45.7	13.7	13.7
9.	55+044	58+228	BH-PLT04	1.0	2.0x2.0	21.9	22.3	21.9
				1.5		26.0	24.3	24.3
				2.0		30.3	25.7	25.7
10.	55+020	58+204	BH-CL	1.0	8.1 X 8.1	35.2	14.3	14.3
				1.5		39.2	14.6	14.6
				2.0		43.2	14.9	14.9
11.	55+910	59+107	BH-A1	2.0	7.2 X 7.2	27.1	11.1	11.1
				3.0		33.8	12.5	12.5
				4.0		40.8	14.4	14.4
			BH-A2	2.0	7.2 X 7.2	63.4	23.4	23.4
				3.0		77.7	24.7	24.7
				4.0		92.6	26.1	26.1
12.	56+403	59+587	BH-CL	1.0	2.7 X 2.7	18.7	12.7	12.7
				1.5		22.2	16.6	16.6
				2.0		25.8	22.5	22.5
13.	56+701	59+886	BH-CL	1.0	11.35 X 11.35	18.1	9.4	9.4
				1.5		19.4	9.8	9.8
				2.0		20.9	10.2	10.2
14.	56+978	60+162	BH-CL	1.0	4.9 X 4.9	31.8	18.4	18.4
				1.5		35.7	20.1	20.1
				2.0		39.6	22.1	22.1
15.	57+400	60+603	BH-A1	2.0	7.2 X 7.2	43.6	15.8	15.8
				3.0		51.1	17.6	17.6
				4.0		58.8	19.7	19.7
			BH-P2	2.0	7.2 X 7.2	60.4	18.2	18.2
				3.0		69.3	18.4	18.4
				4.0		78.4	18.4	18.4
			BH-P3	2.0	7.2 X 7.2	30.4	23.5	23.5
				3.0		35.4	25.7	25.7
				4.0		40.6	28.3	28.3
			BH-P4	2.0	7.2 X 7.2	44.7	28.1	28.1
				3.0		53.3	29.6	29.6

Sr. No.	Old Chainage	New Chainage	BH. No.	Depth of foundation below EGL (m)	Foundation Size (m x m)	Net Safe Bearing Capacity from Shear Failure (t/m^2)	Net Allowable Bearing Pressure from settlement failure (t/m^2)	*Recommended Net Allowable Bearing Capacity (t/m^2)
				4.0		62.3	31.2	31.2
			BH-P5	2.0	7.2 X 7.2	33.6	25.7	25.7
				3.0		40.4	27.0	27.0
	57+400	60+603	BH-P5	4.0		47.4	28.6	28.6
			BH-P6	2.0	7.2 X 7.2	35.5	14.1	14.1
				3.0		42.6	15.0	15.0
				4.0		49.9	16.2	16.2
			BH-P7	2.0	7.2 X 7.2	37.4	18.2	18.2
				3.0		44.8	19.4	19.4
				4.0		52.5	21.0	21.0
			BH-P9	2.0	7.2 X 7.2	43.6	15.7	15.7
				3.0		50.1	16.7	16.7
				4.0		56.7	18.1	18.1
			BH-P10	2.0	7.2 X 7.2	61.4	23.6	23.6
				3.0		72.8	24.8	24.8
				4.0		84.7	25.5	25.5
			BH-P11	2.0	7.2 X 7.2	30.6	15.0	15.0
				3.0		35.6	15.9	15.9
				4.0		40.8	16.8	16.8
			BH-P12	2.0	7.2 X 7.2	69.4	27.8	27.8
				3.0		80.6	28.4	28.4
				4.0		92.1	27.8	27.8
			BH-P13	2.0	7.2 X 7.2	27.0	18.4	18.4
				3.0		32.6	22.6	22.6
				4.0		38.4	28.4	28.4
			BH-P15	2.0	7.2 X 7.2	39.5	21.2	21.2
				3.0		46.3	23.6	23.6
				4.0		53.3	26.5	26.5
			BH-P16	2.0	7.2 X 7.2	45.1	21.2	21.2
				3.0		37.7	19.4	19.4
				4.0		58.7	26.5	26.5
			BH-P17	2.0	7.2 X 7.2	19.8	5.4	5.4
				3.0		22.9	7.9	7.9
				4.0		26.0	17.7	17.7
			BH-P18	2.0	7.2 X 7.2	39.2	15.7	15.7
				3.0		45.1	16.5	16.5

Sr. No.	Old Chainage	New Chainage	BH. No.	Depth of foundation below EGL (m)	Foundation Size (m x m)	Net Safe Bearing Capacity from Shear Failure (t/m^2)	Net Allowable Bearing Pressure from settlement failure (t/m^2)	*Recommended Net Allowable Bearing Capacity (t/m^2)
				4.0		51.2	17.5	17.5
				2.0		22.1	15.9	15.9
			BH-P19	3.0	7.2 X 7.2	25.2	16.8	16.8
				4.0		28.5	17.7	17.7
	57+400	60+603		2.0		34.1	16.7	16.7
			BH-A2	3.0	7.2 X 7.2	39.6	18.1	18.1
				4.0		45.3	19.0	19.0
				1.0		14.0	10.6	10.6
16.	57+980	61+164	BH-CL	1.5	3.7 X 3.7	14.6	11.1	11.1
				2.0		15.1	11.7	11.7
				1.0		21.2	11.2	11.2
17.	58+191	61+376	BH-CL	1.5	3.7 X 3.7	24.1	12.1	12.1
				2.0		27.1	13.4	13.4
				2.0		52.4	23.8	23.8
			BH-A1	3.0	7.2 X 7.2	60.3	25.3	25.3
				4.0		68.4	27.2	27.2
18.	58+497	61+676		2.0		43.6	24.0	24.0
			BH-P1	3.0	7.2 X 7.2	50.0	26.0	26.0
				4.0		56.7	28.4	28.4
				2.0		45.5	18.4	18.4
			BH-P2	3.0	7.2 X 7.2	53.2	18.7	18.7
				4.0		61.2	18.5	18.5
				2.0		37.1	17.4	17.4
			BH-P3	3.0	7.2 X 7.2	44.4	20.0	20.0
				4.0		52.0	23.2	23.2
				2.0		63.7	32.7	32.7
			BH-P4	3.0	7.2 X 7.2	73.2	36.1	36.1
	58+497	61+676		4.0		83.0	39.0	39.0
				2.0		26.3	19.1	19.1
			BH-P5	3.0	7.2 X 7.2	31.8	20.4	20.4
				4.0		37.6	21.9	21.9
				2.0		47.2	21.5	21.5
			BH-P6	3.0	7.2 X 7.2	54.0	23.4	23.4
				4.0		61.0	25.6	25.6
				2.0		43.6	22.1	22.1
			BH-A2	3.0	7.2 X 7.2	50.0	23.3	23.3
				4.0		56.7	24.6	24.6

Sr. No.	Old Chainage	New Chainage	BH. No.	Depth of foundation below EGL (m)	Foundation Size (m x m)	Net Safe Bearing Capacity from Shear Failure (t/m^2)	Net Allowable Bearing Pressure from settlement failure (t/m^2)	*Recommended Net Allowable Bearing Capacity (t/m^2)
19.	58+837	62+026	BH-CL	1.0	4.9 X 4.9	39.1	9.3	9.3
				1.5		44.1	10.7	10.7
				2.0		49.3	12.6	12.6
20.	59+071	62+256	BH-A1	1.0	2.7 X 2.7	26.0	27.8	26.0
				1.5		30.1	29.9	29.9
				2.0		34.3	31.9	31.9
21.	59+206	62+400	BH-CL	1.0	11.5 X 11.5	32.2	19.8	19.8
				1.5		34.5	20.2	20.2
				2.0		36.7	20.5	20.5
22.	59+270	62+546	BH-CL	1.0	2.7 X 2.7	27.7	34.4	27.7
				1.5		31.9	37.0	31.9
				2.0		36.3	39.5	36.3

* The maximum value of recommended net allowable bearing capacity shall be restricted to 30 t/m2.

Table 4.2: Recommended Net Allowable Bearing Capacity for shallow foundation for allowable settlement 50mm

Sr. No.	Old Chainage	New Chainage	BH. No.	Depth of foundation below EGL (m)	Foundation Size (m x m)	Net Safe Bearing Capacity from Shear Failure (t/m^2)	Net Allowable Bearing Pressure from settlement failure (t/m^2)	*Recommended Net Allowable Bearing Capacity (t/m^2)
1.	52+518	55+719	BH-A1	2.0	7.2 X 7.2	32.9	40.2	32.9
				3.0		38.8	47.0	38.8
				4.0		44.9	56.2	44.9
			BH-A2	2.0	7.2 X 7.2	36.1	28.2	28.2
				3.0		42.6	30.7	30.7
				4.0		49.4	33.7	33.7
2.	52+934	56+118	BH-CL	1.0	6.2 X 6.2	28.0	16.7	16.7
				1.5		31.8	17.3	17.3
				2.0		35.7	18.0	18.0

Sr. No.	Old Chainage	New Chainage	BH. No.	Depth of foundation below EGL (m)	Foundation Size (m x m)	Net Safe Bearing Capacity from Shear Failure (t/m^2)	Net Allowable Bearing Pressure from settlement failure (t/m^2)	*Recommended Net Allowable Bearing Capacity (t/m^2)
3.	53+107	56+291	BH-CL	1.0	6.2 X 6.2	23.9	36.8	23.9
				1.5		26.3	39.1	26.3
				2.0		28.8	42.2	28.8
4.	53+282	56+466	BH-CL	1.0	3.7 X 3.7	25.3	34.0	25.3
				1.5		28.8	37.1	28.8
				2.0		32.5	41.1	32.5
5.	53+572	56+756	BH-CL	1.0	3.7 X 3.7	6.3	15.0	6.3
				1.5		6.6	29.6	6.6
				2.0		6.9	37.3	6.9
6.	53+982	57+169	BH-CL	1.0	4.9 X 4.9	9.2	10.2	9.2
				1.5		9.5	11.4	9.5
				2.0		9.9	13.2	9.9
7.	54+363	57+547	BH-CL	1.0	4.7 X 4.7	34.0	46.5	34.0
				1.5		39.1	49.3	39.1
				2.0		44.4	53.0	44.4
8.	54+496	57+672	BH-CL	1.0	11.35 X 11.35	39.5	26.7	26.7
				1.5		42.6	27.0	27.0
				2.0		45.7	27.4	27.4
9.	55+020	58+204	BH-CL	1.0	8.1 X 8.1	35.2	28.6	28.6
				1.5		39.2	29.1	29.1
				2.0		43.2	29.8	29.8
10.	55+044	58+228	BH-PLT-04	1.0	2.0 x2.0	21.9	44.6	21.9
				1.5		26.0	48.6	26.0
				2.0		30.3	51.3	30.3
11.	55+910	59+107	BH-A1	2.0	7.2 X 7.2	27.1	22.3	22.3
				3.0		33.8	25.0	25.0
				4.0		40.8	28.7	28.7
			BH-A2	2.0	7.2 X 7.2	63.4	46.9	46.9
				3.0		77.7	49.4	49.4
				4.0		92.6	52.2	52.2
12.	56+403	59+587	BH-CL	1.0	2.7 X 2.7	18.7	25.5	18.7
				1.5		22.2	33.1	22.2
				2.0		25.8	45.0	25.8
13.	56+701	59+886	BH-CL	1.0	11.35 X 11.35	18.1	18.8	18.1
				1.5		19.4	19.6	19.4
				2.0		20.9	20.4	20.4
14.	56+978	60+162	BH-CL	1.0	4.9 X 4.9	31.8	36.7	31.8
				1.5		35.7	40.2	35.7
				2.0		39.6	44.2	39.6

Sr. No.	Old Chainage	New Chainage	BH. No.	Depth of foundation below EGL (m)	Foundation Size (m x m)	Net Safe Bearing Capacity from Shear Failure (t/m^2)	Net Allowable Bearing Pressure from settlement failure (t/m^2)	*Recommended Net Allowable Bearing Capacity (t/m^2)
15.	57+400	60+603	BH-A1	2.0	7.2 X 7.2	43.6	31.7	31.7
				3.0		51.1	35.2	35.2
				4.0		58.8	39.4	39.4
			BH-P2	2.0	7.2 X 7.2	60.4	36.5	36.5
				3.0		69.3	36.7	36.7
				4.0		78.4	36.8	36.8
	57+400	60+603	BH-P3	2.0	7.2 X 7.2	30.4	47.0	30.4
				3.0		35.4	51.5	35.4
				4.0		40.6	56.5	40.6
			BH-P4	2.0	7.2 X 7.2	44.7	56.1	44.7
				3.0		53.3	59.2	53.3
				4.0		62.3	62.5	62.3
			BH-P5	2.0	7.2 X 7.2	33.6	51.3	33.6
				3.0		40.4	54.1	40.4
				4.0		47.4	57.1	47.4
			BH-P6	2.0	7.2 X 7.2	35.5	28.1	28.1
				3.0		42.6	30.0	30.0
				4.0		49.9	32.5	32.5
			BH-P7	2.0	7.2 X 7.2	37.4	36.4	36.4
				3.0		44.8	38.8	38.8
				4.0		52.5	42.1	42.1
			BH-P9	2.0	7.2 X 7.2	43.6	31.4	31.4
				3.0		50.1	33.4	33.4
				4.0		56.7	36.2	36.2
			BH-P10	2.0	7.2 X 7.2	61.4	47.2	47.2
				3.0		72.8	49.6	49.6
				4.0		84.7	51.0	51.0
			BH-P11	2.0	7.2 X 7.2	30.6	30.1	30.1
				3.0		35.6	31.7	31.7
				4.0		40.8	33.5	33.5
			BH-P12	2.0	7.2 X 7.2	69.4	55.7	55.7
				3.0		80.6	56.7	56.7
				4.0		92.1	55.5	55.5
			BH-P13	2.0	7.2 X 7.2	27.0	36.8	27.0
				3.0		32.6	45.3	32.6
				4.0		38.4	56.7	38.4
			BH-P15	2.0	7.2 X 7.2	39.5	42.5	39.5
				3.0		46.3	47.2	46.3
				4.0		53.3	53.0	53.0

Sr. No.	Old Chainage	New Chainage	BH. No.	Depth of foundation below EGL (m)	Foundation Size (m x m)	Net Safe Bearing Capacity from Shear Failure (t/m^2)	Net Allowable Bearing Pressure from settlement failure (t/m^2)	*Recommended Net Allowable Bearing Capacity (t/m^2)
			BH-P16	2.0	7.2 X 7.2	45.1	42.5	42.5
				3.0		37.7	38.9	37.7
				4.0		58.7	53.0	53.0
			BH-P17	2.0	7.2 X 7.2	19.8	10.8	10.8
				3.0		22.9	15.9	15.9
				4.0		26.0	35.5	26.0
	57+400	60+603	BH-P18	2.0	7.2 X 7.2	39.2	31.5	31.5
				3.0		45.1	33.0	33.0
				4.0		51.2	35.1	35.1
			BH-P19	2.0	7.2 X 7.2	22.1	31.9	22.1
				3.0		25.2	33.6	25.2
				4.0		28.5	35.5	28.5
			BH-A2	2.0	7.2 X 7.2	34.1	33.4	33.4
				3.0		39.6	36.1	36.1
				4.0		45.3	38.0	38.0
16.	57+980	61+164	BH-CL	1.0	3.7 X 3.7	14.0	21.1	14.0
				1.5		14.6	22.2	14.6
				2.0		15.1	23.5	15.1
17.	58+191	61+376	BH-CL	1.0	3.7 X 3.7	21.2	22.5	21.2
				1.5		24.1	24.3	24.1
				2.0		27.1	26.8	26.8
18.	58+497	61+676	BH-A1	2.0	7.2 X 7.2	52.4	47.7	47.7
				3.0		60.3	50.7	50.7
				4.0		68.4	54.3	54.3
			BH-P1	2.0	7.2 X 7.2	43.6	47.9	43.6
				3.0		50.0	52.1	50.0
				4.0		56.7	56.9	56.7
			BH-P2	2.0	7.2 X 7.2	45.5	36.9	36.9
				3.0		53.2	37.5	37.5
				4.0		61.2	37.1	37.1
			BH-P3	2.0	7.2 X 7.2	37.1	34.9	34.9
				3.0		44.4	40.0	40.0
				4.0		52.0	46.4	46.4
			BH-P4	2.0	7.2 X 7.2	63.7	65.3	63.7
				3.0		73.2	72.2	72.2
				4.0		83.0	78.0	78.0
			BH-P5	2.0	7.2 X 7.2	26.3	38.3	26.3
				3.0		31.8	40.8	31.8
				4.0		37.6	43.8	37.6

Sr. No.	Old Chainage	New Chainage	BH. No.	Depth of foundation below EGL (m)	Foundation Size (m x m)	Net Safe Bearing Capacity from Shear Failure (t/m^2)	Net Allowable Bearing Pressure from settlement failure (t/m^2)	*Recommended Net Allowable Bearing Capacity (t/m^2)
			BH-P6	2.0	7.2 X 7.2	47.2	43.1	43.1
				3.0		54.0	46.7	46.7
				4.0		61.0	51.1	51.1
			BH-A2	2.0	7.2 X 7.2	43.6	44.2	43.6
				3.0		50.0	46.6	46.6
				4.0		56.7	49.2	49.2
19.	58+837	62+026	BH-CL	1.0	4.9 X 4.9	39.1	18.6	18.6
				1.5		44.1	21.4	21.4
				2.0		49.3	25.2	25.2
20.	59+071	62+256	BH-A1	1.0	2.7 X 2.7	26.0	55.7	26.0
				1.5		30.1	59.9	30.1
				2.0		34.3	63.8	34.3
21.	59+206	62+400	BH-CL	1.0	11.5 X 11.5	32.2	39.6	32.2
				1.5		34.5	40.3	34.5
				2.0		36.7	41.1	36.7
22.	59+270	62+546	BH-CL	1.0	2.7 X 2.7	27.7	68.9	27.7
				1.5		31.9	74.1	31.9
				2.0		36.3	79.0	36.3

* The maximum value of recommended net allowable bearing capacity shall be restricted to 30 t/m^2.

Based on the method of analysis given under Para 7.2 above, The values of Safe Load Carrying Capacity of piles in compression, uplift and lateral under static conditions have been tabulated below:-

Table 4.3: Recommended Net Allowable Bearing Capacity for shallow foundation for allowable settlement 25mm (Replaced or Compacted Soil)

Sr. No.	Old Chainage	New Chainage	BH. No.	Depth of foundation below EGL (m)	Foundation Size (m x m)	Net Safe Bearing Capacity from Shear Failure (t/m^2)	Net Allowable Bearing Pressure from 25mm settlement failure (t/m^2)	*Recommended Net Allowable Bearing Capacity (t/m^2)
1.	53+982	57+169	BH-CL	1.0	4.9 X 4.9	26.3	21.6	21.6
				1.5		27.3	22.8	22.8
				2.0		28.4	24.2	24.2
2.	52+934	56+118	BH-CL	1.0	6.2 X 6.2	32.5	20.0	20.0
				1.5		36.4	19.5	19.5
				2.0		40.4	19.0	19.0
3.	57+980	61+164	BH-CL	1.0	3.7 X 3.7	43.0	17.8	17.8
				1.5		48.7	18.5	18.5
				2.0		54.0	19.2	19.2

Table 4.4: Recommended Net Allowable Bearing Capacity for shallow foundation for allowable settlement 50mm (Replaced or Compacted Soil)

Sr. No.	Old Chainage	New Chainage	BH. No.	Depth of foundation below EGL (m)	Foundation Size (m x m)	Net Safe Bearing Capacity from Shear Failure (t/m^2)	Net Allowable Bearing Pressure from 50 mm settlement failure (t/m^2)	*Recommended Net Allowable Bearing Capacity (t/m^2)
1.	53+982	57+169	BH-CL	1.0	4.9 X 4.9	26.3	43.2	26.3
				1.5		27.3	45.6	27.3
				2.0		28.4	48.3	28.4
2.	52+934	56+118	BH-CL	1.0	6.2 X 6.2	32.5	40.0	32.5
				1.5		36.4	38.9	36.4
				2.0		40.4	38.0	38.0
3.	57+980	61+164	BH-CL	1.0	3.7 X 3.7	43.0	35.6	35.6
				1.5		48.7	36.9	36.9
				2.0		54.0	39.3	39.3

Note:- Table 4.1& 4.2 Show that the SBC at the location of Ch (Old) 53+982, Ch (Old) 52+934 and Ch (Old) 57+980 are poor. Therefore before laying the open foundation at 1.0, 1.5 m & 2.0m depth it is recommended to replace & compact the soil up to 1.5m depth below the foundation level.

As per the Morth guidelines the gradation of fill soil shall be as per following limits. The effective angle of friction not less than 30º. The gradation of fill soil shall be as per following limits.

Sieve Size	Percentage Passing
75 mm	100%
425 micron	0-60%
75 micron	less than 15 %
PI	≤6

1. *The density of backfill soil should be more than 95% of proctor density. The replaced /compacted soil should be lay down layer wise for each 300mm.*
2. *The design parameters considered for replaced/compacted Soil for calculating the SBC from shear criteria are as follows;*

C=0, Phi = 32 degree, Sp. Gravity= 2.63 Moisture content= 8%, bulk density= 1.84 g/cc, N = 25.

Table 4.5: Safe Load Carrying Capacity of normal bored cast in-situ RCC Pile in Soil

Sr. no.	Old & New Chainage	BH No.	Diameter of Pile (m)	Length of piles below cut-off (m)	Cut-off level below EGL (m)	Safe load carrying capacity of single pile (T)		In Lateral (T)
						In compression	In uplift	Fixed Head
1.	O.C._52+518 N.C._55+719	BH-A1	1.0	22.0	2.0	437.0	275.0	26.22
				24.0		480.0	315.0	
				26.0		523.0	355.0	
				28.0		565.0	394.0	
			1.2	22.0	2.0	644.0	370.0	35.10
				24.0		706.0	427.0	
				26.0		766.0	483.0	
				28.0		827.0	540.0	
2.		BH-A2	1.0	22.0	2.0	437.0	275.0	26.22
				24.0		480.0	315.0	
				26.0		523.0	355.0	
				28.0		565.0	394.0	
			1.2	22.0	2.0	644.0	370.0	35.10
				24.0		706.0	427.0	
				26.0		766.0	483.0	
				28.0		827.0	540.0	
3.	O.C._55+910 N.C._59+107	BH-A1	1.0	22.0	2.0	426.0	270.0	24.91
				24.0		463.0	305.0	
				26.0		501.0	340.0	
				28.0		538.0	375.0	
			1.2	22.0	2.0	589.0	349.0	33.35
				24.0		638.0	395.0	
				26.0		688.0	442.0	
				28.0		736.0	488.0	
4.		BH-A2	1.0	22.0	2.0	419.0	263.0	28.10
				24.0		455.0	298.0	
				26.0		492.0	333.0	
				28.0		529.0	367.0	
			1.2	22.0	2.0	576.0	334.0	37.62
				24.0		625.0	382.0	
				26.0		674.0	428.0	
				28.0		723.0	474.0	
		BH-A1	1.0	16.0	2.0	214.0	163.0	23.56
				18.0		228.0	179.0	
				20.0		243.0	195.0	
				22.0		258.0	205.0	

Sr. no.	Old & New Chainage	BH No.	Diameter of Pile (m)	Length of piles below cut-off (m)	Cut-off level below EGL (m)	Safe load carrying capacity of single pile (T)		In Lateral (T)
						In compression	In uplift	Fixed Head
	O.C._57+400 N.C._60+603	BH-A1	1.2	16.0	2.0	274.0	226.0	31.54
				18.0		293.0	247.0	
				20.0		311.0	268.0	
				22.0		329.0	205.0	
5.		BH-P2	1.0	16.0	2.0	240.0	171.0	29.31
				18.0		258.0	190.0	
				20.0		288.0	219.0	
				22.0		393.0	252.0	
			1.2	16.0	2.0	307.0	213.0	39.23
				18.0		330.0	238.0	
				20.0		371.0	277.0	
				22.0		545.0	322.0	
6.		BH-P3	1.0	16.0	2.0	331.0	192.0	28.71
				18.0		363.0	223.0	
				20.0		397.0	255.0	
				22.0		431.0	287.0	
			1.2	16.0	2.0	458.0	241.0	38.43
				18.0		501.0	283.0	
				20.0		546.0	326.0	
				22.0		591.0	369.0	
7.		BH-P4	1.0	16.0	2.0	343.0	201.0	25.57
				18.0		378.0	234.0	
				20.0		412.0	267.0	
				22.0		447.0	299.0	
			1.2	16.0	2.0	476.0	252.0	34.23
				18.0		523.0	296.0	
				20.0		568.0	340.0	
				22.0		614.0	384.0	
8.		BH-P5	1.0	16.0	2.0	327.0	190.0	24.91
				18.0		359.0	222.0	
				20.0		393.0	254.0	
				22.0		426.0	285.0	
			1.2	16.0	2.0	453.0	238.0	33.35
				18.0		497.0	282.0	
				20.0		542.0	325.0	
				22.0		586.0	367.0	
9.		BH-P6	1.0	16.0	2.0	284.0	153.0	23.56
				18.0		318.0	185.0	
				20.0		352.0	217.0	
				22.0		387.0	250.0	

Sr. no.	Old & New Chainage	BH No.	Diameter of Pile (m)	Length of piles below cut-off (m)	Cut-off level below EGL (m)	Safe load carrying capacity of single pile (T)		In Lateral (T)
						In compression	In uplift	Fixed Head
	O.C._57+400 N.C._60+603	BH-P6	1.2	16.0	2.0	404.0	194.0	31.54
				18.0		449.0	237.0	
				20.0		495.0	281.0	
				22.0		542.0	325.0	
10.		BH-P7	1.0	16.0	2.0	282.0	148.0	25.57
				18.0		316.0	181.0	
				20.0		351.0	214.0	
				22.0		385.0	247.0	
			1.2	16.0	2.0	234.0	189.0	34.23
				18.0		448.0	233.0	
				20.0		495.0	278.0	
				22.0		541.0	322.0	
11.		BH-P9	1.0	20.0	2.0	235.0	194.0	24.91
				22.0		255.0	215.0	
				24.0		378.0	246.0	
				26.0		411.0	278.0	
			1.2	20.0	2.0	300.0	246.0	33.35
				22.0		325.0	272.0	
				24.0		523.0	315.0	
				26.0		568.0	358.0	
12.		BH-P10	1.0	16.0	2.0	299.0	179.0	28.10
				18.0		331.0	210.0	
				20.0		364.0	241.0	
				22.0		417.0	274.0	
			1.2	16.0	2.0	413.0	225.0	37.62
				18.0		456.0	267.0	
				20.0		499.0	309.0	
				22.0		545.0	353.0	
13.		BH-P11	1.0	16.0	2.0	298.0	193.0	24.91
				18.0		329.0	223.0	
				20.0		360.0	254.0	
				22.0		392.0	284.0	
			1.2	16.0	2.0	403.0	242.0	33.35
				18.0		445.0	283.0	
				20.0		487.0	323.0	
				22.0		529.0	364.0	
14.		BH-P12	1.0	16.0	2.0	325.0	201.0	28.10
				18.0		358.0	233.0	
				20.0		391.0	264.0	
				22.0		424.0	296.0	

Sr. no.	Old & New Chainage	BH No.	Diameter of Pile (m)	Length of piles below cut-off (m)	Cut-off level below EGL (m)	Safe load carrying capacity of single pile (T)		In Lateral (T)
						In compression	In uplift	Fixed Head
	O.C._57+400 N.C._60+603	BH-P12	1.2	16.0	2.0	443.0	252.0	37.62
				18.0		487.0	294.0	
				20.0		530.0	336.0	
				22.0		574.0	379.0	
15.		BH-P13	1.0	16.0	2.0	256.0	198.0	31.06
				18.0		271.0	214.0	
				20.0		300.0	242.0	
				22.0		418.0	275.0	
			1.2	16.0	2.0	325.0	247.0	41.58
				18.0		343.0	268.0	
				20.0		382.0	306.0	
				22.0		571.0	350.0	
16.		BH-P15	1.0	16.0	2.0	341.0	200.0	24.91
				18.0		376.0	232.0	
				20.0		410.0	265.0	
				22.0		445.0	298.0	
			1.2	16.0	2.0	472.0	250.0	33.35
				18.0		518.0	294.0	
				20.0		563.0	338.0	
				22.0		609.0	382.0	
17.		BH-P16	1.0	16.0	2.0	318.0	184.0	24.24
				18.0		349.0	214.0	
				20.0		381.0	245.0	
				22.0		414.0	276.0	
			1.2	16.0	2.0	433.0	231.0	32.45
				18.0		482.0	271.0	
				20.0		525.0	313.0	
				22.0		569.0	355.0	
18.		BH-P17	1.0	16.0	2.0	308.0	192.0	22.86
				18.0		448.0	225.0	
				20.0		483.0	259.0	
				22.0		519.0	292.0	
			1.2	16.0	2.0	421.0	241.0	30.61
				18.0		640.0	286.0	
				20.0		688.0	331.0	
				22.0		735.0	377.0	
19.		BH-P18	1.0	16.0	2.0	397.0	223.0	24.91
				18.0		505.0	259.0	
				20.0		543.0	295.0	
				22.0		582.0	331.0	

Sr. no.	Old & New Chainage	BH No.	Diameter of Pile (m)	Length of piles below cut-off (m)	Cut-off level below EGL (m)	Safe load carrying capacity of single pile (T)		In Lateral (T)
						In compression	In uplift	Fixed Head
	O.C._57+400 N.C._60+603	BH-P18	1.2	16.0	2.0	547.0	279.0	33.35
				18.0		718.0	328.0	
				20.0		770.0	376.0	
				22.0		821.0	425.0	
20.		BH-P19	1.0	16.0	2.0	219.0	182.0	24.24
				18.0		234.0	198.0	
				20.0		262.0	226.0	
				22.0		515.0	257.0	
			1.2	16.0	2.0	274.0	226.0	32.45
				18.0		294.0	248.0	
				20.0		332.0	285.0	
				22.0		743.0	328.0	
21.		BH-A2	1.0	22.0	2.0	392.0	270.0	23.56
				24.0		424.0	300.0	
				26.0		456.0	331.0	
				28.0		489.0	362.0	
			1.2	22.0	2.0	535.0	347.0	31.54
				24.0		578.0	388.0	
				26.0		621.0	430.0	
				28.0		664.0	471.0	
22.	O.C._58+497 N.C._61+676	BH-A1	1.0	22.0	2.0	353.0	220.0	29.31
				24.0		386.0	253.0	
				26.0		421.0	285.0	
				28.0		454.0	317.0	
			1.2	22.0	2.0	492.0	282.0	39.23
				24.0		536.0	326.0	
				26.0		582.0	370.0	
				28.0		627.0	413.0	
23.		BH-P1	1.0	22.0	2.0	362.0	225.0	26.22
				24.0		396.0	259.0	
				26.0		432.0	292.0	
				28.0		466.0	324.0	
			1.2	22.0	2.0	513.0	292.0	35.10
				24.0		558.0	338.0	
				26.0		606.0	383.0	
				28.0		652.0	427.0	
24.		BH-P2	1.0	22.0	2.0	408.0	267	28.71
				24.0		442.0	300	
				26.0		479.0	334	
				28.0		607.0	368	

Sr. no.	Old & New Chainage	BH No.	Diameter of Pile (m)	Length of piles below cut-off (m)	Cut-off level below EGL (m)	Safe load carrying capacity of single pile (T)		In Lateral (T)
						In compression	In uplift	Fixed Head
	O.C._58+497 N.C._61+676	BH-P2	1.2	22.0	2.0	564.0	345	38.43
				24.0		609.0	388	
				26.0		658.0	434	
				28.0		855.0	481	
25.		BH-P3	1.0	22.0	2.0	428.0	286	26.22
				24.0		461.0	318	
				26.0		495.0	350	
				28.0		620.0	384	
			1.2	22.0	2.0	587.0	368	35.10
				24.0		632.0	411	
				26.0		677.0	454	
				28.0		725.0	500	
26.		BH-P4	1.0	22.0	2.0	452.0	304	29.31
				24.0		486.0	336	
				26.0		520.0	368	
				28.0		554.0	400	
			1.2	22.0	2.0	617.0	389	39.23
				24.0		662.0	432	
				26.0		707.0	475	
				28.0		753.0	518	
27.		BH-P5	1.0	22.0	2.0	361.0	227	29.90
				24.0		396.0	260	
				26.0		431.0	293	
				28.0		490.0	326	
			1.2	22.0	2.0	508.0	296	40.03
				24.0		556.0	341	
				26.0		602.0	385	
				28.0		648.0	429	
28.		BH-P6	1.0	22.0	2.0	360.0	224	27.48
				24.0		395.0	257	
				26.0		429.0	290	
				28.0		525.0	325	
			1.2	22.0	2.0	510.0	291	36.79
				24.0		557.0	336	
				26.0		603.0	380	
				28.0		654.0	428	
29.		BH-A2	1.0	22.0	2.0	439.0	294	28.10
				24.0		472.0	326	
				26.0		506.0	358	
				28.0		539.0	390	

Sr. no.	Old & New Chainage	BH No.	Diameter of Pile (m)	Length of piles below cut-off (m)	Cut-off level below EGL (m)	Safe load carrying capacity of single pile (T)		In Lateral (T)
						In compression	In uplift	Fixed Head
		BH-A2	1.2	22.0	2.0	599.0	376	37.62
				24.0		643.0	419	
				26.0		688.0	462	
				28.0		732.0	504	

Notes : -

1. Permissible lateral deflection has been taken as 5mm.
2. The self weight of the pile has been taken into account while computing the Safe Load Carrying Capacity of Pile in uplift only and not considered for vertical load capacity in compression.
3. The safe load carrying capacity of piles have been worked out on the basis of IS: 2911 (Part-1/sec-2) – 2010 as per provisions / assumptions provided therein & are only an assessment based on characteristics of the sub-strata obtained at the locations of the above BHs. The safe load carrying capacities as tabulated above will further depend substantially on the piling technique adopted and equipment used for making the piles in the field. However, for the final designs & constructions, the safe/allowable load carrying capacities of these piles should be taken by conducting actual initial load tests on these piles by casting them in the respective areas.
4. While erecting normal bored cast in-situ pile, utmost care should be taken while flushing/cleaning the bottom of pile particularly prior to start of pouring of concrete so as o rest the pile in virgin soil only for obtaining full point bearing as while computing safe load carrying capacity of pile no bottom softening during erection of pile has been considered.
5. Further the pile should have necessary structural strength to transmit / sustain the design load.

***Notes:* -**

All The above recommendations are based on the field and laboratory tests conducted on selected soil/ rock core samples and our experience in this regard. If the actual substrata conditions during excavation for the foundation differ from the observations reported here, the design experts/consultants should be referred for suggestion, further investigations.

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4. IS 8009 : Part 1 : 1976 (Reaffirmed Year : 2018) Code of practice for calculation of settlements of foundations: Part 1 Shallow foundations subjected to symmetrical static vertical loads.
5. IS 8009 : Part 2 : 1980 (Reaffirmed Year : 2020) Code of practice for calculation of settlement of foundations: Part 2 Deep foundations subjected to symmetrical static vertical loading.
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12. IS 1892 : 1979 (Reaffirmed Year : 2016) Code of practice for subsurface investigation for foundations.
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15. IS. 2720 (Part 4). 1985. Methods of Test for Soils: Grain Size Analysis.
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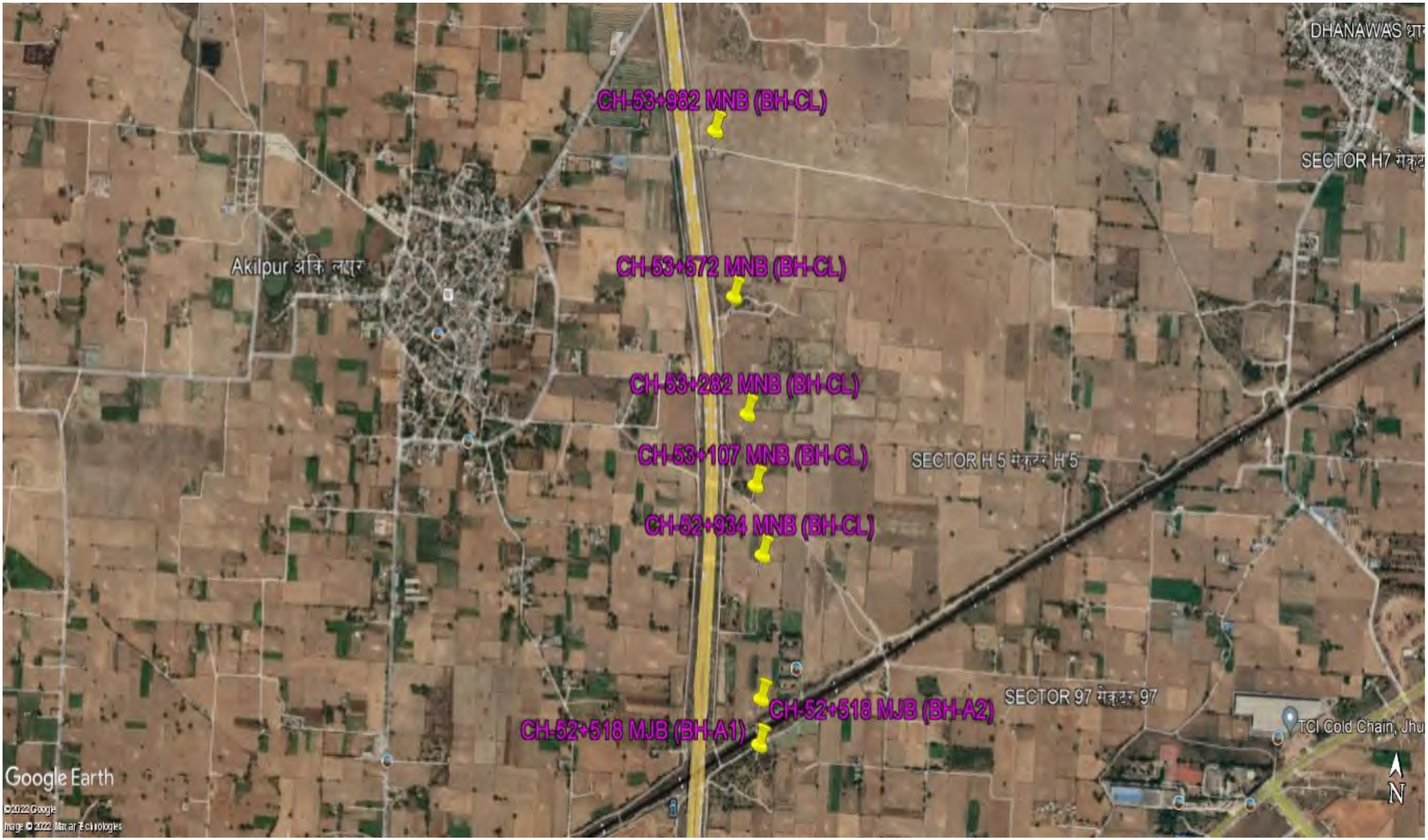
19. IS: 2720 (Part 3/See 1)–(1980) Methods of test for soils, determination of specific gravity of soil. New Delhi, India.
20. IS: 2720 (Part 5) 1985 Methods of test for soils, determination of liquid and plastic limit of soils. New Delhi, India.

Abbreviations

BH	Borehole
ERT	Electrical Resistivity Test
EGL	Existing Ground Level
GWT	Ground Water Table
IS	Indian Standards
SPT	Standard Penetration Test
DS	Disturbed Soil
R.L.	Reduced Level
m	Metre
sp. gr.	Specific Gravity
%	Percentage
mg /l	Milligram per litre
mg /kg	Milligram per kilogram

APPENDIX – A (FIELD DATA RESULTS)

Appendix No.	ITEMS
A-1	LOCATION PLAN
A-2	FIELD BORE HOLE LOGS
A-3	SUB SOIL PROFILE DIAGRAM


CH-53+982 MNB (BH-CL)
CH-53+572 MNB (BH-CL)
CH-53+282 MNB (BH-CL)
CH-53+107 MNB (BH-CL)
CH-52+934 MNB (BH-CL)
CH-52+518 MJB (BH-A2)
CH-52+518 MJB (BH-A1)
Akilpur अकिलपुर
SECTOR H7 सेक्टर
SECTOR H 5 सेक्टर H 5
SECTOR 97 सेक्टर 97
TCI Cold Chain, Jhu
Google Earth
N


CH-56+978 MNB (BH-CL)
Jawahar Navodaya Vidyalaya Gurugram
CH-56+701 MNB (BH-CL)
CH-56+403 MNB (BH-CL)
चांद नगर
CH-55+910 MJB (BH-A1)
CH-55+910 MJB (BH-A2)
IndianOil
Sayyad Mohamadpur सय्यद मोहम्मदपुर
CH-55+020 MNB (BH-CL)
CH-55+044_BH-PLT-04
Akilpur अकिलपुर
Khaintawas खैंटावास
CH-54+496 MNB (BH-CL)
CH-54+363 MNB (BH-CL)
Dronacharya College of Engineering
Patli Hajipur पटली हाजीपुर
Google Earth
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Image © 2022 Airbus


Palwal Expy
CH-57+400 MJB (BH-A2)
CH-57+400 MJB (BH-P19)
CH-57+400 MJB (BH-P18)
CH-57+400 MJB (BH-P17)
CH-57+400 MJB (BH-P16)
CH-57+400 MJB (BH-P15)
CH-57+400 MJB (BH-P13)
CH-57+400 MJB (BH-P12)
CH-57+400 MJB (BH-P11)
CH-57+400 MJB (BH-P10)
CH-57+400 MJB (BH-P9)
CH-57+400 MJB (BH-P7)
CH-57+400 MJB (BH-P6)
CH-57+400 MJB (BH-P5)
CH-57+400 MJB (BH-P4)
CH-57+400 MJB (BH-P3)
CH-57+400 MJB (BH-P2)
Google Earth
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N


CH-58+497 MJB (BH-A2)
CH-58+497 MJB (BH-P5)
CH-58+497 MJB (BH-P4)
CH-58+497 MJB (BH-P3)
CH-58+497 MJB (BH-P2)
CH-58+497 MJB (BH-P1)
CH-58+497 MJB (BH-A1)
CH-58+191 MNB (BH-CL)
CH-57+980 MNB (BH-CL)
Breakfast
Manjeet Fruit
Vijaypal Fruit
FARUKHNAGAR KMP Toll
Shiv Mandir Near Railway Fatak
Farmhouse Sultanpur
Sher Communication
KMP Expressway Toll Plaza
15A
Google Earth
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N


Kats Institute of Fire & safety Engineering
Chauhan dhaba and tea stall
CH-59+270 MNB (BH-CL)
Chaudhary bharat singh cemetery
CH-59+206 MNB (BH-CL)
Government College
CH-59+071 MNB (BH-CL)
Trolltech Engineering
Kundli - Manesar - Palwal Expy
CH-58+837 MNB (BH-CL)
Ram Gopal College of Pharmacy
Google Earth
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N

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*52+518 km	*Northing :*3143671.17 m	*Easting :*683091.771 m
Reduced Level (m):(+)213.216	*BH. No. :*BH-A1	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*22.80	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*20-08-2021	*Date of Completion :*24-08-2021	

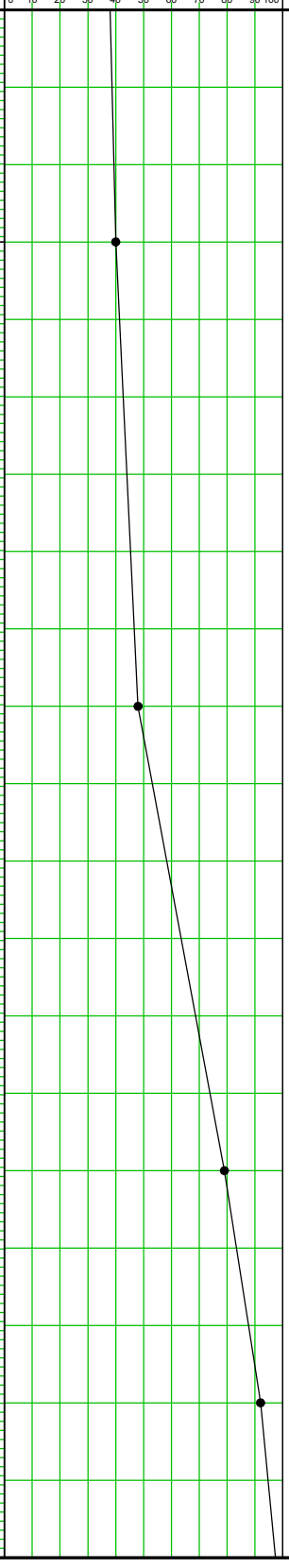
Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	UDS-1									
1.5											
2.0											
2.5	2.5	SPT-1	3	5	7	12					
3.0											
3.5							Brown, Medium dense, Sandy silt of low plasticity	ML-CL			
4.0	4	UDS-2									
4.5											
5.0											
5.5	5.5	SPT-2	5	9	13	22					
6.0											
6.5											
7.0	7	UDS*									
7.5											
8.0											
8.5	8.5	SPT-3	7	15	21	36	Brown, Hard, Silty clay of low plasticity	CL			
9.0											
9.5											
10.0	10	UDS-3									

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*52+518 km	*Northing :*3143671.17 m	*Easting :*683091.771 m
Reduced Level (m):(+)213.216	*BH. No. :*BH-A1	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*22.80	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*20-08-2021	*Date of Completion :*24-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0											
10.5							Brown, Hard, Silty clay of low plasticity	CL			
11.0											
11.5	11.5	SPT-4	9	16	24	40					
12.0											
12.5											
13.0	13	UDS-4									
13.5											
14.0											
14.5	14.5	SPT-5	10	20	28	48					
15.0											
15.5							Brown, Dense to very dense, Sandy silt of low plasticity	ML-CL			
16.0	16	UDS-5									
16.5											
17.0											
17.5	17.5	SPT-6	13	29	50	79					
18.0											
18.5											
19.0	19	SPT-7	15	32	60	92					
19.5											
20.0											



UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*52+518 km	*Northing :*3143671.17 m	*Easting :*683091.771 m
Reduced Level (m):(+)213.216	*BH. No. :*BH-A1	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*22.80	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*20-08-2021	*Date of Completion :*24-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
20.0											
20.5	20.5	SPT-8	30	60	40 (8cm)	>100					
21.0											
21.5											
22.0	22	SPT-9	26	57	43 (7cm)	>100					
22.5											
23.0									22.80m		
23.5	23.5	SPT-10	24	49	51 (5cm)	>100					
24.0											
24.5											
25.0	25	SPT-11	27	62	38 (3cm)	>100	Brown, Dense to very dense, Sandy silt of low plasticity	ML-CL			
25.5											
26.0											
26.5	26.5	SPT-12	28	48	52 (12cm)	>100					
27.0											
27.5											
28.0	28	SPT-13	25	43	56	99					
28.5											
29.0											
29.5	29.5	SPT-14	20	40	60 (13cm)	>100					
30.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*52+518 km	*Northing :*3143671.17 m	*Easting :*683091.771 m
Reduced Level (m):(+)213.216	*BH. No. :*BH-A1	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*22.80	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*20-08-2021	*Date of Completion :*24-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
30.0											
30.5											
31.0	31	SPT-15	26	44	56 (9cm)	>100					
31.5											
32.0											
32.5	32.5	SPT-16	17	29	41	70					
33.0											
33.5											
34.0	34	SPT-17	21	36	45	81					
34.5											
35.0							Brown, Dense to very dense, Sandy silt of low plasticity	ML-CL			
35.5	35.5	SPT-18	19	30	47	77					
36.0											
36.5											
37.0	37	SPT-19	20	38	44	82					
37.5											
38.0											
38.5	38.5	SPT-20	27	62	38 (9cm)	>100					
39.0											
39.5											
40.0	40	SPT-21	29	69	31 (8cm)	>100					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*52+518 km	*Northing :*3143783.105 m	*Easting :*683092.392 m
Reduced Level (m):(+)220.511	*BH. No. :*BH-A2	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*23.50	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*23-08-2021	*Date of Completion :*27-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	UDS-1									
1.5											
2.0											
2.5	2.5	SPT-1	4	6	7	13	Brown, Medium dense, Sandy silt of low plasticity	ML-CL			
3.0											
3.5											
4.0	4	UDS-2									
4.5											
5.0											
5.5	5.5	SPT-2	7	9	13	22					
6.0											
6.5											
7.0	7	UDS-3									
7.5											
8.0							Brown, Very stiff to hard, Silty clay of low plasticity	CL			
8.5	8.5	SPT-3	6	8	14	22					
9.0											
9.5											
10.0	10	UDS-4									

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*52+518 km	*Northing :*3143783.105 m	*Easting :*683092.392 m
Reduced Level (m):(+)220.511	*BH. No. :*BH-A2	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*23.50	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*23-08-2021	*Date of Completion :*27-08-2021	

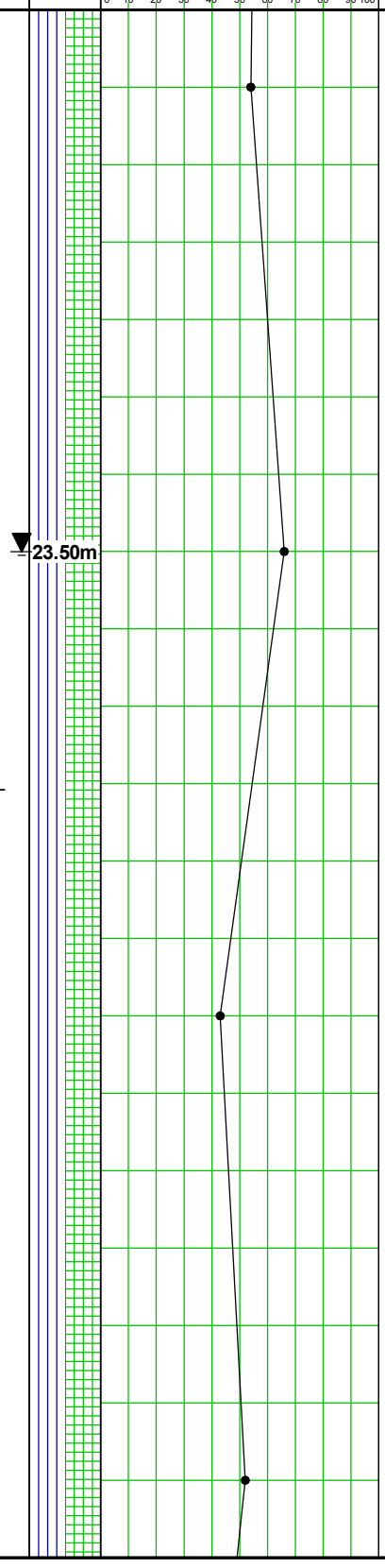
Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0										0 10 20 30 40 50 60 70 80 90 100	
10.5											
11.0											
11.5	11.5	SPT-4	8	13	16	29					
12.0											
12.5											
13.0	13	UDS-5					Brown, Very stiff to hard, Silty clay of low plasticity	CL			
13.5											
14.0											
14.5	14.5	SPT-5	12	17	22	39					
15.0											
15.5											
16.0	16	UDS-6									
16.5											
17.0											
17.5	17.5	SPT-6	14	22	34	56					
18.0							Brown, Very dense, Sandy silt of low plasticity	ML-CL			
18.5											
19.0	19	UDS-7									
19.5											
20.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*52+518 km	*Northing :*3143783.105 m	*Easting :*683092.392 m
Reduced Level (m):(+)220.511	*BH. No. :*BH-A2	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*23.50	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*23-08-2021	*Date of Completion :*27-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
20.0											
20.5	20.5	SPT-7	12	21	33	54					
21.0											
21.5											
22.0	22	UDS-8									
22.5											
23.0											
23.5	23.5	SPT-8	13	29	37	66			23.50m		
24.0											
24.5											
25.0	25	UDS-9					Brown, Very dense, Sandy silt of low plasticity	ML-CL			
25.5											
26.0											
26.5	26.5	SPT-9	9	17	26	43					
27.0											
27.5											
28.0	28	UDS-10									
28.5											
29.0											
29.5	29.5	SPT-10	11	19	33	52					
30.0											



UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*52+518 km	*Northing :*3143783.105 m	*Easting :*683092.392 m
Reduced Level (m):(+)220.511	*BH. No. :*BH-A2	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*23.50	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*23-08-2021	*Date of Completion :*27-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
30.0										0 10 20 30 40 50 60 70 80 90 100	
30.5											
31.0	31	UDS-11									
31.5											
32.0											
32.5	32.5	SPT-11	9	13	21	34					
33.0											
33.5											
34.0	34	UDS-12									
34.5											
35.0							Brown, Very dense, Sandy silt of low plasticity	ML-CL			
35.5	35.5	SPT-12	19	30	39	69					
36.0											
36.5											
37.0	37	SPT-13	24	38	43	81					
37.5											
38.0											
38.5	38.5	SPT-14	29	35	43	78					
39.0											
39.5											
40.0	40	SPT-15	27	40	53	93					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*52+934 km	*Northing :*3144133.557 m	*Easting :*683069.549 m
Reduced Level (m):(+)217.658	*BH. No. :*BH-CL	*BH Termination Depth (m):*10
*Proposed / Existing Structure :*Minor Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*154 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*04-07-2022	*Date of Completion :*04-07-2022	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0											
1.5	1.5	SPT-1	5	7	8	15					
2.0											
	2.25	UDS-1									
2.5							Brown, Very loose to Very dense, Silty Sand with Clay	SM-SC			
3.0	3	SPT-2	6	9	10	19					
3.5											
4.0											
4.5	4.5	SPT-3	9	11	12	23					
5.0											
	5.25	UDS-2									
5.5											
6.0	6	SPT-4	6	9	11	20					
6.5											
7.0											
7.5	7.5	SPT-5	7	10	12	22	Brown, Very Stiff, Silty Clay of Low Plasticity	CL			
8.0											
	8.25	UDS-3									
8.5											
9.0	9	SPT-6	9	12	14	26					
9.5											
10.0	10	SPT-7	11	19	25	44					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*53+107 km	*Northing :*3144302.971 m	*Easting :*683034.675 m
Reduced Level (m):(+)218.950	*BH. No. :*BH-CL	*BH Termination Depth (m):*15
*Proposed / Existing Structure :*Minor Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*15-01-2022	*Date of Completion :*15-01-2022	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5	0.5	SPT-1				15					
1.0											
1.5	1.5	SPT-2				15					
2.0											
	2.25	UDS*									
2.5							Brown, Medium dense, Sandy silt of low plasticity	ML-CL			
3.0	3	SPT-3				13					
3.5											
4.0											
4.5	4.5	SPT-4				17					
5.0											
	5.25	UDS-1									
5.5											
6.0	6	SPT-5				40					
6.5											
7.0											
7.5	7.5	SPT-6				45	Brown, Hard, Silty clay of low plasticity	CL			
8.0											
	8.25	UDS-2									
8.5											
9.0	9	SPT-7				45					
9.5											
10.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*53+107 km	*Northing :*3144302.971 m	*Easting :*683034.675 m
Reduced Level (m):(+)218.950	*BH. No. :*BH-CL	*BH Termination Depth (m):*15
*Proposed / Existing Structure :*Minor Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*15-01-2022	*Date of Completion :*15-01-2022	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0							Brown, Hard, Silty clay of low plasticity	CL			
10.5	10.5	SPT-8				50					
11.0											
	11.25	UDS-3									
11.5											
12.0	12	SPT-9				50					
12.5							Brown, Very dense, Sandy silt of low plasticity	ML-CL			
13.0											
13.5	13.5	SPT-10				51					
14.0											
	14.25	UDS-4									
14.5											
15.0	15	SPT-11				62					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*53+282 km	*Northing :*3144473.609 m	*Easting :*682995.864 m
Reduced Level (m):(+)218.087	*BH. No. :*BH-CL	*BH Termination Depth (m):*10
*Proposed / Existing Structure :*Minor Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*14-01-2022	*Date of Completion :*14-01-2022	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5	0.5	SPT-1	4	5	5	10					
1.0											
1.5	1.5	SPT-2	5	6	7	13					
2.0											
	2.25	UDS*									
2.5							Brown, Medium dense, Sandy silt of low plasticity	ML-CL			
3.0	3	SPT-3	6	6	8	14					
3.5											
4.0											
4.5	4.5	SPT-4	7	8	11	19					
5.0											
	5.25	UDS-1									
5.5											
6.0	6	SPT-5	11	13	16	29					
6.5											
7.0											
7.5	7.5	SPT-6	14	15	19	34	Brown, Very stiff to hard, Silty clay of low plasticity	CL			
8.0											
	8.25	UDS-2									
8.5											
9.0	9	SPT-7	10	11	14	25					
9.5											
10.0	10	SPT-8	12	13	17	30					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*53+572 km	*Northing :*3144756.38 m	*Easting :*682931.5 m
Reduced Level (m):(+)217.532	*BH. No. :*BH-CL	*BH Termination Depth (m):*10
*Proposed / Existing Structure :*Minor Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*14-01-2022	*Date of Completion :*14-01-2022	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5	0.5	SPT-1	2	3	3	6					
1.0											
1.5	1.5	SPT-2	3	4	7	11	Brown, Medium stiff to stiff, Silty clay of low plasticity	CL			
2.0											
	2.25	UDS*									
2.5											
3.0	3	SPT-3	8	11	15	26					
3.5											
4.0											
4.5	4.5	SPT-4	11	13	16	29					
5.0											
	5.25	UDS-1									
5.5											
6.0	6	SPT-5	13	15	19	34					
6.5							Brown, Very stiff to hard, Silty clay of low plasticity	CL			
7.0											
7.5	7.5	SPT-6	15	18	21	39					
8.0											
	8.25	UDS-2									
8.5											
9.0	9	SPT-7	17	20	27	47					
9.5											
10.0	10	SPT-8	19	22	30	52					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*53+982 km	*Northing :*3145156.16 m	*Easting :*682840.528 m
Reduced Level (m):(+)217.050	*BH. No. :*BH-CL	*BH Termination Depth (m):*10
*Proposed / Existing Structure :*Minor Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*12-01-2022	*Date of Completion :*12-01-2022	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5	0.5	SPT-1	2	2	3	5					
1.0											
1.5	1.5	SPT-2	5	5	6	11					
2.0											
2.5	2.25	UDS-1									
3.0	3	SPT-3	7	8	9	17					
3.5							Brown, Medium stiff to very stiff, Silty clay of low plasticity	CL			
4.0											
4.5	4.5	SPT-4	12	12	15	27					
5.0											
5.5	5.25	UDS-2									
6.0	6	SPT-5	10	11	13	24					
6.5											
7.0											
7.5	7.5	SPT-6	13	15	17	32					
8.0											
8.5	8.25	UDS-3									
9.0	9	SPT-7	15	18	24	42	Brown, Medium dense to dense, Sandy silt of low plasticity	ML-CL			
9.5											
10.0	10	SPT-8	15	17	21	38					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*54+363 km	*Northing :*3145527.663 m	*Easting :*682755.991 m
Reduced Level (m):(+)216.014	*BH. No. :*BH-CL	*BH Termination Depth (m):*10
*Proposed / Existing Structure :*Minor Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*11-01-2022	*Date of Completion :*11-01-2022	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5	0.5	SPT-1	9	11	13	24					
1.0											
1.5	1.5	SPT-2	8	9	10	19					
2.0											
	2.25	UDS*									
2.5							Brown, Medium dense, Silty sand with clay	SM-SC			
3.0	3	SPT-3	7	9	9	18					
3.5											
4.0											
4.5	4.5	SPT-4	8	10	12	22					
5.0											
	5.25	UDS-1									
5.5											
6.0	6	SPT-5	11	14	17	31					
6.5											
7.0							Brown, Hard, Silty clay of low plasticity	CL			
7.5	7.5	SPT-6	13	15	19	34					
8.0											
	8.25	UDS-2									
8.5											
9.0	9	SPT-7	11	17	21	38	Brown, Dense, Sandy silt of low plasticity	ML-CL			
9.5											
10.0	10	SPT-8	12	19	23	42					

(Depth v/s SPT N Value) axis: 0 10 20 30 40 50 60 70 80 90 100

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*54+496 km	*Northing :*3145657.348 m	*Easting :*682726.48 m
Reduced Level (m):(+)217.393	*BH. No. :*BH-CL	*BH Termination Depth (m):*15
*Proposed / Existing Structure :*Minor Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*12-01-2022	*Date of Completion :*12-01-2022	

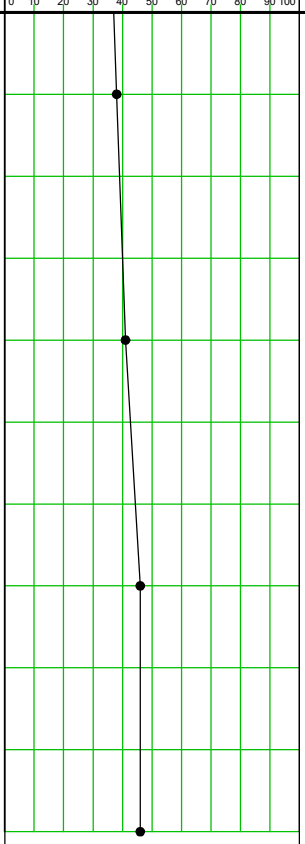
Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5	0.5	SPT-1	3	4	5	9					
1.0											
1.5	1.5	SPT-2	5	6	7	13					
2.0											
2.5	2.25	UDS*					Brown, Loose to medium dense, Sandy silt of low plasticity	ML-CL			
3.0	3	SPT-3	6	8	9	17					
3.5											
4.0											
4.5	4.5	SPT-4	7	9	11	20					
5.0											
5.5	5.25	UDS-1									
6.0	6	SPT-5	12	14	16	30					
6.5											
7.0											
7.5	7.5	SPT-6	13	15	19	34	Brown, Hard, Silty clay of low plasticity with gravel	CL			
8.0											
8.5	8.25	UDS-2									
9.0	9	SPT-7	12	16	19	35					
9.5											
10.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*54+496 km	*Northing :*3145657.348 m	*Easting :*682726.48 m
Reduced Level (m):(+)217.393	*BH. No. :*BH-CL	*BH Termination Depth (m):*15
*Proposed / Existing Structure :*Minor Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*12-01-2022	*Date of Completion :*12-01-2022	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0											
10.5	10.5	SPT-8	15	17	21	38					
11.0											
	11.25	UDS-3									
11.5											
12.0	12	SPT-9	13	19	22	41					
12.5											
13.0											
13.5	13.5	SPT-10	15	21	25	46					
14.0											
	14.25	UDS-4									
14.5											
15.0	15	SPT-11	18	20	26	46					



UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*55+020 km	*Northing :*3146168.286 m	*Easting :*682610.214 m
Reduced Level (m):(+)215.845	*BH. No. :*BH-CL	*BH Termination Depth (m):*13
*Proposed / Existing Structure :*Minor Bridge	*Water Table (m):*10.00	*Inclination :* Vertical
*Boring type :*Shell	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*02-07-2022	*Date of Completion :*03-07-2022	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0											
1.5	1.5	SPT-1	4	6	6	12					
2.0											
2.5	2.25	UDS-1					Medium dense, Brownish, Silty Sand	SM-SC			
3.0	3	SPT-2	4	6	8	14					
3.5											
4.0											
4.5	4.5	SPT-3	4	7	8	15					
5.0											
5.5	5.25	UDS-2									
6.0	6	SPT-4	8	10	10	20	Medium dense, Brownish, Silty Sand	SM			
6.5											
7.0											
7.5	7.5	SPT-5	7	9	11	20					
8.0											
8.5	8.25	UDS-3					Very Stiff to Hard, Brown, Silty Clay of LowPlasticity	CL			
9.0	9	SPT-6	6	10	12	22					
9.5											
10.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*55+020 km	*Northing :*3146168.286 m	*Easting :*682610.214 m
Reduced Level (m):(+)215.845	*BH. No. :*BH-CL	*BH Termination Depth (m):*13
*Proposed / Existing Structure :*Minor Bridge	*Water Table (m):*10.00	*Inclination :* Vertical
*Boring type :*Shell	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*02-07-2022	*Date of Completion :*03-07-2022	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0									10.00m	0 10 20 30 40 50 60 70 80 90 100	
10.5	10.5	SPT-7	8	11	15	26					
11.0											
	11.25	UDS-4									
11.5							Very Stiff to Hard, Brown, Silty Clay of LowPlasticity	CL			
12.0	12	SPT-8	9	15	19	34					
12.5											
13.0	13	SPT-9	11	16	23	39					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*55+044	*Northing :*3146175.461 m	*Easting :*682575.147 m
Reduced Level (m):(+)215.725	*BH. No. :*BH-PLT-04	*BH Termination Depth (m):*12
Proposed / Existing Structure :-	*Water Table (m):*Not encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*23-10-2021	*Date of Completion :*23-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
	0.75	UDS-1									
1.0							Brown, Loose, Silty sand	SM			
1.5	1.5	SPT-1	2	3	4	7					
2.0											
	2.25	SPT-2	3	5	7	12					
2.5											
3.0	3	SPT-3	5	7	9	16					
3.5											
	3.75	SPT-4	7	10	11	21					
4.0											
4.5	4.5	UDS-2									
5.0											
5.5							Brown, Medium dense, Sandy silt of low plasticity	ML-CL			
6.0	6	SPT-5	10	13	15	28					
6.5											
7.0											
7.5	7.5	UDS-3									
8.0											
8.5											
9.0	9	SPT-6	9	11	13	24					
9.5							Brown, Very stiff, Silty clay of low plasticity	CL			
10.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*55+044	*Northing :*3146175.461 m	*Easting :*682575.147 m
Reduced Level (m):(+)215.725	*BH. No. :*BH-PLT-04	*BH Termination Depth (m):*12
Proposed / Existing Structure :-	*Water Table (m):*Not encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*23-10-2021	*Date of Completion :*23-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0										0 10 20 30 40 50 60 70 80 90 100	
10.5	10.5	UDS-4					Brown, Very stiff, Silty clay of low plasticity	CL			
11.0											
11.5											
12.0	12	SPT-7	11	14	16	30					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*55+910 km	*Northing :*3147009.213 m	*Easting :*682418.856 m
Reduced Level (m):(+)218.101	*BH. No. :*BH-A1	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*16.00	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*23-08-2021	*Date of Completion :*24-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	UDS-1									
1.5											
2.0											
2.5	2.5	SPT-1	2	4	5	9					
3.0											
3.5							Brown, loose to medium dense, Silty sand	SM			
4.0	4	UDS-2									
4.5											
5.0											
5.5	5.5	SPT-2	4	7	9	16					
6.0											
6.5											
7.0	7	UDS-3									
7.5											
8.0											
8.5	8.5	SPT-3	7	10	14	24	Brown, Very stiff to Hard, Silty clay of low plasticity	CL			
9.0											
9.5											
10.0	10	UDS-4									

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*55+910 km	*Northing :*3147009.213 m	*Easting :*682418.856 m
Reduced Level (m):(+)218.101	*BH. No. :*BH-A1	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*16.00	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*23-08-2021	*Date of Completion :*24-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0											
10.5											
11.0											
11.5	11.5	SPT-4	12	15	17	32	Brown, Very stiff to Hard, Silty clay of low plasticity	CL			
12.0											
12.5											
13.0	13	UDS-5									
13.5											
14.0											
14.5	14.5	SPT-5	15	18	21	39					
15.0											
15.5											
16.0	16	UDS-6							16.00m		
16.5							Brown, Dense to Very dense, Sandy silt of low plasticity with gravel	ML-CL			
17.0											
17.5	17.5	SPT-6	17	22	24	46					
18.0											
18.5											
19.0	19	UDS-7									
19.5											
20.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*55+910 km	*Northing :*3147009.213 m	*Easting :*682418.856 m
Reduced Level (m):(+)218.101	*BH. No. :*BH-A1	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*16.00	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*23-08-2021	*Date of Completion :*24-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
20.0											
20.5	20.5	SPT-7	18	24	27	51					
21.0											
21.5											
22.0	22	UDS-8									
22.5											
23.0											
23.5	23.5	SPT-8	19	25	29	54					
24.0											
24.5											
25.0	25	UDS-9					Brown, Dense to Very dense, Sandy silt of low plasticity with gravel	ML-CL			
25.5											
26.0											
26.5	26.5	SPT-9	21	28	37	65					
27.0											
27.5											
28.0	28	UDS-10									
28.5											
29.0											
29.5	29.5	SPT-10	24	30	39	69					
30.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*55+910 km	*Northing :*3147009.213 m	*Easting :*682418.856 m
Reduced Level (m):(+)218.101	*BH. No. :*BH-A1	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*16.00	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*23-08-2021	*Date of Completion :*24-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
30.0										0 10 20 30 40 50 60 70 80 90 100	
30.5											
31.0	31	UDS-11									
31.5											
32.0											
32.5	32.5	SPT-11	27	38	47	85					
33.0											
33.5											
34.0	34	UDS-12									
34.5											
35.0							Brown, Dense to Very dense, Sandy silt of low plasticity with gravel	ML-CL			
35.5	35.5	SPT-12	37	48	54 (4cm)	>100					
36.0											
36.5											
37.0	37	SPT-13	39	50	50 (10cm)	>100					
37.5											
38.0											
38.5	38.5	SPT-14	65	85	15 (12cm)	>100					
39.0											
39.5											
40.0	40	SPT-15	67	59	41 (7cm)	>100					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*55+910 km	*Northing :*3147059.917 m	*Easting :*682407.318 m
Reduced Level (m):(+)217.474	*BH. No. :*BH-A2	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*15.60	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*19-08-2021	*Date of Completion :*21-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	SPT-1	5	7	8	15					
1.5											
2.0											
2.5	2.5	UDS-1									
3.0											
3.5											
4.0	4	SPT-2	7	10	12	22					
4.5											
5.0							Brown, Medium dense to dense, Silty sand	SM			
5.5	5.5	UDS-2									
6.0											
6.5											
7.0	7	SPT-3	10	12	14	26					
7.5											
8.0											
8.5	8.5	UDS-3									
9.0											
9.5											
10.0	10	SPT-4	11	15	17	32					

(Depth v/s SPT N Value) axis: 0 10 20 30 40 50 60 70 80 90 100

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*55+910 km	*Northing :*3147059.917 m	*Easting :*682407.318 m
Reduced Level (m):(+)217.474	*BH. No. :*BH-A2	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*15.60	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*19-08-2021	*Date of Completion :*21-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0											
10.5											
11.0											
11.5	11.5	UDS-4									
12.0											
12.5											
13.0	13	SPT-5	14	18	21	39	Brown, Medium dense to dense, Silty sand	SM			
13.5											
14.0											
14.5	14.5	UDS-5									
15.0											
15.5									15.60m		
16.0	16	SPT-6	12	16	19	35					
16.5											
17.0											
17.5	17.5	UDS-6									
18.0							Brown, Hard, Silty clay of low plasticity	CL			
18.5											
19.0	19	SPT-7	15	20	23	43					
19.5											
20.0											

(Depth v/s SPT N Value) axis: 0 10 20 30 40 50 60 70 80 90 100

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*55+910 km	*Northing :*3147059.917 m	*Easting :*682407.318 m
Reduced Level (m):(+)217.474	*BH. No. :*BH-A2	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*15.60	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*19-08-2021	*Date of Completion :*21-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
20.0							Brown, Hard, Silty clay of low plasticity	CL			
20.5	20.5	UDS-7									
21.0											
21.5											
22.0	22	SPT-8	20	24	29	53					
22.5											
23.0											
23.5	23.5	UDS-8									
24.0											
24.5											
25.0	25	SPT-9	21	27	31	58	Brown, Very dense, Sandy silt of low plasticity with gravel	ML-CL			
25.5											
26.0											
26.5	26.5	UDS-9									
27.0											
27.5											
28.0	28	SPT-10	24	32	41	73					
28.5											
29.0											
29.5	29.5	UDS*									
30.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*55+910 km	*Northing :*3147059.917 m	*Easting :*682407.318 m
Reduced Level (m):(+)217.474	*BH. No. :*BH-A2	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*15.60	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*19-08-2021	*Date of Completion :*21-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
30.0										0 10 20 30 40 50 60 70 80 90 100	
30.5											
31.0	31	SPT-11	40	54	46 (4cm)	>100					
31.5											
32.0											
32.5	32.5	SPT-12	44	62	38 (3cm)	>100					
33.0											
33.5											
34.0	34	SPT-13	38	58	42 (5cm)	>100					
34.5											
35.0							Brown, Very dense, Sandy silt of low plasticity with gravel	ML-CL			
35.5	35.5	SPT-14	33	65	35 (6cm)	>100					
36.0											
36.5											
37.0	37	SPT-15	39	73	27 (3cm)	>100					
37.5											
38.0											
38.5	38.5	SPT-16	42	69	31 (4cm)	>100					
39.0											
39.5											
40.0	40	SPT-17	48	70	30 (5cm)	>100					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*56+403 km	*Northing :*3147516.813 m	*Easting :*682303.349 m
Reduced Level (m):(+)215.389	*BH. No. :*BH-CL	*BH Termination Depth (m):*10
*Proposed / Existing Structure :*Minor Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*25-09-2021	*Date of Completion :*25-09-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	SPT-1	2	3	4	7					
1.5											
2.0							Brown, Loose, Silty sand	SM			
2.5	2.5	UDS-1									
3.0											
3.5											
4.0	4	SPT-2	7	10	12	22					
4.5											
5.0											
5.5	5.5	UDS-2									
6.0											
6.5											
7.0	7	SPT-3	8	11	14	25	Brown, Medium dense to dense, Sandy silt of low plasticity	ML-CL			
7.5											
8.0											
8.5	8.5	UDS-3									
9.0											
9.5											
10.0	10	SPT-4	11	15	27	42					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*56+701 km	*Northing :*3147807.384 m	*Easting :*682237.228 m
Reduced Level (m):(+)215.273	*BH. No. :*BH-CL	*BH Termination Depth (m):*15
*Proposed / Existing Structure :*Minor Bridge	*Water Table (m):*1.40	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*10-01-2022	*Date of Completion :*10-01-2022	

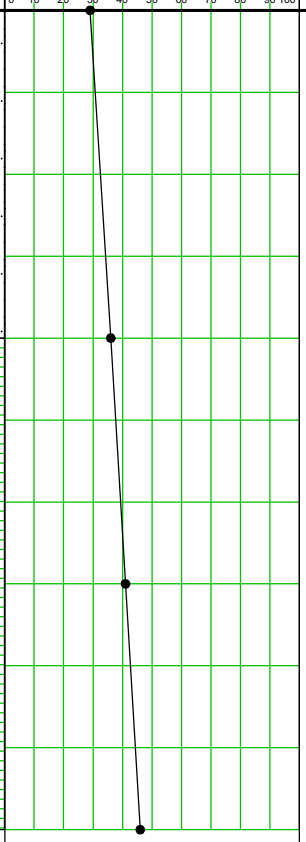
Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5	0.5	SPT-1	3	4	4	8					
1.0											
1.5	1.5	SPT-2	5	7	9	16			1.40m		
2.0											
	2.25	UDS-1									
2.5							Brown, Loose to medium dense, Sandy silt of low plasticity	ML-CL			
3.0	3	SPT-3	4	6	8	14					
3.5											
4.0											
4.5	4.5	SPT-4	7	9	10	19					
5.0											
	5.25	UDS-2									
5.5											
6.0	6	SPT-5	10	13	16	29					
6.5											
7.0											
7.5	7.5	SPT-6	11	14	19	33	Brown, Medium dense to dense, Silty sand	SP-SM			
8.0											
	8.25	UDS-3									
8.5											
9.0	9	SPT-7	12	15	20	35					
9.5											
10.0	10	SPT-8	10	13	16	29					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*56+701 km	*Northing :*3147807.384 m	*Easting :*682237.228 m
Reduced Level (m):(+)215.273	*BH. No. :*BH-CL	*BH Termination Depth (m):*15
*Proposed / Existing Structure :*Minor Bridge	*Water Table (m):*1.40	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*10-01-2022	*Date of Completion :*10-01-2022	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0											
10.5											
11.0							Brown, Medium dense to dense, Silty sand	SP-SM			
	11.25	UDS*									
11.5											
12.0	12	SPT-9	11	15	21	36					
12.5											
13.0											
13.5	13.5	SPT-10	14	19	22	41	Brown, Hard, Silty clay of low plasticity	CL			
14.0											
	14.25	UDS*									
14.5											
15.0	15	SPT-11	16	21	25	46					



UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*56+978 km	*Northing :*3148077.48 m	*Easting :*682175.767 m
Reduced Level (m):(+)212.389	*BH. No. :*BH-CL	*BH Termination Depth (m):*10
*Proposed / Existing Structure :*Minor Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*10-01-2022	*Date of Completion :*10-01-2022	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5	0.5	SPT-1	3	5	6	11					
1.0											
1.5	1.5	SPT-2	7	8	8	16	Brown, Medium dense, Sandy silt of low plasticity	ML-CL			
2.0											
	2.25	UDS-1									
2.5											
3.0	3	SPT-3	7	9	11	20					
3.5											
4.0											
4.5	4.5	SPT-4	8	10	12	22					
5.0											
	5.25	UDS-2									
5.5							Brown, Very stiff to hard, Silty clay of low plasticity	CL			
6.0	6	SPT-5	9	12	14	26					
6.5											
7.0											
7.5	7.5	SPT-6	11	13	16	29					
8.0											
	8.25	UDS*									
8.5											
9.0	9	SPT-7	9	11	19	30	Brown, Medium dense, Silty sand with clay	SM-SC			
9.5											
10.0	10	SPT-8	13	15	22	37					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*57+400 km	*Northing :*3148361.347 m	*Easting :*682111.171 m
Reduced Level (m):(+)217.941	*BH. No. :*BH-A1	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*10.90	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*27-08-2021	*Date of Completion :*27-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	SPT-1	3	5	7	12					
1.5											
2.0											
2.5	2.5	UDS-1									
3.0											
3.5											
4.0	4	SPT-2	5	7	9	16	Brown, Medium dense, Silty sand with clay	SM-SC			
4.5											
5.0											
5.5	5.5	UDS-2									
6.0											
6.5											
7.0	7	SPT-3	7	10	12	22					
7.5											
8.0											
8.5	8.5	UDS-3									
9.0							Brown, Hard, Silty clay of low plasticity	CL			
9.5											
10.0	10	SPT-4	12	15	17	32					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*57+400 km	*Northing :*3148361.347 m	*Easting :*682111.171 m
Reduced Level (m):(+)217.941	*BH. No. :*BH-A1	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*10.90	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*27-08-2021	*Date of Completion :*27-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0											
10.5											
11.0											
11.5	11.5	UDS-4					Brown, Hard, Silty clay of low plasticity	CL			
12.0											
12.5											
13.0	13	SPT-5	18	23	29	52					
13.5											
14.0											
14.5	14.5	UDS-5									
15.0											
15.5							Brown, Very dense, Silty sand	SM			
16.0	16	SPT-6	23	28	34	62					
16.5											
17.0											
17.5	17.5	UDS-6									
18.0											
18.5											
19.0	19	SPT-7	16	24	27	51	Brown, Hard, Silty clay of low plasticity	CL			
19.5											
20.0											

10.90m

0 10 20 30 40 50 60 70 80 90 100

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*57+400 km	*Northing :*3148361.347 m	*Easting :*682111.171 m
Reduced Level (m):(+)217.941	*BH. No. :*BH-A1	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*10.90	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*27-08-2021	*Date of Completion :*27-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
20.0											
20.5	20.5	UDS-7									
21.0											
21.5											
22.0	22	SPT-8	21	28	32	60	Brown, Hard, Silty clay of low plasticity	CL			
22.5											
23.0											
23.5	23.5	SPT-9	27	34	41	75					
24.0											
24.5											
25.0	25	SPT-10	29	36	49	85					
25.5											
26.0											
26.5	26.5	SPT-11	34	48	51	99	Brown, Very dense, Sandy silt of low plasticity	ML-CL			
27.0											
27.5											
28.0	28	SPT-12	40	55	45 (4cm)	>100					
28.5											
29.0											
29.5	29.5	SPT-13	46	66	34 (13cm)	>100					
30.0	30	-									

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*57+400 km	*Northing :*3148389.429 m	*Easting :*682104.781 m
Reduced Level (m):(+)213.893	*BH. No. :*BH-P2	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*11.85	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*23-08-2021	*Date of Completion :*24-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	SPT-1	6	7	8	15					
1.5											
2.0											
2.5	2.5	UDS-1					Brown, Medium dense, Sandy silt of low plasticity	ML-CL			
3.0											
3.5											
4.0	4	SPT-2	8	10	14	24					
4.5											
5.0											
5.5	5.5	UDS-2									
6.0											
6.5											
7.0	7	SPT-3	10	14	18	32	Brown, Hard, Silty clay of low plasticity	CL			
7.5											
8.0											
8.5	8.5	UDS-3									
9.0											
9.5							Brown, Dense, Sandy silt of low plasticity	ML-CL			
10.0	10	SPT-4	12	16	21	37					

(Depth v/s SPT N Value) axis: 0 10 20 30 40 50 60 70 80 90 100

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*57+400 km	*Northing :*3148389.429 m	*Easting :*682104.781 m
Reduced Level (m):(+)213.893	*BH. No. :*BH-P2	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*11.85	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*23-08-2021	*Date of Completion :*24-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0											
10.5											
11.0											
11.5	11.5	UDS-4									
12.0									11.85m		
12.5							Brown, Dense, Sandy silt of low plasticity	ML-CL			
13.0	13	SPT-5	10	19	23	42					
13.5											
14.0											
14.5	14.5	UDS-5									
15.0											
15.5											
16.0	16	SPT-6	18	26	38	64					
16.5											
17.0											
17.5	17.5	UDS-6					Brown, Hard, Silty clay of low plasticity	CL			
18.0											
18.5											
19.0	19	SPT-7	24	29	41	70					
19.5											
20.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*57+400 km	*Northing :*3148389.429 m	*Easting :*682104.781 m
Reduced Level (m):(+)213.893	*BH. No. :*BH-P2	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*11.85	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*23-08-2021	*Date of Completion :*24-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
20.0							Brown, Hard, Silty clay of low plasticity	CL			
20.5	20.5	UDS-7									
21.0											
21.5											
22.0	22	SPT-8	27	36	48	84					
22.5											
23.0											
23.5	23.5	UDS-8									
24.0											
24.5							Brown, Very dense, Sandy silt of low plasticity	ML-CL			
25.0	25	SPT-9	26	38	58	96					
25.5											
26.0											
26.5	26.5	UDS-9									
27.0											
27.5											
28.0	28	SPT-10	32	58	42 (6cm)	>100					
28.5											
29.0							Brown, Very dense, Sandy silt of low plasticity	ML-CL			
29.5	29.5	SPT-11	42	62	38 (7cm)	>100					
30.0	30										

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*57+400 km	*Northing :*3148402.495 m	*Easting :*682101.808 m
Reduced Level (m):(+)214.414	*BH. No. :*BH-P3	*BH Termination Depth (m):*31
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*11.50	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*23-08-2021	*Date of Completion :*24-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	UDS-1									
1.5											
2.0											
2.5	2.5	SPT-1	2	5	7	12					
3.0											
3.5											
4.0	4	UDS-2									
4.5											
5.0							Brown, Medium dense to dense, Sandy silt of low plasticity	ML-CL			
5.5	5.5	SPT-2	7	11	15	26					
6.0											
6.5											
7.0	7	UDS-3									
7.5											
8.0											
8.5	8.5	SPT-3	13	16	19	35					
9.0											
9.5											
10.0	10	UDS-4									

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*57+400 km	*Northing :*3148402.495 m	*Easting :*682101.808 m
Reduced Level (m):(+)214.414	*BH. No. :*BH-P3	*BH Termination Depth (m):*31
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*11.50	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*23-08-2021	*Date of Completion :*24-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0										0 10 20 30 40 50 60 70 80 90 100	
10.5											
11.0											
11.5	11.5	SPT-4	15	17	20	37			11.50m		
12.0											
12.5											
13.0	13	UDS-5									
13.5											
14.0											
14.5	14.5	SPT-5	16	18	21	39	Brown, Dense, Silty sand	SM			
15.0											
15.5											
16.0	16	UDS-6									
16.5											
17.0											
17.5	17.5	SPT-6	17	20	24	44					
18.0											
18.5											
19.0	19	UDS-7									
19.5							Brown, Dense to very dense, Sandy silt of low plasticity	ML-CL			
20.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*57+400 km	*Northing :*3148402.495 m	*Easting :*682101.808 m
Reduced Level (m):(+)214.414	*BH. No. :*BH-P3	*BH Termination Depth (m):*31
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*11.50	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*23-08-2021	*Date of Completion :*24-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
20.0											
20.5	20.5	SPT-7	19	23	25	48					
21.0											
21.5											
22.0	22	UDS-8									
22.5											
23.0											
23.5	23.5	SPT-8	22	27	30	57					
24.0											
24.5											
25.0	25	UDS-9					Brown, Dense to very dense, Sandy silt of low plasticity	ML-CL			
25.5											
26.0											
26.5	26.5	SPT-9	24	29	32	61					
27.0											
27.5											
28.0	28	UDS-10									
28.5											
29.0											
29.5	29.5	SPT-10	31	37	42	79					
30.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*57+400 km	*Northing :*3148402.495 m	*Easting :*682101.808 m
Reduced Level (m):(+)214.414	*BH. No. :*BH-P3	*BH Termination Depth (m):*31
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*11.50	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*23-08-2021	*Date of Completion :*24-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
30.0										0 10 20 30 40 50 60 70 80 90 100	
30.5							Brown, Dense to very dense, Sandy silt of low plasticity	ML-CL			
31.0	31	UDS-11									

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*57+400 km	*Northing :*3148415.561 m	*Easting :*682098.835 m
Reduced Level (m):(+)214.498	*BH. No. :*BH-P4	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*11.80	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*24-08-2021	*Date of Completion :*25-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	SPT-1	3	5	7	12					
1.5											
2.0											
2.5	2.5	UDS-1									
3.0											
3.5							Brown, Medium dense, Silty sand	SM			
4.0	4	SPT-2	5	8	11	19					
4.5											
5.0											
5.5	5.5	UDS-2									
6.0											
6.5											
7.0	7	SPT-3	10	15	32	47					
7.5											
8.0											
8.5	8.5	UDS-3					Brown, Very dense, Sandy silt of low plasticity	ML-CL			
9.0											
9.5											
10.0	10	SPT-4	11	17	37	54					

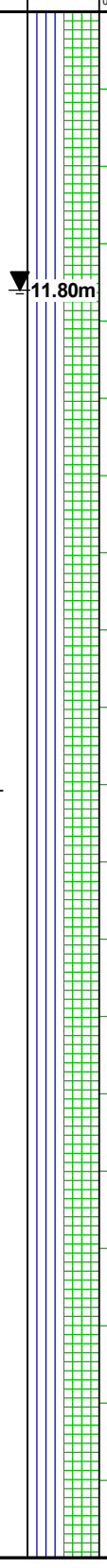
(Depth v/s SPT N Value) axis: 0 10 20 30 40 50 60 70 80 90 100

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*57+400 km	*Northing :*3148415.561 m	*Easting :*682098.835 m
Reduced Level (m):(+)214.498	*BH. No. :*BH-P4	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*11.80	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*24-08-2021	*Date of Completion :*25-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0											
10.5											
11.0											
11.5	11.5	UDS-4									
12.0									11.80m		
12.5											
13.0	13	SPT-5	10	19	39	58					
13.5											
14.0											
14.5	14.5	UDS-5									
15.0							Brown, Very dense, Sandy silt of low plasticity	ML-CL			
15.5											
16.0	16	SPT-6	13	21	38	59					
16.5											
17.0											
17.5	17.5	UDS-6									
18.0											
18.5											
19.0	19	SPT-7	15	35	40	75					
19.5											
20.0											



UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*57+400 km	*Northing :*3148415.561 m	*Easting :*682098.835 m
Reduced Level (m):(+)214.498	*BH. No. :*BH-P4	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*11.80	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*24-08-2021	*Date of Completion :*25-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
20.0											
20.5	20.5	UDS-7									
21.0											
21.5											
22.0	22	SPT-8	17	29	42	71					
22.5											
23.0											
23.5	23.5	UDS-8									
24.0											
24.5											
25.0	25	SPT-9	20	31	45	76	Brown, Very dense, Sandy silt of low plasticity	ML-CL			
25.5											
26.0											
26.5	26.5	UDS*									
27.0											
27.5											
28.0	28	SPT-10	28	36	48	84					
28.5											
29.0											
29.5	29.5	UDS-9									
30.0	30	-									

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*57+400 km	*Northing :*3148428.627 m	*Easting :*682095.861 m
Reduced Level (m):(+)214.548	*BH. No. :*BH-P5	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*12.00	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*24-08-2021	*Date of Completion :*25-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	UDS-1									
1.5											
2.0											
2.5	2.5	SPT-1	3	5	6	11					
3.0											
3.5											
4.0	4	UDS-2									
4.5											
5.0							Brown, Medium dense to dense, Silty sand	SM			
5.5	5.5	SPT-2	7	9	11	20					
6.0											
6.5											
7.0	7	UDS-3									
7.5											
8.0											
8.5	8.5	SPT-3	12	14	17	31					
9.0											
9.5											
10.0	10	UDS-4									

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*57+400 km	*Northing :*3148428.627 m	*Easting :*682095.861 m
Reduced Level (m):(+)214.548	*BH. No. :*BH-P5	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*12.00	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*24-08-2021	*Date of Completion :*25-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0											
10.5											
11.0											
11.5	11.5	SPT-4	15	20	25	45					
12.0									12.00m		
12.5											
13.0	13	UDS-5									
13.5											
14.0											
14.5	14.5	SPT-5	18	24	29	53					
15.0							Brown, Dense to very dense, Sandy silt of low plasticity	ML-CL			
15.5											
16.0	16	UDS-6									
16.5											
17.0											
17.5	17.5	SPT-6	22	28	33	61					
18.0											
18.5											
19.0	19	UDS-7									
19.5											
20.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*57+400 km	*Northing :*3148428.627 m	*Easting :*682095.861 m
Reduced Level (m):(+)214.548	*BH. No. :*BH-P5	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*12.00	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*24-08-2021	*Date of Completion :*25-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
20.0											
20.5	20.5	SPT-7	19	31	37	68					
21.0											
21.5											
22.0	22	UDS-8									
22.5											
23.0											
23.5	23.5	SPT-8	27	36	43	79					
24.0							Brown, Dense to very dense, Sandy silt of low plasticity	ML-CL			
24.5											
25.0	25	UDS*									
25.5											
26.0											
26.5	26.5	SPT-9	28	43	47	90					
27.0											
27.5											
28.0	28	UDS-9									
28.5											
29.0							Brown, Dense to very dense, Sandy silt of low plasticity	ML-CL			
29.5	29.5	SPT-10	26	45	59	94					
30.0	30										

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*57+400 km	*Northing :*3148441.693 m	*Easting :*682092.888 m
Reduced Level (m):(+)214.417	*BH. No. :*BH-P6	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*11.40	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*23-08-2021	*Date of Completion :*24-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	SPT-1	2	4	6	10					
1.5											
2.0											
2.5	2.5	UDS-1									
3.0											
3.5											
4.0	4	SPT-2	4	7	9	16	Brown, Medium dense, Silty sand	SM			
4.5											
5.0											
5.5	5.5	UDS-2									
6.0											
6.5											
7.0	7	SPT-3	4	8	12	20					
7.5											
8.0											
8.5	8.5	UDS-3									
9.0							Brown, Very stiff to hard, Silty clay of low plasticity	CL			
9.5											
10.0	10	SPT-4	6	10	16	26					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*57+400 km	*Northing :*3148441.693 m	*Easting :*682092.888 m
Reduced Level (m):(+)214.417	*BH. No. :*BH-P6	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*11.40	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*23-08-2021	*Date of Completion :*24-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0										0 10 20 30 40 50 60 70 80 90 100	
10.5											
11.0											
11.5	11.5	UDS-4							11.40m		
12.0											
12.5							Brown, Very stiff to hard, Silty clay of low plasticity	CL			
13.0	13	SPT-5	9	13	19	32					
13.5											
14.0											
14.5	14.5	UDS-5									
15.0											
15.5											
16.0	16	SPT-6	15	21	29	50					
16.5											
17.0											
17.5	17.5	UDS-6					Brown, Very dense, Sandy silt of low plasticity	ML-CL			
18.0											
18.5											
19.0	19	SPT-7	14	22	31	53					
19.5											
20.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*57+400 km	*Northing :*3148441.693 m	*Easting :*682092.888 m
Reduced Level (m):(+)214.417	*BH. No. :*BH-P6	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*11.40	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*23-08-2021	*Date of Completion :*24-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
20.0											
20.5	20.5	UDS-7									
21.0											
21.5											
22.0	22	SPT-8	16	25	35	60					
22.5											
23.0											
23.5	23.5	UDS-8									
24.0											
24.5											
25.0	25	SPT-9	17	26	37	63	Brown, Very dense, Sandy silt of low plasticity	ML-CL			
25.5											
26.0											
26.5	26.5	UDS-9									
27.0											
27.5											
28.0	28	SPT-10	19	31	42	73					
28.5											
29.0											
29.5	29.5	UDS*									
30.0	30	-									

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*57+400 km	*Northing :*3148454.759 m	*Easting :*682089.915 m
Reduced Level (m):(+)214.599	*BH. No. :*BH-P7	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*11.00	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*23-08-2021	*Date of Completion :*24-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	UDS-1									
1.5											
2.0											
2.5	2.5	SPT-1	4	6	8	14					
3.0											
3.5											
4.0	4	UDS-2									
4.5											
5.0							Brown, Medium dense, Silty sand	SM			
5.5	5.5	SPT-2	7	10	11	21					
6.0											
6.5											
7.0	7	UDS-3									
7.5											
8.0											
8.5	8.5	SPT-3	9	14	16	30					
9.0											
9.5											
10.0	10	UDS-4									

(Depth v/s SPT N Value) axis: 0 10 20 30 40 50 60 70 80 90 100

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*57+400 km	*Northing :*3148454.759 m	*Easting :*682089.915 m
Reduced Level (m):(+)214.599	*BH. No. :*BH-P7	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*11.00	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*23-08-2021	*Date of Completion :*24-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0											
10.5											
11.0									11.00m		
11.5	11.5	SPT-4	13	19	23	42					
12.0											
12.5											
13.0	13	UDS-5					Brown, hard, Silty clay of low plasticity	CL			
13.5											
14.0											
14.5	14.5	SPT-5	12	15	18	33					
15.0											
15.5											
16.0	16	UDS-6									
16.5											
17.0											
17.5	17.5	SPT-6	14	20	23	43					
18.0							Brown, Dense to very dense, Sandy silt of low plasticity	ML-CL			
18.5											
19.0	19	UDS-7									
19.5											
20.0											

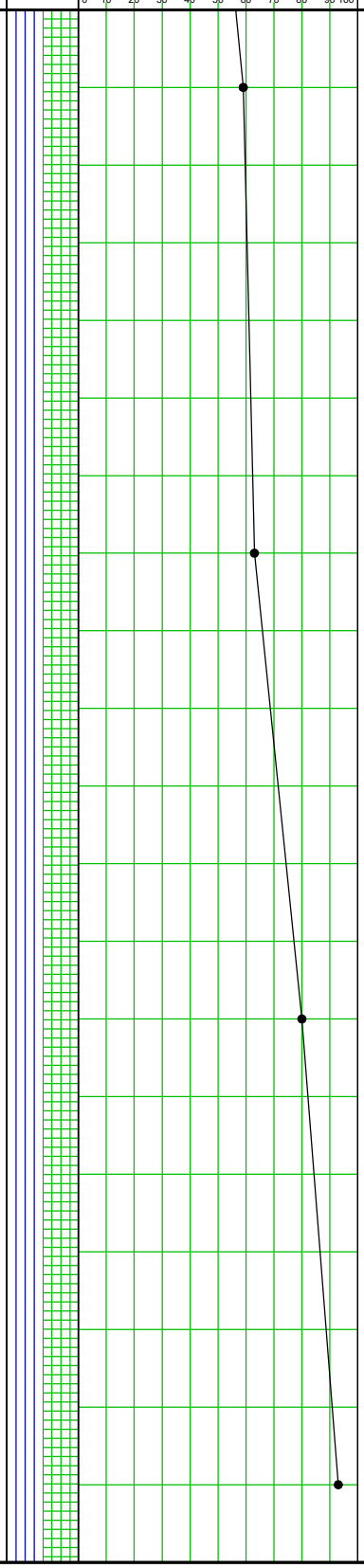
(Depth v/s SPT N Value) axis: 0 10 20 30 40 50 60 70 80 90 100

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*57+400 km	*Northing :*3148454.759 m	*Easting :*682089.915 m
Reduced Level (m):(+)214.599	*BH. No. :*BH-P7	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*11.00	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*23-08-2021	*Date of Completion :*24-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
20.0											
20.5	20.5	SPT-7	25	27	32	59					
21.0											
21.5											
22.0	22	UDS-8									
22.5											
23.0											
23.5	23.5	SPT-8	24	29	34	63					
24.0											
24.5											
25.0	25	UDS-9					Brown, Dense to very dense, Sandy silt of low plasticity	ML-CL			
25.5											
26.0											
26.5	26.5	SPT-9	27	35	45	80					
27.0											
27.5											
28.0	28	UDS-10									
28.5											
29.0											
29.5	29.5	SPT-10	31	42	51	93					
30.0	30	-									



UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*57+400 km	*Northing :*3148480.891 m	*Easting :*682083.968 m
Reduced Level (m):(+)214.330	*BH. No. :*BH-P9	*BH Termination Depth (m):*35
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*12.00	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*28.00
*Date of Start :*20-08-2021	*Date of Completion :*22-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	SPT-1	3	6	7	13					
1.5											
2.0											
2.5	2.5	UDS-1									
3.0											
3.5											
4.0	4	SPT-2	4	8	10	18	Brown, Medium dense, Sandy silt of low plasticity	ML-CL			
4.5											
5.0											
5.5	5.5	UDS-2									
6.0											
6.5											
7.0	7	SPT-3	6	9	10	19					
7.5											
8.0											
8.5	8.5	UDS-3									
9.0							Brown, Hard, Silty clay of low plasticity	CL			
9.5											
10.0	10	SPT-4	9	14	19	33					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*57+400 km	*Northing :*3148480.891 m	*Easting :*682083.968 m
Reduced Level (m):(+)214.330	*BH. No. :*BH-P9	*BH Termination Depth (m):*35
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*12.00	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*28.00
*Date of Start :*20-08-2021	*Date of Completion :*22-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0											
10.5											
11.0											
11.5	11.5	UDS-4									
12.0									12.00m		
12.5							Brown, Hard, Silty clay of low plasticity	CL			
13.0	13	SPT-5	8	13	17	30					
13.5											
14.0											
14.5	14.5	UDS-5									
15.0											
15.5											
16.0	16	SPT-6	16	30	36	66	Brown, Very dense, Sandy silt of low plasticity with gravel	ML-CL			
16.5											
17.0											
17.5	17.5	UDS-6									
18.0											
18.5											
19.0	19	SPT-7	12	17	25	42	Brown, Hard, Silty clay of low plasticity	CL			
19.5											
20.0											

(Depth v/s SPT N Value) axis: 0 10 20 30 40 50 60 70 80 90 100

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*57+400 km	*Northing :*3148480.891 m	*Easting :*682083.968 m
Reduced Level (m):(+)214.330	*BH. No. :*BH-P9	*BH Termination Depth (m):*35
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*12.00	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*28.00
*Date of Start :*20-08-2021	*Date of Completion :*22-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
20.0											
20.5	20.5	UDS-7									
21.0											
21.5											
22.0	22	SPT-8	13	20	28	48	Brown, Hard, Silty clay of low plasticity	CL			
22.5											
23.0											
23.5	23.5	SPT-9	18	24	36	60					
24.0											
24.5											
25.0	25	SPT-10	29	32	39	71					
25.5											
26.0											
26.5	26.5	SPT-11	30	36	41	77	Brown, Very dense, Sandy silt of low plasticity with gravel	ML-CL			
27.0											
27.5											
28.0	28	SPT-12	35	40	48	88					
28.5											
29.0											
29.5	29.5	SPT-13	37	41	50	91					
30.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*57+400 km	*Northing :*3148480.891 m	*Easting :*682083.968 m
Reduced Level (m):(+)214.330	*BH. No. :*BH-P9	*BH Termination Depth (m):*35
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*12.00	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*28.00
*Date of Start :*20-08-2021	*Date of Completion :*22-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
30.0										0 10 20 30 40 50 60 70 80 90 100	
30.5											
31.0	31	SPT-14	32	45	52	97					
31.5											
32.0											
32.5	32.5	SPT-15	29	52	48 (10cm)	>100	Brown, Very dense, Sandy silt of low plasticity with gravel	ML-CL			
33.0											
33.5											
34.0	34	SPT-16	31	58	42 (8cm)	>100					
34.5											
35.0	35	SPT-17	33	67	33 (5cm)	>100					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*57+400 km	*Northing :*3148493.957 m	*Easting :*682080.995 m
Reduced Level (m):(+)214.021	*BH. No. :*BH-P10	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*11.85	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*27.00
*Date of Start :*23-08-2021	*Date of Completion :*24-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	UDS-1									
1.5											
2.0											
2.5	2.5	SPT-1	9	12	15	27					
3.0											
3.5							Brown, Medium dense, Silty sand	SM			
4.0	4	UDS-2									
4.5											
5.0											
5.5	5.5	SPT-2	6	11	14	25					
6.0											
6.5											
7.0	7	UDS-3									
7.5											
8.0											
8.5	8.5	SPT-3	8	11	16	27	Brown, Very stiff, Silty clay of low plasticity	CL			
9.0											
9.5											
10.0	10	UDS-4									

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*57+400 km	*Northing :*3148493.957 m	*Easting :*682080.995 m
Reduced Level (m):(+)214.021	*BH. No. :*BH-P10	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*11.85	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*27.00
*Date of Start :*23-08-2021	*Date of Completion :*24-08-2021	

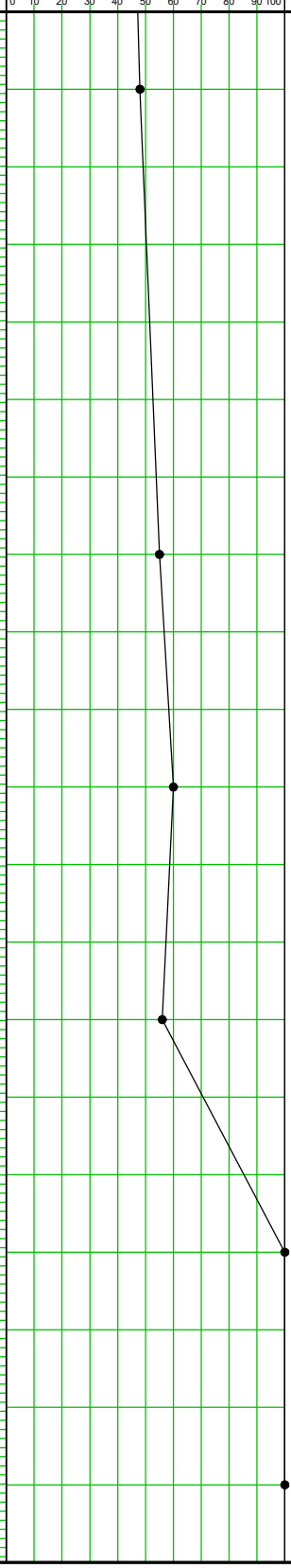
Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0										0 10 20 30 40 50 60 70 80 90 100	
10.5											
11.0											
11.5	11.5	SPT-4	9	13	18	31					
12.0									11.85m		
12.5											
13.0	13	UDS-5									
13.5											
14.0											
14.5	14.5	SPT-5	10	15	22	37					
15.0							Brown, Very dense, Sandy silt of low plasticity with gravel	ML-CL			
15.5											
16.0	16	UDS-6									
16.5											
17.0											
17.5	17.5	SPT-6	13	18	25	43					
18.0											
18.5											
19.0	19	UDS-7									
19.5											
20.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*57+400 km	*Northing :*3148493.957 m	*Easting :*682080.995 m
Reduced Level (m):(+)214.021	*BH. No. :*BH-P10	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*11.85	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*27.00
*Date of Start :*23-08-2021	*Date of Completion :*24-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
20.0											
20.5	20.5	SPT-7	14	20	28	48					
21.0											
21.5											
22.0	22	UDS-8									
22.5											
23.0											
23.5	23.5	SPT-8	15	24	31	55					
24.0											
24.5											
25.0	25	SPT-9	16	28	32	60	Brown, Very dense, Sandy silt of low plasticity with gravel	ML-CL			
25.5											
26.0											
26.5	26.5	SPT-10	14	23	33	56					
27.0											
27.5											
28.0	28	SPT-11	16	42	58	>100					
28.5											
29.0											
29.5	29.5	SPT-12	52	64	36 (4cm)	>100					
30.0	30										



UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*57+400 km	*Northing :*3148507.023 m	*Easting :*682078.022 m
Reduced Level (m):(+)213.946	*BH. No. :*BH-P11	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*11.80	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*27.50
*Date of Start :*24-08-2021	*Date of Completion :*25-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	SPT-1	2	4	5	9					
1.5											
2.0											
2.5	2.5	UDS-1									
3.0											
3.5											
4.0	4	SPT-2	5	8	10	18					
4.5											
5.0							Brown, Loose to medium dense, Sandy silt of low plasticity	ML-CL			
5.5	5.5	UDS-2									
6.0											
6.5											
7.0	7	SPT-3	6	10	12	22					
7.5											
8.0											
8.5	8.5	UDS-3									
9.0											
9.5											
10.0	10	SPT-4	8	12	15	27					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*57+400 km	*Northing :*3148507.023 m	*Easting :*682078.022 m
Reduced Level (m):(+)213.946	*BH. No. :*BH-P11	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*11.80	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*27.50
*Date of Start :*24-08-2021	*Date of Completion :*25-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0											
10.5											
11.0											
11.5	11.5	UDS-4									
12.0									11.80m		
12.5											
13.0	13	SPT-5	10	14	16	30					
13.5											
14.0											
14.5	14.5	UDS-5									
15.0							Brown, Loose to medium dense, Sandy silt of low plasticity	ML-CL			
15.5											
16.0	16	SPT-6	7	9	13	22					
16.5											
17.0											
17.5	17.5	UDS-6									
18.0											
18.5											
19.0	19	SPT-7	8	10	15	25					
19.5											
20.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*57+400 km	*Northing :*3148507.023 m	*Easting :*682078.022 m
Reduced Level (m):(+)213.946	*BH. No. :*BH-P11	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*11.80	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*27.50
*Date of Start :*24-08-2021	*Date of Completion :*25-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
20.0											
20.5	20.5	UDS-7									
21.0											
21.5											
22.0	22	SPT-8	9	13	17	30	Brown, Loose to medium dense, Sandy silt of low plasticity	ML-CL			
22.5											
23.0											
23.5	23.5	SPT-9	11	25	20	45					
24.0											
24.5											
25.0	25	SPT-10	12	20	24	44	Brown, Hard, Silty clay of low plasticity	CL			
25.5											
26.0											
26.5	26.5	SPT-11	20	35	50	85					
27.0											
27.5											
28.0	28	SPT-12	21	50	50 (10cm)	>100	Brown, Very dense, Sandy silt of low plastic	ML-CL			
28.5											
29.0											
29.5	29.5	SPT-13	40	80	20 (3cm)	>100					
30.0	30	-									

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*57+400 km	*Northing :*3148520.089 m	*Easting :*682075.049 m
Reduced Level (m):(+)214.402	*BH. No. :*BH-P12	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*12.10	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*26-08-2021	*Date of Completion :*27-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	UDS-1									
1.5											
2.0											
2.5	2.5	SPT-1	8	11	14	25					
3.0											
3.5							Brown, Medium dense, Silty sand	SM-SC			
4.0	4	UDS-2									
4.5											
5.0											
5.5	5.5	SPT-2	10	12	14	26					
6.0											
6.5											
7.0	7	UDS-3									
7.5											
8.0											
8.5	8.5	SPT-3	12	13	16	29	Brown, Medium dense to very dense, Sandy silt of low plasticity	ML-CL			
9.0											
9.5											
10.0	10	UDS-4									

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*57+400 km	*Northing :*3148520.089 m	*Easting :*682075.049 m
Reduced Level (m):(+)214.402	*BH. No. :*BH-P12	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*12.10	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*26-08-2021	*Date of Completion :*27-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0											
10.5											
11.0											
11.5	11.5	SPT-4	13	15	18	33					
12.0									12.10m		
12.5											
13.0	13	UDS-5									
13.5											
14.0											
14.5	14.5	SPT-5	14	17	20	37					
15.0							Brown, Medium dense to very dense, Sandy silt of low plasticity	ML-CL			
15.5											
16.0	16	UDS-6									
16.5											
17.0											
17.5	17.5	SPT-6	12	16	19	35					
18.0											
18.5											
19.0	19	UDS-7									
19.5											
20.0											

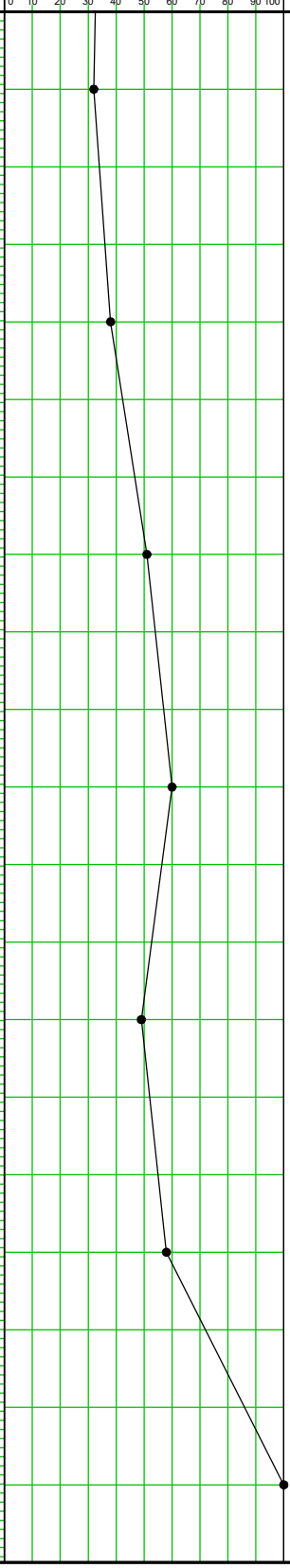
(Depth v/s SPT N Value) axis: 0 10 20 30 40 50 60 70 80 90 100

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*57+400 km	*Northing :*3148520.089 m	*Easting :*682075.049 m
Reduced Level (m):(+)214.402	*BH. No. :*BH-P12	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*12.10	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*26-08-2021	*Date of Completion :*27-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
20.0											
20.5	20.5	SPT-7	11	13	19	32					
21.0											
21.5											
22.0	22	SPT-8	13	16	22	38					
22.5											
23.0											
23.5	23.5	SPT-9	15	20	31	51					
24.0											
24.5											
25.0	25	SPT-10	16	26	34	60	Brown, Medium dense to very dense, Sandy silt of low plasticity	ML-CL			
25.5											
26.0											
26.5	26.5	SPT-11	17	22	27	49					
27.0											
27.5											
28.0	28	SPT-12	20	25	33	58					
28.5											
29.0											
29.5	29.5	SPT-13	38	70	30 (4cm)	>100					
30.0	30	-									



UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*57+400 km	*Northing :*3148533.155 m	*Easting :*682072.075 m
Reduced Level (m):(+)214.579	*BH. No. :*BH-P13	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*12.30	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*27-08-2021	*Date of Completion :*28-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	SPT-1	3	4	5	9					
1.5											
2.0							Brown, Loose, Silty sand	SM			
2.5	2.5	UDS-1									
3.0											
3.5											
4.0	4	SPT-2	10	15	19	34					
4.5											
5.0											
5.5	5.5	UDS-2									
6.0											
6.5											
7.0	7	SPT-3	11	17	21	38	Brown, Dense, Sandy silt of low plasticity	ML-CL			
7.5											
8.0											
8.5	8.5	UDS-3									
9.0											
9.5											
10.0	10	SPT-4	12	19	23	42					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*57+400 km	*Northing :*3148533.155 m	*Easting :*682072.075 m
Reduced Level (m):(+)214.579	*BH. No. :*BH-P13	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*12.30	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*27-08-2021	*Date of Completion :*28-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0										0 10 20 30 40 50 60 70 80 90 100	
10.5											
11.0											
11.5	11.5	UDS-4									
12.0											
12.5									12.30m		
13.0	13	SPT-5	14	21	25	46					
13.5											
14.0							Brown, Dense, Sandy silt of low plasticity	ML-CL			
14.5	14.5	UDS-5									
15.0											
15.5											
16.0	16	SPT-6	10	16	22	38					
16.5											
17.0											
17.5	17.5	UDS-6									
18.0											
18.5											
19.0	19	SPT-7	12	18	33	51	Brown, Hard, Silty clay of low plasticity	CL			
19.5											
20.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*57+400 km	*Northing :*3148533.155 m	*Easting :*682072.075 m
Reduced Level (m):(+)214.579	*BH. No. :*BH-P13	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*12.30	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*27-08-2021	*Date of Completion :*28-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
20.0											
20.5	20.5	UDS-7					Brown, Hard, Silty clay of low plasticity	CL			
21.0											
21.5											
22.0	22	SPT-8	15	33	40	73					
22.5											
23.0											
23.5	23.5	SPT-9	14	25	35	60					
24.0											
24.5											
25.0	25	SPT-10	15	27	40	67	Brown, Very dense, Sandy silt of low plasticity	ML-CL			
25.5											
26.0											
26.5	26.5	SPT-11	14	25	35	60					
27.0											
27.5											
28.0	28	SPT-12	15	24	35	59					
28.5											
29.0											
29.5	29.5	SPT-13	19	28	34	62					
30.0	30	-									

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*57+400 km	*Northing :*3148559.287 m	*Easting :*682066.129 m
Reduced Level (m):(+)213.460	*BH. No. :*BH-P15	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*11.80	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*25-08-2021	*Date of Completion :*26-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	SPT-1	4	7	8	15					
1.5											
2.0											
2.5	2.5	UDS-1									
3.0											
3.5											
4.0	4	SPT-2	6	8	10	18					
4.5											
5.0							Brown, Medium dense, Silty sand	SM-SC			
5.5	5.5	UDS-2									
6.0											
6.5											
7.0	7	SPT-3	8	11	14	25					
7.5											
8.0											
8.5	8.5	UDS*									
9.0											
9.5											
10.0	10	SPT-4	18	25	31	56					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*57+400 km	*Northing :*3148559.287 m	*Easting :*682066.129 m
Reduced Level (m):(+)213.460	*BH. No. :*BH-P15	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*11.80	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*25-08-2021	*Date of Completion :*26-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0											
10.5											
11.0											
11.5	11.5	UDS-3									
12.0									11.80m		
12.5											
13.0	13	SPT-5	20	28	33	61					
13.5											
14.0											
14.5	14.5	UDS-4									
15.0							Brown, Very dense, Sandy silt of low plasticity	ML-CL			
15.5											
16.0	16	SPT-6	18	23	28	51					
16.5											
17.0											
17.5	17.5	UDS-5									
18.0											
18.5											
19.0	19	SPT-7	21	26	30	56					
19.5											
20.0											

(Depth v/s SPT N Value) axis: 0 10 20 30 40 50 60 70 80 90 100

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*57+400 km	*Northing :*3148559.287 m	*Easting :*682066.129 m
Reduced Level (m):(+)213.460	*BH. No. :*BH-P15	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*11.80	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*25-08-2021	*Date of Completion :*26-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
20.0											
20.5	20.5	SPT-8	24	29	35	64					
21.0											
21.5											
22.0	22	SPT-9	22	27	32	59					
22.5											
23.0											
23.5	23.5	SPT-10	28	35	39	74					
24.0											
24.5											
25.0	25	SPT-11	26	37	42	79	Brown, Very dense, Sandy silt of low plasticity	ML-CL			
25.5											
26.0											
26.5	26.5	SPT-12	29	40	46	86					
27.0											
27.5											
28.0	28	SPT-13	32	38	43	81					
28.5											
29.0											
29.5	29.5	SPT-14	35	41	49	90					
30.0	30	-									

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*57+400 km	*Northing :*3148572.353 m	*Easting :*682063.156 m
Reduced Level (m):(+)212.949	*BH. No. :*BH-P16	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*11.20	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*27-08-2021	*Date of Completion :*28-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	UDS-1									
1.5											
2.0											
2.5	2.5	SPT-1	5	7	9	16					
3.0											
3.5											
4.0	4	UDS-2									
4.5											
5.0							Brown, Medium dense, Sandy silt of low plasticity	ML-CL			
5.5	5.5	SPT-2	6	8	11	19					
6.0											
6.5											
7.0	7	UDS-3									
7.5											
8.0											
8.5	8.5	SPT-3	7	9	12	21					
9.0											
9.5											
10.0	10	UDS-4									

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*57+400 km	*Northing :*3148572.353 m	*Easting :*682063.156 m
Reduced Level (m):(+)212.949	*BH. No. :*BH-P16	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*11.20	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*27-08-2021	*Date of Completion :*28-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0											
10.5											
11.0									11.20m		
11.5	11.5	SPT-4	7	10	14	24					
12.0											
12.5											
13.0	13	UDS*									
13.5											
14.0											
14.5	14.5	SPT-5	9	13	18	31	Brown, Medium dense to dense, Silty sand	SM			
15.0											
15.5											
16.0	16	UDS-5									
16.5											
17.0											
17.5	17.5	SPT-6	12	16	23	39					
18.0											
18.5											
19.0	19	SPT-7	22	34	43	77					
19.5							Brown, Very dense, Sandy silt of low plasticity	ML-CL			
20.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*57+400 km	*Northing :*3148572.353 m	*Easting :*682063.156 m
Reduced Level (m):(+)212.949	*BH. No. :*BH-P16	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*11.20	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*27-08-2021	*Date of Completion :*28-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
20.0											
20.5	20.5	SPT-8	29	63	37 (9cm)	>100					
21.0											
21.5											
22.0	22	SPT-9	31	65	35 (8cm)	>100					
22.5											
23.0											
23.5	23.5	SPT-10	30	67	33 (11cm)	>100	Brown, Very dense, Sandy silt of low plasticity	ML-CL			
24.0											
24.5											
25.0	25	SPT-11	27	55	45 (8cm)	>100					
25.5											
26.0											
26.5	26.5	SPT-12	38	62	38 (11cm)	>100					
27.0											
27.5											
28.0	28	SPT-13	33	60	40 (9cm)	>100	Brown, Very dense, Silty sand	SM			
28.5											
29.0											
29.5	29.5	SPT-14	33	46	44	90					
30.0	30	-									

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*57+400 km	*Northing :*3148585.419 m	*Easting :*682060.182 m
Reduced Level (m):(+)213.184	*BH. No. :*BH-P17	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*10.80	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*26-08-2021	*Date of Completion :*27-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	SPT-1	3	3	2	5					
1.5											
2.0							Brown, Medium stiff, Silty clay of low plasticity	CL			
2.5	2.5	UDS-1									
3.0											
3.5											
4.0	4	SPT-2	4	7	10	17					
4.5											
5.0											
5.5	5.5	UDS-2									
6.0											
6.5											
7.0	7	SPT-3	6	8	12	20	Brown, Medium dense to dense, Sandy silt of low plasticity	ML-CL			
7.5											
8.0											
8.5	8.5	UDS-3									
9.0											
9.5											
10.0	10	SPT-4	8	10	14	24					

(Depth v/s SPT N Value) axis: 0 10 20 30 40 50 60 70 80 90 100

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*57+400 km	*Northing :*3148585.419 m	*Easting :*682060.182 m
Reduced Level (m):(+)213.184	*BH. No. :*BH-P17	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*10.80	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*26-08-2021	*Date of Completion :*27-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0											
10.5											
11.0									10.80m		
11.5	11.5	SPT-5	9	11	16	27					
12.0											
12.5											
13.0	13	SPT-6	9	13	18	31					
13.5							Brown, Medium dense to dense, Sandy silt of low plasticity	ML-CL			
14.0											
14.5	14.5	SPT-7	11	14	20	34					
15.0											
15.5											
16.0	16	SPT-8	12	15	21	36					
16.5											
17.0											
17.5	17.5	UDS-4									
18.0											
18.5							Brown, Very dense, Sandy silt of low plasticity	ML-CL			
19.0	19	SPT-9	43	68	32 (3cm)	>100					
19.5											
20.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*57+400 km	*Northing :*3148585.419 m	*Easting :*682060.182 m
Reduced Level (m):(+)213.184	*BH. No. :*BH-P17	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*10.80	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*26-08-2021	*Date of Completion :*27-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
20.0											
20.5	20.5	SPT-10	35	55	45 (10cm)	>100					
21.0											
21.5											
22.0	22	SPT-11	33	53	47 (9cm)	>100					
22.5											
23.0											
23.5	23.5	SPT-12	36	62	38 (5cm)	>100					
24.0											
24.5											
25.0	25	SPT-13	38	65	35 (9cm)	>100	Brown, Very dense, Sandy silt of low plasticity	ML-CL			
25.5											
26.0											
26.5	26.5	SPT-14	34	67	33 (9cm)	>100					
27.0											
27.5											
28.0	28	SPT-15	30	75	25 (5cm)	>100					
28.5											
29.0											
29.5	29.5	SPT-16	39	68	32 (3cm)	>100					
30.0	30	-									

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*57+400 km	*Northing :*3148598.485 m	*Easting :*682057.209 m
Reduced Level (m):(+)213.517	*BH. No. :*BH-P18	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*10.50	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*27.50
*Date of Start :*24-08-2021	*Date of Completion :*25-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	UDS-1									
1.5											
2.0											
2.5	2.5	SPT-1	5	6	9	15					
3.0											
3.5											
4.0	4	UDS-2									
4.5											
5.0							Brown, Medium dense, Sandy silt of low plasticity	ML-CL			
5.5	5.5	SPT-2	7	9	11	20					
6.0											
6.5											
7.0	7	UDS-3									
7.5											
8.0											
8.5	8.5	SPT-3	8	12	14	26					
9.0											
9.5											
10.0	10	UDS-4									

(Depth v/s SPT N Value) axis: 0 10 20 30 40 50 60 70 80 90 100

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*57+400 km	*Northing :*3148598.485 m	*Easting :*682057.209 m
Reduced Level (m):(+)213.517	*BH. No. :*BH-P18	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*10.50	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*27.50
*Date of Start :*24-08-2021	*Date of Completion :*25-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0											
10.5									10.50m		
11.0											
11.5	11.5	SPT-4	10	14	16	30					
12.0											
12.5											
13.0	13	SPT-5	8	13	17	30					
13.5											
14.0							Brown, Hard, Silty clay of low plasticity	CL			
14.5	14.5	SPT-6	11	15	19	34					
15.0											
15.5											
16.0	16	SPT-7	9	14	20	34					
16.5											
17.0											
17.5	17.5	SPT-8	37	67	33 (5cm)	>100					
18.0											
18.5											
19.0	19	SPT-9	35	65	35 (7cm)	>100	Brown, Very dense, Sandy silt of low plasticity	ML-CL			
19.5											
20.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*57+400 km	*Northing :*3148598.485 m	*Easting :*682057.209 m
Reduced Level (m):(+)213.517	*BH. No. :*BH-P18	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*10.50	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*27.50
*Date of Start :*24-08-2021	*Date of Completion :*25-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
20.0											
20.5	20.5	SPT-10	36	65	35 (3cm)	>100					
21.0											
21.5											
22.0	22	SPT-11	36	66	34 (10cm)	>100					
22.5											
23.0											
23.5	23.5	SPT-12	38	68	32 (6cm)	>100					
24.0											
24.5											
25.0	25	SPT-13	31	59	41 (9cm)	>100	Brown, Very dense, Sandy silt of low plasticity	ML-CL			
25.5											
26.0											
26.5	26.5	SPT-14	39	59	44 (11cm)	>100					
27.0											
27.5											
28.0	28	SPT-15	32	58	42 (8cm)	>100					
28.5											
29.0											
29.5	29.5	SPT-16	48	69	31 (12cm)	>100					
30.0	30	-									

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*57+400 km	*Northing :*3148611.551 m	*Easting :*682054.236 m
Reduced Level (m):(+)213.504	*BH. No. :*BH-P19	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*11.50	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*26.00
*Date of Start :*23-08-2021	*Date of Completion :*24-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	SPT-1	4	5	6	11					
1.5											
2.0											
2.5	2.5	UDS-1									
3.0											
3.5											
4.0	4	SPT-2	7	7	7	14					
4.5											
5.0							Brown, Medium dense, Sandy silt of low plasticity	ML-CL			
5.5	5.5	UDS-2									
6.0											
6.5											
7.0	7	SPT-3	6	9	10	19					
7.5											
8.0											
8.5	8.5	UDS-3									
9.0											
9.5											
10.0	10	SPT-4	7	10	13	23					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*57+400 km	*Northing :*3148611.551 m	*Easting :*682054.236 m
Reduced Level (m):(+)213.504	*BH. No. :*BH-P19	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*11.50	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*26.00
*Date of Start :*23-08-2021	*Date of Completion :*24-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0											
10.5											
11.0											
11.5	11.5	SPT-5	8	11	20	31			11.50m		
12.0											
12.5											
13.0	13	SPT-6	9	13	18	31	Brown, Medium dense, Sandy silt of low plasticity	ML-CL			
13.5											
14.0											
14.5	14.5	SPT-7	7	11	16	27					
15.0											
15.5											
16.0	16	SPT-8	8	12	19	31					
16.5											
17.0											
17.5	17.5	UDS-4									
18.0							Brown, Hard, Silty clay of medium plasticity	CL			
18.5											
19.0	19	SPT-9	11	14	21	35					
19.5											
20.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*57+400 km	*Northing :*3148611.551 m	*Easting :*682054.236 m
Reduced Level (m):(+)213.504	*BH. No. :*BH-P19	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*11.50	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*26.00
*Date of Start :*23-08-2021	*Date of Completion :*24-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
20.0							Brown, Hard, Silty clay of medium plasticity	CL			
20.5	20.5	SPT-10	64	36 (9cm)	-	>100					
21.0											
21.5											
22.0	22	SPT-11	56	44 (8cm)	-	>100					
22.5											
23.0											
23.5	23.5	SPT-12	59	41 (7cm)	-	>100					
24.0											
24.5											
25.0	25	SPT-13	54	46 (5cm)	-	>100					
25.5							Brown, Very dense, Silty sand	SM			
26.0											
26.5	26.5	SPT-14	22	56	44 (3cm)	>100					
27.0											
27.5											
28.0	28	SPT-15	24	51	49 (10cm)	>100					
28.5											
29.0											
29.5	29.5	SPT-16	33	64 (10cm)	-	>100					
30.0	30										

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*57+400 km	*Northing :*3148626.567 m	*Easting :*682050.819 m
Reduced Level (m):(+)213.090	*BH. No. :*BH-A2	*BH Termination Depth (m):*35
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*10.90	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*26.00
*Date of Start :*20-08-2021	*Date of Completion :*22-08-2021	

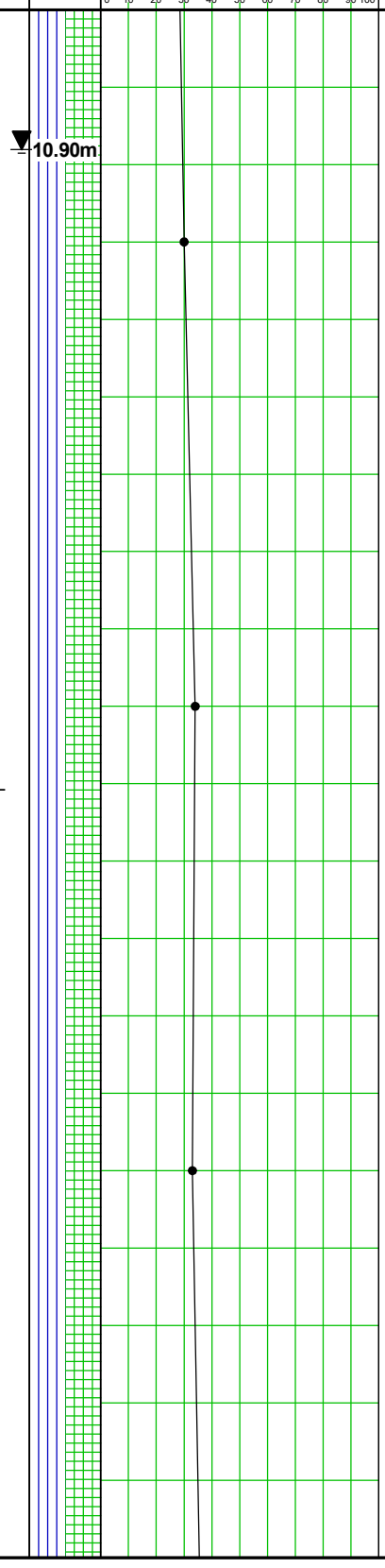
Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	UDS-1									
1.5											
2.0							Brown, Medium dense, Sandy silt of low plasticity	ML-CL			
2.5	2.5	SPT-1	4	6	8	14					
3.0											
3.5											
4.0	4	UDS-2									
4.5											
5.0											
5.5	5.5	SPT-2	8	11	15	26					
6.0											
6.5											
7.0	7	UDS-3					Brown, Very stiff, Silty clay of low plasticity	CL			
7.5											
8.0											
8.5	8.5	SPT-3	7	10	17	27					
9.0											
9.5											
10.0	10	UDS-4									

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*57+400 km	*Northing :*3148626.567 m	*Easting :*682050.819 m
Reduced Level (m):(+)213.090	*BH. No. :*BH-A2	*BH Termination Depth (m):*35
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*10.90	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*26.00
*Date of Start :*20-08-2021	*Date of Completion :*22-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0											
10.5											
11.0									10.90m		
11.5	11.5	SPT-4	8	11	19	30					
12.0											
12.5											
13.0	13	UDS-5									
13.5											
14.0											
14.5	14.5	SPT-5	9	13	21	34					
15.0							Brown, Dense, Sandy silt of low plasticity with gravel	ML-CL			
15.5											
16.0	16	UDS-6									
16.5											
17.0											
17.5	17.5	SPT-6	11	14	19	33					
18.0											
18.5											
19.0	19	UDS-7									
19.5											
20.0											



UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*57+400 km	*Northing :*3148626.567 m	*Easting :*682050.819 m
Reduced Level (m):(+)213.090	*BH. No. :*BH-A2	*BH Termination Depth (m):*35
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*10.90	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*26.00
*Date of Start :*20-08-2021	*Date of Completion :*22-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
20.0											
20.5	20.5	SPT-7	12	15	21	36	Brown, Dense, Sandy silt of low plasticity with gravel	ML-CL			
21.0											
21.5											
22.0	22	SPT-8	70	30 (9cm)	-	>100					
22.5											
23.0											
23.5	23.5	SPT-9	66	34 (7cm)	-	>100					
24.0											
24.5											
25.0	25	SPT-10	19	25	29	54					
25.5											
26.0							Brown, Very dense, Sandy silt of low plasticity with gravel	ML-CL			
26.5	26.5	SPT-11	24	45	55 (13cm)	>100					
27.0											
27.5											
28.0	28	SPT-12	29	49	50	99					
28.5											
29.0											
29.5	29.5	SPT-13	25	79	21 (3cm)	>100					
30.0											

(Depth v/s SPT N Value) axis: 0 10 20 30 40 50 60 70 80 90 100

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*57+400 km	*Northing :*3148626.567 m	*Easting :*682050.819 m
Reduced Level (m):(+)213.090	*BH. No. :*BH-A2	*BH Termination Depth (m):*35
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*10.90	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*26.00
*Date of Start :*20-08-2021	*Date of Completion :*22-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
30.0										0 10 20 30 40 50 60 70 80 90 100	
30.5											
31.0	31	SPT-14	26	76	34 (5cm)	>100					
31.5											
32.0											
32.5	32.5	SPT-15	28	71	29 (4cm)	>100	Brown, Very dense, Sandy silt of low plasticity with gravel	ML-CL			
33.0											
33.5											
34.0	34	SPT-16	31	69	31 (7cm)	>100					
34.5											
35.0	35	SPT-17	37	76	34 (8cm)	>100					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*57+980 km	*Northing :*3149053.752 m	*Easting :*681950.308 m
Reduced Level (m):(+)213.055	*BH. No. :*BH-CL	*BH Termination Depth (m):*10
*Proposed / Existing Structure :*Minor Bridge	*Water Table (m):*9.28	*Inclination :* Vertical
*Boring type :*Shell	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*03-07-2022	*Date of Completion :*03-07-2022	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0											
1.5	1.5	SPT-1	3	5	6	11	Brown, Silty Clay of medium Plasticity	CI			
2.0											
	2.25	UDS-1									
2.5											
3.0	3	SPT-2	4	7	7	14					
3.5											
4.0											
4.5	4.5	SPT-3	6	8	9	17					
5.0											
	5.25	UDS-2									
5.5											
6.0	6	SPT-4	9	13	16	29					
6.5							Stiff to Hard, Brown, Silty Clay of LowPlasticity	CL			
7.0											
7.5	7.5	SPT-5	10	15	18	33					
8.0											
	8.25	UDS-3									
8.5											
9.0	9	SPT-6	5	7	7	14					
9.5									9.28m		
10.0	10	SPT-7	6	9	12	21					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*58+191 km	*Northing :*3149257.396 m	*Easting :*681895.083 m
Reduced Level (m):(+)212.823	*BH. No. :*BH-CL	*BH Termination Depth (m):*10
*Proposed / Existing Structure :*Minor Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*24-09-2021	*Date of Completion :*24-09-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	SPT-1	2	3	3	6					
1.5											
2.0											
2.5	2.5	UDS-1					Brown, Loose to medium dense, Sandy silt of low plasticity	ML-CL			
3.0											
3.5											
4.0	4	SPT-2	5	7	9	16					
4.5											
5.0											
5.5	5.5	UDS-2									
6.0											
6.5											
7.0	7	SPT-3	11	14	17	31					
7.5											
8.0							Brown, Hard, Silty clay of low plasticity with gravel	CL			
8.5	8.5	UDS-3									
9.0											
9.5											
10.0	10	SPT-4	13	20	26	46					

(Depth v/s SPT N Value) axis: 0 10 20 30 40 50 60 70 80 90 100

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*58+497 km	*Northing :*3149467.024 m	*Easting :*681858.38 m
Reduced Level (m):(+)213.216	*BH. No. :*BH-A1	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*100 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*14-08-2021	*Date of Completion :*16-08-2021	

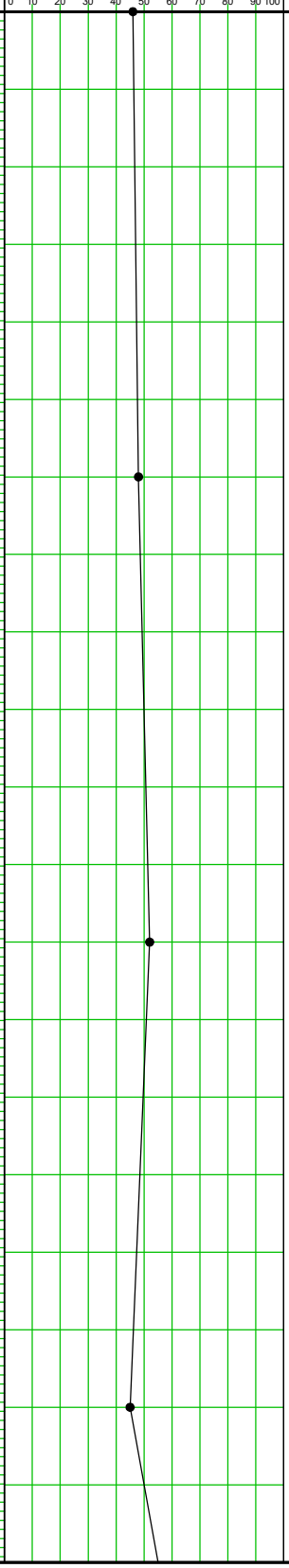
Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	SPT-1	4	7	10	17					
1.5											
2.0											
2.5	2.5	UDS-1									
3.0											
3.5											
4.0	4	SPT-2	8	11	13	24	Brown, Medium dense TO DENSE, Sandy silt of low plasticity	ML-CL			
4.5											
5.0											
5.5	5.5	UDS-2									
6.0											
6.5											
7.0	7	SPT-3	10	14	18	32					
7.5											
8.0											
8.5	8.5	UDS-3									
9.0							Brown, Hard, Silty clay of low plasticity	CL			
9.5											
10.0	10	SPT-4	18	21	25	46					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*58+497 km	*Northing :*3149467.024 m	*Easting :*681858.38 m
Reduced Level (m):(+)213.216	*BH. No. :*BH-A1	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*100 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*14-08-2021	*Date of Completion :*16-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0											
10.5											
11.0											
11.5	11.5	UDS*									
12.0											
12.5											
13.0	13	SPT-5	17	22	26	48					
13.5											
14.0											
14.5	14.5	UDS-4									
15.0							Brown, Hard, Silty clay of low plasticity	CL			
15.5											
16.0	16	SPT-6	20	24	28	52					
16.5											
17.0											
17.5	17.5	UDS-5									
18.0											
18.5											
19.0	19	SPT-7	18	21	24	45					
19.5											
20.0											



UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*58+497 km	*Northing :*3149467.024 m	*Easting :*681858.38 m
Reduced Level (m):(+)213.216	*BH. No. :*BH-A1	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*100 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*14-08-2021	*Date of Completion :*16-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
20.0							Brown, Hard, Silty clay of low plasticity	CL			
20.5	20.5	UDS-6									
21.0											
21.5											
22.0	22	SPT-8	25	34	41	75					
22.5											
23.0											
23.5	23.5	UDS-7									
24.0											
24.5											
25.0	25	SPT-9	23	31	38	69	Brown, Very dense, Sandy silt of low plasticity	ML-CL			
25.5											
26.0											
26.5	26.5	UDS-8									
27.0											
27.5											
28.0	28	SPT-10	21	34	41	75					
28.5											
29.0											
29.5	29.5	UDS-9									
30.0											

(Depth v/s SPT N Value) axis: 0 10 20 30 40 50 60 70 80 90 100

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*58+497 km	*Northing :*3149467.024 m	*Easting :*681858.38 m
Reduced Level (m):(+)213.216	*BH. No. :*BH-A1	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*100 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*14-08-2021	*Date of Completion :*16-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
30.0											
30.5											
31.0	31	SPT-11	24	35	45	80					
31.5											
32.0											
32.5	32.5	UDS-10									
33.0											
33.5											
34.0	34	SPT-12	34	55	45 (5cm)	>100					
34.5											
35.0							Brown, Very dense, Sandy silt of low plasticity	ML-CL			
35.5	35.5	SPT-13	30	64	36 (8cm)	>100					
36.0											
36.5											
37.0	37	SPT-14	38	70	30 (11cm)	>100					
37.5											
38.0											
38.5	38.5	SPT-15	22	29	38	67					
39.0											
39.5											
40.0	40	UDS-11									

(Depth v/s SPT N Value) axis: 0 10 20 30 40 50 60 70 80 90 100

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*58+497 km	*Northing :*3149495.176 m	*Easting :*681844.488 m
Reduced Level (m):(+)214.371	*BH. No. :*BH-P1	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*11.60	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*16-08-2021	*Date of Completion :*18-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	UDS-1									
1.5											
2.0											
2.5	2.5	SPT-1	5	8	9	17					
3.0											
3.5							Brown, Medium dense, Sandy silt of low plasticity	ML-CL			
4.0	4	UDS-2									
4.5											
5.0											
5.5	5.5	SPT-2	10	14	16	30					
6.0											
6.5											
7.0	7	UDS-3									
7.5											
8.0											
8.5	8.5	SPT-3	15	18	22	40	Brown, Hard, Silty clay of low plasticity	CL			
9.0											
9.5											
10.0	10	UDS-4									

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*58+497 km	*Northing :*3149495.176 m	*Easting :*681844.488 m
Reduced Level (m):(+)214.371	*BH. No. :*BH-P1	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*11.60	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*16-08-2021	*Date of Completion :*18-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0										0 10 20 30 40 50 60 70 80 90 100	
10.5											
11.0											
11.5	11.5	SPT-4	17	21	24	45			11.60m		
12.0											
12.5											
13.0	13	UDS-5									
13.5											
14.0											
14.5	14.5	SPT-5	19	23	26	49	Brown, Hard, Silty clay of low plasticity	CL			
15.0											
15.5											
16.0	16	UDS-6									
16.5											
17.0											
17.5	17.5	SPT-6	18	25	29	54					
18.0											
18.5											
19.0	19	UDS-7									
19.5							Brown, Very dense, Sandy silt of low plasticity	ML-CL			
20.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*58+497 km	*Northing :*3149495.176 m	*Easting :*681844.488 m
Reduced Level (m):(+)214.371	*BH. No. :*BH-P1	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*11.60	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*16-08-2021	*Date of Completion :*18-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
20.0										0 10 20 30 40 50 60 70 80 90 100	
20.5	20.5	SPT-7	15	28	33	61					
21.0											
21.5											
22.0	22	UDS-8									
22.5											
23.0											
23.5	23.5	SPT-8	20	30	38	68					
24.0											
24.5											
25.0	25	UDS*	28	39	42	81	Brown, Very dense, Sandy silt of low plasticity	ML-CL			
25.5											
26.0											
26.5	26.5	SPT-10	23	32	37	69					
27.0											
27.5											
28.0	28	UDS-9									
28.5											
29.0											
29.5	29.5	SPT-11	27	36	41	77					
30.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*58+497 km	*Northing :*3149495.176 m	*Easting :*681844.488 m
Reduced Level (m):(+)214.371	*BH. No. :*BH-P1	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*11.60	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*16-08-2021	*Date of Completion :*18-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
30.0											
30.5											
31.0	31	UDS*	24	39	47	86					
31.5											
32.0											
32.5	32.5	SPT-13	34	51	49 (2cm)	>100					
33.0											
33.5											
34.0	34	UDS*	40	65	35 (10cm)	>100					
34.5											
35.0							Brown, Very dense, Sandy silt of low plasticity	ML-CL			
35.5	35.5	UDS*	31	72	28 (11cm)	>100					
36.0											
36.5											
37.0	37	UDS*	36	67	33 (10cm)	>100					
37.5											
38.0											
38.5	38.5	SPT-14	23	32	41	73					
39.0											
39.5											
40.0	40	UDS-10									

(Depth v/s SPT N Value) axis: 0 10 20 30 40 50 60 70 80 90 100

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*58+497 km	*Northing :*3149522.156 m	*Easting :*681840.419 m
Reduced Level (m):(+)213.108	*BH. No. :*BH-P2	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*10.70	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*19-08-2021	*Date of Completion :*20-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	SPT-1	5	8	11	19					
1.5											
2.0							Brown, Medium dense, Silty sand with clay	SM-SC			
2.5	2.5	UDS-1									
3.0											
3.5											
4.0	4	SPT-2	6	10	16	26					
4.5											
5.0											
5.5	5.5	UDS-2									
6.0											
6.5											
7.0	7	SPT-3	8	12	15	27	Brown, Very stiff, Silty clay of low plasticity	CL			
7.5											
8.0											
8.5	8.5	UDS-3									
9.0											
9.5											
10.0	10	SPT-4	7	13	17	30					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*58+497 km	*Northing :*3149522.156 m	*Easting :*681840.419 m
Reduced Level (m):(+)213.108	*BH. No. :*BH-P2	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*10.70	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*19-08-2021	*Date of Completion :*20-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0											
10.5							Brown, Very stiff, Silty clay of low plasticity	CL	▼10.70m		
11.0											
11.5	11.5	UDS-4									
12.0											
12.5											
13.0	13	SPT-5	8	16	22	38					
13.5											
14.0											
14.5	14.5	UDS-5									
15.0											
15.5							Brown, Dense to very dense, Sandy silt of low plasticity	ML-CL			
16.0	16	SPT-6	12	19	26	45					
16.5											
17.0											
17.5	17.5	UDS*									
18.0											
18.5											
19.0	19	SPT-7	20	27	36	63					
19.5											
20.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*58+497 km	*Northing :*3149522.156 m	*Easting :*681840.419 m
Reduced Level (m):(+)213.108	*BH. No. :*BH-P2	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*10.70	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*19-08-2021	*Date of Completion :*20-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
20.0											
20.5	20.5	UDS-6									
21.0											
21.5											
22.0	22	SPT-8	18	26	32	58					
22.5											
23.0											
23.5	23.5	UDS-7									
24.0											
24.5											
25.0	25	SPT-9	21	27	37	64	Brown, Dense to very dense, Sandy silt of low plasticity	ML-CL			
25.5											
26.0											
26.5	26.5	UDS-8									
27.0											
27.5											
28.0	28	SPT-10	80	20 (12cm)	-	>100					
28.5											
29.0											
29.5	29.5	SPT-11	42	62	38 (5cm)	>100					
30.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*58+497 km	*Northing :*3149522.156 m	*Easting :*681840.419 m
Reduced Level (m):(+)213.108	*BH. No. :*BH-P2	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*10.70	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*19-08-2021	*Date of Completion :*20-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
30.0										0 10 20 30 40 50 60 70 80 90 100	
30.5											
31.0	31	SPT-12	70	30 (8cm)	-	>100					
31.5											
32.0											
32.5	32.5	SPT-13	48	72	28 (10cm)	>100					
33.0											
33.5											
34.0	34	SPT-14	36	52	48 (10cm)	>100					
34.5											
35.0							Brown, Dense to very dense, Sandy silt of low plasticity	ML-CL			
35.5	35.5	SPT-15	77	23 (9cm)	-	>100					
36.0											
36.5											
37.0	37	SPT-16	59	41 (12cm)	-	>100					
37.5											
38.0											
38.5	38.5	SPT-17	60	40 (8cm)	-	>100					
39.0											
39.5											
40.0	40	SPT-18	73	27 (6cm)	-	>100					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*58+497 km	*Northing :*3149565 m	*Easting :*681840 m
Reduced Level (m):(+)214.145	*BH. No. :*BH-P3	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*11.00	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*23-08-2021	*Date of Completion :*24-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	UDS-1									
1.5											
2.0											
2.5	2.5	SPT-1	4	6	8	14					
3.0											
3.5							Brown, Medium dense, Silty sand	SM			
4.0	4	UDS-2									
4.5											
5.0											
5.5	5.5	SPT-2	6	7	9	16					
6.0											
6.5											
7.0	7	UDS-3									
7.5											
8.0											
8.5	8.5	SPT-3	10	15	18	33	Brown, Dense to very dense, Sandy silt of low plasticity	ML-CL			
9.0											
9.5											
10.0	10	UDS-4									

(Depth v/s SPT N Value) axis: 0 10 20 30 40 50 60 70 80 90 100

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*58+497 km	*Northing :*3149565 m	*Easting :*681840 m
Reduced Level (m):(+)214.145	*BH. No. :*BH-P3	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*11.00	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*23-08-2021	*Date of Completion :*24-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0											
10.5											
11.0									11.00m		
11.5	11.5	SPT-4	12	18	20	38					
12.0											
12.5											
13.0	13	UDS-5									
13.5											
14.0											
14.5	14.5	SPT-5	13	19	21	40					
15.0							Brown, Dense to very dense, Sandy silt of low plasticity	ML-CL			
15.5											
16.0	16	UDS-6									
16.5											
17.0											
17.5	17.5	SPT-6	18	24	29	53					
18.0											
18.5											
19.0	19	UDS-7									
19.5											
20.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*58+497 km	*Northing :*3149565 m	*Easting :*681840 m
Reduced Level (m):(+)214.145	*BH. No. :*BH-P3	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*11.00	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*23-08-2021	*Date of Completion :*24-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
20.0										0 10 20 30 40 50 60 70 80 90 100	
20.5	20.5	SPT-7	26	38	42	80					
21.0											
21.5											
22.0	22	UDS-8									
22.5											
23.0											
23.5	23.5	SPT-8	24	36	48	84					
24.0											
24.5											
25.0	25	UDS-9					Brown, Dense to very dense, Sandy silt of low plasticity	ML-CL			
25.5											
26.0											
26.5	26.5	SPT-9	28	42	58	100					
27.0											
27.5											
28.0	28	UDS-10									
28.5											
29.0											
29.5	29.5	SPT-10	36	68	32 (10cm)	>100					
30.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*58+497 km	*Northing :*3149565 m	*Easting :*681840 m
Reduced Level (m):(+)214.145	*BH. No. :*BH-P3	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*11.00	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*23-08-2021	*Date of Completion :*24-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
30.0											
30.5											
31.0	31	SPT-11	58	58	42 (8cm)	>100					
31.5											
32.0											
32.5	32.5	SPT-12	62	58	42 (10cm)	>100					
33.0											
33.5											
34.0	34	SPT-13	68	48	52 (5cm)	>100					
34.5											
35.0							Brown, Dense to very dense, Sandy silt of low plasticity	ML-CL			
35.5	35.5	SPT-14	43	63	42	105				>>	
36.0											
36.5											
37.0	37	SPT-15	39	72	35 (4cm)	>100					
37.5											
38.0											
38.5	38.5	SPT-16	42	80	20 (8cm)	>100					
39.0											
39.5											
40.0	40	SPT-17	65	76	24 (10cm)	>100					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*58+497 km	*Northing :*3149594.593 m	*Easting :*681837.92 m
Reduced Level (m):(+)214.312	*BH. No. :*BH-P4	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*11.90	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*18-08-2021	*Date of Completion :*19-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	SPT-1	6	8	11	19					
1.5											
2.0											
2.5	2.5	UDS-1					Brown, Medium dense, Sandy silt of low plasticity	ML-CL			
3.0											
3.5											
4.0	4	SPT-2	8	10	14	24					
4.5											
5.0											
5.5	5.5	UDS-2									
6.0											
6.5											
7.0	7	SPT-3	11	16	19	35					
7.5											
8.0							Brown, Dense, Sandy silt of low plasticity	ML-CL			
8.5	8.5	UDS-3									
9.0											
9.5											
10.0	10	SPT-4	17	20	23	43					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*58+497 km	*Northing :*3149594.593 m	*Easting :*681837.92 m
Reduced Level (m):(+)214.312	*BH. No. :*BH-P4	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*11.90	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*18-08-2021	*Date of Completion :*19-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0											
10.5											
11.0											
11.5	11.5	SPT-5	19	22	26	48	Brown, Dense, Sandy silt of low plasticity	ML-CL			
12.0									11.90m		
12.5											
13.0	13	SPT-6	18	25	29	54					
13.5											
14.0											
14.5	14.5	UDS-4									
15.0											
15.5											
16.0	16	SPT-7	21	27	31	58					
16.5							Brown, Very dense, Sandy silt of low plasticity	ML-CL			
17.0											
17.5	17.5	UDS-5									
18.0											
18.5											
19.0	19	SPT-8	14	24	29	53					
19.5											
20.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*58+497 km	*Northing :*3149594.593 m	*Easting :*681837.92 m
Reduced Level (m):(+)214.312	*BH. No. :*BH-P4	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*11.90	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*18-08-2021	*Date of Completion :*19-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
20.0											
20.5	20.5	UDS-6									
21.0											
21.5											
22.0	22	SPT-9	26	30	36	66					
22.5											
23.0											
23.5	23.5	UDS*									
24.0											
24.5											
25.0	25	SPT-10	22	35	43	78	Brown, Very dense, Sandy silt of low plasticity	ML-CL			
25.5											
26.0											
26.5	26.5	UDS-7									
27.0											
27.5											
28.0	28	SPT-11	24	38	40	78					
28.5											
29.0											
29.5	29.5	UDS-8									
30.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*58+497 km	*Northing :*3149594.593 m	*Easting :*681837.92 m
Reduced Level (m):(+)214.312	*BH. No. :*BH-P4	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*11.90	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*18-08-2021	*Date of Completion :*19-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
30.0											
30.5											
31.0	31	SPT-12	26	34	48	82					
31.5											
32.0											
32.5	32.5	UDS-9									
33.0											
33.5											
34.0	34	SPT-13	38	55	45 (9cm)	>100					
34.5											
35.0							Brown, Very dense, Sandy silt of low plasticity	ML-CL			
35.5	35.5	SPT-14	43	70	30 (4cm)	>100					
36.0											
36.5											
37.0	37	SPT-15	32	53	47 (11cm)	>100					
37.5											
38.0											
38.5	38.5	SPT-16	30	58	42 (8cm)	>100					
39.0											
39.5											
40.0	40	SPT-17	26	41	48	89					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*58+497 km	*Northing :*3149620.114 m	*Easting :*681834.868 m
Reduced Level (m):(+)213.726	*BH. No. :*BH-P5	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*12.00	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*19-08-2021	*Date of Completion :*20-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	SPT-1	2	3	5	8					
1.5											
2.0							Brown, Loose, Silty sand	SM			
2.5	2.5	UDS-1									
3.0											
3.5											
4.0	4	SPT-2	4	10	15	25					
4.5											
5.0											
5.5	5.5	UDS-2									
6.0											
6.5							Brown, Medium dense, Silty sand	SM			
7.0	7	SPT-3	9	13	18	31					
7.5											
8.0											
8.5	8.5	UDS-3									
9.0											
9.5							Brown, Hard, Silty clay of low plasticity	CL			
10.0	10	SPT-4	12	18	21	39					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*58+497 km	*Northing :*3149620.114 m	*Easting :*681834.868 m
Reduced Level (m):(+)213.726	*BH. No. :*BH-P5	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*12.00	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*19-08-2021	*Date of Completion :*20-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0											
10.5											
11.0											
11.5	11.5	UDS-4									
12.0									12.00m		
12.5											
13.0	13	SPT-5	14	17	20	37	Brown, Hard, Silty clay of low plasticity	CL			
13.5											
14.0											
14.5	14.5	UDS-5									
15.0											
15.5											
16.0	16	SPT-6	11	15	19	34					
16.5											
17.0											
17.5	17.5	UDS-6									
18.0											
18.5											
19.0	19	SPT-7	17	24	27	51	Brown, Very dense, Sandy silt of low plasticity	ML-CL			
19.5											
20.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*58+497 km	*Northing :*3149620.114 m	*Easting :*681834.868 m
Reduced Level (m):(+)213.726	*BH. No. :*BH-P5	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*12.00	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*19-08-2021	*Date of Completion :*20-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
20.0											
20.5	20.5	UDS-7									
21.0											
21.5											
22.0	22	SPT-8	20	26	30	56					
22.5											
23.0											
23.5	23.5	UDS-8									
24.0											
24.5											
25.0	25	SPT-9	28	31	36	67	Brown, Very dense, Sandy silt of low plasticity	ML-CL			
25.5											
26.0											
26.5	26.5	UDS-9									
27.0											
27.5											
28.0	28	SPT-10	34	40	49	89					
28.5											
29.0											
29.5	29.5	UDS-10									
30.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*58+497 km	*Northing :*3149620.114 m	*Easting :*681834.868 m
Reduced Level (m):(+)213.726	*BH. No. :*BH-P5	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*12.00	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*19-08-2021	*Date of Completion :*20-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
30.0										0 10 20 30 40 50 60 70 80 90 100	
30.5											
31.0	31	SPT-11	42	52	48 (10cm)	>100					
31.5											
32.0											
32.5	32.5	SPT-12	40	54	46 (10cm)	>100					
33.0											
33.5											
34.0	34	SPT-13	36	47	53	100					
34.5											
35.0							Brown, Very dense, Sandy silt of low plasticity	ML-CL			
35.5	35.5	SPT-14	40	49	51	100					
36.0											
36.5											
37.0	37	SPT-15	42	45	55 (11cm)	>100					
37.5											
38.0											
38.5	38.5	SPT-16	37	47	53 (9cm)	>100					
39.0											
39.5											
40.0	40	SPT-17	52	48 (10cm)	-	>100					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*58+497 km	*Northing :*3149645.522 m	*Easting :*681836.405 m
Reduced Level (m):(+)213.711	*BH. No. :*BH-P6	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*11.00	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*17-08-2021	*Date of Completion :*18-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	UDS-1									
1.5											
2.0											
2.5	2.5	SPT-1	9	7	9	16					
3.0											
3.5							Brown, Medium dense, Sandy silt of low plasticity	ML-CL			
4.0	4	UDS-2									
4.5											
5.0											
5.5	5.5	SPT-2	9	11	16	27					
6.0											
6.5											
7.0	7	UDS-3									
7.5											
8.0											
8.5	8.5	SPT-3	14	17	19	36	Brown, Hard, Silty clay of low plasticity	CL			
9.0											
9.5											
10.0	10	UDS-4									

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*58+497 km	*Northing :*3149645.522 m	*Easting :*681836.405 m
Reduced Level (m):(+)213.711	*BH. No. :*BH-P6	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*11.00	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*17-08-2021	*Date of Completion :*18-08-2021	

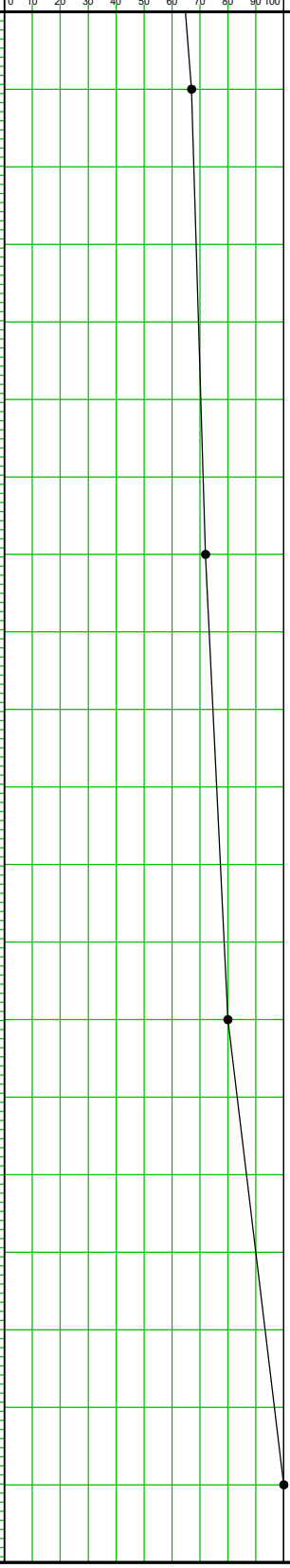
Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0										0 10 20 30 40 50 60 70 80 90 100	
10.5											
11.0									11.00m		
11.5	11.5	SPT-4	16	19	24	43					
12.0											
12.5											
13.0	13	UDS-5									
13.5											
14.0											
14.5	14.5	SPT-5	19	24	27	51	Brown, Hard, Silty clay of low plasticity	CL			
15.0											
15.5											
16.0	16	UDS-6									
16.5											
17.0											
17.5	17.5	SPT-6	21	25	29	54					
18.0											
18.5											
19.0	19	UDS-7									
19.5							Brown, Very dense, Sandy silt of low plasticity	ML-CL			
20.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*58+497 km	*Northing :*3149645.522 m	*Easting :*681836.405 m
Reduced Level (m):(+)213.711	*BH. No. :*BH-P6	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*11.00	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*17-08-2021	*Date of Completion :*18-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
20.0											
20.5	20.5	SPT-7	25	30	37	67					
21.0											
21.5											
22.0	22	UDS-8									
22.5											
23.0											
23.5	23.5	SPT-8	29	38	39	72					
24.0											
24.5											
25.0	25	UDS-9					Brown, Very dense, Sandy silt of low plasticity	ML-CL			
25.5											
26.0											
26.5	26.5	SPT-9	30	35	45	80					
27.0											
27.5											
28.0	28	UDS-10									
28.5											
29.0											
29.5	29.5	SPT-10	54	46 (10cm)	-	>100					
30.0											



UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*58+497 km	*Northing :*3149645.522 m	*Easting :*681836.405 m
Reduced Level (m):(+)213.711	*BH. No. :*BH-P6	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*11.00	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*17-08-2021	*Date of Completion :*18-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
30.0										0 10 20 30 40 50 60 70 80 90 100	
30.5											
31.0	31	SPT-11	58	42 (8cm)	-	>100					
31.5											
32.0											
32.5	32.5	SPT-12	50	50 (9cm)	-	>100					
33.0											
33.5											
34.0	34	SPT-13	54	46 (8cm)	-	>100					
34.5											
35.0							Brown, Very dense, Sandy silt of low plasticity	ML-CL			
35.5	35.5	SPT-14	41	53	47 (10cm)	>100					
36.0											
36.5											
37.0	37	SPT-15	45	57	43 (7cm)	>100					
37.5											
38.0											
38.5	38.5	SPT-16	55	45 (10cm)	-	>100					
39.0											
39.5											
40.0	40	SPT-17	57	43 (9cm)	-	>100					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*58+497 km	*Northing :*3149673.452 m	*Easting :*681833.809 m
Reduced Level (m):(+)214.044	*BH. No. :*BH-A2	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*12.00	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*17-08-2021	*Date of Completion :*18-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	SPT-1	5	6	7	13					
1.5											
2.0							Brown, Medium dense, Sandy silt of low plasticity	ML-CL			
2.5	2.5	UDS-1									
3.0											
3.5											
4.0	4	SPT-2	8	12	14	26					
4.5											
5.0											
5.5	5.5	UDS-2									
6.0											
6.5											
7.0	7	SPT-3	9	13	18	31	Brown, Medium dense to dense, Sandy silt of low plasticity	ML-CL			
7.5											
8.0											
8.5	8.5	UDS-3									
9.0											
9.5											
10.0	10	SPT-4	8	12	19	31					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*58+497 km	*Northing :*3149673.452 m	*Easting :*681833.809 m
Reduced Level (m):(+)214.044	*BH. No. :*BH-A2	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*12.00	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*17-08-2021	*Date of Completion :*18-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0											
10.5											
11.0											
11.5	11.5	UDS-4									
12.0									12.00m		
12.5											
13.0	13	SPT-5	7	14	18	32					
13.5											
14.0											
14.5	14.5	UDS-5									
15.0							Brown, Medium dense to dense, Sandy silt of low plasticity	ML-CL			
15.5											
16.0	16	SPT-6	9	11	17	28					
16.5											
17.0											
17.5	17.5	UDS-6									
18.0											
18.5											
19.0	19	SPT-7	12	18	23	41					
19.5											
20.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*58+497 km	*Northing :*3149673.452 m	*Easting :*681833.809 m
Reduced Level (m):(+)214.044	*BH. No. :*BH-A2	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*12.00	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*17-08-2021	*Date of Completion :*18-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
20.0										0 10 20 30 40 50 60 70 80 90 100	
20.5	20.5	UDS-7					Brown, Medium dense to dense, Sandy silt of low plasticity	ML-CL			
21.0											
21.5											
22.0	22	SPT-8	17	21	29	50					
22.5											
23.0											
23.5	23.5	UDS-8									
24.0											
24.5											
25.0	25	SPT-9	20	24	31	55	Brown, Very dense, Sandy silt of low plasticity	ML-CL			
25.5											
26.0											
26.5	26.5	UDS-9									
27.0											
27.5											
28.0	28	SPT-10	21	24	34	58					
28.5											
29.0											
29.5	29.5	UDS-10									
30.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*58+497 km	*Northing :*3149673.452 m	*Easting :*681833.809 m
Reduced Level (m):(+)214.044	*BH. No. :*BH-A2	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*12.00	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*17-08-2021	*Date of Completion :*18-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
30.0											
30.5											
31.0	31	SPT-11	22	27	38	65					
31.5											
32.0											
32.5	32.5	UDS-11									
33.0											
33.5											
34.0	34	SPT-12	27	48	51	99					
34.5											
35.0							Brown, Very dense, Sandy silt of low plasticity	ML-CL			
35.5	35.5	SPT-13	38	54	46 (6cm)	>100					
36.0											
36.5											
37.0	37	SPT-14	48	60	40 (8cm)	>100					
37.5											
38.0											
38.5	38.5	SPT-15	53	47 (11cm)	-	>100					
39.0											
39.5											
40.0	40	SPT-16	30 (3cm)	-	-	>100					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*58+837 km	*Northing :*3149897.982 m	*Easting :*681823.952 m
Reduced Level (m):(+)213.610	*BH. No. :*BH-CL	*BH Termination Depth (m):*10
*Proposed / Existing Structure :*Minor Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*24-09-2021	*Date of Completion :*24-09-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	SPT-1	2	2	4	6					
1.5											
2.0							Brown, Loose, Silty sand	SM			
2.5	2.5	UDS-1									
3.0											
3.5											
4.0	4	SPT-2	4	8	14	22					
4.5											
5.0											
5.5	5.5	UDS-2									
6.0											
6.5											
7.0	7	SPT-3	8	12	20	32	Brown, Medium dense to dense, Sandy silt of low plasticity with gravel	ML-CL			
7.5											
8.0											
8.5	8.5	UDS-3									
9.0											
9.5											
10.0	10	SPT-4	11	19	28	47					

(Depth v/s SPT N Value) axis: 0 10 20 30 40 50 60 70 80 90 100

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*59+071 km	*Northing :*3150131.892 m	*Easting :*681817.835 m
Reduced Level (m):(+)213.832	*BH. No. :*BH-CL	*BH Termination Depth (m):*10
*Proposed / Existing Structure :*Minor Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*24-09-2021	*Date of Completion :*24-09-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	UDS-1									
1.5											
2.0											
2.5	2.5	SPT-1	4	7	11	18					
3.0											
3.5											
4.0	4	UDS-2									
4.5											
5.0							Brown, Medium dense to dense, Sandy silt of low plasticity with gravel	ML-CL			
5.5	5.5	SPT-2	6	12	17	29					
6.0											
6.5											
7.0	7	UDS-3									
7.5											
8.0											
8.5	8.5	SPT-3	9	13	19	32					
9.0											
9.5											
10.0	10	UDS-4									

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*59+206 km	*Northing :*3150266 m	*Easting :*681807 m
Reduced Level (m):(+)213.360	*BH. No. :*BH-CL	*BH Termination Depth (m):*15
*Proposed / Existing Structure :*Minor Bridge	*Water Table (m):*12.65	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*23-09-2021	*Date of Completion :*24-09-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	UDS-1									
1.5											
2.0											
2.5	2.5	SPT-1	5	8	12	20					
3.0											
3.5											
4.0	4	UDS-2									
4.5											
5.0							Brown, Medium dense to dense, Sandy silt of low plasticity	ML-CL			
5.5	5.5	SPT-2	7	12	14	26					
6.0											
6.5											
7.0	7	UDS-3									
7.5											
8.0											
8.5	8.5	SPT-3	8	10	14	24					
9.0											
9.5											
10.0	10	UDS-4									

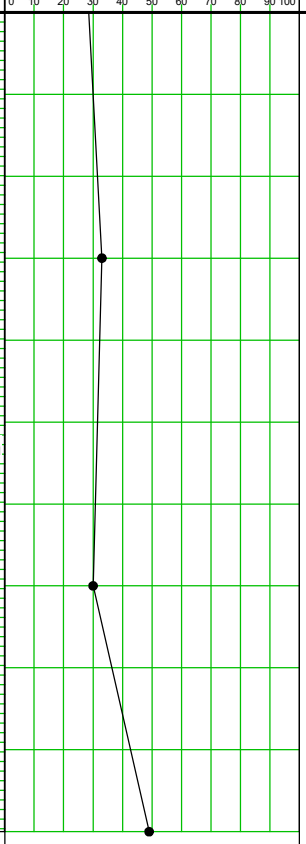
(Depth v/s SPT N Value) axis: 0 10 20 30 40 50 60 70 80 90 100

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*59+206 km	*Northing :*3150266 m	*Easting :*681807 m
Reduced Level (m):(+)213.360	*BH. No. :*BH-CL	*BH Termination Depth (m):*15
*Proposed / Existing Structure :*Minor Bridge	*Water Table (m):*12.65	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*23-09-2021	*Date of Completion :*24-09-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0											
10.5											
11.0											
11.5	11.5	SPT-4	12	15	18	33					
12.0											
12.5							Brown, Medium dense to dense, Sandy silt of low plasticity	ML-CL	12.65m		
13.0	13	UDS*									
13.5	13.5	SPT-5	12	14	16	30					
14.0											
14.5											
15.0	15	SPT-6	17	22	27	49					



UDS*-UDS not recovered

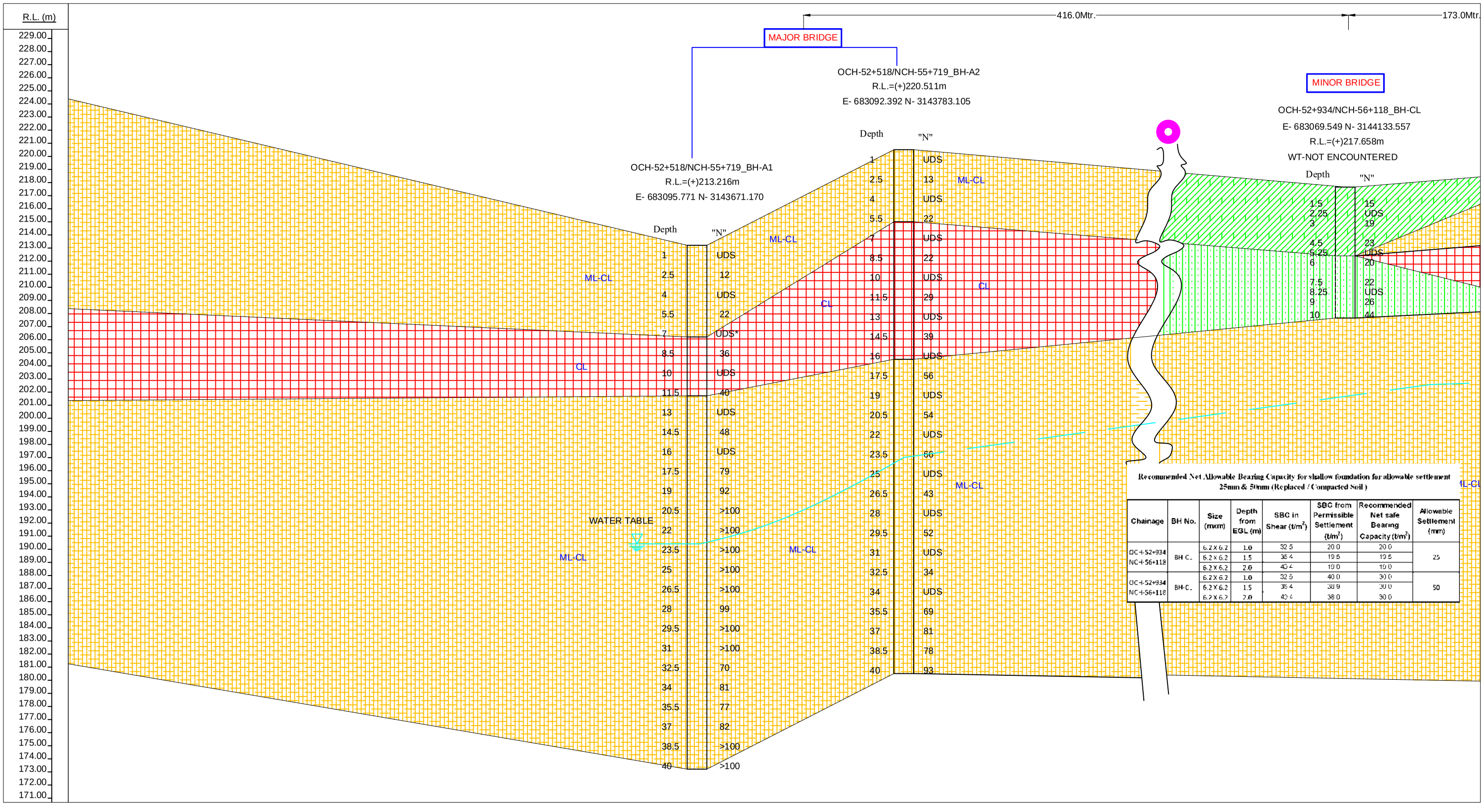
FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*59+270 km	*Northing :*3150330 m	*Easting :*681801 m
Reduced Level (m):(+)212.593	*BH. No. :*BH-CL	*BH Termination Depth (m):*10
*Proposed / Existing Structure :*Minor Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*23-09-2021	*Date of Completion :*23-09-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	SPT-1	7	9	11	20					
1.5											
2.0											
2.5	2.5	UDS-1									
3.0											
3.5											
4.0	4	SPT-2	8	12	14	26					
4.5											
5.0							Brown, Medium dense to dense, Sandy silt of low plasticity with gravel	ML-CL			
5.5	5.5	UDS-2									
6.0											
6.5											
7.0	7	SPT-3	15	19	20	39					
7.5											
8.0											
8.5	8.5	UDS-3									
9.0											
9.5											
10.0	10	SPT-4	19	20	22	42					

UDS*-UDS not recovered

CONDUCTING GEOTECHNICAL INVESTIGATION, PREPARATION OF GEOTECHNICAL REPORT FOR DESIGNING OF BRIDGES AND FOR EMBANKMENT IN CONNECTION WITH CONSTRUCTION OF HARYANA ORBITAL RAIL CORRIDOR (HORC) PROJECT FROM PALWAL TO HARSANA KALAN INCLUDING CONNECTIVITY TO EXISTING IR NETWORK IN THE STATE OF HARYANA.



Recommended Net Allowable Bearing Capacity for shallow foundation for allowable settlement 25mm & 50mm (Replaced / Compacted Soil)

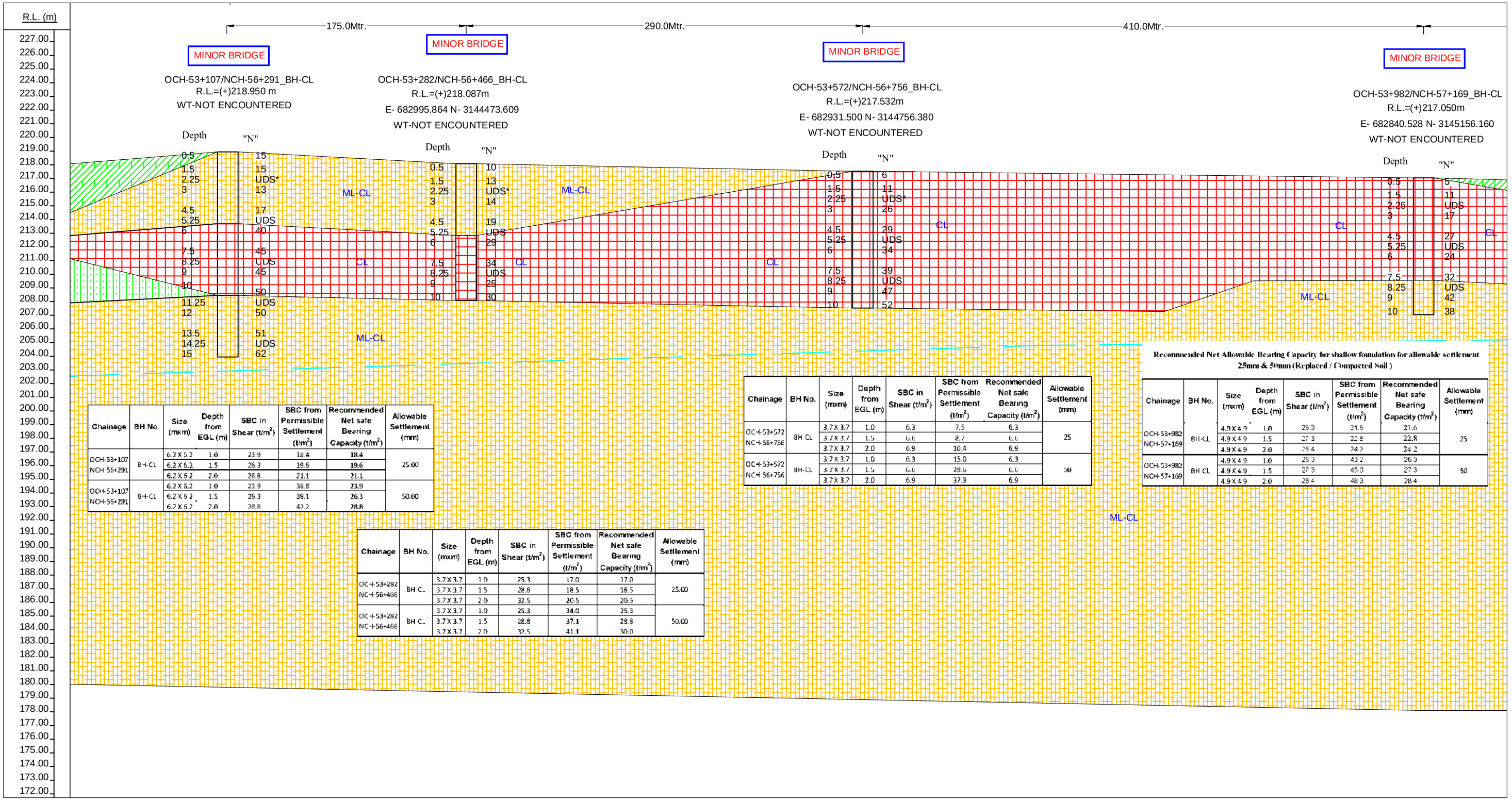
Chainage	BH No.	Size (mxm)	Depth from EGL (m)	SBC in Shear (t/m²)	SBC from Permissible Settlement (t/m²)	Recommended Net safe Bearing Capacity (t/m²)	Allowable Settlement (mm)
OCH-52+934 NCH-56+118	BH C-	6.2 X 6.2	1.0	32.5	20.0	20.0	25
		6.2 X 6.2	1.5	38.4	19.5	19.5	
		6.2 X 6.2	2.0	40.4	19.0	19.0	
OCH-52+934 NCH-56+118	BH-C-	6.2 X 6.2	1.0	32.5	40.0	30.0	50
		6.2 X 6.2	1.5	38.4	30.9	30.0	
		6.2 X 6.2	2.0	40.4	38.0	30.0	

Chainage	BH No.	Size (mxm)	Depth from EGL (m)	SBC in Shear (t/m²)	SBC from Permissible Settlement (t/m²)	Recommended Net safe Bearing Capacity (t/m²)	Allowable Settlement (mm)
OCH-52+518 NCH-55+719	BH-A1	7.2 X 7.2	2.0	32.9	20.1	20.1	25.00
		7.2 X 7.2	3.0	38.8	23.5	23.5	
		7.2 X 7.2	4.0	44.9	28.1	28.1	
OCH-52+518 NCH-55+719	BH A1	7.2 X 7.2	2.0	32.9	40.2	30.0	50.00
		7.2 X 7.2	3.0	38.8	47.0	30.0	
		7.2 X 7.2	4.0	44.9	55.2	30.0	
OCH-52+518 NCH-55+719	BH-A2	7.2 X 7.2	0.7	25.5	50.1	25.5	25.00
		7.2 X 7.2	1.0	27.2	51.6	27.2	
		7.2 X 7.2	1.5	30.0	54.5	30.0	
OCH-52+518 NCH-55+719	BH-A2	7.2 X 7.2	0.7	25.5	47.6	25.5	50.00
		7.2 X 7.2	1.0	27.2	48.2	27.2	
		7.2 X 7.2	1.5	30.0	49.2	30.0	

SYMBOL	DESCRIPTION
	SM- Silty Sand (Having fines Less Than 50% and no plasticity or below A-line)
	SM-SC -Clayey Sand (Having fines Less Than 50% and in the hatched zone (4<PI<7)
	ML-CL -Sandy with clay (Having fines greater than 50% and in the hatched zone (LL<35 & 4<PI<7)
	CL-Silty Clay of low plasticity (Above A-line, LL<35)
	CI- Clay of medium plasticity (Above A-line, 35≤LL<50)
	BOREHOLE REQUIRED / WATER TABLE

Note:- Fines= Percentage of Silty + Clay A-line=.73(wl-20) | SCALE:- HOR:- 1:2850 SCALE:- VER:- 1:285

CONDUCTING GEOTECHNICAL INVESTIGATION, PREPARATION OF GEOTECHNICAL REPORT FOR DESIGNING OF BRIDGES AND FOR EMBANKMENT IN CONNECTION WITH CONSTRUCTION OF HARYANA ORBITAL RAIL CORRIDOR (HORC) PROJECT FROM PALWAL TO HARSANA KALAN INCLUDING CONNECTIVITY TO EXISTING IR NETWORK IN THE STATE OF HARYANA.



Chainage	BH No.	Size (mxm)	Depth from EGL (m)	SBC in Shear (t/m²)	SBC from Permissible Settlement (t/m²)	Recommended Net safe Bearing Capacity (t/m²)	Allowable Settlement (mm)
OCH-53+107 NCH-56+291	BH-CL	6.2 X 6.2	1.0	23.9	18.4	18.4	25.00
		6.2 X 6.2	1.5	26.3	19.6	19.6	
		6.2 X 6.2	2.0	28.8	21.1	21.1	
OCH-53+107 NCH-56+291	BH-CL	6.2 X 6.2	1.0	23.9	36.8	23.9	50.00
		6.2 X 6.2	1.5	26.3	39.1	26.3	
		6.2 X 6.2	2.0	28.8	42.2	28.8	

Chainage	BH No.	Size (mxm)	Depth from EGL (m)	SBC in Shear (t/m²)	SBC from Permissible Settlement (t/m²)	Recommended Net safe Bearing Capacity (t/m²)	Allowable Settlement (mm)
OCH-53+572 NCH-56+756	BH-CL	3.7 X 3.7	1.0	6.3	7.5	6.3	25
		3.7 X 3.7	1.5	6.6	8.7	6.6	
		3.7 X 3.7	2.0	6.9	10.4	6.9	
OCH-53+572 NCH-56+756	BH-CL	3.7 X 3.7	1.0	6.3	15.0	6.3	50
		3.7 X 3.7	1.5	6.6	29.6	6.6	
		3.7 X 3.7	2.0	6.9	37.3	6.9	

Recommended Net Allowable Bearing Capacity for shallow foundation for allowable settlement 25mm & 50mm (Replaced / Compacted Soil)

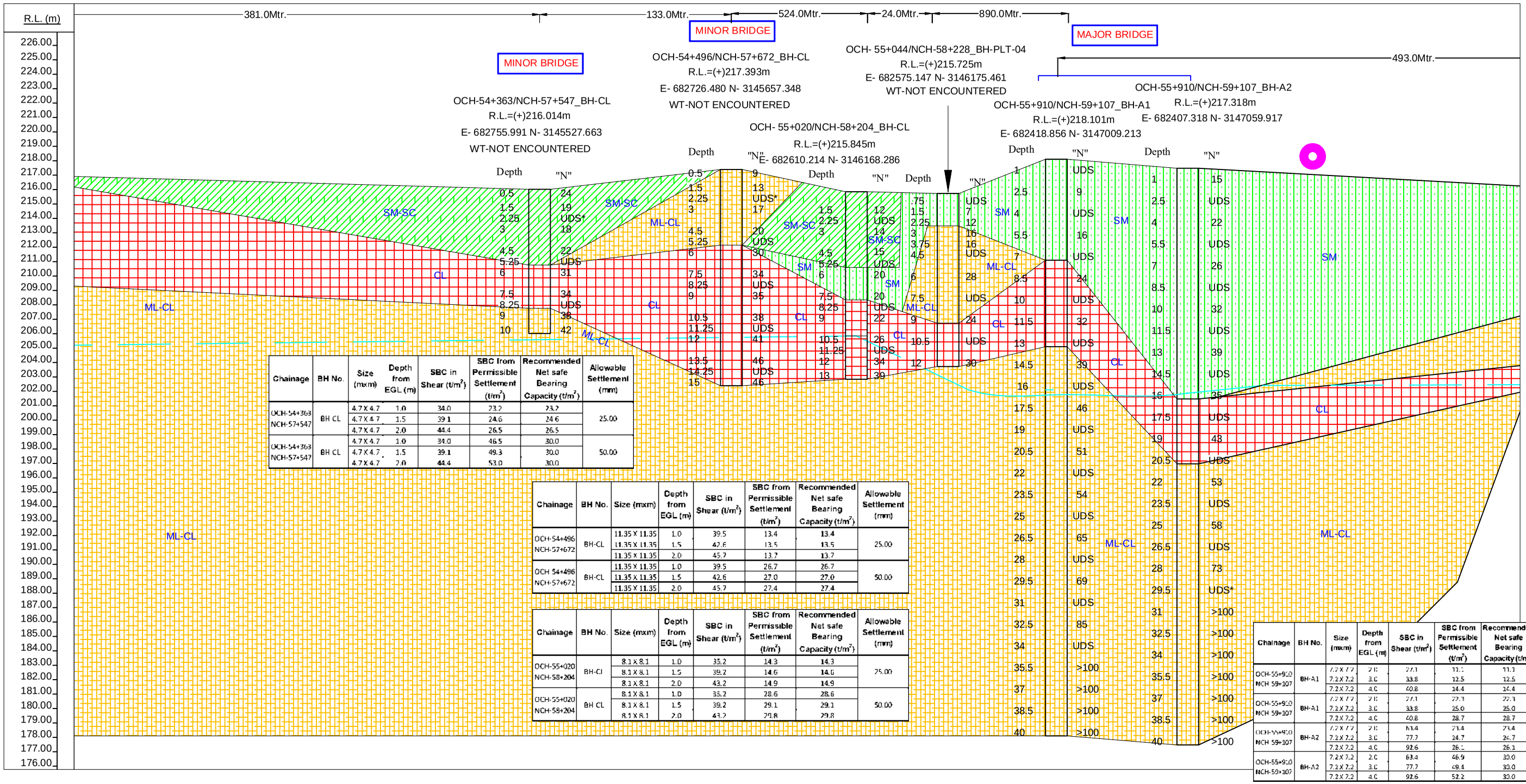
Chainage	BH No.	Size (mxm)	Depth from EGL (m)	SBC in Shear (t/m²)	SBC from Permissible Settlement (t/m²)	Recommended Net safe Bearing Capacity (t/m²)	Allowable Settlement (mm)
OCH-53+982 NCH-57+169	BH-CL	4.9 X 4.9	1.0	26.3	21.6	21.6	25
		4.9 X 4.9	1.5	27.3	22.8	22.8	
		4.9 X 4.9	2.0	28.4	24.2	24.2	
OCH-53+982 NCH-57+169	BH CL	4.9 X 4.9	1.0	26.3	43.2	26.3	50
		4.9 X 4.9	1.5	27.3	45.6	27.3	
		4.9 X 4.9	2.0	28.4	48.3	28.4	

Chainage	BH No.	Size (mxm)	Depth from EGL (m)	SBC in Shear (t/m²)	SBC from Permissible Settlement (t/m²)	Recommended Net safe Bearing Capacity (t/m²)	Allowable Settlement (mm)
OCH-53+282 NCH-56+466	BH-CL	3.7 X 3.7	1.0	25.3	17.0	17.0	25.00
		3.7 X 3.7	1.5	28.8	18.5	18.5	
		3.7 X 3.7	2.0	32.5	20.5	20.5	
OCH-53+282 NCH-56+466	BH-CL	3.7 X 3.7	1.0	25.3	34.0	25.3	50.00
		3.7 X 3.7	1.5	28.8	37.1	28.8	
		3.7 X 3.7	2.0	32.5	41.1	30.0	

SYMBOL	DESCRIPTION
	SM- Silty Sand (Having fines Less Than 50% and no plasticity or below A-line)
	SM-SC -Clayey Sand (Having fines Less Than 50% and in the hatched zone (4<PI<7)
	ML-CL -Sandy with clay (Having fines greater than 50% and in the hatched zone (LL<35 & 4<PI<7)
	CL-Silty Clay of low plasticity (Above A-line, LL<35)
	CI- Clay of medium plasticity (Above A-line, 35≤LL<50)
	BOREHOLE REQUIRED / WATER TABLE

Note:- Fines= Percentage of Silty + Clay A-line=.73(wl-20) | SCALE:- HOR:- 1:2850 | SCALE:- VER:- 1:285

CONDUCTING GEOTECHNICAL INVESTIGATION, PREPARATION OF GEOTECHNICAL REPORT FOR DESIGNING OF BRIDGES AND FOR EMBANKMENT IN CONNECTION WITH CONSTRUCTION OF HARYANA ORBITAL RAIL CORRIDOR (HORC) PROJECT FROM PALWAL TO HARSANA KALAN INCLUDING CONNECTIVITY TO EXISTING IR NETWORK IN THE STATE OF HARYANA.



Chainage	BH No.	Size (mxm)	Depth from EGL (m)	SBC in Shear (t/m²)	SBC from Permissible Settlement (t/m²)	Recommended Net safe Bearing Capacity (t/m²)	Allowable Settlement (mm)
OCH-54+363 NCH-57+547	BH CL	4.7 X 4.7	1.0	34.0	23.2	23.2	25.00
		4.7 X 4.7	1.5	39.1	24.6	24.6	
		4.7 X 4.7	2.0	44.4	26.5	26.5	
OCH-54+363 NCH-57+547	BH CL	4.7 X 4.7	1.0	34.0	46.5	30.0	50.00
		4.7 X 4.7	1.5	39.1	49.3	30.0	
		4.7 X 4.7	2.0	44.4	53.0	30.0	

Chainage	BH No.	Size (mxm)	Depth from EGL (m)	SBC in Shear (t/m²)	SBC from Permissible Settlement (t/m²)	Recommended Net safe Bearing Capacity (t/m²)	Allowable Settlement (mm)
OCH-54+496 NCH-57+672	BH-CL	11.35 X 11.35	1.0	39.5	13.4	13.4	25.00
		11.35 X 11.35	1.5	42.6	13.5	13.5	
		11.35 X 11.35	2.0	45.7	13.7	13.7	
OCH 54+496 NCH-57+672	BH-CL	11.35 X 11.35	1.0	39.5	26.7	26.7	50.00
		11.35 X 11.35	1.5	42.6	27.0	27.0	
		11.35 X 11.35	2.0	45.7	27.4	27.4	

Chainage	BH No.	Size (mxm)	Depth from EGL (m)	SBC in Shear (t/m²)	SBC from Permissible Settlement (t/m²)	Recommended Net safe Bearing Capacity (t/m²)	Allowable Settlement (mm)
OCH-55+020 NCH-58+204	BH-CL	8.1 X 8.1	1.0	35.2	14.3	14.3	25.00
		8.1 X 8.1	1.5	39.2	14.6	14.6	
		8.1 X 8.1	2.0	43.2	14.9	14.9	
OCH-55+020 NCH-58+204	BH CL	8.1 X 8.1	1.0	35.2	28.6	28.6	50.00
		8.1 X 8.1	1.5	39.2	29.1	29.1	
		8.1 X 8.1	2.0	43.2	29.8	29.8	

Chainage	BH No.	Size (mxm)	Depth from EGL (m)	SBC in Shear (t/m²)	SBC from Permissible Settlement (t/m²)	Recommended Net safe Bearing Capacity (t/m²)	Allowable Settlement (mm)
OCH-55+910 NCH-59+107	BH-A1	7.2 X 7.2	2.0	27.1	11.1	11.1	25.00
		7.2 X 7.2	3.0	33.8	12.5	12.5	
		7.2 X 7.2	4.0	40.8	14.4	14.4	
OCH-55+910 NCH-59+107	BH-A1	7.2 X 7.2	2.0	27.1	22.3	22.3	50.00
		7.2 X 7.2	3.0	33.8	25.0	25.0	
		7.2 X 7.2	4.0	40.8	28.7	28.7	
OCH-55+910 NCH-59+107	BH-A2	7.2 X 7.2	2.0	61.4	23.4	23.4	25.00
		7.2 X 7.2	3.0	77.7	24.7	26.7	
		7.2 X 7.2	4.0	92.6	26.1	26.1	
OCH-55+910 NCH-59+107	BH-A2	7.2 X 7.2	2.0	63.4	46.9	30.0	50.00
		7.2 X 7.2	3.0	77.7	49.4	30.0	
		7.2 X 7.2	4.0	92.6	52.2	30.0	

Chainage	BH No.	Size (mxm)	Depth from EGL (m)	SBC in Shear (t/m²)	SBC from Permissible Settlement (t/m²)	Recommended Net safe Bearing Capacity (t/m²)	Allowable Settlement (mm)
OCH-55+044 NCH-58+228	BH-PLT-04	2 X 2	1.0	21.9	22.3	21.9	25.00
		2 X 2	1.5	26.0	24.3	24.3	
		2 X 2	2.0	30.3	25.7	25.7	
OCH-55+044 NCH-58+228	BH-PLT-04	2 X 2	1.0	21.9	44.6	21.9	50.00
		2 X 2	1.5	26.0	48.6	26.0	
		2 X 2	2.0	30.3	51.3	30.0	

SYMBOL	DESCRIPTION
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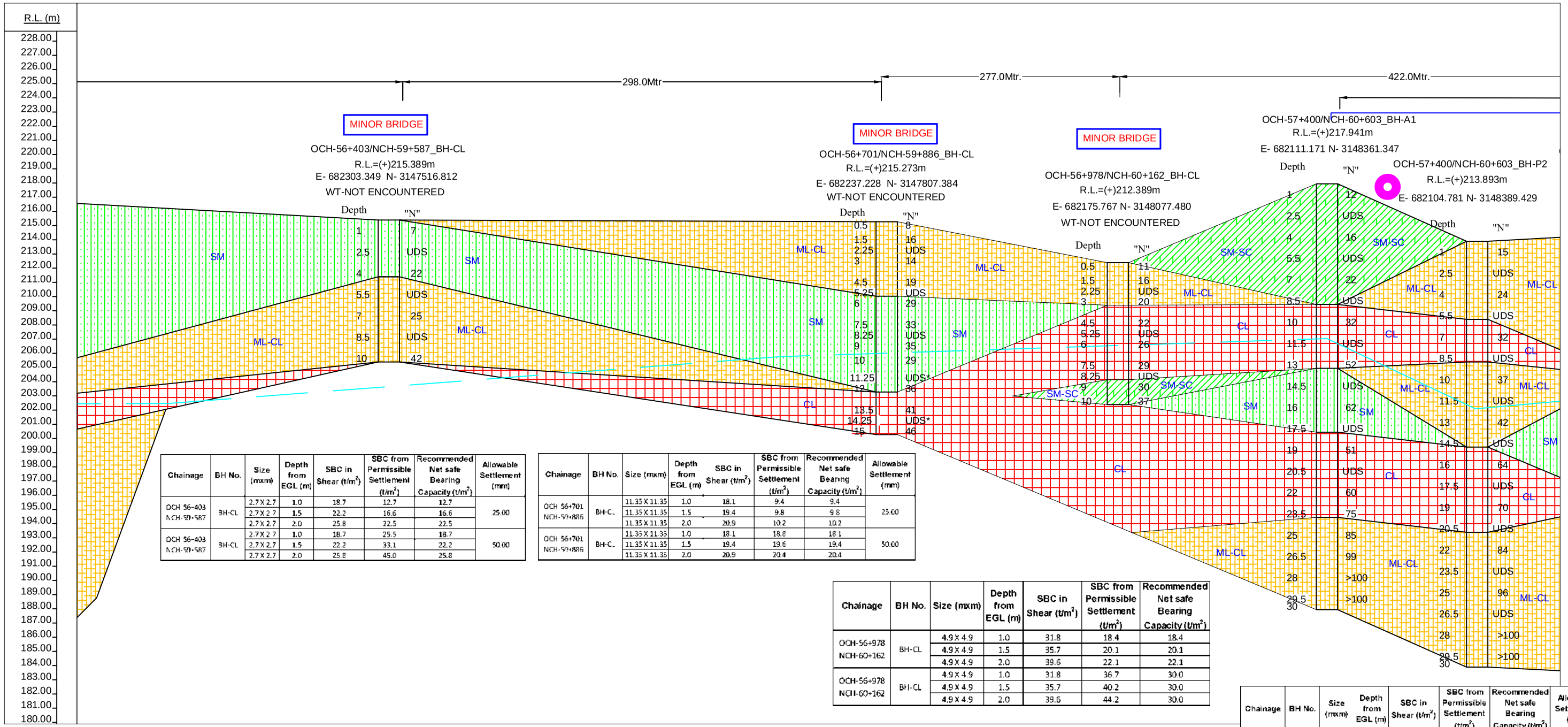
	CL-Silty Clay of low plasticity (Above A-line, LL<35)
	CI- Clay of medium plasticity (Above A-line, 35≤LL<50)
	BOREHOLE REQUIRED / WATER TABLE

Note:- Fines= Percentage of Silty + Clay A-line=.73(wl-20)

SCALE:- HOR:- 1:2850 SCALE:- VER:- 1:285

CONDUCTING GEOTECHNICAL INVESTIGATION, PREPARATION OF GEOTECHNICAL REPORT FOR DESIGNING OF BRIDGES AND FOR EMBANKMENT IN CONNECTION WITH CONSTRUCTION OF HARYANA ORBITAL RAIL CORRIDOR (HORC) PROJECT FROM PALWAL TO HARSANA KALAN INCLUDING CONNECTIVITY TO EXISTING IR NETWORK IN THE STATE OF HARYANA.



Chainage	BH No.	Size (mxm)	Depth from EGL (m)	SBC in Shear (t/m²)	SBC from Permissible Settlement (t/m²)	Recommended Net safe Bearing Capacity (t/m²)	Allowable Settlement (mm)
OCH 56+403 NCH-59+587	BH-CL	2.7 X 2.7	1.0	18.7	12.7	12.7	25.00
		2.7 X 2.7	1.5	22.2	16.6	16.6	
		2.7 X 2.7	2.0	25.8	22.5	22.5	
OCH 56+403 NCH-59+587	BH-CL	2.7 X 2.7	1.0	18.7	25.5	18.7	50.00
		2.7 X 2.7	1.5	22.2	33.1	22.2	
		2.7 X 2.7	2.0	25.8	45.0	25.8	

Chainage	BH No.	Size (mxm)	Depth from EGL (m)	SBC in Shear (t/m²)	SBC from Permissible Settlement (t/m²)	Recommended Net safe Bearing Capacity (t/m²)	Allowable Settlement (mm)
OCH 56+701 NCH-59+886	BH-C..	11.35 X 11.35	1.0	18.1	9.4	9.4	25.00
		11.35 X 11.35	1.5	19.4	9.8	9.8	
		11.35 X 11.35	2.0	20.9	10.2	10.2	
OCH 56+701 NCH-59+886	BH-C..	11.35 X 11.35	1.0	18.1	18.8	18.1	50.00
		11.35 X 11.35	1.5	19.4	19.6	19.4	
		11.35 X 11.35	2.0	20.9	20.4	20.4	

Chainage	BH No.	Size (mxm)	Depth from EGL (m)	SBC in Shear (t/m²)	SBC from Permissible Settlement (t/m²)	Recommended Net safe Bearing Capacity (t/m²)
OCH-56+978 NCH-60+162	BH-CL	4.9 X 4.9	1.0	31.8	18.4	18.4
		4.9 X 4.9	1.5	35.7	20.1	20.1
		4.9 X 4.9	2.0	39.6	22.1	22.1
OCH-56+978 NCH-60+162	BH-CL	4.9 X 4.9	1.0	31.8	36.7	30.0
		4.9 X 4.9	1.5	35.7	40.2	30.0
		4.9 X 4.9	2.0	39.6	44.2	30.0

Chainage	BH No.	Size (mxm)	Depth from EGL (m)	SBC in Shear (t/m²)	SBC from Permissible Settlement (t/m²)	Recommended Net safe Bearing Capacity (t/m²)	Allowable Settlement (mm)
OCH-57+400 NCH-60+603	A1	7.2 X 7.2	2.0	43.6	15.8	15.8	25.00
		7.2 X 7.2	3.0	51.1	17.6	17.6	
		7.2 X 7.2	4.0	58.8	19.7	19.7	
	A1	7.2 X 7.2	2.0	43.6	31.7	30.0	50.00
		7.2 X 7.2	3.0	51.1	35.2	30.0	
		7.2 X 7.2	4.0	58.8	39.4	30.0	
	P2	7.2 X 7.2	2.0	60.4	18.2	18.2	25.00
		7.2 X 7.2	3.0	69.3	18.4	18.4	
		7.2 X 7.2	4.0	78.4	18.4	18.4	
	P2	7.2 X 7.2	2.0	60.4	36.5	30.0	50.00
		7.2 X 7.2	3.0	69.3	36.7	30.0	
		7.2 X 7.2	4.0	78.4	36.8	30.0	

SYMBOL	DESCRIPTION
	SM- Silty Sand (Having fines Less Than 50% and no plasticity or below A-line)
	SM-SC -Clayey Sand (Having fines Less Than 50% and in the hatched zone (4<PI<7)
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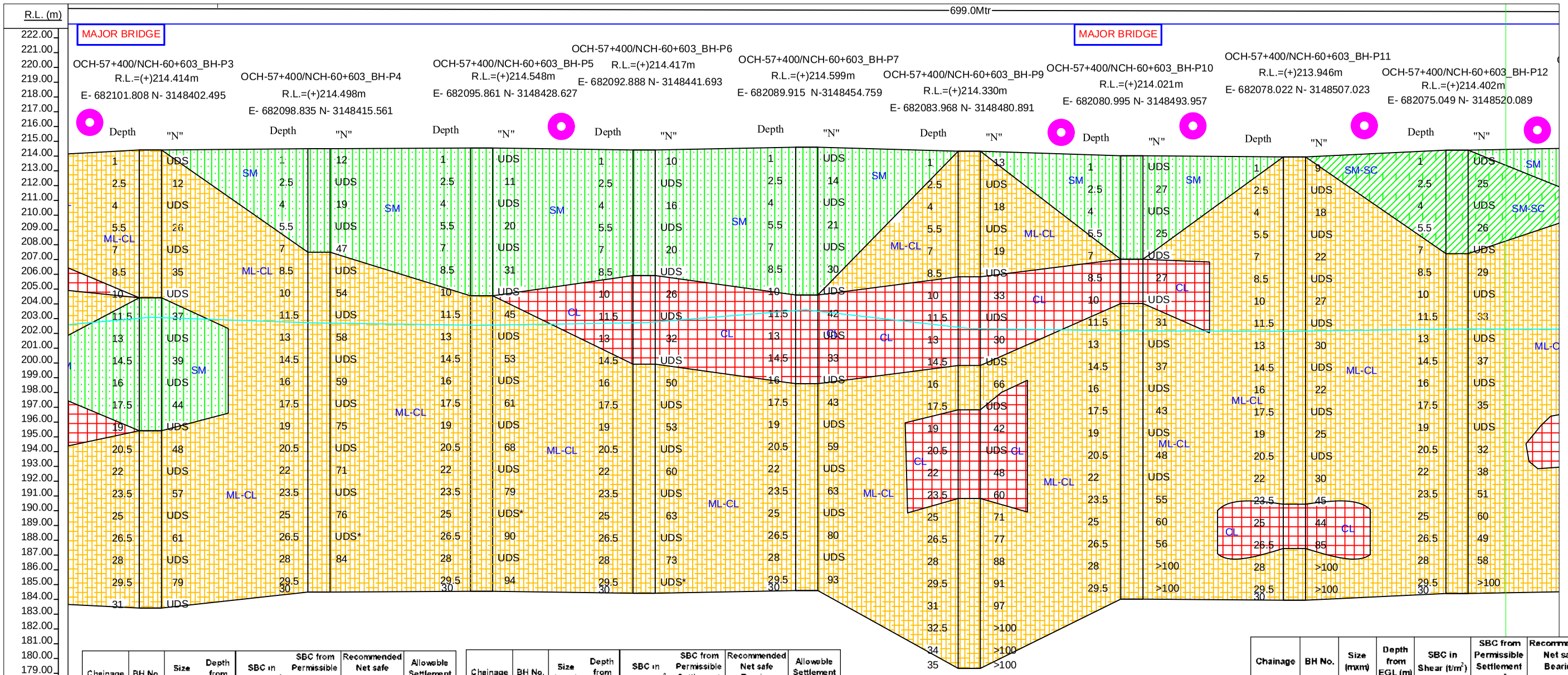
	CL-Silty Clay of low plasticity (Above A-line, LL<35)
	CI- Clay of medium plasticity (Above A-line, 35≤LL<50)
	BOREHOLE REQUIRED / WATER TABLE

Note:- Fines= Percentage of Silty + Clay A-line=.73(wl-20)

SCALE:- HOR:- 1:2850 SCALE:- VER:- 1:285

CONDUCTING GEOTECHNICAL INVESTIGATION, PREPARATION OF GEOTECHNICAL REPORT FOR DESIGNING OF BRIDGES AND FOR EMBANKMENT IN CONNECTION WITH CONSTRUCTION OF HARYANA ORBITAL RAIL CORRIDOR (HORC) PROJECT FROM PALWAL TO HARSANA KALAN INCLUDING CONNECTIVITY TO EXISTING IR NETWORK IN THE STATE OF HARYANA.



Chainage	BH No.	Size (mxm)	Depth from EGL (m)	SBC in Shear (t/m²)	SBC from Permissible Settlement (t/m²)	Recommended Net safe Bearing Capacity (t/m²)	Allowable Settlement (mm)
OCH-57+400 NCH-60+603	P3	7.2 X 7.2	2.0	30.4	23.5	23.5	25.00
		7.2 X 7.2	3.0	35.4	25.7	25.7	
		7.2 X 7.2	4.0	40.6	28.3	28.3	
	P3	7.2 X 7.2	2.0	30.4	47.0	30.0	50.00
		7.2 X 7.2	3.0	35.4	51.5	30.0	
		7.2 X 7.2	4.0	40.6	56.5	30.0	
	P4	7.2 X 7.2	2.0	44.7	26.1	26.1	25.00
		7.2 X 7.2	3.0	53.3	29.6	29.6	
		7.2 X 7.2	4.0	62.3	31.2	30.0	
	P4	7.2 X 7.2	2.0	44.7	56.1	30.0	50.00
		7.2 X 7.2	3.0	53.3	59.2	30.0	
		7.2 X 7.2	4.0	62.3	52.5	30.0	

Chainage	BH No.	Size (mxm)	Depth from EGL (m)	SBC in Shear (t/m²)	SBC from Permissible Settlement (t/m²)	Recommended Net safe Bearing Capacity (t/m²)	Allowable Settlement (mm)
OCH-57+400 NCH 60+603	P-5	7.2 X 7.2	2.0	33.6	23.7	23.7	25.00
		7.2 X 7.2	3.0	40.4	27.0	27.0	
		7.2 X 7.2	4.0	47.4	28.6	28.6	
	P-5	7.2 X 7.2	2.0	33.6	51.3	30.0	50.00
		7.2 X 7.2	3.0	40.4	54.1	30.0	
		7.2 X 7.2	4.0	47.4	57.1	30.0	
	P-6	7.2 X 7.2	2.0	35.5	14.1	14.1	25.00
		7.2 X 7.2	3.0	42.6	15.0	15.0	
		7.2 X 7.2	4.0	49.9	16.2	16.2	
	P 6	7.2 X 7.2	2.0	35.5	28.1	28.1	
		7.2 X 7.2	3.0	42.6	30.0	30.0	50.00
		7.2 X 7.2	4.0	49.9	32.5	30.0	

Chainage	BH No.	Size (mxm)	Depth from EGL (m)	SBC in Shear (t/m²)	SBC from Permissible Settlement (t/m²)	Recommended Net safe Bearing Capacity (t/m²)	Allowable Settlement (mm)
OCH-57+400 NCH-60+603	P-7	7.2 X 7.2	2.0	37.4	18.2	18.2	25.00
		7.2 X 7.2	3.0	44.8	19.4	19.4	
		7.2 X 7.2	4.0	52.5	21.0	21.0	
	P-7	7.2 X 7.2	2.0	37.4	36.4	30.0	50.00
		7.2 X 7.2	3.0	44.8	38.8	30.0	
		7.2 X 7.2	4.0	52.5	42.1	30.0	
	P-9	7.2 X 7.2	2.0	43.6	15.7	15.7	25.00
		7.2 X 7.2	3.0	50.1	16.7	16.7	
		7.2 X 7.2	4.0	56.7	18.1	18.1	
	P-9	7.2 X 7.2	2.0	43.6	31.4	30.0	50.00
		7.2 X 7.2	3.0	50.1	33.4	30.0	
		7.2 X 7.2	4.0	56.7	36.2	30.0	

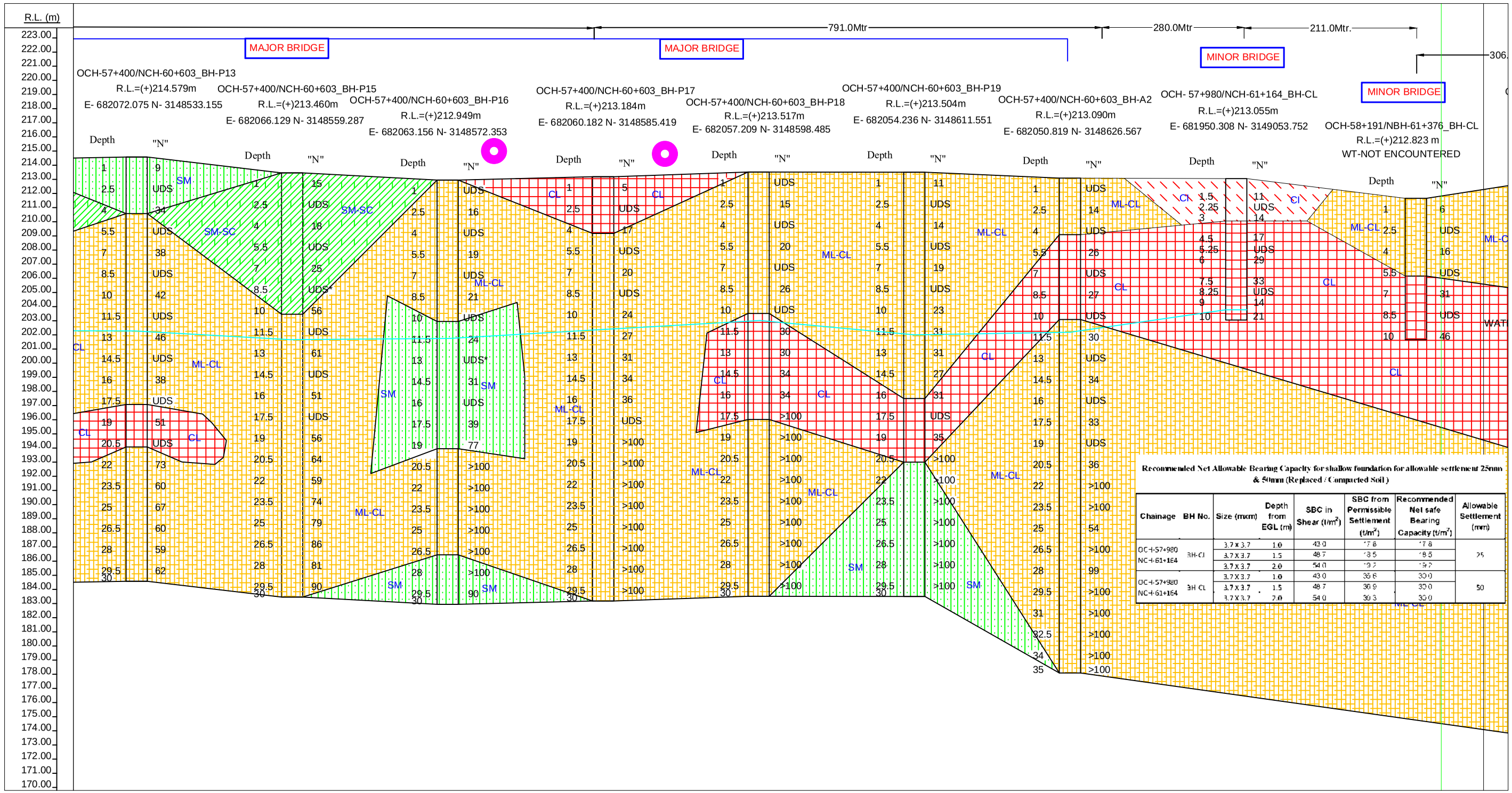
Chainage	BH No.	Size (mxm)	Depth from EGL (m)	SBC in Shear (t/m²)	SBC from Permissible Settlement (t/m²)	Recommended Net safe Bearing Capacity (t/m²)	Allowable Settlement (mm)
OCH-57+400 NCH-60+603	P 10	7.2 X 7.2	2.0	61.4	23.6	23.6	25.00
		7.2 X 7.2	3.0	72.8	24.8	24.8	
		7.2 X 7.2	4.0	84.7	25.5	25.5	
	P-10	7.2 X 7.2	2.0	61.4	47.2	30.0	50.00
		7.2 X 7.2	3.0	72.8	49.6	30.0	
		7.2 X 7.2	4.0	84.7	51.0	30.0	
	P-11	7.2 X 7.2	2.0	30.6	15.0	15.0	25.00
		7.2 X 7.2	3.0	35.6	15.9	15.9	
		7.2 X 7.2	4.0	40.8	16.8	16.8	
	P 11	7.2 X 7.2	2.0	30.6	30.1	30.0	50.00
		7.2 X 7.2	3.0	35.6	31.7	30.0	
		7.2 X 7.2	4.0	40.8	33.5	30.0	
	P-12	7.2 X 7.2	2.0	69.4	27.8	27.8	25.00
		7.2 X 7.2	3.0	80.6	28.4	28.4	
		7.2 X 7.2	4.0	92.1	27.8	27.8	
	P-12	7.2 X 7.2	2.0	69.4	55.7	30.0	50.00
		7.2 X 7.2	3.0	80.6	56.7	30.0	
		7.2 X 7.2	4.0	92.1	55.5	30.0	

SYMBOL	DESCRIPTION
	SM- Silty Sand (Having fines Less Than 50% and no plasticity or below A-line)
	SM-SC -Clayey Sand (Having fines Less Than 50% and in the hatched zone (4<PI<7)
	ML-CL -Sandy with clay (Having fines greater than 50% and in the hatched zone (LL<35 & 4<PI<7)
	CL-Silty Clay of low plasticity (Above A-line, LL<35)
	CI- Clay of medium plasticity (Above A-line, 35≤LL<50)
	BOREHOLE REQUIRED / WATER TABLE

Note:- Fines= Percentage of Silty + Clay A-line=.73(wl-20)

SCALE:- HOR:- 1:2850 SCALE:- VER:- 1:285

CONDUCTING GEOTECHNICAL INVESTIGATION, PREPARATION OF GEOTECHNICAL REPORT FOR DESIGNING OF BRIDGES AND FOR EMBANKMENT IN CONNECTION WITH CONSTRUCTION OF HARYANA ORBITAL RAIL CORRIDOR (HORC) PROJECT FROM PALWAL TO HARSANA KALAN INCLUDING CONNECTIVITY TO EXISTING IR NETWORK IN THE STATE OF HARYANA.



Recommended Net Allowable Bearing Capacity for shallow foundation for allowable settlement 25mm & 50mm (Replaced / Compacted Soil)

Chainage	BH No.	Size (mxm)	Depth from EGL (m)	SBC in Shear (t/m²)	SBC from Permissible Settlement (t/m²)	Recommended Net safe Bearing Capacity (t/m²)	Allowable Settlement (mm)
OCH-57+980 NCH-61+164	BH-CL	3.7 X 3.7	1.0	42.0	17.8	17.8	25
		3.7 X 3.7	1.5	48.7	18.5	18.5	
		3.7 X 3.7	2.0	54.0	19.2	19.2	
OCH-57+980 NCH-61+164	BH-CL	3.7 X 3.7	1.0	43.0	35.6	30.0	50
		3.7 X 3.7	1.5	48.7	36.9	30.0	
		3.7 X 3.7	2.0	54.0	36.3	30.0	

Chainage	BH No.	Size (mxm)	Depth from EGL (m)	SBC in Shear (t/m²)	SBC from Permissible Settlement (t/m²)	Recommended Net safe Bearing Capacity (t/m²)	Allowable Settlement (mm)
OCH-57-400 NCH-60-603	P-13	7.2 X 7.2	2.0	27.0	18.4	18.4	25.00
		7.2 X 7.2	3.0	32.6	22.6	22.6	
		7.2 X 7.2	4.0	38.4	28.4	28.4	
	P-13	7.2 X 7.2	2.0	27.0	35.8	27.0	50.00
		7.2 X 7.2	3.0	32.6	45.3	30.0	
		7.2 X 7.2	4.0	38.4	55.7	30.0	
	P-15	7.2 X 7.2	2.0	39.5	21.2	21.2	25.00
		7.2 X 7.2	3.0	46.3	23.6	23.6	
		7.2 X 7.2	4.0	53.3	26.5	26.5	
	P-15	7.2 X 7.2	2.0	39.5	42.5	30.0	50.00
		7.2 X 7.2	3.0	46.3	47.2	30.0	
		7.2 X 7.2	4.0	53.3	53.0	30.0	

Chainage	BH No.	Size (mxm)	Depth from EGL (m)	SBC in Shear (t/m²)	SBC from Permissible Settlement (t/m²)	Recommended Net safe Bearing Capacity (t/m²)	Allowable Settlement (mm)
OCH-57-400 NCH 60-603	P-15	7.2 X 7.2	2.0	45.1	21.2	21.2	25.00
		7.2 X 7.2	3.0	37.7	19.4	19.4	
		7.2 X 7.2	4.0	58.7	26.5	26.5	
	P-15	7.2 X 7.2	2.0	45.1	42.5	30.0	50.00
		7.2 X 7.2	3.0	37.7	38.9	30.0	
		7.2 X 7.2	4.0	58.7	53.0	30.0	
	P-17	7.2 X 7.2	2.0	19.8	5.4	5.4	25.00
		7.2 X 7.2	3.0	22.9	7.9	7.9	
		7.2 X 7.2	4.0	26.0	17.7	17.7	
	P-17	7.2 X 7.2	2.0	19.8	10.8	10.8	50.00
		7.2 X 7.2	3.0	22.9	15.9	15.9	
		7.2 X 7.2	4.0	26.0	35.5	26.0	

Chainage	BH No.	Size (mxm)	Depth from EGL (m)	SBC in Shear (t/m²)	SBC from Permissible Settlement (t/m²)	Recommended Net safe Bearing Capacity (t/m²)	Allowable Settlement (mm)
OCH-57-400 NCH 60-603	P-18	7.2 X 7.2	2.0	39.2	15.7	15.7	25.00
		7.2 X 7.2	3.0	45.1	16.5	16.5	
		7.2 X 7.2	4.0	51.2	17.5	17.5	
	P-18	7.2 X 7.2	2.0	39.2	31.5	30.0	50.00
		7.2 X 7.2	3.0	45.1	33.0	30.0	
		7.2 X 7.2	4.0	51.2	35.1	30.0	
	P-19	7.2 X 7.2	2.0	22.1	15.9	15.9	25.00
		7.2 X 7.2	3.0	25.2	16.8	16.8	
		7.2 X 7.2	4.0	28.5	17.7	17.7	
	P-19	7.2 X 7.2	2.0	22.1	31.9	22.1	50.00
		7.2 X 7.2	3.0	25.2	33.6	25.2	
		7.2 X 7.2	4.0	28.5	35.5	28.5	
	A2	7.2 X 7.2	2.0	34.1	15.7	15.7	25.00
		7.2 X 7.2	3.0	39.6	18.1	18.1	
		7.2 X 7.2	4.0	45.3	19.0	19.0	
	A2	7.2 X 7.2	2.0	34.1	33.4	30.0	50.00
		7.2 X 7.2	3.0	39.6	35.1	30.0	
		7.2 X 7.2	4.0	45.3	38.0	30.0	

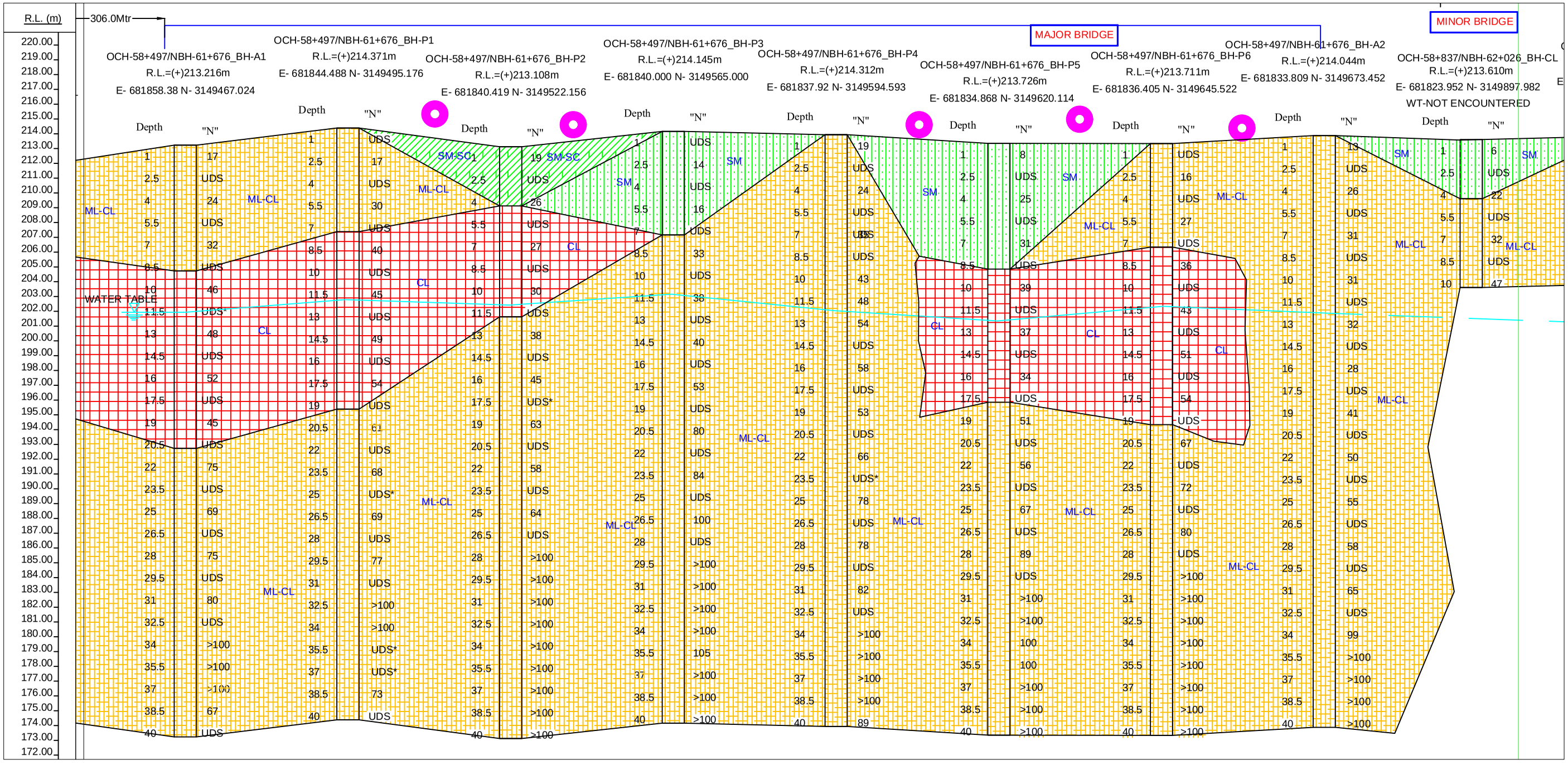
Chainage	BH No.	Size (mxm)	Depth from EGL (m)	SBC in Shear (t/m²)	SBC from Permissible Settlement (t/m²)	Recommended Net safe Bearing Capacity (t/m²)	Allowable Settlement (mm)
OCH-58+191 NCH-61+376	BH-CL	3.7 X 3.7	1.0	21.2	11.2	11.2	25.00
		3.7 X 3.7	1.5	24.1	12.1	12.1	
		3.7 X 3.7	2.0	27.1	13.4	13.4	
OCH-58+191 NCH-61+376	BH CL	3.7 X 3.7	1.0	21.2	22.5	21.2	50.00
		3.7 X 3.7	1.5	24.1	24.3	24.1	
		3.7 X 3.7	2.0	27.1	26.8	26.8	

SYMBOL	DESCRIPTION
	SM- Silty Sand (Having fines Less Than 50% and no plasticity or below A-line)
	SM-SC -Clayey Sand (Having fines Less Than 50% and in the hatched zone (4<PI<7)
	ML-CL -Sandy with clay (Having fines greater than 50% and in the hatched zone (LL<35 & 4<PI<7)
	CL-Silty Clay of low plasticity (Above A-line, LL<35)
	CI- Clay of medium plasticity (Above A-line, 35≤LL<50)
	BOREHOLE REQUIRED / WATER TABLE

Note:- Fines= Percentage of Silty + Clay A-line=.73(wl-20)

SCALE:- HOR:- 1:2850 SCALE:- VER:- 1:285

CONDUCTING GEOTECHNICAL INVESTIGATION, PREPARATION OF GEOTECHNICAL REPORT FOR DESIGNING OF BRIDGES AND FOR EMBANKMENT IN CONNECTION WITH CONSTRUCTION OF HARYANA ORBITAL RAIL CORRIDOR (HORC) PROJECT FROM PALWAL TO HARSANA KALAN INCLUDING CONNECTIVITY TO EXISTING IR NETWORK IN THE STATE OF HARYANA.



Chainage	BH No.	Size (mxm)	Depth from EGL (m)	SBC in Shear (t/m²)	SBC from Permissible Settlement (t/m²)	Recommended Net safe Bearing Capacity (t/m²)	Allowable Settlement (mm)
OCH-58+497 NCH-61+676	BH-A1	7.2 X 7.2	2.0	52.4	29.8	29.8	25
		7.2 X 7.2	3.0	60.3	25.3	25.3	
		7.2 X 7.2	4.0	68.4	27.2	27.2	
	BH-A1	7.2 X 7.2	2.0	52.4	47.7	30.0	50
		7.2 X 7.2	3.0	60.3	50.7	30.0	
		7.2 X 7.2	4.0	68.4	54.3	30.0	
OCH-58+497 NCH-61+676	BH-P1	7.2 X 7.2	2.0	41.5	23.1	23.1	25
		7.2 X 7.2	3.0	48.3	24.9	24.9	
		7.2 X 7.2	4.0	55.0	27.1	27.1	
	BH-P1	7.2 X 7.2	2.0	41.5	43.6	30.0	50
		7.2 X 7.2	3.0	48.3	44.8	30.0	
		7.2 X 7.2	4.0	55.0	46.3	30.0	

Chainage	BH No.	Size (mxm)	Depth from EGL (m)	SBC in Shear (t/m²)	SBC from Permissible Settlement (t/m²)	Recommended Net safe Bearing Capacity (t/m²)	Allowable Settlement (mm)
OCH-58+497 NCH-61+676	BH-P2	7.2 X 7.2	2.0	41.8	25.1	23.1	25
		7.2 X 7.2	3.0	48.6	26.9	24.9	
		7.2 X 7.2	4.0	55.6	27.1	27.1	
	BH-P2	7.2 X 7.2	2.0	41.8	46.8	30.0	50
		7.2 X 7.2	3.0	48.6	49.9	30.0	
		7.2 X 7.2	4.0	55.6	52.1	30.0	
OCH-58+497 NCH-61+676	BH-P3	7.2 X 7.2	2.0	31.1	15.6	15.6	25
		7.2 X 7.2	3.0	41.3	16.8	16.8	
		7.2 X 7.2	4.0	48.9	17.9	17.9	
	BH-P3	7.2 X 7.2	2.0	31.1	31.1	30.0	50
		7.2 X 7.2	3.0	41.3	33.7	30.0	
		7.2 X 7.2	4.0	48.9	35.9	30.0	

Chainage	BH No.	Size (mxm)	Depth from EGL (m)	SBC in Shear (t/m²)	SBC from Permissible Settlement (t/m²)	Recommended Net safe Bearing Capacity (t/m²)	Allowable Settlement (mm)
OCH-58+497 NCH-61+676	BH-P4	7.2 X 7.2	2.0	37.5	24.1	24.1	25
		7.2 X 7.2	3.0	43.5	24.1	24.1	
		7.2 X 7.2	4.0	50.0	23.4	23.4	
	BH-P4	7.2 X 7.2	2.0	37.5	48.3	30.0	50
		7.2 X 7.2	3.0	43.5	48.3	30.0	
		7.2 X 7.2	4.0	50.0	46.8	30.0	
OCH-58+497 NCH-61+676	BH-P5	7.2 X 7.2	2.0	44.5	19.1	19.1	25
		7.2 X 7.2	3.0	54.4	20.2	20.2	
		7.2 X 7.2	4.0	64.5	21.6	21.6	
	BH-P5	7.2 X 7.2	2.0	44.5	38.1	30.0	50
		7.2 X 7.2	3.0	54.4	40.4	30.0	
		7.2 X 7.2	4.0	64.5	43.1	30.0	

Chainage	BH No.	Size (mxm)	Depth from EGL (m)	SBC in Shear (t/m²)	SBC from Permissible Settlement (t/m²)	Recommended Net safe Bearing Capacity (t/m²)	Allowable Settlement (mm)
OCH-58+497 NCH-61+676	BH-P6	7.2 X 7.2	2.0	50.1	21.5	21.5	25
		7.2 X 7.2	3.0	57.9	23.4	23.4	
		7.2 X 7.2	4.0	66.1	25.6	25.6	
	BH-P6	7.2 X 7.2	2.0	50.1	49.1	30.0	50
		7.2 X 7.2	3.0	57.9	46.7	30.0	
		7.2 X 7.2	4.0	66.1	51.1	30.0	
OCH-58+497 NCH-61+676	BH-A2	7.2 X 7.2	2.0	44.7	19.4	19.4	25
		7.2 X 7.2	3.0	51.8	18.5	18.5	
		7.2 X 7.2	4.0	59.0	16.9	16.9	
	BH-A2	7.2 X 7.2	2.0	44.7	38.6	30.0	50
		7.2 X 7.2	3.0	51.8	37.0	30.0	
		7.2 X 7.2	4.0	59.0	33.8	30.0	

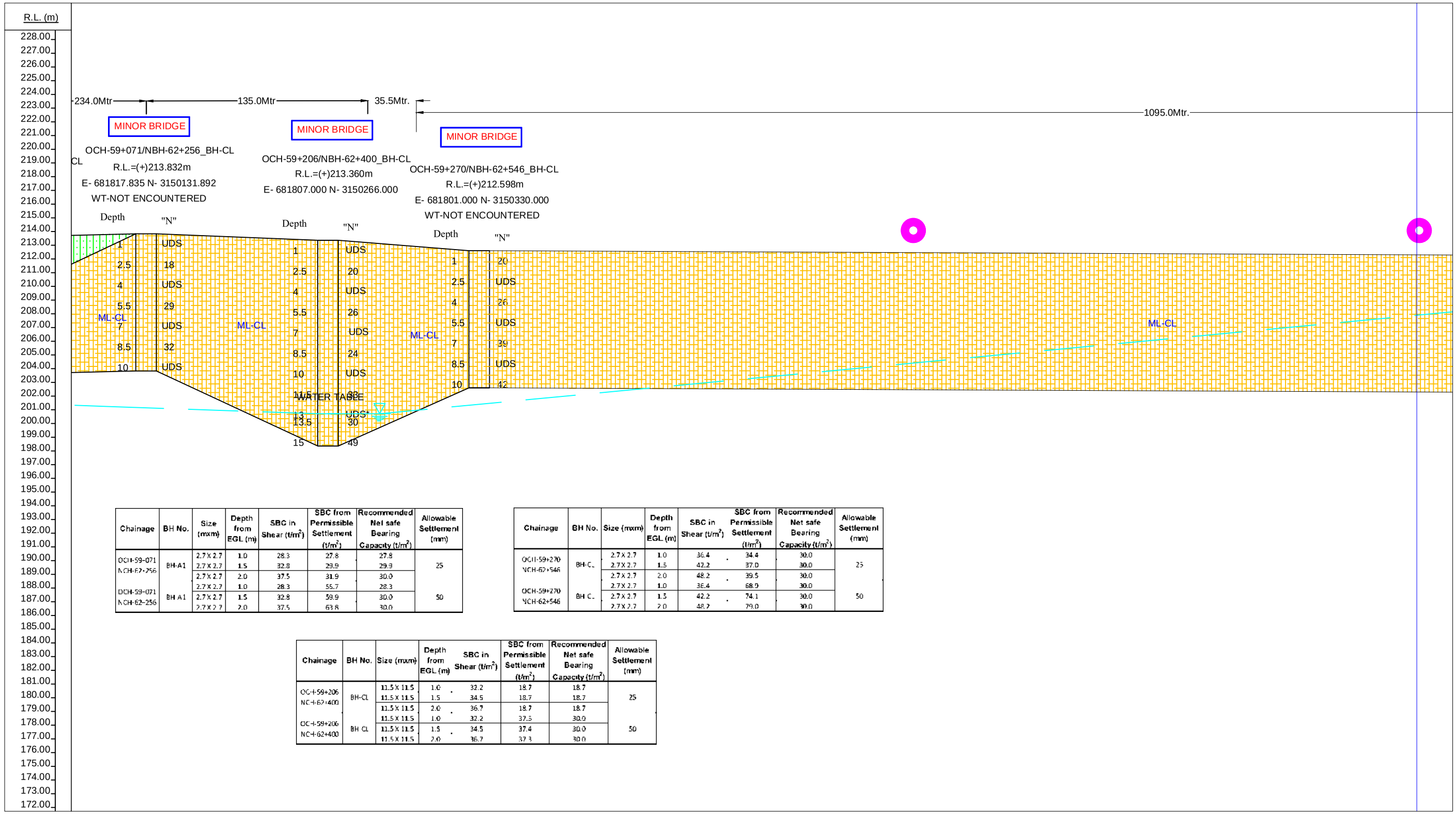
Chainage	BH No.	Size (mxm)	Depth from EGL (m)	SBC in Shear (t/m²)	SBC from Permissible Settlement (t/m²)	Recommended Net safe Bearing Capacity (t/m²)	Allowable Settlement (mm)
OCH-58+837 NCH-62+026	BH-CL	1.0 X 1.0	1.0	13.0	23.7	13.0	25
		1.0 X 1.0	1.5	18.5	22.6	16.5	
		1.0 X 1.0	2.0	14.1	35.6	19.4	
OCH-58+837 NCH-62+026	BH-CL	1.0 X 1.0	1.0	13.0	47.4	13.0	50
		1.0 X 1.0	1.5	18.5	45.2	16.5	
		1.0 X 1.0	2.0	14.1	34.2	19.1	

SYMBOL	DESCRIPTION
	SM- Silty Sand (Having fines Less Than 50% and no plasticity or below A-line)
	SM-SC -Clayey Sand (Having fines Less Than 50% and in the hatched zone (4<PI<7)
	ML-CL -Sandy with clay (Having fines greater than 50% and in the hatched zone (LL<35 & 4<PI<7)
	CL-Silty Clay of low plasticity (Above A-line, LL<35)
	CI- Clay of medium plasticity (Above A-line, 35≤LL<50)
	BOREHOLE REQUIRED / WATER TABLE

Note:- Fines= Percentage of Silty + Clay A-line=.73(wl-20)

SCALE:- HOR:- 1:2850 SCALE:- VER:- 1:285

CONDUCTING GEOTECHNICAL INVESTIGATION, PREPARATION OF GEOTECHNICAL REPORT FOR DESIGNING OF BRIDGES AND FOR EMBANKMENT IN CONNECTION WITH CONSTRUCTION OF HARYANA ORBITAL RAIL CORRIDOR (HORC) PROJECT FROM PALWAL TO HARSANA KALAN INCLUDING CONNECTIVITY TO EXISTING IR NETWORK IN THE STATE OF HARYANA.



Chainage	BH No.	Size (mxm)	Depth from EGL (m)	SBC in Shear (t/m²)	SBC from Permissible Settlement (t/m²)	Recommended Net safe Bearing Capacity (t/m²)	Allowable Settlement (mm)
OCH-59+071 NCH-62+256	BH-A1	2.7 X 2.7	1.0	28.3	27.8	27.8	25
		2.7 X 2.7	1.5	32.8	29.9	29.9	
		2.7 X 2.7	2.0	37.5	31.9	30.0	
OCH-59+071 NCH-62+256	BH A1	2.7 X 2.7	1.0	28.3	55.7	28.3	50
		2.7 X 2.7	1.5	32.8	59.9	30.0	
		2.7 X 2.7	2.0	37.5	63.8	30.0	

Chainage	BH No.	Size (mxm)	Depth from EGL (m)	SBC in Shear (t/m²)	SBC from Permissible Settlement (t/m²)	Recommended Net safe Bearing Capacity (t/m²)	Allowable Settlement (mm)
OCH-59+270 NCH-62+546	BH-CL	2.7 X 2.7	1.0	36.4	34.4	30.0	25
		2.7 X 2.7	1.5	42.2	37.0	30.0	
		2.7 X 2.7	2.0	48.2	39.5	30.0	
OCH-59+270 NCH-62+546	BH CL	2.7 X 2.7	1.0	36.4	68.9	30.0	50
		2.7 X 2.7	1.5	42.2	74.1	30.0	
		2.7 X 2.7	2.0	48.2	79.0	30.0	

Chainage	BH No.	Size (mxm)	Depth from EGL (m)	SBC in Shear (t/m²)	SBC from Permissible Settlement (t/m²)	Recommended Net safe Bearing Capacity (t/m²)	Allowable Settlement (mm)
OCH-59+206 NCH-62+400	BH-CL	11.5 X 11.5	1.0	32.2	18.7	18.7	25
		11.5 X 11.5	1.5	34.5	18.7	18.7	
		11.5 X 11.5	2.0	36.7	18.7	18.7	
OCH-59+206 NCH-62+400	BH CL	11.5 X 11.5	1.0	32.2	37.5	30.0	50
		11.5 X 11.5	1.5	34.5	37.4	30.0	
		11.5 X 11.5	2.0	36.7	37.3	30.0	

SYMBOL	DESCRIPTION
	SM- Silty Sand (Having fines Less Than 50% and no plasticity or below A-line)
	SM-SC -Clayey Sand (Having fines Less Than 50% and in the hatched zone (4<PI<7)
	ML-CL -Sandy with clay (Having fines greater than 50% and in the hatched zone (LL<35 & 4<PI<7)
	CL-Silty Clay of low plasticity (Above A-line, LL<35)
	CI- Clay of medium plasticity (Above A-line, 35≤LL<50)
	BOREHOLE REQUIRED / WATER TABLE

Note:- Fines= Percentage of Silty + Clay A-line=.73(wl-20)

SCALE:- HOR:- 1:2850 SCALE:- VER:- 1:285

APPENDIX – B (LAB TEST RESULTS)

Appendix No.	ITEMS
B-1	SOIL CHARACTERISTICS SHEETS
B-2	RESULT OF CHEMICAL ANALYSIS OF SOIL SAMPLES
B-3	RESULT OF CHEMICAL ANALYSIS OF WATER SAMPLES
B-4	GSD CURVES
B-5	SAMPLE SHEAR CURVE
B-6	CONSOLIDATION CURVE

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		20-08-2021	to	24-08-2021	52+518	BH-A1	22.80 m	40.00 m	683095.771 m	3143671.170 m	(+)213.216 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
									Sand			Gravel																				
							Clay	Silt	Fine	Medium	Coarse	Fine	Coarse	Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
DS	0.00	-	-	Brown, Medium dense, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	1.00	-	-		ML-CL		5	63	31	1	0	0	0	26	21	5	-	1.70	12.06	1.52	2.67	DST	0.20	23	-	-	-	-	-	-	-	-
SPT-1	2.50	12	15		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	4.00	-	-		ML-CL		6	58	26	2	1	7	0	26	20	6	-	1.76	12.64	1.56	2.66	DST	0.21	24	-	-	-	-	-	-	-	-
SPT-2	5.50	22	22		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	7.00	-	-	Brown, Hard, Silty clay of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-3	8.50	36	36		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	10.00	-	-		CL		11	54	31	2	0	2	0	30	20	10	-	1.85	14.63	1.61	2.68	UUT	1.22	4	-	-	-	-	-	-	-	-
SPT-4	11.50	40	31	Brown, Dense to very dense, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	13.00	-	-		ML-CL		6	60	26	3	1	4	0	26	20	6	-	1.86	15.67	1.61	2.66	DST	0.21	26	-	-	-	-	-	-	-	-
SPT-5	14.50	48	33		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-5	16.00	-	-		ML-CL		8	59	22	5	1	5	0	27	21	6	-	1.92	17.10	1.64	2.66	DST	0.15	27	-	-	-	-	-	-	-	-
SPT-6	17.50	79	49		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-7	19.00	92	54		ML-CL		7	63	24	3	1	2	0	27	20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	20.50	100 (23cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-9	22.00	100 (22cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-10	23.50	100 (20cm)	-		ML-CL		6	52	30	2	3	7	0	26	20	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-11	25.00	100 (18cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-12	26.50	100 (27cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEGTH
CEG TEST HOUSE

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		20-08-2021	to	24-08-2021	52+518	BH-A1	22.80 m	40.00 m	683095.771 m	3143671.170 m	(+)213.216 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction ($\varphi°$)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
SPT-13	28.00	99	32	Brown, Dense to very dense, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-14	29.50	100 (28cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-15	31.00	100 (24cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-16	32.50	70	24		ML-CL		5	47	41	2	1	4	0	26	20	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-17	34.00	81	26		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-18	35.50	77	25		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-19	37.00	82	26		ML-CL		8	51	35	2	1	3	0	28	21	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-20	38.50	100 (24cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-21	40.00	100 (23cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEGTH
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SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		23-08-2021	to	27-08-2021	52+518	BH-A2	23.50 m	40.00 m	683092.392 m	3143783.105 m	(+)220.511 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Brown, Medium dense, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	1.00	-	-		ML-CL		7	50	38	2	2	1	0	27	20	7	-	1.72	12.11	1.53	2.66	DST	0.19	23	-	-	-	-	-	-	-	-	-
SPT-1	2.50	13	17		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	4.00	-	-		ML-CL		8	46	43	1	1	1	0	28	21	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-2	5.50	22	22	Brown, Very stiff to hard, Silty clay of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	7.00	-	-		CL		11	62	17	4	4	2	0	31	20	11	-	1.78	14.16	1.56	2.68	UUT	0.74	5	-	-	-	-	-	-	-	-	-
SPT-3	8.50	22	22		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	10.00	-	-		CL		10	73	16	0	0	1	0	30	20	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-4	11.50	29	29		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-5	13.00	-	-		CL		12	58	19	5	3	3	0	32	21	11	-	1.85	15.78	1.60	2.67	UUT	1.12	4	-	-	-	-	-	-	-	-	-
SPT-5	14.50	39	39		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-6	16.00	-	-	Brown, Very dense, Sandy silt of low plasticity	ML-CL		8	55	23	5	3	6	0	28	21	7	-	1.87	16.04	1.61	2.66	DST	0.21	26	-	-	-	-	-	-	-	-	-
SPT-6	17.50	56	35		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-7	19.00	-	-		ML-CL		7	44	37	2	1	9	0	26	19	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-7	20.50	54	31		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-8	22.00	-	-		ML-CL		7	65	22	1	0	5	0	27	20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	23.50	66	35		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-9	25.00	-	-		ML-CL		6	51	29	3	4	6	1	26	20	6	-	1.84	17.32	1.57	2.65	DST	0.23	25	-	-	-	-	-	-	-	-	-
SPT-9	26.50	43	18		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

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SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		23-08-2021	to	27-08-2021	52+518	BH-A2	23.50 m	40.00 m	683092.392 m	3143783.105 m	(+)220.511 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %			Shrinkage Limit	Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index						Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
UDS-10	28.00	-	-	Brown, Very dense, Sandy silt of low plasticity	ML-CL		6	57	26	2	0	9	0	26	20	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-10	29.50	52	20		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-11	31.00	-	-		ML-CL		7	50	25	5	2	11	0	27	20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-11	32.50	34	16		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-12	34.00	-	-		ML-CL		8	53	26	3	4	6	0	29	22	7	-	1.89	18.29	1.60	2.66	DST	0.17	27	-	-	-	-	-	-	-	-	-
SPT-12	35.50	69	23		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-13	37.00	81	26		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-14	38.50	78	25		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-15	40.00	93	29		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

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SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.						Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
							04-07-2022	to	04-07-2022	52+934 Minor Bridge	BH-CL	Not Encountered	10.00 m	683069.549 m	3144133.557 m	(+)217.658 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Brown, Very loose to Very dense, Silty Sand with Clay	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	1.50	15	22		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.25	-	-		SM-SC		21	15	50	10	3	1	0	26	20	6	-	1.77	15.60	1.53	2.64	DST	0.09	28	-	-	-	-	-	-	-	-	-	-
SPT-2	3.00	19	23		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-3	4.50	23	25		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	5.25	-	-	Brown, Very Stiff, Silty Clay of Low Plasticity	CL		9	53	28	7	1	2	0	33	22	11	-	1.92	16.90	1.64	2.65	UUT	0.81	6	-	-	-	-	-	-	-	-	-	-
SPT-4	6.00	20	20		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-5	7.50	22	22		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	8.25	-	-		CL		9	42	36	9	1	3	0	28	20	8	-	1.94	16.60	1.66	2.64	UUT	0.98	7	-	-	-	-	-	-	-	-	-	-
SPT-6	9.00	26	26		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-7	10.00	44	44		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

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SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.					Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
						15-01-2022	to	15-01-2022	53+107	BH-CL	Not Encountered	15.00 m	683034.675 m	3144302.971 m	(+)218.950 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Brown, Medium dense, Sandy silt of low plasticity	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	0.50	15	27		ML-CL	-	7	49	36	4	2	2	0	27	20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-2	1.50	15	22		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	2.25	-	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-3	3.00	13	16		ML-CL	-	6	46	38	5	3	2	0	26	20	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-4	4.50	17	18		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	5.25	-	-	Brown, Hard, Silty clay of low plasticity	CL	-	11	46	30	6	2	5	0	31	20	11	-	1.89	16.23	1.63	2.67	UUT	1.42	5	-	-	-	-	-	-	-	-	-
SPT-5	6.00	40	40		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-6	7.50	45	45		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	8.25	-	-		CL	-	12	48	24	7	3	6	0	33	22	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-7	9.00	45	45		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	10.50	50	39	Brown, Very dense, Sandy silt of low plasticity	ML-CL	-	8	44	34	5	1	8	0	28	21	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	11.25	-	-		ML-CL	-	7	45	35	4	2	7	0	26	19	7	-	1.90	17.13	1.62	2.66	DST	0.20	28	-	-	-	-	-	-	-	-	-
SPT-9	12.00	50	37		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-10	13.50	51	36		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	14.25	-	-		ML-CL	-	6	46	33	4	3	8	0	26	20	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-11	15.00	62	41		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

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SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.						Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
							14-01-2022	to	14-01-2022	53+282	BH-CL	Not Encountered	10.00 m	682995.864 m	3144473.609 m	(+)218.087 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Brown, Medium dense, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	0.50	10	18		ML-CL		7	49	37	4	2	1	0	27	20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-2	1.50	13	19		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	2.25	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-3	3.00	14	17		ML-CL		8	47	34	6	3	2	0	28	21	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-4	4.50	19	21		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	5.25	-	-	Brown, Very stiff to hard, Silty clay of low plasticity	CL		11	50	28	3	4	4	0	31	20	11	-	1.89	18.23	1.60	2.67	UUT	1.02	5	-	-	-	-	-	-	-	-	-	-
SPT-5	6.00	29	29		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-6	7.50	34	34		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	8.25	-	-		CL		10	49	31	5	2	3	0	30	20	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-7	9.00	25	25		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	10.00	30	30		CL		11	41	37	4	3	4	0	31	20	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEGTH
CEG TEST HOUSE

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.					Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
						14-01-2022	to	14-01-2022	53+572	BH-CL	Not Encountered	10.00 m	682931.500 m	3144756.380 m	(+)217.532 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																			
DS	0.00	-	-	Brown, Medium stiff to stiff, Silty clay of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	0.50	6	6		CL		12	55	26	4	2	1	0	33	22	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-2	1.50	11	11		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	2.25	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-3	3.00	26	26	Brown, Very stiff to hard, Silty clay of low plasticity	CL		11	49	29	5	3	3	0	32	21	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-4	4.50	29	29		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	5.25	-	-		CL		13	54	22	6	1	4	0	34	23	11	-	1.91	19.34	1.60	2.67	UUT	1.09	4	-	-	-	-	-	-	-	-	-
SPT-5	6.00	34	34		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-6	7.50	39	39		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	8.25	-	-		CL		11	49	25	7	2	6	0	31	20	11	-	1.97	20.26	1.64	2.68	UUT	1.65	4	-	-	-	-	-	-	-	-	-
SPT-7	9.00	47	47		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	10.00	52	52		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEGTH
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SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.					Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
						12-01-2022	to	12-01-2022	53+982	BH-CL	0.60 m	10.00 m	682840.528 m	3145156.160 m	(+)217.050 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Brown, Medium stiff to very stiff, Silty clay of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	0.50	5	5		CL		12	56	25	5	2	0	0	33	22	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-2	1.50	11	11		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.25	-	-		CL		10	50	31	4	3	2	0	30	20	10	-	1.89	27.45	1.48	2.67	UUT	0.39	5	-	-	-	-	-	-	-	-	-
SPT-3	3.00	17	17		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-4	4.50	27	27		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	5.25	-	-		CL		11	51	27	6	2	3	0	31	20	11	-	1.97	24.74	1.58	2.68	UUT	0.85	4	-	-	-	-	-	-	-	-	-
SPT-5	6.00	24	24		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-6	7.50	32	25	Brown, Medium dense to dense, Sandy silt of low plasticity	ML-CL		7	45	38	3	2	5	0	27	20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	8.25	-	-		ML-CL		8	43	36	6	1	6	0	28	21	7	-	1.90	19.74	1.59	2.66	DST	0.20	28	-	-	-	-	-	-	-	-	-
SPT-7	9.00	42	29		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	10.00	38	27		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEGTH
CEG TEST HOUSE

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.					Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
						11-01-2022	to	11-01-2022	54+363	BH-CL	1.48 m	10.00 m	682755.991 m	3145527.663 m	(+)216.014 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ °)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Brown, Medium dense, Silty sand with clay	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	0.50	24	43		SM-SC		5	36	46	7	3	3	0	25	20	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-2	1.50	19	23		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	2.25	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-3	3.00	18	20		SM-SC		6	35	44	8	4	3	0	25	19	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-4	4.50	22	22		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	5.25	-	-	Brown, Hard, Silty clay of low plasticity	CL		11	44	31	6	3	5	0	31	20	11	-	1.99	24.65	1.60	2.67	UUT	1.09	4	-	-	-	-	-	-	-	-	-	-	-
SPT-5	6.00	31	31		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-6	7.50	34	34		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	8.25	-	-	Brown, Dense, Sandy silt of low plasticity	ML-CL		7	45	36	5	2	5	0	27	20	7	-	1.90	19.74	1.59	2.66	DST	0.20	27	-	-	-	-	-	-	-	-	-	-	-
SPT-7	9.00	38	28		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	10.00	42	29		ML-CL		8	44	35	4	3	6	0	28	21	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.					Date of Boring			Chainage (km.)/Location		B.H. No.		Depth of Water Table		Termination Depth		Cordinates (E,N)			R.L.		Ref. Code	
						12-01-2022	to	12-01-2022	54+496		BH-CL		1.36 m		15.00 m		682726.480 m			3145657.348 m		(+)217.393 m		SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction ($\varphi°$)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Brown, Loose to medium dense, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	0.50	9	16		ML-CL		6	47	39	5	2	1	0	26	20	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-2	1.50	13	18		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	2.25	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-3	3.00	17	20		ML-CL		7	46	34	8	3	2	0	27	20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-4	4.50	20	21		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	5.25	-	-	Brown, Hard, Silty clay of low plasticity with gravel	CL		11	51	28	5	1	4	0	31	20	11	-	1.98	23.85	1.60	2.67	UUT	1.09	5	-	-	-	-	-	-	-	-	-
SPT-5	6.00	30	30		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-6	7.50	34	34		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	8.25	-	-		CL		10	47	31	4	3	5	0	30	20	10	-	1.99	23.66	1.61	2.68	UUT	1.26	4	-	-	-	-	-	-	-	-	-
SPT-7	9.00	35	35		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	10.50	38	38		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	11.25	-	-		CL		12	48	24	7	2	7	0	33	22	11	-	2.00	22.80	1.63	2.68	UUT	1.42	4	-	-	-	-	-	-	-	-	-
SPT-9	12.00	41	41		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-10	13.50	46	46		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	14.25	-	-		CL		11	49	26	5	2	7	0	32	21	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-11	15.00	46	46		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEGTH
CEG TEST HOUSE

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		2-7-2022	to	3-07-2022	55+020	CL	10.00 m	13.00 m	682610.214 m	3146168.286 m	(+)215.845 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																			
DS	0.00	-	-	Medium dense, Brownish, Silty Sand	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	1.50	12	17		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.25	-	-		SM-SC		11	23	52	12	2	0	0	24	19	5	-	1.75	13.60	1.54	2.64	DST	0.09	28	-	-	-	-	-	-	-	-	-
SPT-2	3.00	14	17		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-3	4.50	15	16		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	5.25	-	-		SM		0	29	56	11	3	1	0	-	NIL	NP	-	1.76	13.10	1.56	2.63	DST	0.00	30	-	-	-	-	-	-	-	-	-
SPT-4	6.00	20	20		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-5	7.50	20	18	Very Stiff to Hard, Brown, Silty Clay of LowPlasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	8.25	-	-		CL		9	50	32	6	1	2	0	33	23	10	-	1.95	19.40	1.63	2.66	UUT	0.85	8	-	-	-	-	-	-	-	-	-
SPT-6	9.00	22	22		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-7	10.50	26	26		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	11.25	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	12.00	34	27		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-9	13.00	39	30		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEGTH
CEG TEST HOUSE
AND RESEARCH CENTRE PVT LTD

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.					Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
						23-10-2021	to	23-10-2021	55+044	BH-PLT-04	Not encountered	12.00 m	682575.147 m	3146175.461 m	(+)215.725 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																			
DS	0.00	-	-	Brown, Loose, Silty sand	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	0.75	-	-		SM		0	23	73	4	0	0	0	-	Nil	NP	-	1.63	10.23	1.48	2.62	DST	0.00	28	-	-	-	-	-	-	-	-	-
SPT-1	1.50	7	10		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-2	2.25	12	16	Brown, Medium dense, Sandy silt of low plasticity	ML-CL		6	48	31	9	4	2	0	26	20	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-3	3.00	16	20		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-4	3.75	21	24		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	4.50	-	-		ML-CL		7	49	33	6	1	4	0	28	21	7	-	1.75	12.74	1.55	2.66	DST	0.18	25	-	-	-	-	-	-	-	-	-
SPT-5	6.00	28	28		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	7.50	-	-		ML-CL		6	48	30	11	2	3	0	27	21	6	-	1.78	13.24	1.57	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-6	9.00	24	21	Brown, Very stiff, Silty clay of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	10.50	-	-		CL		10	47	29	5	6	3	0	30	20	10	-	1.82	15.80	1.57	2.67	UUT	0.82	5	-	-	-	-	-	-	-	-	-
SPT-7	12.00	30	30		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations;-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEGTH
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SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.					Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
						23-08-2021	to	24-08-2021	55+910	BH-A1	16.00 m	40.00 m	682418.856 m	3147009.213 m	(+)218.101 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction ($\varphi°$)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Brown, loose to medium dense, Silty sand	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	1.00	-	-		SM		0	18	72	6	4	0	0	-	Nil	NP	-	1.68	11.36	1.51	2.62	DST	0.00	28	-	-	-	-	-	-	-	-
SPT-1	2.50	9	12		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	4.00	-	-		SM		0	17	67	12	3	1	0	-	Nil	NP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-2	5.50	16	16		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	7.00	-	-	Brown, Very stiff to Hard, Silty clay of low plasticity	CL		11	62	19	5	1	2	0	31	20	11	-	1.81	14.26	1.58	2.68	UUT	0.85	4	-	-	-	-	-	-	-	-
SPT-3	8.50	24	24		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	10.00	-	-		CL		12	62	16	3	4	3	0	32	21	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-4	11.50	32	32		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-5	13.00	-	-	Brown, Dense to Very dense, Sandy silt of low plasticity with gravel	ML-CL		9	54	23	7	2	5	0	29	22	7	-	1.83	15.28	1.59	2.66	DST	0.20	25	-	-	-	-	-	-	-	-
SPT-5	14.50	39	27		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-6	16.00	-	-		ML-CL		7	56	29	3	1	4	0	27	20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-6	17.50	46	23		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-7	19.00	-	-		ML-CL		8	54	28	2	1	7	0	28	21	7	-	1.85	17.14	1.58	2.66	DST	0.18	26	-	-	-	-	-	-	-	-
SPT-7	20.50	51	24		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-8	22.00	-	-		ML-CL		7	53	28	4	2	6	0	26	19	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	23.50	54	24		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-9	25.00	-	-		ML-CL		6	57	27	2	1	5	2	26	20	6	-	1.87	17.91	1.59	2.67	DST	0.20	26	-	-	-	-	-	-	-	-
SPT-9	26.50	65	26		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEGTH
CEG TEST HOUSE
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SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.						Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
							23-08-2021	to	24-08-2021	55+910	BH-A1	16.00 m	40.00 m	682418.856 m	3147009.213 m	(+)218.101 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
UDS-10	28.00	-	-	Brown, Dense to Very dense, Sandy silt of low plasticity with gravel	ML-CL		6	53	30	3	4	4	0	27	21	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-10	29.50	69	27		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-11	31.00	-	-		ML-CL		7	50	26	5	2	9	1	27	20	7	-	1.89	18.06	1.60	2.67	DST	0.18	27	-	-	-	-	-	-	-	-	-
SPT-11	32.50	85	30		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-12	34.00	-	-		ML-CL		8	57	22	3	4	6	0	28	21	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-12	35.50	102 (19cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-13	37.00	100 (25cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-14	38.50	100 (27cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-15	40.00	100 (22cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

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SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.						Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
							19-08-2021	to	21-08-2021	55+910	BH-A2	15.60 m	40.00 m	682407.318 m	3147059.917 m	(+)217.474 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																			
DS	0.00	-	-	Brown, Medium dense to dense, Silty sand	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	1.00	15	24		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.50	-	-		SM		0	18	75	3	4	0	0	-	Nil	NP	-	1.75	10.69	1.58	2.62	DST	0.00	29	-	-	-	-	-	-	-	-	-
SPT-2	4.00	22	25		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	5.50	-	-		SM		0	26	67	5	1	1	0	-	Nil	NP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-3	7.00	26	24		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	8.50	-	-		SM		0	34	60	4	2	0	0	-	Nil	NP	-	1.77	12.04	1.58	2.63	DST	0.00	30	-	-	-	-	-	-	-	-	-
SPT-4	10.00	32	26		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	11.50	-	-		SM		0	32	64	1	2	1	0	-	Nil	NP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-5	13.00	39	28		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-5	14.50	-	-		SM		0	27	69	3	1	0	0	-	Nil	NP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-6	16.00	35	35	Brown, Hard, Silty clay of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-6	17.50	-	-		CL		11	61	22	2	1	3	0	30	20	10	-	1.99	23.14	1.62	2.68	UUT	1.34	4	-	-	-	-	-	-	-	-	-
SPT-7	19.00	43	43		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-7	20.50	-	-	Brown, Very dense, Sandy silt of low plasticity with gravel	ML-CL		8	45	33	2	1	11	0	27	20	7	-	1.86	17.64	1.58	2.66	DST	0.20	26	-	-	-	-	-	-	-	-	-
SPT-8	22.00	53	24		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-8	23.50	-	-		ML-CL		6	48	34	2	1	7	2	27	21	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-9	25.00	58	24				-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-9	26.50	-	-		ML-CL		7	61	28	2	1	1	0	26	19	7	-	1.95	18.06	1.65	2.67	DST	0.16	28	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

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SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		19-08-2021	to	21-08-2021	55+910	BH-A2	15.60 m	40.00 m	682407.318 m	3147059.917 m	(+)217.474 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
SPT-10	28.00	73	28	Brown, Very dense, Sandy silt of low plasticity with gravel	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	29.50	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-11	31.00	100 (19cm)	-		ML-CL		8	44	26	3	2	9	8	28	21	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-12	32.50	100 (18cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-13	34.00	100 (20cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-14	35.50	100 (21cm)	-		ML-CL		6	46	34	3	2	9	0	27	20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-15	37.00	100 (18cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-16	38.50	100 (19cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-17	40.00	100 (20cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

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SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.						Date of Boring			Chainage (km.)/Location		B.H. No.		Depth of Water Table		Termination Depth		Cordinates (E,N)				R.L.		Ref. Code					
							25-09-2021	to	25-09-2021	56+403 km		BH-C/L		Not encountered		10.00 m		682303.349 m				3147516.813 m		(+)215.389		SR-544_21-22				
Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																			
DS	0.00	-	-	Brown, Loose, Silty sand	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	1.00	7	11		SM	-	0	41	56	2	1	0	0	-	Nil	NP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.50	-	-		SM	-	0	40	58	1	1	0	0	-	Nil	NP	-	1.65	10.64	1.49	2.62	DST	0.00	27	-	-	-	-	-	-	-	-
SPT-2	4.00	22	25	Brown, Medium dense to dense, Sandy silt of low plasticity	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	5.50	-	-		ML-CL	-	6	54	33	4	1	2	0	27	20	7	-	1.78	12.88	1.58	2.66	DST	0.21	24	-	-	-	-	-	-	-	-
SPT-3	7.00	25	24		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	8.50	-	-		ML-CL	-	7	54	31	4	1	3	0	28	21	7	-	1.83	13.46	1.61	2.66	DST	0.19	26	-	-	-	-	-	-	-	-
SPT-4	10.00	42	34		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

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						10-01-2022	to	10-01-2022	56+701 Minor Bridge	BH-CL	1.40 m	15.00 m	682237.228 m	3147807.384 m	(+)215.273	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																			
DS	0.00	-	-	Brown, Loose to medium dense, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	0.50	8	14		ML-CL		7	50	37	4	2	0	0	27	20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-2	1.50	16	20		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.25	-	-		ML-CL		6	45	39	5	3	2	0	26	20	6	-	1.80	20.16	1.50	2.65	DST	0.18	25	-	-	-	-	-	-	-	-	-
SPT-3	3.00	14	17		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-4	4.50	19	20		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	5.25	-	-	Brown, Medium dense to dense, Silty sand	SP-SM		0	12	74	8	3	3	0	-	Nil	NP	-	1.85	17.40	1.58	2.62	DST	0.00	31	-	-	-	-	-	-	-	-	-
SPT-5	6.00	29	25		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-6	7.50	33	26		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	8.25	-	-		SP-SM		0	12	70	11	4	3	0	-	Nil	NP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-7	9.00	35	26		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	10.00	29	23		SM		0	15	72	6	2	5	0	-	Nil	NP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	11.25	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-9	12.00	36	36	Brown, Hard, Silty clay of low plasticity	CL		11	44	31	6	3	5	0	31	20	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-10	13.50	41	41		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	14.25	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-11	15.00	46	46		CL		12	50	26	5	2	5	0	32	21	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

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							10-01-2022	to	10-01-2022	56+978	BH-CL	1.36 m	10.00 m	682175.767 m	3148077.480 m	(+)212.389 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Brown, Medium dense, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	0.50	11	20		ML-CL		7	46	38	5	2	2	0	27	20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-2	1.50	16	20		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.25	-	-		ML-CL		8	44	35	7	4	2	0	28	21	7	-	1.86	19.74	1.55	2.66	DST	0.22	24	-	-	-	-	-	-	-	-
SPT-3	3.00	20	20	Brown, Very stiff to hard, Silty clay of low plasticity	CL		11	49	28	6	3	3	0	31	20	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-4	4.50	22	22		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	5.25	-	-		CL		12	52	25	5	2	4	0	32	21	11	-	1.95	23.70	1.58	2.68	UUT	0.85	5	-	-	-	-	-	-	-	-
SPT-5	6.00	26	26		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-6	7.50	29	29		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	8.25	-	-	Brown, Medium dense, Silty sand with clay	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-7	9.00	30	23		SM-SC		6	36	45	3	5	5	0	26	20	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	10.00	37	26		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

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							27-08-2021	to	27-08-2021	57+400 Major Bridge	BH-A1	10.90 m	30.00 m	682111.171 m	3148361.347 m	(+)217.941 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Brown, Medium dense, Silty sand with clay	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	1.00	12	19		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.50	-	-		SM-SC		6	25	61	3	1	4	0	26	20	6	-	1.73	12.64	1.54	2.65	DST	0.10	27	-	-	-	-	-	-	-	-	-
SPT-2	4.00	16	18		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	5.50	-	-		SM-SC		5	31	57	3	1	3	0	25	20	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-3	7.00	22	21		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	8.50	-	-	Brown, Hard, Silty clay of low plasticity	CL		11	62	25	1	0	1	0	33	22	11	-	1.86	16.22	1.60	2.68	UUT	1.06	5	-	-	-	-	-	-	-	-	-
SPT-4	10.00	32	32		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	11.50	-	-		CL		12	64	20	1	1	2	0	34	22	12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-5	13.00	52	27	Brown, Very dense, Silty sand	SM		0	16	75	1	2	6	0	-	Nil	NP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-5	14.50	-	-		SM		0	17	68	3	4	8	0	-	Nil	NP	-	1.86	16.17	1.60	2.62	DST	0.00	31	-	-	-	-	-	-	-	-	-
SPT-6	16.00	62	30		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-6	17.50	-	-	Brown, Hard, Silty clay of low plasticity	CL		9	64	22	1	1	3	0	31	20	11	-	2.01	22.36	1.64	2.68	UUT	1.66	4	-	-	-	-	-	-	-	-	-
SPT-7	19.00	51	51		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-7	20.50	-	-		CL		11	67	20	1	1	0	0	32	21	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	22.00	60	60		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-9	23.50	75	31	Brown, Very dense, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-10	25.00	85	34		ML-CL		7	56	26	2	1	8	0	27	20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-11	26.50	99	37		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEGTH
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SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		27-08-2021	to	27-08-2021	57+400 Major Bridge	BH-A1	10.90 m	30.00 m	682111.171 m	3148361.347 m	(+)217.941 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction ($\varphi°$)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
SPT-12	28.00	100 (19cm)	-	Brown, Very dense, Sandy silt of low plasticity	ML-CL		8	53	24	1	3	11	0	28	21	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-13	29.50	100 (27cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	30.00		-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

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							23-08-2021	to	24-08-2021	57+400 Major Bridge	BH-P2	11.85 m	30.00 m	682104.781 m	3148389.429 m	(+)213.893 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																			
DS	0.00	-	-	Brown, Medium dense, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	1.00	15	24		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.50	-	-		ML-CL		7	51	36	2	3	1	0	27	20	7	-	1.78	12.41	1.58	2.67	DST	0.21	24	-	-	-	-	-	-	-	-	-
SPT-2	4.00	24	27		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	5.50	-	-	Brown, Hard, Silty clay of low plasticity	CL		9	67	11	4	3	6	0	30	20	10	-	1.83	14.26	1.60	2.69	UUT	1.10	4	-	-	-	-	-	-	-	-	-
SPT-3	7.00	32	32		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	8.50	-	-	Brown, Dense, Sandy silt of low plasticity	ML-CL		7	52	33	2	3	3	0	26	19	7	-	1.84	15.22	1.60	2.67	DST	0.20	25	-	-	-	-	-	-	-	-	-
SPT-4	10.00	37	30		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	11.50	-	-		ML-CL		8	56	30	1	1	4	0	28	21	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-5	13.00	42	23		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-5	14.50	-	-	Brown, Hard, Silty clay of low plasticity	CL		11	50	32	4	2	1	0	31	20	11	-	2.01	21.26	1.66	2.68	UUT	2.22	4	-	-	-	-	-	-	-	-	-
SPT-6	16.00	64	64		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-6	17.50	-	-		CL		10	60	26	1	1	2	0	30	20	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-7	19.00	70	70		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-7	20.50	-	-	Brown, Very dense, Sandy silt of low plasticity	ML-CL		6	56	33	1	2	2	0	26	20	6	-	1.90	17.86	1.61	2.66	DST	0.21	27	-	-	-	-	-	-	-	-	-
SPT-8	22.00	84	34		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-8	23.50	-	-		ML-CL		7	56	29	5	1	2	0	27	21	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-9	25.00	96	36		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-9	26.50	-	-		ML-CL		9	62	25	2	0	2	0	27	20	7	-	1.94	18.20	1.64	2.66	DST	0.20	28	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

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SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		23-08-2021	to	24-08-2021	57+400 Major Bridge	BH-P2	11.85 m	30.00 m	682104.781 m	3148389.429 m	(+)213.893 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction ($\varphi°$)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
SPT-10	28.00	100 (21cm)	-	Brown, Very dense, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-11	29.50	100 (22cm)	-		ML-CL		7	52	27	1	3	10	0	27	20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-12	30.00	>100	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

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							23-08-2021	to	24-08-2021	57+400 Major Bridge	BH-P3	11.50 m	31.00 m	682101.808 m	3148402.495 m	(+)214.414 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																			
DS	0.00	-	-	Brown, Medium dense to dense, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	1.00	-	-		ML-CL		8	53	37	1	1	0	0	27	20	7	-	1.71	12.36	1.52	2.67	DST	0.16	24	-	-	-	-	-	-	-	-	-
SPT-1	2.50	12	15		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	4.00	-	-		ML-CL		6	52	40	1	0	1	0	27	20	7	-	1.81	12.89	1.60	2.66	DST	0.18	25	-	-	-	-	-	-	-	-	-
SPT-2	5.50	26	26		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	7.00	-	-		ML-CL		10	51	31	2	3	3	0	28	21	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-3	8.50	35	30		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	10.00	-	-	Brown, Dense, Silty sand	SM		0	26	60	5	8	1	0	-	Nil	NP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-4	11.50	37	29		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-5	13.00	-	-		SM		0	27	71	1	1	0	0	-	Nil	NP	-	1.82	15.46	1.58	2.63	DST	0.00	30	-	-	-	-	-	-	-	-	-
SPT-5	14.50	39	22		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-6	16.00	-	-		SM		0	32	65	3	0	0	0	-	Nil	NP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-6	17.50	44	23		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-7	19.00	-	-	Brown, Dense to very dense, Sandy silt of low plasticity	ML-CL		7	44	33	3	3	10	0	27	20	7	-	1.88	18.21	1.59	2.66	DST	0.21	26	-	-	-	-	-	-	-	-	-
SPT-7	20.50	48	24		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-8	22.00	-	-		ML-CL		9	49	30	2	1	9	0	28	21	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	23.50	57	26		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-9	25.00	-	-		ML-CL		8	51	27	2	4	6	2	26	19	7	-	1.90	18.62	1.60	2.67	DST	0.20	27	-	-	-	-	-	-	-	-	-
SPT-9	26.50	61	26		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
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		23-08-2021	to	24-08-2021	57+400 Major Bridge	BH-P3	11.50 m	31.00 m	682101.808 m	3148402.495 m	(+)214.414 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
UDS-10	28.00	-	-	Brown, Dense to very dense, Sandy silt of low plasticity	ML-CL		7	52	29	3	2	7	0	26	20	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-10	29.50	79	31		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-11	31.00	-	-		ML-CL		9	51	27	1	2	10	0	29	22	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

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							24-08-2021	to	25-08-2021	57+400 Major Bridge	BH-P4	11.80 m	30.00 m	682098.835 m	3148415.561 m	(+)214.498 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Brown, Medium dense, Silty sand	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	1.00	12	19		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.50	-	-		SM		0	16	79	3	0	2	0	-	Nil	NP	-	1.73	11.67	1.55	2.62	DST	0.00	29	-	-	-	-	-	-	-	-
SPT-2	4.00	19	21		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	5.50	-	-		SM		0	39	61	0	0	0	0	-	Nil	NP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-3	7.00	47	44	Brown, Very dense, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	8.50	-	-		ML-CL		8	58	25	3	1	5	0	28	21	7	-	1.84	13.44	1.62	2.66	DST	0.25	25	-	-	-	-	-	-	-	-
SPT-4	10.00	54	44		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	11.50	-	-		ML-CL		9	51	26	2	4	8	0	29	22	7	-	1.90	18.88	1.60	2.67	DST	0.21	26	-	-	-	-	-	-	-	-
SPT-5	13.00	58	29		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-5	14.50	-	-		ML-CL		7	53	28	3	2	5	2	27	20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-6	16.00	59	28		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-6	17.50	-	-		ML-CL		7	47	30	4	2	10	0	26	19	7	-	1.93	20.14	1.61	2.67	DST	0.19	27	-	-	-	-	-	-	-	-
SPT-7	19.00	75	32		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-7	20.50	-	-		ML-CL		8	44	33	3	1	9	2	27	20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	22.00	71	30		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-8	23.50	-	-		ML-CL		10	43	26	4	2	15	0	29	22	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-9	25.00	76	30		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	26.50	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEG TEST HOUSE AND RESEARCH CENTRE PVT. LTD.

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		24-08-2021	to	25-08-2021	57+400 Major Bridge	BH-P4	11.80 m	30.00 m	682098.835 m	3148415.561 m	(+)214.498 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
SPT-10	28.00	84	32	Brown, Very dense, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-9	29.50	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	30.00		-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

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							24-08-2021	to	25-08-2021	57+400 Major Bridge	BH-P5	12.00 m	30.00 m	682095.861 m	3148428.627 m	(+)214.548 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																			
DS	0.00	-	-	Brown, Medium dense to dense, Silty sand	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	1.00	-	-		SM		0	17	80	1	1	1	0	-	Nil	NP	-	1.69	11.21	1.52	2.62	DST	0.00	28	-	-	-	-	-	-	-	-	-
SPT-1	2.50	11	14		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	4.00	-	-		SM		0	17	79	2	1	1	0	-	Nil	NP	-	1.75	11.86	1.56	2.63	DST	0.00	29	-	-	-	-	-	-	-	-	-
SPT-2	5.50	20	20		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	7.00	-	-		SM		0	20	73	3	2	2	0	-	Nil	NP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-3	8.50	31	27		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	10.00	-	-	Brown, Dense to very dense, Sandy silt of low plasticity	ML-CL		8	55	27	2	1	7	0	28	21	7	-	1.85	15.36	1.60	2.66	DST	0.23	25	-	-	-	-	-	-	-	-	-
SPT-4	11.50	45	34		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-5	13.00	-	-		ML-CL		9	60	23	3	1	4	0	29	22	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-5	14.50	53	27		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-6	16.00	-	-		ML-CL		7	44	37	2	1	9	0	27	20	7	-	1.88	17.22	1.60	2.67	DST	0.22	26	-	-	-	-	-	-	-	-	-
SPT-6	17.50	61	29		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-7	19.00	-	-		ML-CL		6	48	39	1	1	5	0	26	21	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-7	20.50	68	30		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-8	22.00	-	-		ML-CL		7	52	30	1	3	7	0	27	20	7	-	1.91	18.56	1.61	2.67	DST	0.18	27	-	-	-	-	-	-	-	-	-
SPT-8	23.50	79	32		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	25.00	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-9	26.50	90	34		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

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SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		24-08-2021	to	25-08-2021	57+400 Major Bridge	BH-P5	12.00 m	30.00 m	682095.861 m	3148428.627 m	(+)214.548 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
UDS-9	28.00	-	-	Brown, Dense to very dense, Sandy silt of low plasticity	ML-CL		6	48	32	4	2	5	3	27	21	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-10	29.50	94	34		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
DS-2	30.00	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

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DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

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		23-08-2021	to	24-08-2021	57+400 Major Bridge	BH-P6	11.40 m	30.00 m	682092.888 m	3148441.693 m	(+)214.417 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction ($\varphi°$)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Brown, Medium dense, Silty sand	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	1.00	10	16		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.50	-	-		SM		0	22	72	3	2	1	0	-	Nil	NP	-	1.71	11.84	1.53	2.63	DST	0.00	28	-	-	-	-	-	-	-	-	-
SPT-2	4.00	16	18		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	5.50	-	-		SM		0	34	63	2	1	0	0	-	Nil	NP	-	1.73	12.04	1.54	2.62	DST	0.00	29	-	-	-	-	-	-	-	-	-
SPT-3	7.00	20	19		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	8.50	-	-	Brown, Very stiff to hard, Silty clay of low plasticity	CL		12	54	23	6	1	4	0	33	22	11	-	1.84	16.22	1.58	2.67	UUT	0.90	4	-	-	-	-	-	-	-	-	-
SPT-4	10.00	26	26		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	11.50	-	-		CL		11	63	20	1	2	3	0	32	21	11	-	1.96	22.26	1.60	2.68	UUT	1.03	5	-	-	-	-	-	-	-	-	-
SPT-5	13.00	32	32		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-5	14.50	-	-	Brown, Very dense, Sandy silt of low plasticity	ML-CL		10	50	31	3	1	5	0	29	22	7	-	1.90	19.94	1.58	2.66	DST	0.19	26	-	-	-	-	-	-	-	-	-
SPT-6	16.00	50	26		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-6	17.50	-	-		ML-CL		9	42	27	7	7	8	0	28	21	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-7	19.00	53	26		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-7	20.50	-	-		ML-CL		6	50	33	3	1	7	0	26	20	6	-	1.90	20.43	1.58	2.67	DST	0.22	27	-	-	-	-	-	-	-	-	-
SPT-8	22.00	60	27		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-8	23.50	-	-		ML-CL		8	51	29	5	1	6	0	27	20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-9	25.00	63	27		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-9	26.50	-	-		ML-CL		7	48	32	3	1	9	0	26	19	7	-	1.92	20.84	1.59	2.67	DST	0.24	27	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

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		23-08-2021	to	24-08-2021	57+400 Major Bridge	BH-P6	11.40 m	30.00 m	682092.888 m	3148441.693 m	(+)214.417 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
SPT-10	28.00	73	29	Brown, Very dense, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	29.50	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	30.00		-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

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DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

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		23-08-2021	to	24-08-2021	57+400 Major Bridge	BH-P7	11.00 m	30.00 m	682089.915 m	3148454.759 m	(+)214.599 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	1.00	-	-		SM		0	21	75	1	1	2	0	-	Nil	NP	-	1.71	11.63	1.53	2.62	DST	0.00	28	-	-	-	-	-	-	-	-
SPT-1	2.50	14	18		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	4.00	-	-	Brown, Medium dense, Silty sand	SM		0	25	71	2	1	1	0	-	Nil	NP	-	1.74	12.06	1.55	2.63	DST	0.00	29	-	-	-	-	-	-	-	-
SPT-2	5.50	21	21		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	7.00	-	-		SM		0	24	68	4	2	2	0	-	Nil	NP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-3	8.50	30	26		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	10.00	-	-		CL		12	64	17	2	3	2	0	34	22	12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-4	11.50	42	42	Brown, hard, Silty clay of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-5	13.00	-	-		CL		10	63	21	2	1	3	0	33	22	11	-	1.99	23.63	1.61	2.68	UUT	1.15	4	-	-	-	-	-	-	-	-
SPT-5	14.50	33	33		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-6	16.00	-	-		ML-CL		8	51	34	1	0	6	0	28	21	7	-	1.88	19.26	1.58	2.66	DST	0.22	26	-	-	-	-	-	-	-	-
SPT-6	17.50	43	23		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-7	19.00	-	-		ML-CL		7	45	33	7	1	7	0	27	20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-7	20.50	59	27		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-8	22.00	-	-	Brown, Dense to very dense, Sandy silt of low plasticity	ML-CL		7	48	30	2	2	11	0	26	19	7	-	1.91	20.04	1.59	2.67	DST	0.20	27	-	-	-	-	-	-	-	-
SPT-8	23.50	63	28		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-9	25.00	-	-		ML-CL		6	51	32	2	0	9	0	26	20	6	-	1.94	20.42	1.61	2.66	DST	0.23	27	-	-	-	-	-	-	-	-
SPT-9	26.50	80	32		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-10	28.00	-	-		ML-CL		8	44	35	3	4	6	0	27	20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

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SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		23-08-2021	to	24-08-2021	57+400 Major Bridge	BH-P7	11.00 m	30.00 m	682089.915 m	3148454.759 m	(+)214.599 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction ($\varphi°$)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
SPT-10	29.50	93	35	Brown, Dense to very dense, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	30.00		-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

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		20-08-2021	to	22-08-2021	57+400 Major Bridge	BH-P9	12.00 m	35.00 m	682083.968 m	3148480.891 m	(+)214.330 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Brown, Medium dense, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	1.00	13	21		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.50	-	-		ML-CL		5	49	32	4	3	3	4	26	20	6	-	1.74	12.46	1.55	2.67	DST	0.22	23	-	-	-	-	-	-	-	-	-
SPT-2	4.00	18	20		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	5.50	-	-		ML-CL		6	58	35	1	0	0	0	26	19	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-3	7.00	19	18		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	8.50	-	-	Brown, Hard, Silty clay of low plasticity	CL		10	70	20	0	0	0	0	30	20	10	-	1.86	16.24	1.60	2.68	UUT	1.02	4	-	-	-	-	-	-	-	-	-
SPT-4	10.00	33	33		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	11.50	-	-		CL		12	69	16	2	0	1	0	31	20	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-5	13.00	30	30		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-5	14.50	-	-	Brown, Very dense, Sandy silt of low plasticity with gravel	ML-CL		7	50	37	1	0	5	0	27	20	7	-	1.88	17.45	1.60	2.66	DST	0.20	26	-	-	-	-	-	-	-	-	-
SPT-6	16.00	66	31		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-6	17.50	-	-	Brown, Hard, Silty clay of low plasticity	CL		11	73	14	1	1	0	0	32	21	11	-	1.98	22.36	1.62	2.68	UUT	1.42	4	-	-	-	-	-	-	-	-	-
SPT-7	19.00	42	42		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-7	20.50	-	-		CL		10	65	18	4	1	2	0	31	21	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	22.00	48	48		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-9	23.50	60	26	Brown, Very dense, Sandy silt of low plasticity with gravel	ML-CL		8	45	35	4	2	6	0	28	21	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-10	25.00	71	29		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-11	26.50	77	30		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-12	28.00	88	33		ML-CL		6	48	33	4	2	5	2	26	20	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

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SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		20-08-2021	to	22-08-2021	57+400 Major Bridge	BH-P9	12.00 m	35.00 m	682083.968 m	3148480.891 m	(+)214.330 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
SPT-13	29.50	91	33	Brown, Very dense, Sandy silt of low plasticity with gravel	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-14	31.00	97	34		ML-CL		7	48	32	1	3	9	0	27	20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-15	32.50	100 (25cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-16	34.00	107 (23cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-17	35.00	100 (20cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

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							23-08-2021	to	24-08-2021	57+400 Major Bridge	BH-P10	11.85 m	30.00 m	682080.995 m	3148493.957 m	(+)214.021 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Brown, Medium dense, Silty sand	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	1.00	-	-		SM		0	20	78	1	0	1	0	-	Nil	NP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	2.50	27	######		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	4.00	-	-		SM		0	30	67	1	1	1	0	-	Nil	NP	-	1.78	12.35	1.58	2.63	DST	0.00	29	-	-	-	-	-	-	-	-
SPT-2	5.50	25	######		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	7.00	-	-	Brown, Very stiff, Silty clay of low plasticity	CL		9	57	16	6	4	8	0	30	20	10	-	1.83	15.63	1.58	2.68	UUT	0.92	5	-	-	-	-	-	-	-	-	-
SPT-3	8.50	27	27		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	10.00	-	-	Brown, Very dense, Sandy silt of low plasticity with gravel	ML-CL		6	61	25	4	1	3	0	26	20	6	-	1.84	17.20	1.57	2.66	DST	0.21	25	-	-	-	-	-	-	-	-	-
SPT-4	11.50	31	######		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-5	13.00	-	-		ML-CL		7	58	26	3	2	4	0	26	19	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-5	14.50	37	######		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-6	16.00	-	-		ML-CL		7	55	30	1	2	5	0	27	20	7	-	1.88	18.79	1.58	2.67	DST	0.18	26	-	-	-	-	-	-	-	-	-
SPT-6	17.50	43	######		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-7	19.00	-	-		ML-CL		6	57	29	3	1	4	0	27	20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-7	20.50	48	######		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-8	22.00	-	-		ML-CL		8	54	26	4	2	6	0	28	21	7	-	1.91	19.26	1.60	2.67	DST	0.21	26	-	-	-	-	-	-	-	-	-
SPT-8	23.50	55	######		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-9	25.00	60	######		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-10	26.50	56	######		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

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		23-08-2021	to	24-08-2021	57+400 Major Bridge	BH-P10	11.85 m	30.00 m	682080.995 m	3148493.957 m	(+)214.021 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
SPT-11	28.00	100	######	Brown, Very dense, Sandy silt of low plasticity with gravel	ML-CL		7	53	25	5	4	6	0	27	20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-12	29.50	100 (19cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-13	30.00	>100	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

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AND RESEARCH CENTRE PVT. LTD.

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.						Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
							24-08-2021	to	25-08-2021	57+400 Major Bridge	BH-P11	11.80 m	30.00 m	682078.022 m	3148507.023 m	(+)213.946 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Brown, Loose to medium dense, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	1.00	9	14		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.50	-	-		ML-CL		6	55	37	1	1	0	0	26	20	6	-	1.72	13.06	1.52	2.66	DST	0.16	24	-	-	-	-	-	-	-	-	-
SPT-2	4.00	18	20		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	5.50	-	-		ML-CL		8	54	31	2	3	2	0	28	21	7	-	1.78	14.74	1.55	2.67	DST	0.21	24	-	-	-	-	-	-	-	-	-
SPT-3	7.00	22	21		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	8.50	-	-		ML-CL		7	57	28	4	2	2	0	26	19	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-4	10.00	27	22		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	11.50	-	-		ML-CL		9	53	29	3	2	4	0	29	22	7	-	1.83	18.24	1.55	2.67	DST	0.21	25	-	-	-	-	-	-	-	-	-
SPT-5	13.00	30	19		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-5	14.50	-	-		ML-CL		7	54	28	5	2	3	1	27	20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-6	16.00	22	15		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-6	17.50	-	-		ML-CL		8	52	32	4	1	2	1	27	20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-7	19.00	25	16		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-7	20.50	-	-		ML-CL		7	58	27	2	3	3	0	26	19	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	22.00	30	17		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-9	23.50	45	45	Brown, Hard, Silty clay of low plasticity	CL		12	77	3	2	4	2	0	33	22	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-10	25.00	44	44		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEGTH
CEG TEST HOUSE
AND RESEARCH CENTRE PVT LTD

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		24-08-2021	to	25-08-2021	57+400 Major Bridge	BH-P11	11.80 m	30.00 m	682078.022 m	3148507.023 m	(+)213.946 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
SPT-11	26.50	85	33	Brown, Very dense, Sandy silt of low plastic	ML-CL		0	79	7	2	7	6	0	26	20	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-12	28.00	100 (25cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-13	29.50	100 (18cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	30.00		-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

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Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.						Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
							26-08-2021	to	27-08-2021	57+400 Major Bridge	BH-P12	12.10 m	30.00 m	682075.049 m	3148520.089 m	(+)214.402 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																			
DS	0.00	-	-	Brown, Medium dense, Silty sand	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	1.00	-	-		SM-SC		6	30	63	1	0	0	0	25	20	5	-	1.77	11.86	1.58	2.65	DST	0.11	28	-	-	-	-	-	-	-	-	-
SPT-1	2.50	25	32		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	4.00	-	-		SM-SC		5	29	65	1	0	0	0	25	19	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-2	5.50	26	26		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	7.00	-	-	Brown, Medium dense to very dense, Sandy silt of low plasticity	ML-CL		8	47	44	1	0	0	0	27	20	7	-	1.81	14.63	1.58	2.67	DST	0.22	25	-	-	-	-	-	-	-	-	-
SPT-3	8.50	29	25		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	10.00	-	-		ML-CL		7	53	34	3	1	2	0	28	21	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-4	11.50	33	25		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-5	13.00	-	-		ML-CL		8	47	38	4	1	2	0	27	20	7	-	1.83	17.25	1.56	2.66	DST	0.21	26	-	-	-	-	-	-	-	-	-
SPT-5	14.50	37	21		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-6	16.00	-	-		ML-CL		8	43	46	1	1	1	0	28	21	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-6	17.50	35	20		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-7	19.00	-	-		ML-CL		7	59	31	2	0	1	0	26	20	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-7	20.50	32	18		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	22.00	38	20		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-9	23.50	51	24		ML-CL		6	56	29	2	1	6	0	26	20	6	-	1.87	18.50	1.58	2.67	DST	0.22	27	-	-	-	-	-	-	-	-	-
SPT-10	25.00	60	26		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-11	26.50	49	22		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEG TEST HOUSE

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		26-08-2021	to	27-08-2021	57+400 Major Bridge	BH-P12	12.10 m	30.00 m	682075.049 m	3148520.089 m	(+)214.402 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
SPT-12	28.00	58	25	Brown, Medium dense to very dense, Sandy silt of low plasticity	ML-CL		5	46	36	3	2	8	0	25	19	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-13	29.50	100 (19cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	30.00	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEG TEST HOUSE

SOIL CHARACTERISTICS

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							27-08-2021	to	28-08-2021	57+400 Major Bridge	BH-P13	12.30 m	30.00 m	682072.075 m	3148533.155 m	(+)214.579 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																			
DS	0.00	-	-	Brown, Loose, Silty sand	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	1.00	9	14		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.50	-	-		SM		0	37	61	1	1	0	0	-	Nil	NP	-	1.68	11.46	1.51	2.62	DST	0.00	28	-	-	-	-	-	-	-	-
SPT-2	4.00	34	39	Brown, Dense, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	5.50	-	-		ML-CL		7	55	31	2	1	4	0	26	19	7	-	1.82	13.22	1.61	2.67	DST	0.21	26	-	-	-	-	-	-	-	-
SPT-3	7.00	38	36		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	8.50	-	-		ML-CL		6	49	36	2	1	6	0	26	20	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-4	10.00	42	34		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	11.50	-	-		ML-CL		7	51	35	2	1	3	1	27	20	7	-	1.85	16.54	1.59	2.66	DST	0.23	26	-	-	-	-	-	-	-	-
SPT-5	13.00	46	25		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-5	14.50	-	-		ML-CL		8	47	36	3	2	4	0	28	21	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-6	16.00	38	21		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-6	17.50	-	-	Brown, Hard, Silty clay of low plasticity	CL		11	59	21	2	1	6	0	32	21	11	-	2.00	22.14	1.64	2.68	UUT	1.67	4	-	-	-	-	-	-	-	-
SPT-7	19.00	51	51		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-7	20.50	-	-	Brown, Very dense, Sandy silt of low plasticity	ML-CL		7	46	37	2	1	5	2	27	20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	22.00	73	31		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-9	23.50	60	26		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-10	25.00	67	28		ML-CL		6	52	31	2	1	8	0	26	20	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-11	26.50	60	25		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-12	28.00	59	24		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEG TEST HOUSE

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		27-08-2021	to	28-08-2021	57+400 Major Bridge	BH-P13	12.30 m	30.00 m	682072.075 m	3148533.155 m	(+)214.579 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction ($\varphi°$)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
SPT-13	29.50	62	25	Brown, Very dense, Sandy silt of low plasticity	ML-CL		8	54	28	2	1	7	0	28	21	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	30.00		-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEG TEST HOUSE

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.						Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
							25-08-2021	to	26-08-2021	57+400 Major Bridge	BH-P15	11.80 m	30.00 m	682066.129 m	3148559.287 m	(+)213.460 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																			
DS	0.00	-	-	Brown, Medium dense, Silty sand	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	1.00	15	24		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.50	-	-		SM-SC		5	38	56	1	0	0	0	25	20	5	-	1.76	12.16	1.57	2.65	DST	0.09	28	-	-	-	-	-	-	-	-	-
SPT-2	4.00	18	20		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	5.50	-	-		SM-SC		6	43	51	0	0	0	0	26	20	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-3	7.00	25	23		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	8.50	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-4	10.00	56	46	Brown, Very dense, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	11.50	-	-		ML-CL		8	50	33	2	1	6	0	27	20	7	-	1.86	16.32	1.60	2.67	DST	0.19	26	-	-	-	-	-	-	-	-	-
SPT-5	13.00	61	30		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	14.50	-	-		ML-CL		10	55	28	1	1	5	0	29	22	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-6	16.00	51	25		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-5	17.50	-	-		ML-CL		7	54	27	2	3	6	1	27	20	7	-	1.87	17.63	1.59	2.67	DST	0.22	26	-	-	-	-	-	-	-	-	-
SPT-7	19.00	56	26		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	20.50	64	28		ML-CL		8	51	29	2	2	8	0	28	21	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-9	22.00	59	26		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-10	23.50	74	31		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-11	25.00	79	32		ML-CL		7	49	27	4	2	11	0	26	20	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-12	26.50	86	33		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

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CEGTH
CEG TEST HOUSE
AND RESEARCH CENTRE PVT LTD

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		25-08-2021	to	26-08-2021	57+400 Major Bridge	BH-P15	11.80 m	30.00 m	682066.129 m	3148559.287 m	(+)213.460 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
SPT-13	28.00	81	31	Brown, Very dense, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-14	29.50	90	33		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	30.00	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

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SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.						Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
							27-08-2021	to	28-08-2021	57+400 Major Bridge	BH-P16	11.20 m	30.00 m	682063.156 m	3148572.353 m	(+)212.949 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																			
DS	0.00	-	-	Brown, Medium dense, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	1.00	-	-		ML-CL		7	59	31	2	1	0	0	26	20	6	-	1.75	12.63	1.55	2.66	DST	0.21	24	-	-	-	-	-	-	-	-	-
SPT-1	2.50	16	20		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	4.00	-	-		ML-CL		6	56	33	1	3	1	0	26	19	7	-	1.76	13.41	1.55	2.67	DST	0.19	25	-	-	-	-	-	-	-	-	-
SPT-2	5.50	19	19		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	7.00	-	-		ML-CL		8	56	32	1	2	1	0	27	20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-3	8.50	21	18		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	10.00	-	-	Brown, Medium dense to dense, Silty sand	SM		0	18	78	2	1	1	0	-	Nil	NP	-	1.78	14.78	1.55	2.63	DST	0.00	29	-	-	-	-	-	-	-	-	-
SPT-4	11.50	24	17		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	13.00	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-5	14.50	31	19		SM		0	14	80	3	2	1	0	-	Nil	NP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-5	16.00	-	-		SM		0	19	74	2	2	3	0	-	Nil	NP	-	1.81	16.34	1.56	2.62	DST	0.00	30	-	-	-	-	-	-	-	-	-
SPT-6	17.50	39	21		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-7	19.00	77	34	Brown, Very dense, Sandy silt of low plasticity	ML-CL		7	55	26	3	2	7	0	27	20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	20.50	100 (24cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-9	22.00	100 (23cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-10	23.50	100 (26cm)	-		ML-CL		8	51	31	5	1	4	0	28	21	7	-	1.94	18.00	1.64	2.66	DST	0.17	28	-	-	-	-	-	-	-	-	-
SPT-11	25.00	100 (23cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

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CEG TEST HOUSE

SOIL CHARACTERISTICS

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		27-08-2021	to	28-08-2021	57+400 Major Bridge	BH-P16	11.20 m	30.00 m	682063.156 m	3148572.353 m	(+)212.949 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
SPT-12	26.50	100 (26cm)	-	Brown, Very dense, Silty sand	SM		0	20	76	2	1	1	0	-	Nil	NP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-13	28.00	100 (24cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-14	29.50	90	34		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	30.00	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

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DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

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SOIL CHARACTERISTICS

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							26-08-2021	to	27-08-2021	57+400 Major Bridge	BH-P17	10.80 m	30.00 m	682060.182 m	3148585.419 m	(+)213.184 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Brown, Medium stiff, Silty clay of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	1.00	5	5		CL		12	82	5	1	0	0	0	31	20	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.50	-	-		CL		10	78	8	2	2	0	0	30	20	10	-	1.66	14.22	1.45	2.68	UUT	0.20	4	-	-	-	-	-	-	-	-	-
SPT-2	4.00	17	17	Brown, Medium dense to dense, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	5.50	-	-		ML-CL		7	55	30	5	2	1	0	26	19	7	-	1.75	13.79	1.54	2.66	DST	0.23	24	-	-	-	-	-	-	-	-	-
SPT-3	7.00	20	19		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	8.50	-	-		ML-CL		7	53	33	2	3	2	0	27	20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-4	10.00	24	20		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-5	11.50	27	18		ML-CL		6	58	28	2	4	2	0	26	20	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-6	13.00	31	20		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-7	14.50	34	20		ML-CL		8	52	33	2	2	3	0	28	21	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	16.00	36	21		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	17.50	-	-	Brown, Very dense, Sandy silt of low plasticity	ML-CL		9	53	24	5	2	7	0	28	21	7	-	1.94	18.12	1.64	2.66	DST	0.18	28	-	-	-	-	-	-	-	-	-
SPT-9	19.00	100 (18cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-10	20.50	100 (25cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-11	22.00	100 (24cm)	-		ML-CL		8	50	26	3	4	9	0	27	20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-12	23.50	100 (20cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-13	25.00	100 (24cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-14	26.50	100 (24cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-15	28.00	100 (20cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

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CEG TEST HOUSE

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		26-08-2021	to	27-08-2021	57+400 Major Bridge	BH-P17	10.80 m	30.00 m	682060.182 m	3148585.419 m	(+)213.184 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
SPT-16	29.50	100 (18cm)	-	Brown, Very dense, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	30.00	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

SOIL CHARACTERISTICS

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						24-08-2021	to	25-08-2021	57+400 Major Bridge	BH-P18	10.50 m	30.00 m	682057.209 m	3148598.485 m	(+)213.517 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																			
DS	0.00	-	-	Brown, Medium dense, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	1.00	-	-		ML-CL		8	48	42	1	1	0	0	27	20	7	-	1.74	13.10	1.54	2.67	DST	0.21	24	-	-	-	-	-	-	-	-	-
SPT-1	2.50	15	19		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	4.00	-	-		ML-CL		8	57	28	3	2	2	0	28	21	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-2	5.50	20	20		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	7.00	-	-		ML-CL		7	51	33	4	2	2	1	27	20	7	-	1.80	15.26	1.56	2.66	DST	0.19	25	-	-	-	-	-	-	-	-	-
SPT-3	8.50	26	23		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	10.00	-	-	Brown, Hard, Silty clay of low plasticity	CL		12	61	18	4	2	3	0	34	22	12	-	1.93	20.65	1.60	2.68	UUT	1.07	4	-	-	-	-	-	-	-	-	-
SPT-4	11.50	30	30		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-5	13.00	30	30		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-6	14.50	34	34		CL		11	65	12	6	2	4	0	33	22	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-7	16.00	34	34		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	17.50	100 (20cm)	-	Brown, Very dense, Sandy silt of low plasticity	ML-CL		7	52	27	5	2	7	0	27	20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-9	19.00	100 (22cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-10	20.50	100 (18cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-11	22.00	100 (25cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-12	23.50	100 (21cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-13	25.00	100 (24cm)	-		ML-CL		6	54	24	2	3	11	0	26	20	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-14	26.50	103 (26cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

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DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEGTH
CEG TEST HOUSE
AND RESEARCH CENTRE PVT. LTD

SOIL CHARACTERISTICS

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		24-08-2021	to	25-08-2021	57+400 Major Bridge	BH-P18	10.50 m	30.00 m	682057.209 m	3148598.485 m	(+)213.517 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction ($\varphi°$)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
SPT-15	28.00	100 (23cm)	-	Brown, Very dense, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-16	29.50	100 (27cm)	-		ML-CL		8	51	30	2	1	8	0	27	20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	30.00	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

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							23-08-2021	to	24-08-2021	57+400 Major Bridge	BH-P19	11.50 m	30.00 m	682054.236 m	3148611.551 m	(+)213.504 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Brown, Medium dense, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	1.00	11	17		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.50	-	-		ML-CL		7	46	45	2	0	0	0	26	20	6	-	1.72	12.64	1.53	2.67	DST	0.22	23	-	-	-	-	-	-	-	-	-
SPT-2	4.00	14	16		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	5.50	-	-		ML-CL		8	49	41	2	0	0	0	28	21	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-3	7.00	19	18		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	8.50	-	-		ML-CL		6	52	37	4	0	1	0	26	20	6	-	1.77	14.26	1.55	2.66	DST	0.19	24	-	-	-	-	-	-	-	-	-
SPT-4	10.00	23	19		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-5	11.50	31	25		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-6	13.00	31	20		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-7	14.50	27	18		ML-CL		7	47	44	1	1	0	0	27	20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	16.00	31	31	Brown, Hard, Silty clay of medium plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	17.50	-	-		CL		12	68	16	2	1	1	0	30	20	10	-	1.94	21.34	1.60	2.68	UUT	1.02	5	-	-	-	-	-	-	-	-	-
SPT-9	19.00	35	35		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-10	20.50	>100	-	Brown, Very dense, Silty sand	SM		0	20	48	20	2	10	0	-	Nil	NP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-11	22.00	>100	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-12	23.50	>100	-		SM		0	19	42	32	1	6	0	-	Nil	NP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-13	25.00	>100	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

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		23-08-2021	to	24-08-2021	57+400 Major Bridge	BH-P19	11.50 m	30.00 m	682054.236 m	3148611.551 m	(+)213.504 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
SPT-14	26.50	100 (18cm)	-	Brown, Very dense, Silty sand	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-15	28.00	100 (25cm)	-		SM		0	22	77	1	0	0	0	-	Nil	NP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-16	29.50	>100	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-17	30.00	>100	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

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							20-08-2021	to	22-08-2021	57+400 Major Bridge	BH-A2	10.90 m	35.00 m	682050.819 m	3148626.567 m	(+)213.090 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction ($\varphi°$)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Brown, Medium dense, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	1.00	-	-		ML-CL		6	61	31	1	1	0	0	26	20	6	-	1.72	12.36	1.53	2.66	DST	0.16	23	-	-	-	-	-	-	-	-	-
SPT-1	2.50	14	18		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	4.00	-	-	Brown, Very stiff, Silty clay of low plasticity	CL		9	69	19	1	1	1	0	30	20	10	-	1.80	14.22	1.58	2.68	UUT	0.88	4	-	-	-	-	-	-	-	-	-
SPT-2	5.50	26	26		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	7.00	-	-		CL		10	74	11	2	1	2	0	31	20	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-3	8.50	27	27		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	10.00	-	-	Brown, Dense, Sandy silt of low plasticity with gravel	ML-CL		6	47	39	1	1	6	0	26	20	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-4	11.50	30	19		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-5	13.00	-	-		ML-CL		7	53	30	5	2	3	0	26	19	7	-	1.82	17.49	1.55	2.67	DST	0.20	25	-	-	-	-	-	-	-	-	-
SPT-5	14.50	34	20		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-6	16.00	-	-		ML-CL		8	45	33	4	4	6	0	27	20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-6	17.50	33	19		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-7	19.00	-	-		ML-CL		9	51	28	5	3	4	0	28	21	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-7	20.50	36	20		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	22.00	>100	-	Brown, Very dense, Sandy silt of low plasticity with gravel	ML-CL		6	48	27	4	4	11	0	26	20	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-9	23.50	>100	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-10	25.00	54	25		ML-CL		8	43	29	2	1	9	8	27	20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-11	26.50	100 (28cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEGTH
CEG TEST HOUSE
AND RESEARCH CENTRE PVT LTD

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		20-08-2021	to	22-08-2021	57+400 Major Bridge	BH-A2	10.90 m	35.00 m	682050.819 m	3148626.567 m	(+)213.090 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
SPT-12	28.00	99	38	Brown, Very dense, Sandy silt of low plasticity with gravel	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-13	29.50	100 (18cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-14	31.00	110 (20cm)	-		ML-CL		6	48	36	2	1	7	0	26	20	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-15	32.50	100 (19cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-16	34.00	100 (22cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-17	35.00	110 (23cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.						Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
							3-7-2022	to	3-7-2022	57+980	CL	9.28 m	10.00 m	681950.308 m	3149053.752 m	(+)213.055 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																			
DS	0.00	-	-	Brown, Silty Clay of medium Plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	1.50	11	11		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.25	-	-		CI		19	68	7	5	1	0	0	42	24	18	-	1.80	18.60	1.52	2.71	UUT	0.61	5	-	-	-	-	-	-	-	-	-
SPT-2	3.00	14	14	Stiff to Hard, Brown, Silty Clay of LowPlasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-3	4.50	17	17		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	5.25	-	-		CL		11	44	34	7	1	3	0	32	21	11	-	1.93	19.70	1.61	2.66	UUT	1.17	7	-	-	-	-	-	-	-	-	-
SPT-4	6.00	29	29		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-5	7.50	33	33		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	8.25	-	-		CL		12	51	28	5	1	3	0	31	22	9	-	1.89	19.88	1.58	2.68	UUT	0.68	7	-	-	-	-	-	-	-	-	-
SPT-6	9.00	14	14		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-7	10.00	21	21		-		-	-	43	13	2	0	0	27	21	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEGTH
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SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.						Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
							24-09-2021	to	24-09-2021	58+191	BH-CL	Not Encountered	10.00 m	681895.083 m	3149257.396 m	(+)212.823 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																			
DS	0.00	-	-	Brown, Loose to medium dense, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	1.00	6	10		ML-CL		7	50	37	4	2	0	0	27	20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.50	-	-		ML-CL		6	48	35	6	3	2	0	26	20	6	-	1.69	12.60	1.50	2.65	DST	0.21	24	-	-	-	-	-	-	-	-	-
SPT-2	4.00	16	18		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	5.50	-	-	Brown, Hard, Silty clay of low plasticity with gravel	CL		11	49	28	5	2	5	0	31	20	11	-	1.84	15.24	1.60	2.67	UUT	1.05	5	-	-	-	-	-	-	-	-	-
SPT-3	7.00	31	31		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	8.50	-	-		CL		10	53	24	4	3	6	0	30	20	10	-	1.90	16.49	1.63	2.68	UUT	1.51	4	-	-	-	-	-	-	-	-	-
SPT-4	10.00	46	46		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

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SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		14-08-2021	to	16-08-2021	58+497	BH-A1	11.30 m	40.00 m	681858.380 m	3149467.024 m	(+)213.216 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Brown, Medium dense TO DENSE, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	1.00	17	27		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.50	-	-		ML-CL		7	51	36	4	2	0	0	26	20	6	-	1.76	11.56	1.58	2.67	DST	0.19	24	-	-	-	-	-	-	-	-	-
SPT-2	4.00	24	27		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	5.50	-	-		ML-CL		8	56	32	3	1	0	0	27	20	7	-	1.80	12.31	1.60	2.67	DST	0.22	25	-	-	-	-	-	-	-	-	-
SPT-3	7.00	32	30		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	8.50	-	-	Brown, Hard, Silty clay of low plasticity	CL		11	56	25	2	1	5	0	31	20	11	-	2.68	2.68	2.68	2.68	UUT	1.52	5	-	-	-	-	-	-	-	-	-
SPT-4	10.00	46	46		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	11.50	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-5	13.00	48	48		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	14.50	-	-		CL		13	58	20	3	2	3	1	33	22	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-6	16.00	52	52		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-5	17.50	-	-		CL		12	56	26	2	1	3	0	32	21	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-7	19.00	45	45		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-6	20.50	-	-	Brown, Very dense, Sandy silt of low plasticity	ML-CL		8	58	27	2	1	4	0	28	21	7	-	1.86	15.06	1.62	2.66	DST	0.21	27	-	-	-	-	-	-	-	-	-
SPT-8	22.00	75	28		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-7	23.50	-	-		ML-CL		7	49	30	3	4	6	1	27	20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-9	25.00	69	26		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-8	26.50	-	-		ML-CL		8	53	27	5	2	5	0	26	19	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

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SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.						Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
							14-08-2021	to	16-08-2021	58+497	BH-A1	11.30 m	40.00 m	681858.380 m	3149467.024 m	(+)213.216 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
									Sand			Gravel																				
							Clay	Silt	Fine	Medium	Coarse	Fine	Coarse	Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
SPT-10	28.00	75	27	Brown, Very dense, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-9	29.50	-	-		ML-CL		6	46	36	2	2	8	0	27	20	7	-	2.66	2.66	2.66	2.66	DST	0.17	28	-	-	-	-	-	-	-	-
SPT-11	31.00	80	26		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-10	32.50	-	-		ML-CL		6	49	37	3	1	4	0	26	20	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-12	34.00	100 (20cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-13	35.50	100 (23cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-14	37.00	100 (26cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-15	38.50	67	23		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-11	40.00	-	-		ML-CL		7	47	32	3	2	9	0	26	19	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

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							16-08-2021	to	18-08-2021	58+497	BH-P1	11.60 m	40.00 m	681844.488 m	3149495.176 m	(+)214.371 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Brown, Medium dense, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	1.00	-	-		ML-CL		7	67	25	1	0	0	0	27	20	7	-	1.75	12.36	1.56	2.66	DST	0.23	23	-	-	-	-	-	-	-	-	-
SPT-1	2.50	17	22		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	4.00	-	-		ML-CL		8	64	24	3	1	0	0	28	21	7	-	1.81	12.86	1.60	2.67	DST	0.19	24	-	-	-	-	-	-	-	-	-
SPT-2	5.50	30	30		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	7.00	-	-	Brown, Hard, Silty clay of low plasticity	CL		13	63	18	3	2	1	0	32	21	11	-	1.86	15.10	1.62	2.68	UUT	1.34	5	-	-	-	0.655	0.5-1.0 1.0-2.0 2.0-4.0 4.0-8.0	7.05 5.79 5.17 4.25	1.84 1.36 0.91 0.59	0.1230
SPT-3	8.50	40	40		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	10.00	-	-		CL		12	63	15	3	4	3	0	33	22	11	-	1.91	17.22	1.63	2.69	UUT	1.48	4	-	-	-	-	-	-	-	-	-
SPT-4	11.50	45	45		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-5	13.00	-	-		CL		14	53	19	8	4	2	0	34	23	11	-	1.97	20.34	1.64	2.68	UUT	1.65	5	-	-	-	-	-	-	-	-	-
SPT-5	14.50	49	49		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-6	16.00	-	-		CL		14	71	12	1	2	0	0	33	22	11	-	2.02	22.29	1.65	2.69	UUT	1.80	4	-	-	-	-	-	-	-	-	-
SPT-6	17.50	54	54		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-7	19.00	-	-	Brown, Very dense, Sandy silt of low plasticity	ML-CL		6	55	30	3	2	4	0	26	20	6	-	1.88	17.25	1.60	2.66	DST	0.20	26	-	-	-	-	-	-	-	-	-
SPT-7	20.50	61	27		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-8	22.00	-	-		ML-CL		8	52	28	5	2	5	0	28	21	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	23.50	68	28		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	25.00	81	32		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-10	26.50	69	28		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEGTH
CEG TEST HOUSE
AND RESEARCH CENTRE PVT LTD

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.						Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
							16-08-2021	to	18-08-2021	58+497	BH-P1	11.60 m	40.00 m	681844.488 m	3149495.176 m	(+)214.371 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction ($\varphi°$)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
UDS-9	28.00	-	-	Brown, Very dense, Sandy silt of low plasticity	ML-CL		7	51	34	4	1	3	0	27	20	7	-	1.91	18.34	1.61	2.67	DST	0.16	28	-	-	-	-	-	-	-	-
SPT-11	29.50	77	29		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	31.00	86	31		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-13	32.50	100 (17cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	34.00	100 (20cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	35.50	100 (24cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	37.00	100 (18cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-14	38.50	73	25		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-10	40.00	-	-		ML-CL		8	51	30	1	1	9	0	27	20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

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SOIL CHARACTERISTICS

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							19-08-2021	to	20-08-2021	58+497		BH-P2		11.40 m		40.00 m		681840.419 m			3149522.156 m			(+)213.108 m		SR-544_21-22			
Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction ($\varphi°$)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																			
DS	0.00	-	-	Brown, Medium dense, Silty sand with clay	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	1.00	19	30		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.50	-	-		SM-SC		6	33	55	2	3	1	0	25	19	6	-	1.74	11.34	1.56	2.65	DST	0.09	27	-	-	-	-	-	-	-	-
SPT-2	4.00	26	26	Brown, Very stiff, Silty clay of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	5.50	-	-		CL		11	74	10	1	2	2	0	30	20	10	-	1.81	14.67	1.58	2.68	UUT	0.93	4	-	-	-	-	-	-	-	-
SPT-3	7.00	27	27		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	8.50	-	-		CL		12	58	14	4	2	10	0	32	21	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-4	10.00	30	30		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	11.50	-	-	Brown, Dense to very dense, Sandy silt of low plasticity	ML-CL		7	52	34	4	2	1	0	26	19	7	-	1.83	16.80	1.57	2.66	DST	0.20	25	-	-	-	-	-	-	-	-
SPT-5	13.00	38	22		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-5	14.50	-	-		ML-CL		6	50	38	4	1	1	0	26	20	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-6	16.00	45	24		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	17.50	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-7	19.00	63	29		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-6	20.50	-	-		ML-CL		7	51	33	3	2	4	0	27	20	7	-	1.88	17.76	1.60	2.67	DST	0.21	26	-	-	-	-	-	-	-	-
SPT-8	22.00	58	27		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-7	23.50	-	-		ML-CL		8	49	28	1	3	11	0	27	20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-9	25.00	64	28		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-8	26.50	-	-		ML-CL		6	51	25	3	2	13	0	26	20	6	-	2.66	2.66	2.66	2.66	DST	0.17	28	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

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SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		19-08-2021	to	20-08-2021	58+497	BH-P2	11.40 m	40.00 m	681840.419 m	3149522.156 m	(+)213.108 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
SPT-10	28.00	>100	-	Brown, Dense to very dense, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-11	29.50	100 (20cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-12	31.00	>100	-		ML-CL		7	47	32	2	2	10	0	26	19	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-13	32.50	100 (25cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-14	34.00	100 (25cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-15	35.50	>100	-		ML-CL		8	53	28	2	0	9	0	28	21	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-16	37.00	>100	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-17	38.50	>100	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-18	40.00	>100	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

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SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.						Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
							23-08-2021	to	24-08-2021	58+497	BH-P3	11.00 m	40.00 m	681840.000 m	3149565.000 m	(+)214.145 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction ($\varphi°$)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Brown, Medium dense, Silty sand	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	1.00	-	-		SM		0	22	77	1	0	0	0	-	Nil	NP	-	1.69	10.63	1.53	2.62	DST	0.00	29	-	-	-	-	-	-	-	-
SPT-1	2.50	14	18		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	4.00	-	-		SM		0	22	72	3	2	1	0	-	Nil	NP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-2	5.50	16	16		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	7.00	-	-	Brown, Dense to very dense, Sandy silt of low plasticity	ML-CL		5	59	30	3	2	1	0	25	20	5	-	1.80	14.22	1.58	2.66	DST	0.21	25	-	-	-	-	-	-	-	-
SPT-3	8.50	33	29		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	10.00	-	-		ML-CL		6	56	34	1	1	2	0	26	20	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-4	11.50	38	23		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-5	13.00	-	-		ML-CL		7	56	29	3	2	3	0	27	20	7	-	1.85	16.87	1.58	2.66	DST	0.19	26	-	-	-	-	-	-	-	-
SPT-5	14.50	40	23		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-6	16.00	-	-		ML-CL		8	45	33	4	4	6	0	28	21	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-6	17.50	53	26		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-7	19.00	-	-		ML-CL		6	57	21	1	2	8	5	26	20	6	-	1.89	17.64	1.61	2.67	DST	0.22	27	-	-	-	-	-	-	-	-
SPT-7	20.50	80	35		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-8	22.00	-	-		ML-CL		9	51	19	1	1	9	10	29	22	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	23.50	84	35		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-9	25.00	-	-		ML-CL		6	46	40	1	1	6	0	27	21	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-9	26.50	100	38		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

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SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		23-08-2021	to	24-08-2021	58+497	BH-P3	11.00 m	40.00 m	681840.000 m	3149565.000 m	(+)214.145 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction ($\varphi°$)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
UDS-10	28.00	-	-	Brown, Dense to very dense, Sandy silt of low plasticity	ML-CL		7	51	35	1	1	5	0	26	19	7	-	1.94	18.10	1.64	2.66	DST	0.18	28	-	-	-	-	-	-	-	-	-
SPT-10	29.50	100 (25cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-11	31.00	100 (23cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-12	32.50	100 (25cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-13	34.00	100 (20cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-14	35.50	105	36		ML-CL		8	55	25	3	1	8	0	28	21	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-15	37.00	107 (19cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-16	38.50	100 (23cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-17	40.00	100 (25cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

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SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		18-08-2021	to	19-08-2021	58+497	BH-P4	11.90 m	40.00 m	681837.920 m	3149594.593 m	(+)214.312 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Brown, Medium dense, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	1.00	19	30		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.50	-	-		ML-CL		5	63	30	2	0	0	0	26	20	6	-	1.77	11.23	1.59	2.66	DST	0.18	24	-	-	-	-	-	-	-	-	-
SPT-2	4.00	24	27		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	5.50	-	-	Brown, Dense, Sandy silt of low plasticity	ML-CL		6	60	29	3	1	1	0	26	19	7	-	1.80	11.84	1.61	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-3	7.00	35	32		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	8.50	-	-		ML-CL		7	53	32	4	1	3	0	27	20	7	-	2.67	2.67	2.67	2.67	DST	0.20	25	-	-	-	-	-	-	-	-	-
SPT-4	10.00	43	33		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-5	11.50	48	34		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-6	13.00	54	26	Brown, Very dense, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	14.50	-	-		ML-CL		7	51	35	2	3	2	0	27	21	6	-	2.66	2.66	2.66	2.66	DST	0.19	26	-	-	-	-	-	-	-	-	-
SPT-7	16.00	58	25		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-5	17.50	-	-		ML-CL		8	51	29	6	2	4	0	28	21	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	19.00	53	22		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-6	20.50	-	-		ML-CL		7	55	26	4	3	5	0	27	20	7	-	1.87	16.75	1.60	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-9	22.00	66	25		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	23.50	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-10	25.00	78	28		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-7	26.50	-	-		ML-CL		9	59	23	3	4	2	0	29	22	7	-	2.66	2.66	2.66	2.66	DST	0.19	27	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

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SOIL CHARACTERISTICS

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						18-08-2021	to	19-08-2021	58+497	BH-P4	11.90 m	40.00 m	681837.920 m	3149594.593 m	(+)214.312 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction ($\varphi°$)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
SPT-11	28.00	78	26	Brown, Very dense, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-8	29.50	-	-		ML-CL		7	61	27	3	2	0	0	27	20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-12	31.00	82	26		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-9	32.50	-	-		ML-CL		8	65	24	2	1	0	0	28	21	7	-	2.66	2.66	2.66	2.66	DST	0.22	27	-	-	-	-	-	-	-	-	-	-
SPT-13	34.00	100 (24cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-14	35.50	100 (19cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-15	37.00	100 (26cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-16	38.50	100 (23cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-17	40.00	89	28		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

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Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Brown, Loose, Silty sand	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	1.00	8	13		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.50	-	-		SM		0	33	66	0	0	1	0	-	Nil	NP	-	1.66	10.81	1.50	2.62	DST	0.00	28	-	-	-	-	-	-	-	-
SPT-2	4.00	25	28	Brown, Medium dense, Silty sand	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	5.50	-	-		SM		0	23	75	1	0	1	0	-	Nil	NP	-	1.76	11.26	1.58	2.63	DST	0.00	29	-	-	-	-	-	-	-	-
SPT-3	7.00	31	29		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	8.50	-	-	Brown, Hard, Silty clay of low plasticity	CL		13	66	8	2	2	9	0	33	21	12	-	0.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-4	10.00	39	39		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	11.50	-	-		CL		10	69	12	2	4	3	0	30	20	10	-	1.92	19.22	1.61	2.68	UUT	1.26	4	-	-	-	-	-	-	-	-
SPT-5	13.00	37	37		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-5	14.50	-	-		CL		11	56	19	6	2	5	1	31	20	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-6	16.00	34	34		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-6	17.50	-	-	Brown, Very dense, Sandy silt of low plasticity	ML-CL		7	56	28	3	2	4	0	27	21	6	2.66	2.66	2.66	2.66	2.66	DST	0.20	26	-	-	-	-	-	-	-	-
SPT-7	19.00	51	26		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-7	20.50	-	-		ML-CL		6	51	30	2	3	8	0	26	20	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	22.00	56	26		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-8	23.50	-	-		ML-CL		7	56	27	3	2	5	0	27	20	7	-	2.67	2.67	2.67	2.67	DST	0.22	27	-	-	-	-	-	-	-	-
SPT-9	25.00	67	27				-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-9	26.50	-	-		ML-CL		8	58	22	5	1	6	0	28	21	7	-	0.00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

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SOIL CHARACTERISTICS

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Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
SPT-10	28.00	89	35	Brown, Very dense, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-10	29.50	-	-		ML-CL		9	56	26	3	1	5	0	29	22	7	-	2.66	2.66	2.66	2.66	DST	0.17	28	-	-	-	-	-	-	-	-	-	-
SPT-11	31.00	100 (25cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-12	32.50	100 (25cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-13	34.00	100	34		ML-CL		7	56	24	4	1	8	0	27	20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-14	35.50	100	33		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-15	37.00	100 (26cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-16	38.50	100 (24cm)	-		ML-CL		9	65	25	1	0	0	0	28	21	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-17	40.00	>100	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

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DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

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Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		17-08-2021	to	18-08-2021	58+497	BH-P6	11.00 m	40.00 m	681836.405 m	3149645.522 m	-	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction ($\varphi°$)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Brown, Medium dense, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	1.00	-	-		ML-CL		7	58	27	4	3	1	0	27	20	7	-	1.74	12.19	1.55	2.66	DST	0.24	23	-	-	-	-	-	-	-	-	-
SPT-1	2.50	16	20		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	4.00	-	-		ML-CL		9	58	24	5	2	2	0	28	21	7	-	1.79	13.26	1.58	2.67	DST	0.19	24	-	-	-	-	-	-	-	-	-
SPT-2	5.50	27	27		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	7.00	-	-	Brown, Hard, Silty clay of low plasticity	CL		13	71	11	3	1	1	0	33	22	11	-	1.87	16.34	1.61	2.68	UUT	1.22	5	-	-	-	-	-	-	-	-	-
SPT-3	8.50	36	36		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	10.00	-	-		CL		12	66	15	3	2	2	0	32	21	11	-	1.90	17.48	1.62	2.68	UUT	1.36	5	-	-	-	0.655	0.5-1.0 1.0-2.0 2.0-4.0 4.0-8.0	8.61 6.38 5.24 4.03	1.71 1.23 0.81 0.52	0.1100
SPT-4	11.50	43	43		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-5	13.00	-	-		CL		12	61	18	4	1	4	0	31	20	11	-	1.99	21.63	1.64	2.67	UUT	1.65	4	-	-	-	-	-	-	-	-	-
SPT-5	14.50	51	51		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-6	16.00	-	-		CL		13	57	16	5	3	5	1	33	22	11	-	2.02	22.20	1.65	2.68	UUT	1.79	4	-	-	-	-	-	-	-	-	-
SPT-6	17.50	54	54		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-7	19.00	-	-	Brown, Very dense, Sandy silt of low plasticity	ML-CL		8	58	28	2	1	3	0	28	21	7	-	1.87	17.10	1.60	2.66	DST	0.18	26	-	-	-	-	-	-	-	-	-
SPT-7	20.50	67	29		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-8	22.00	-	-		ML-CL		6	52	32	3	1	6	0	27	20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	23.50	72	30		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-9	25.00	-	-		ML-CL		7	62	21	4	1	5	0	26	19	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-9	26.50	80	31		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEGTH
CEG TEST HOUSE
AND RESEARCH CENTRE PVT LTD

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		17-08-2021	to	18-08-2021	58+497	BH-P6	11.00 m	40.00 m	681836.405 m	3149645.522 m	-	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction ($\varphi°$)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
UDS-10	28.00	-	-	Brown, Very dense, Sandy silt of low plasticity	ML-CL		8	63	22	1	0	6	0	28	21	7	-	1.95	18.19	1.65	2.67	DST	0.20	28	-	-	-	-	-	-	-	-	-
SPT-10	29.50	>100	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-11	31.00	>100	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-12	32.50	>100	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-13	34.00	>100	-		ML-CL		7	59	26	7	1	0	0	27	20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-14	35.50	100 (25cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-15	37.00	100 (22cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-16	38.50	>100	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-17	40.00	>100	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEGTH
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SOIL CHARACTERISTICS

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							17-08-2021	to	18-08-2021	58+497	BH-A2	12.00 m	40.00 m	681833.809 m	3149673.452 m	(+)214.044 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																			
DS	0.00	-	-	Brown, Medium dense, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	1.00	13	21		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.50	-	-		ML-CL		7	54	34	4	1	0	0	27	20	7	-	1.74	12.36	1.55	2.67	DST	0.22	23	-	-	-	-	-	-	-	-	-
SPT-2	4.00	26	29	Brown, Medium dense to dense, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	5.50	-	-		ML-CL		9	51	33	6	1	0	0	29	22	7	-	1.80	13.21	1.59	2.66	DST	0.20	25	-	-	-	-	-	-	-	-	-
SPT-3	7.00	31	29		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	8.50	-	-		ML-CL		8	50	35	3	3	1	0	28	21	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-4	10.00	31	25		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	11.50	-	-	Brown, Medium dense to dense, Sandy silt of low plasticity	ML-CL		7	57	31	2	0	3	0	26	19	7	-	1.81	16.63	1.55	2.67	DST	0.18	25	-	-	-	-	-	-	-	-	-
SPT-5	13.00	32	19		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-5	14.50	-	-		ML-CL		6	55	33	3	2	1	0	26	20	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-6	16.00	28	17		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-6	17.50	-	-		ML-CL		9	59	24	2	2	4	0	29	22	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-7	19.00	41	21		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-7	20.50	-	-	Brown, Very dense, Sandy silt of low plasticity	ML-CL		7	52	29	3	4	5	0	27	20	7	-	1.87	18.10	1.58	2.66	DST	0.19	26	-	-	-	-	-	-	-	-	-
SPT-8	22.00	50	24		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-8	23.50	-	-		ML-CL		8	56	25	6	1	3	1	26	19	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-9	25.00	55	24				-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-9	26.50	-	-		ML-CL		6	55	30	3	4	2	0	26	20	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
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CEG TEST HOUSE AND RESEARCH CENTRE PVT LTD

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		17-08-2021	to	18-08-2021	58+497	BH-A2	12.00 m	40.00 m	681833.809 m	3149673.452 m	(+)214.044 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction ($\varphi°$)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
SPT-10	28.00	58	25	Brown, Very dense, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-10	29.50	-	-		ML-CL		7	67	26	0	0	0	0	26	20	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-11	31.00	65	26		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-11	32.50	-	-		ML-CL		5	51	36	4	1	3	0	26	19	7	-	2.66	2.66	2.66	2.66	DST	0.17	27	-	-	-	-	-	-	-	-	-	-
SPT-12	34.00	99	33		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-13	35.50	100 (21cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-14	37.00	100 (23cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-15	38.50	>100	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-16	40.00	>100	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

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SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.						Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
							24-09-2021	to	24-09-2021	58+837 Minor Bridge	BH-CL	Not Encountered	10.00 m	681823.952 m	3149897.982 m	(+)213.610 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction ($\varphi°$)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Brown, Loose, Silty sand	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	1.00	6	10		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.50	-	-		SM		0	38	55	6	1	0	0	-	Nil	NP	-	1.66	12.31	1.48	2.62	DST	0.00	28	-	-	-	-	-	-	-	-
SPT-2	4.00	22	25	Brown, Medium dense to dense, Sandy silt of low plasticity with gravel	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	5.50	-	-		ML-CL		7	53	30	6	1	3	0	26	20	6	-	1.82	15.13	1.58	2.66	DST	0.18	25	-	-	-	-	-	-	-	-
SPT-3	7.00	32	30		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	8.50	-	-		ML-CL		8	52	28	6	2	4	0	28	21	7	-	1.88	15.94	1.62	2.66	DST	0.19	26	-	-	-	-	-	-	-	-
SPT-4	10.00	47	38		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

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Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.						Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
							24-09-2021	to	24-09-2021	59+071 Minor Bridge	BH-CL	Not Encountered	10.00 m	681817.835 m	3150131.892 m	(+)213.832 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																			
DS	0.00	-	-	Brown, Medium dense to dense, Sandy silt of low plasticity with gravel	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	1.00	-	-		ML-CL		7	51	33	5	1	3	0	27	20	7	-	1.79	14.60	1.56	2.66	DST	0.20	24	-	-	-	-	-	-	-	-	-
SPT-1	2.50	18	23		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	4.00	-	-		ML-CL		6	54	30	4	2	4	0	26	20	6	-	1.85	15.41	1.60	2.66	DST	0.22	25	-	-	-	-	-	-	-	-	-
SPT-2	5.50	29	29		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	7.00	-	-		ML-CL		8	51	28	6	1	6	0	28	21	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-3	8.50	32	27		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	10.00	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

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SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.					Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
						23-09-2021	to	24-09-2021	59+206 Minor Bridge	BH-CL	12.65 m	15.00 m	681807.000 m	3150266.000 m	(+)213.360 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																			
DS	0.00	-	-	Brown, Medium dense to dense, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	1.00	-	-		ML-CL		6	49	40	4	1	0	0	27	20	7	-	1.79	13.56	1.58	2.66	DST	0.21	24	-	-	-	-	-	-	-	-	-
SPT-1	2.50	20	25		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	4.00	-	-		ML-CL		7	53	33	3	2	2	0	26	19	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-2	5.50	26	26		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	7.00	-	-		ML-CL		8	57	28	5	1	1	0	28	21	7	-	1.80	14.80	1.57	2.66	DST	0.22	25	-	-	-	-	-	-	-	-	-
SPT-3	8.50	24	21		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	10.00	-	-		ML-CL		6	57	27	4	3	3	0	26	20	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-4	11.50	33	25		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	13.00	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-5	13.50	30	18		ML-CL		7	51	31	6	1	4	0	27	20	7	-	1.88	21.00	1.55	2.65	DST	0.19	26	-	-	-	-	-	-	-	-	-
SPT-6	15.00	49	25		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

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SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.						Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
							23-09-2021	to	23-09-2021	59+270 Minor Bridge	BH-CL	Not Encountered	10.00 m	681801.000 m	3150330.000 m	(+)212.598 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																			
DS	0.00	-	-	Brown, Medium dense to dense, Sandy silt of low plasticity with gravel	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	1.00	20	31		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.50	-	-		ML-CL		6	55	31	5	1	2	0	26	20	6	-	1.83	14.23	1.60	2.66	DST	0.20	25	-	-	-	-	-	-	-	-	-
SPT-2	4.00	26	29		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	5.50	-	-		ML-CL		8	53	28	6	1	4	0	28	21	7	-	1.85	15.10	1.61	2.65	DST	0.21	26	-	-	-	-	-	-	-	-	-
SPT-3	7.00	39	36		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	8.50	-	-		ML-CL		7	52	29	5	1	6	0	27	20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-4	10.00	42	33		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

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RESULT OF CHEMICAL ANALYSIS OF SOIL SAMPLES

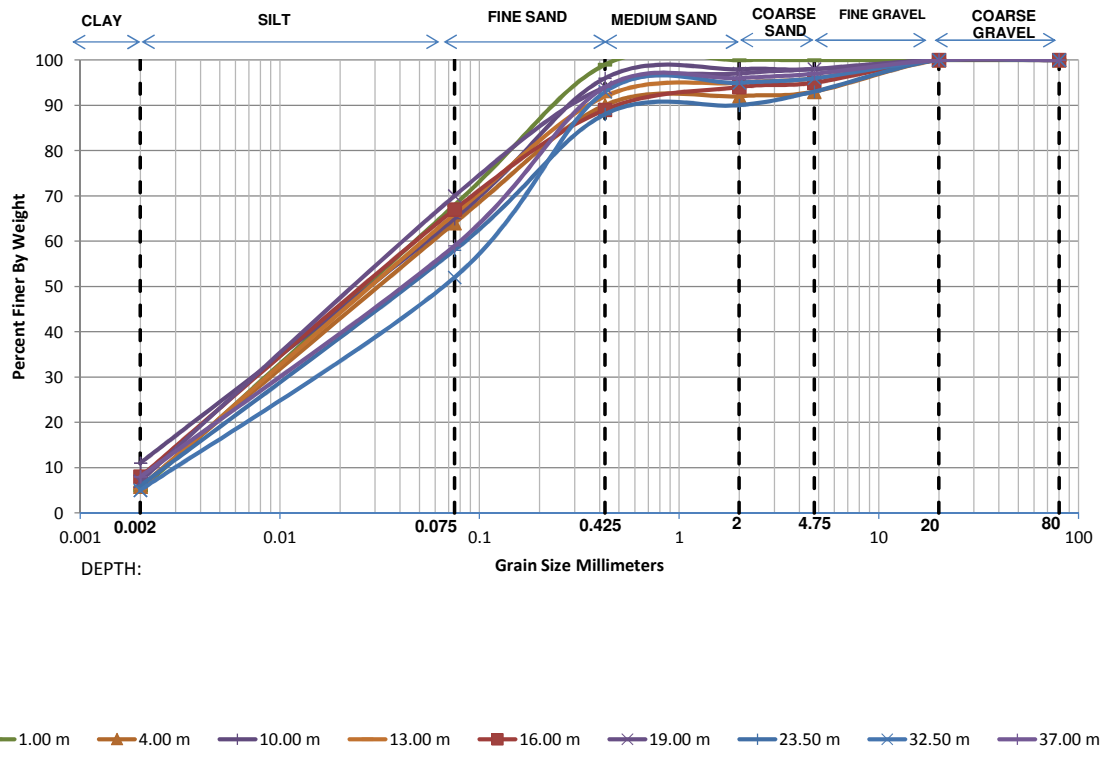
Sr. No	Chainage Old	Chainage New	BH No.	Depth of collected sample (m)	pH	Chlorides (Cl^-)		Sulphate (SO_3^{2-})	
						(mg/kg)	(%)	(mg/kg)	(%)
1.	52+518	55+719	BH-A1	1.0	8.79	76.23	0.0076	18.14	0.0018
			BH-A2	16.0	7.88	85.68	0.0086	29.30	0.0029
2.	55+910	59+107	BH-A1	13.0	7.14	56.12	0.0056	19.35	0.0019
			BH-A2	2.5	9.34	65.67	0.0066	24.26	0.0024
3.	57+400	60+603	BH-P3	13.0	8.74	74.54	0.0074	23.10	0.0023
			BH-P19	5.5	9.70	61.71	0.0062	29.20	0.0029
4.	58+497	61+676	BH-A1	2.5	8.90	80.43	0.0080	17.04	0.0017
			BH-A2	11.5	8.75	79.71	0.0080	22.40	0.0022

RESULT OF CHEMICAL ANALYSIS OF WATER SAMPLE

Sr. No	Chainage Old	Chainage New	BH No.	pH	Chlorides (Cl^-) (mg/l)	Sulphate (SO_3^{2-}) (mg/l)
1.	52+518	55+719	BH-A1	9.23	55.34	20.64
2.	55+910	59+107	BH-A1	9.06	70.33	24.19
3.	57+400	60+603	BH-A1	10.12	57.73	25.43
4.	58+497	61+676	BH-A1	9.43	57.65	23.28

GRAIN SIZE DISTRIBUTION CURVES

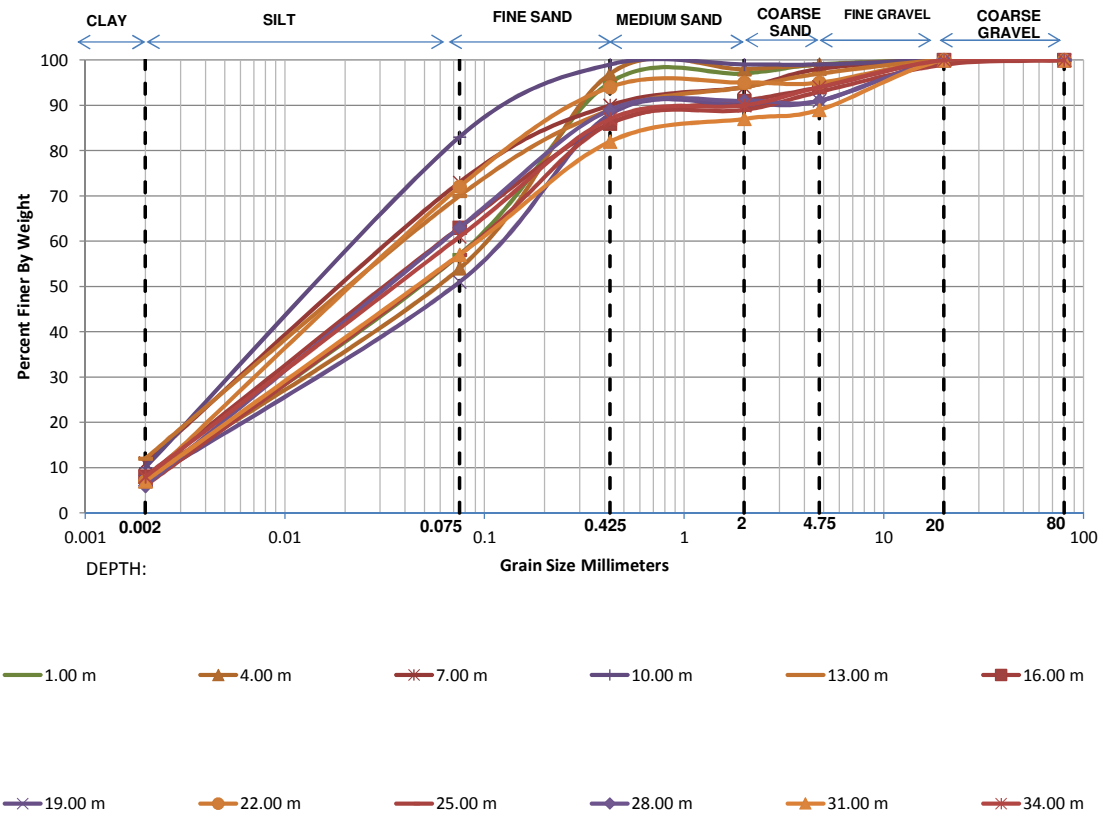
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	52+518 (Old Ch) & 55+719 (New Ch) Major Bridge
B.H. No.	BH-A1



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
1.00 m	5.00	63.00	31.00	1.00	0.00	0.00	0.00	0.0051	0.0202	0.0595	11.76	1.36
4.00 m	5.80	58.20	26.00	2.00	1.00	7.00	0.00	0.0044	0.0203	0.0662	15.06	1.42
10.00 m	11.00	54.00	31.00	2.00	0.00	2.00	0.00	-	0.0148	0.0634	-	-
13.00 m	5.60	60.40	26.00	3.00	1.00	4.00	0.00	0.0045	0.0199	0.0625	13.79	1.39
16.00 m	8.00	59.00	22.00	5.00	1.00	5.00	0.00	0.0029	0.0167	0.0600	20.88	1.61
19.00 m	7.00	63.00	24.00	3.00	1.00	2.00	0.00	0.0034	0.0169	0.0555	16.15	1.50
23.50 m	6.00	52.00	30.00	2.00	3.00	7.00	0.00	0.0044	0.0231	0.0810	18.60	1.51
32.50 m	5.00	47.00	41.00	2.00	1.00	4.00	0.00	0.0056	0.0291	0.1022	18.27	1.48
37.00 m	8.00	51.00	35.00	2.00	1.00	3.00	0.00	0.0029	0.0205	0.0777	26.55	1.86

GRAIN SIZE DISTRIBUTION CURVES

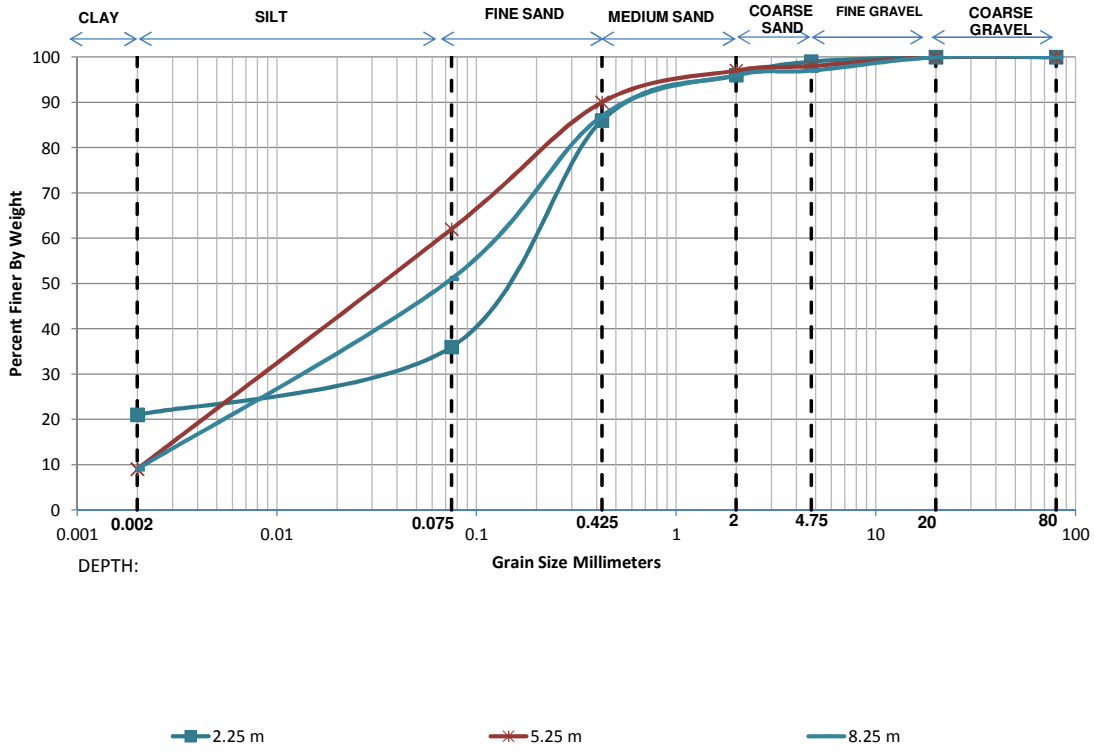
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	52+518 (Old Ch) & 55+719 (New Ch) Major Bridge
B.H. No.	BH-A2



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
1.00 m	7.00	50.00	38.00	2.00	2.00	1.00	0.00	0.0036	0.0229	0.0836	23.25	1.75
4.00 m	8.00	46.00	43.00	1.00	1.00	1.00	0.00	0.0030	0.0241	0.0937	31.52	2.09
7.00 m	11.00	62.00	17.00	4.00	4.00	2.00	0.00	-	0.0122	0.0493	-	-
10.00 m	10.00	73.00	16.00	0.00	0.00	1.00	0.00	0.0020	0.0113	0.0388	19.42	1.66
13.00 m	12.00	58.00	19.00	5.00	3.00	3.00	0.00	-	0.0122	0.0535	-	-
16.00 m	8.00	55.00	23.00	5.00	3.00	6.00	0.00	0.0029	0.0181	0.0679	23.47	1.67
19.00 m	7.00	44.00	37.00	2.00	1.00	9.00	0.00	0.0037	0.0273	0.1106	29.87	1.82
22.00 m	7.00	65.00	22.00	1.00	0.00	5.00	0.00	0.0034	0.0163	0.0525	15.37	1.48
25.00 m	6.00	51.00	29.00	3.00	4.00	6.00	1.00	0.0044	0.0236	0.0851	19.45	1.50
28.00 m	6.00	57.00	26.00	2.00	0.00	9.00	0.00	0.0042	0.0205	0.0682	16.06	1.45
31.00 m	7.00	50.00	25.00	5.00	2.00	11.00	0.00	0.0036	0.0222	0.0866	24.20	1.60
34.00 m	8.00	53.00	26.00	3.00	4.00	6.00	0.00	0.0029	0.0191	0.0725	24.96	1.74

GRAIN SIZE DISTRIBUTION CURVES

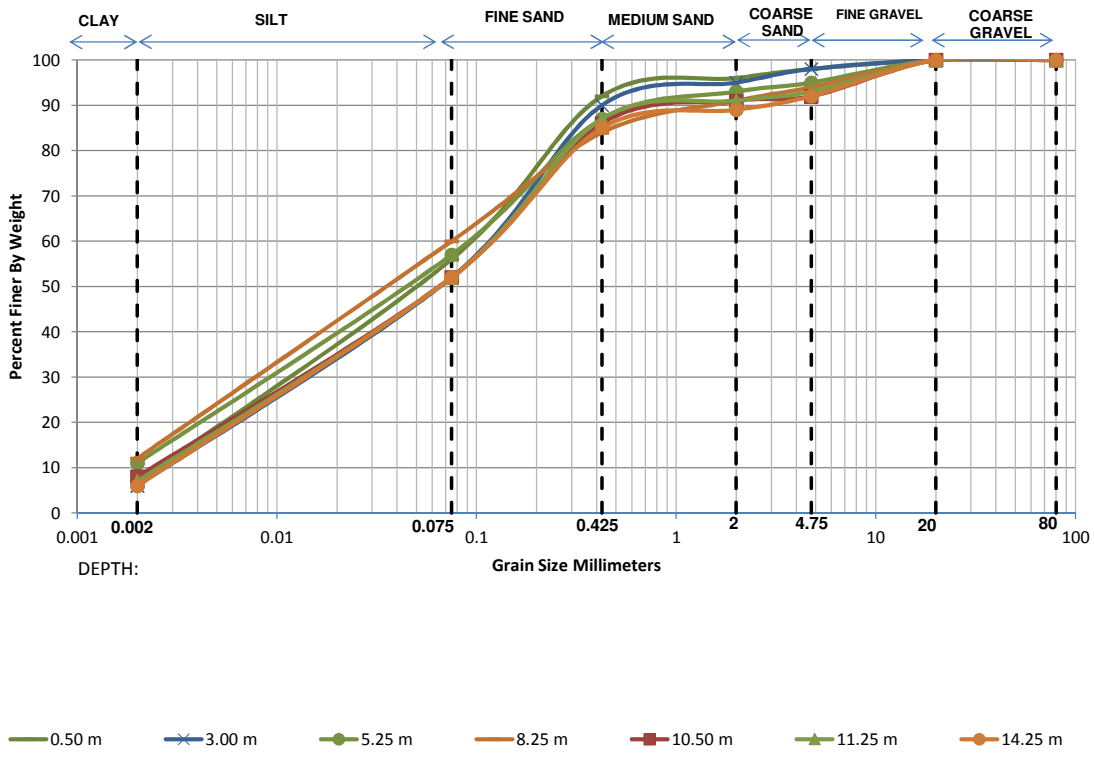
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	52+934 Minor Bridge
B.H. No.	BH-CL



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
2.25 m	21.00	15.00	50.00	10.00	3.00	1.00	0.00	-	0.0372	0.1965	-	-
5.25 m	9.00	53.00	28.00	7.00	1.00	2.00	0.00	0.0024	0.0178	0.0701	29.23	1.88
8.25 m	9.00	42.00	36.00	9.00	1.00	3.00	0.00	0.0024	0.0251	0.1135	46.74	2.28

GRAIN SIZE DISTRIBUTION CURVES

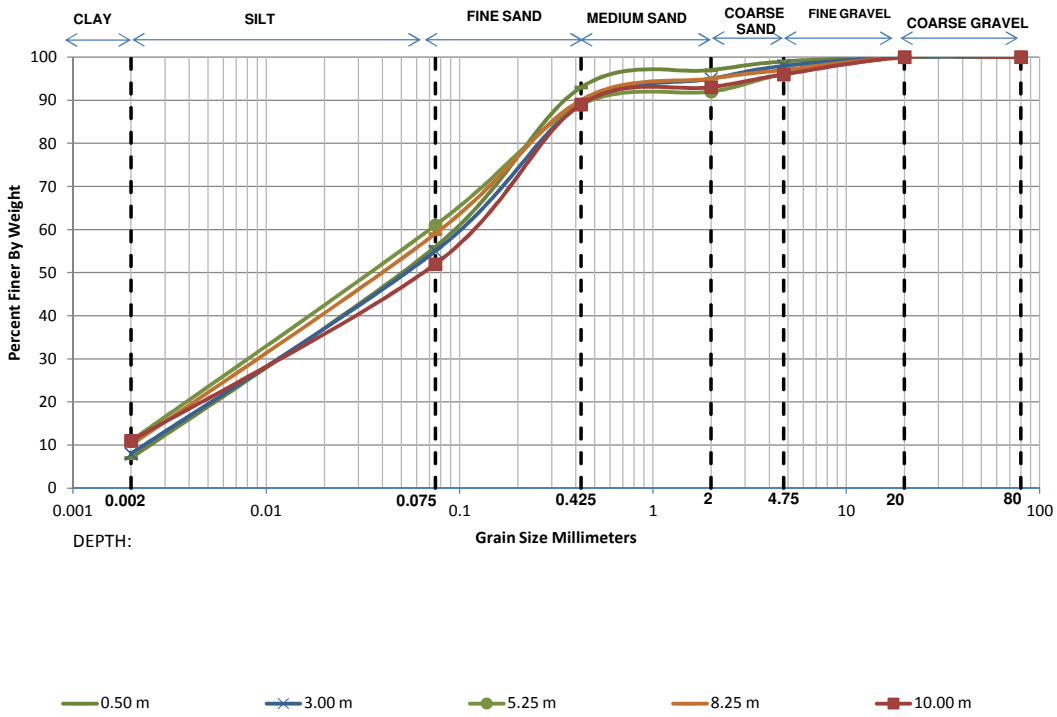
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	53+107
B.H. No.	BH-CL



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
0.50 m	7.00	49.00	36.00	4.00	2.00	2.00	0.00	0.0036	0.0235	0.0877	24.29	1.74
3.00 m	6.00	46.00	38.00	5.00	3.00	2.00	0.00	0.0045	0.0277	0.1047	23.08	1.61
5.25 m	11.00	46.00	30.00	6.00	2.00	5.00	0.00	-	0.0183	0.0856	-	-
8.25 m	12.00	48.00	24.00	7.00	3.00	6.00	0.00	-	0.0156	0.0750	-	-
10.50 m	8.00	44.00	34.00	5.00	1.00	8.00	0.00	0.0030	0.0252	0.1087	36.44	1.95
11.25 m	7.00	45.00	35.00	4.00	2.00	7.00	0.00	0.0037	0.0263	0.1073	29.16	1.76
14.25 m	6.00	46.00	33.00	4.00	3.00	8.00	0.00	0.0045	0.0274	0.1091	24.13	1.52

GRAIN SIZE DISTRIBUTION CURVES

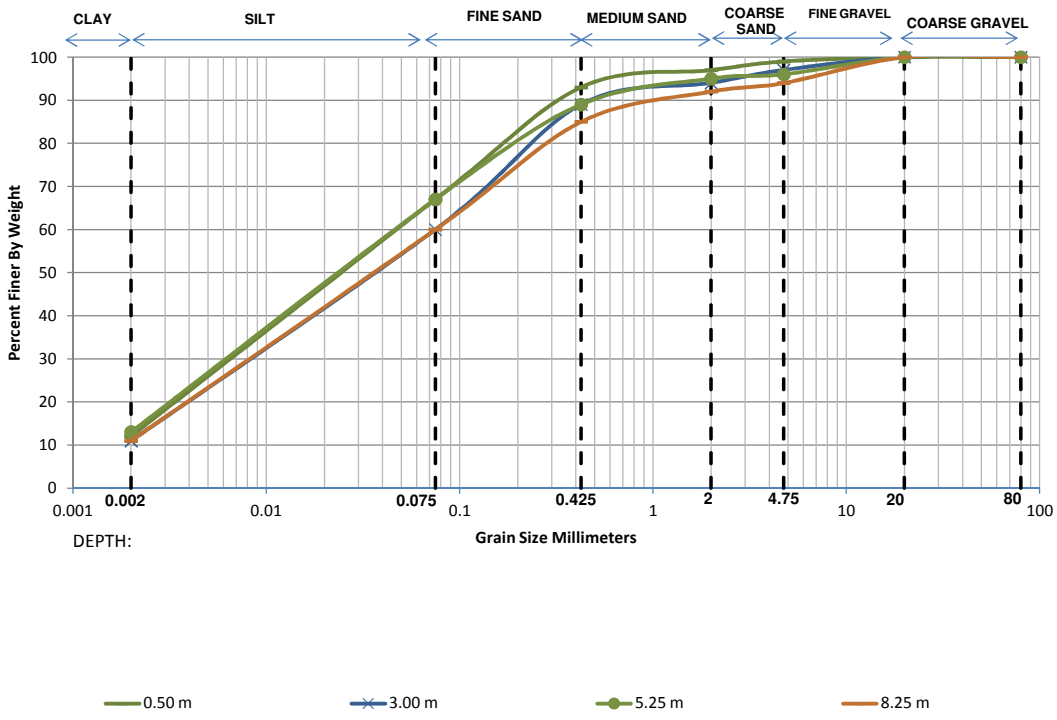
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	53+282
B.H. No.	BH-CL



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
0.50 m	7.00	49.00	37.00	4.00	2.00	1.00	0.00	0.0036	0.0235	0.0875	24.22	1.75
3.00 m	8.00	47.00	34.00	6.00	3.00	2.00	0.00	0.0030	0.0229	0.0929	31.43	1.91
5.25 m	11.00	50.00	28.00	3.00	4.00	4.00	0.00	-	0.0163	0.0724	-	-
8.25 m	10.00	49.00	31.00	5.00	2.00	3.00	0.00	0.0020	0.0183	0.0779	38.93	2.15
10.00 m	11.00	41.00	37.00	4.00	3.00	4.00	0.00	-	0.0221	0.1067	-	-

GRAIN SIZE DISTRIBUTION CURVES

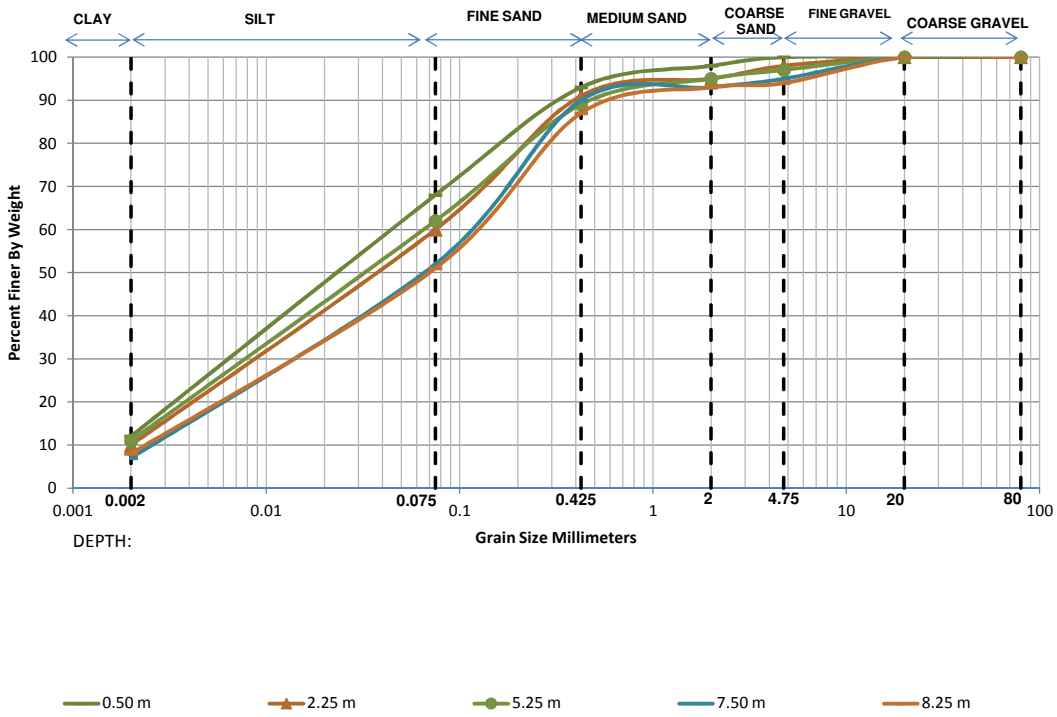
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	53+572
B.H. No.	BH-CL



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
0.50 m	12.00	55.00	26.00	4.00	2.00	1.00	0.00	-	0.0132	0.0591	-	-
3.00 m	11.00	49.00	29.00	5.00	3.00	3.00	0.00	-	0.0168	0.0750	-	-
5.25 m	13.00	54.00	22.00	6.00	1.00	4.00	0.00	-	0.0122	0.0586	-	-
8.25 m	11.00	49.00	25.00	7.00	2.00	6.00	0.00	-	0.0166	0.0750	-	-

GRAIN SIZE DISTRIBUTION CURVES

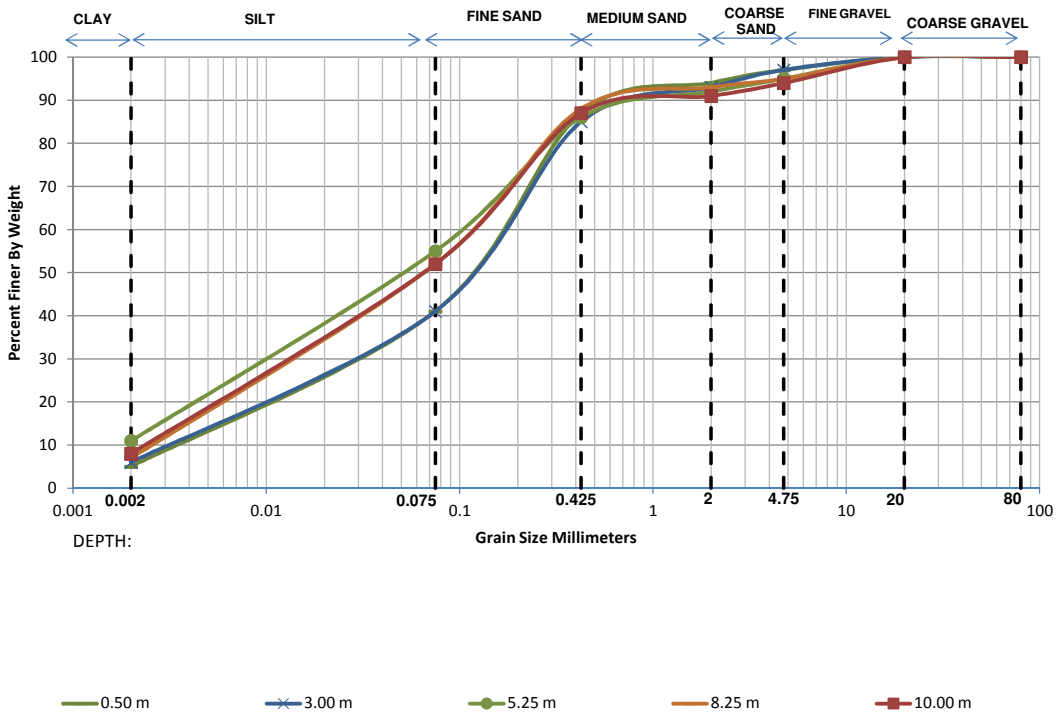
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	53+982
B.H. No.	BH-CL



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
0.50 m	12.00	56.00	25.00	5.00	2.00	0.00	0.00	-	0.0129	0.0572	-	-
2.25 m	10.00	50.00	31.00	4.00	3.00	2.00	0.00	0.0020	0.0178	0.0750	37.50	2.12
5.25 m	11.00	51.00	27.00	6.00	2.00	3.00	0.00	-	0.0158	0.0699	-	-
7.50 m	7.00	45.00	38.00	3.00	2.00	5.00	0.00	0.0037	0.0265	0.1047	28.41	1.82
8.25 m	8.00	43.00	36.00	6.00	1.00	6.00	0.00	0.0030	0.0262	0.1127	37.62	2.03

GRAIN SIZE DISTRIBUTION CURVES

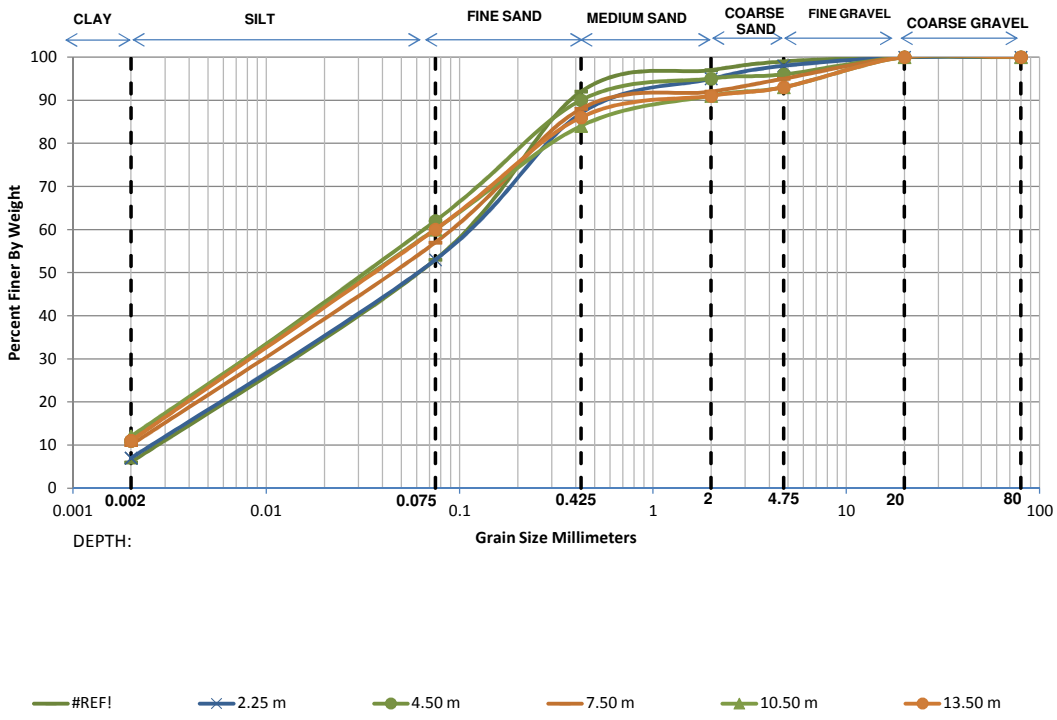
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	54+363
B.H. No.	BH-CL



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
0.50 m	5.00	36.00	46.00	7.00	3.00	3.00	0.00	0.0064	0.0433	0.1580	24.70	1.85
3.00 m	6.00	35.00	44.00	8.00	4.00	3.00	0.00	0.0051	0.0422	0.1634	31.99	2.13
5.25 m	11.00	44.00	31.00	6.00	3.00	5.00	0.00	-	0.0196	0.0949	-	-
8.25 m	7.00	45.00	36.00	5.00	2.00	5.00	0.00	0.0037	0.0264	0.1065	28.95	1.78
10.00 m	8.00	44.00	35.00	4.00	3.00	6.00	0.00	0.0030	0.0252	0.1075	36.04	1.99

GRAIN SIZE DISTRIBUTION CURVES

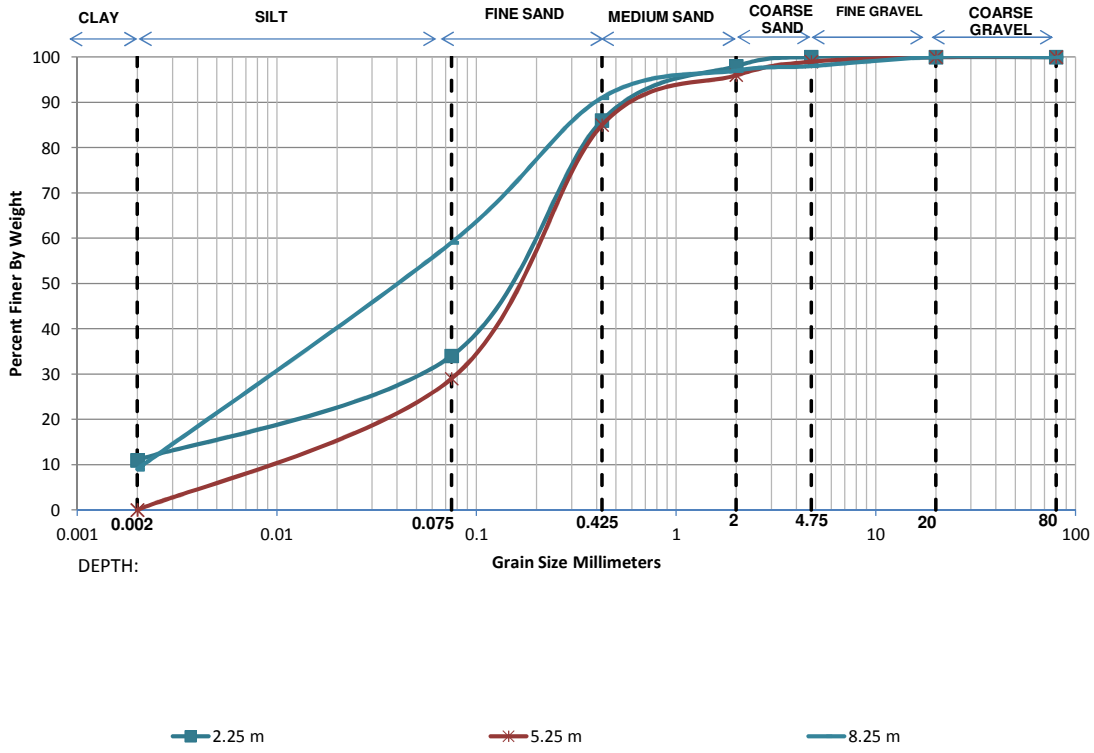
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	54+496
B.H. No.	BH-CL



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
#REF!	6.00	47.00	39.00	5.00	2.00	1.00	0.00	0.0045	0.0269	0.0993	22.01	1.62
2.25 m	7.00	46.00	34.00	8.00	3.00	2.00	0.00	0.0037	0.0255	0.1031	28.20	1.72
4.50 m	11.00	51.00	28.00	5.00	1.00	4.00	0.00	-	0.0159	0.0700	-	-
7.50 m	10.00	47.00	31.00	4.00	3.00	5.00	0.00	0.0020	0.0194	0.0851	42.56	2.21
10.50 m	12.00	48.00	24.00	7.00	2.00	7.00	0.00	-	0.0156	0.0750	-	-
13.50 m	11.00	49.00	26.00	5.00	2.00	7.00	0.00	-	0.0166	0.0750	-	-

GRAIN SIZE DISTRIBUTION CURVES

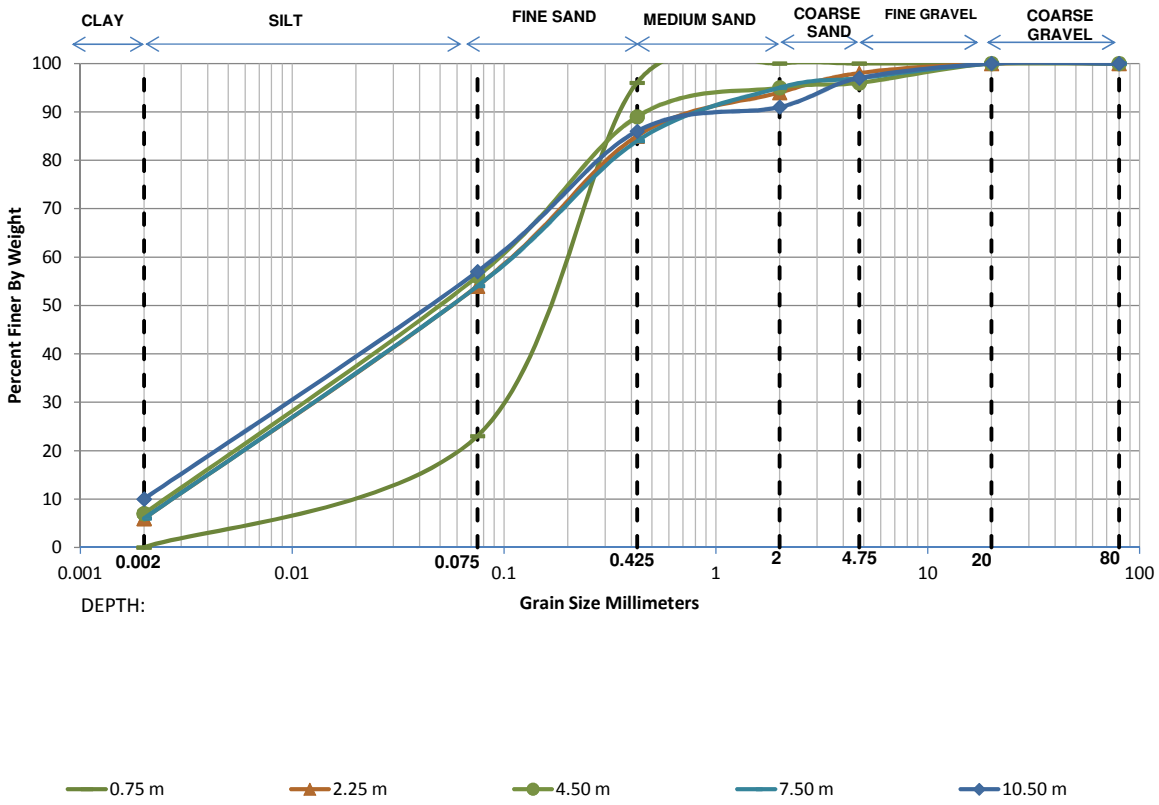
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	55+020
B.H. No.	CL



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
2.25 m	11.00	23.00	52.00	12.00	2.00	0.00	0.00	-	0.0576	0.1948	-	-
5.25 m	0.00	29.00	56.00	11.00	3.00	1.00	0.00	0.0139	0.0786	0.2084	14.95	2.12
8.25 m	9.00	50.00	32.00	6.00	1.00	2.00	0.00	0.0024	0.0194	0.0778	32.32	2.00

GRAIN SIZE DISTRIBUTION CURVES

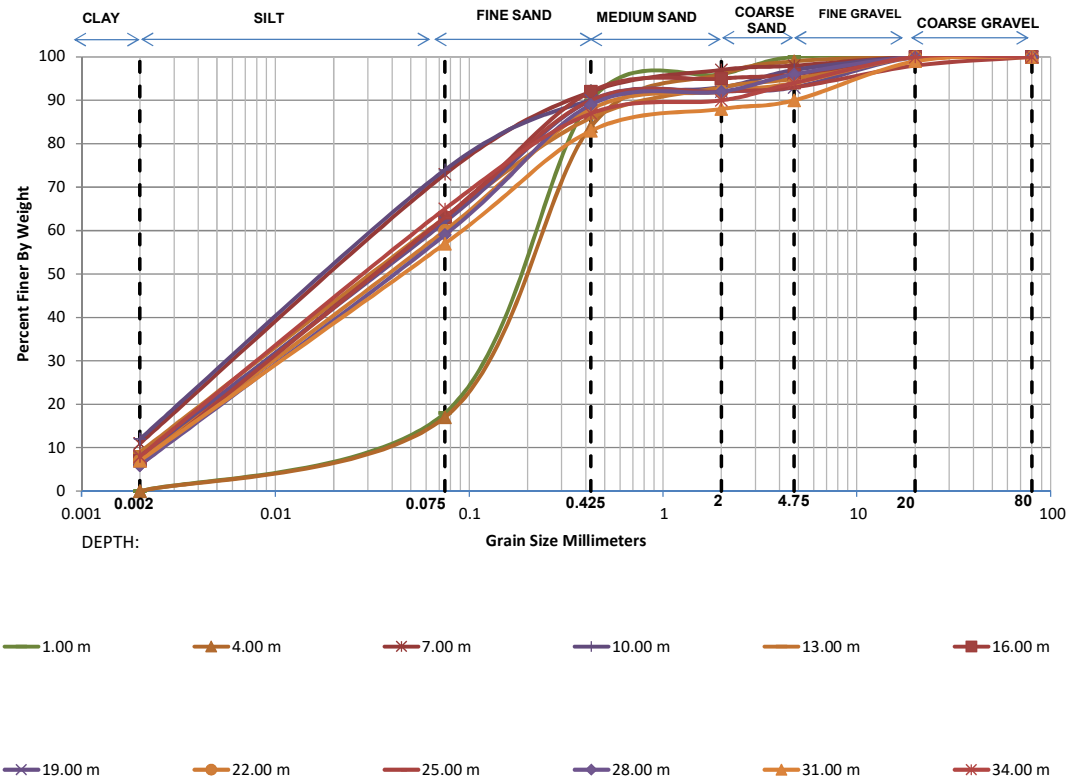
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	55+044
B.H. No.	BH-PLT-04



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
0.75 m	0.00	23.00	73.00	4.00	0.00	0.00	0.00	0.0220	0.1001	0.2003	9.10	2.27
2.25 m	6.00	48.00	31.00	9.00	4.00	2.00	0.00	0.0045	0.0257	0.0999	22.41	1.48
4.50 m	7.00	49.00	33.00	6.00	1.00	4.00	0.00	0.0036	0.0233	0.0886	24.57	1.70
7.50 m	6.00	48.00	30.00	11.00	2.00	3.00	0.00	0.0045	0.0256	0.1010	22.69	1.46
10.50 m	10.00	47.00	29.00	5.00	6.00	3.00	0.00	0.0020	0.0193	0.0856	42.82	2.17

GRAIN SIZE DISTRIBUTION CURVES

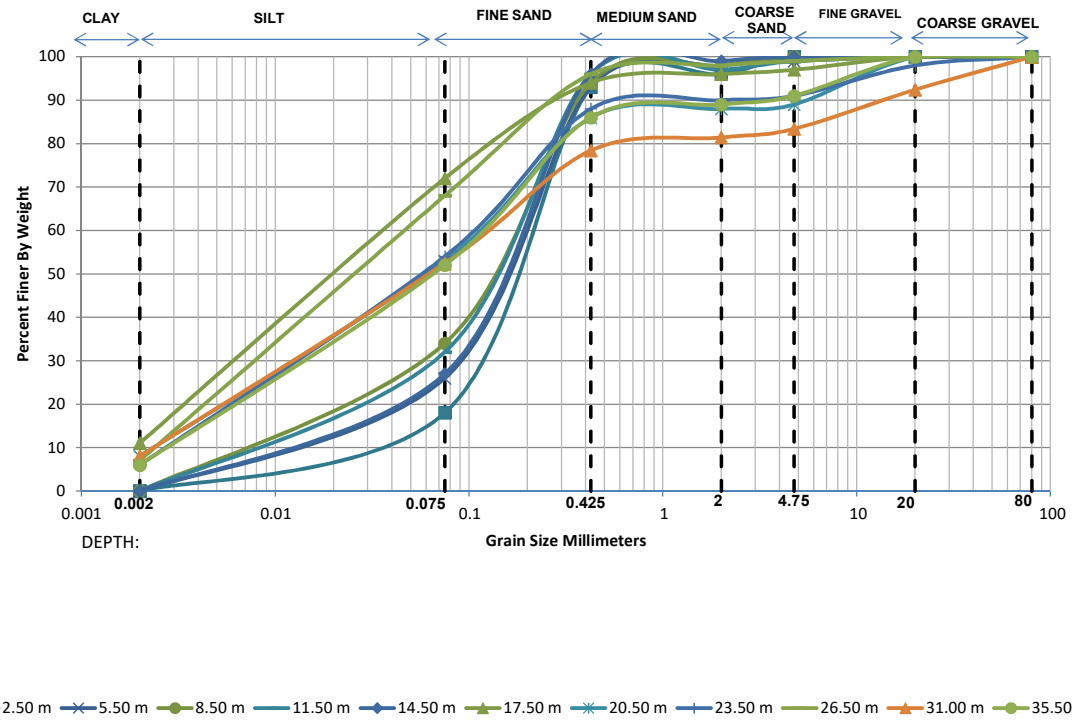
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	55+910 Major Bridge
B.H. No.	BH-A1



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
1.00 m	0.00	18.00	72.00	6.00	4.00	0.00	0.00	0.0336	0.1219	0.2281	6.78	1.94
4.00 m	0.00	17.00	67.00	12.00	3.00	1.00	0.00	0.0366	0.1288	0.2491	6.80	1.82
7.00 m	11.00	62.00	19.00	5.00	1.00	2.00	0.00	-	0.0123	0.0494	-	-
10.00 m	12.00	62.00	16.00	3.00	4.00	3.00	0.00	-	0.0112	0.0475	-	-
13.00 m	9.00	54.00	23.00	7.00	2.00	5.00	0.00	0.0024	0.0171	0.0678	28.27	1.81
16.00 m	7.00	56.00	29.00	3.00	1.00	4.00	0.00	0.0035	0.0195	0.0681	19.43	1.59
19.00 m	8.00	54.00	28.00	2.00	1.00	7.00	0.00	0.0029	0.0188	0.0702	24.20	1.73
22.00 m	7.00	53.00	28.00	4.00	2.00	6.00	0.00	0.0035	0.0208	0.0750	21.18	1.63
25.00 m	6.00	57.00	27.00	2.00	1.00	5.00	2.00	0.0042	0.0205	0.0682	16.05	1.46
28.00 m	6.00	53.00	30.00	3.00	4.00	4.00	0.00	0.0043	0.0226	0.0777	17.94	1.51
31.00 m	7.00	50.00	26.00	5.00	2.00	9.00	1.00	0.0036	0.0223	0.0862	24.09	1.61
34.00 m	8.00	57.00	22.00	3.00	4.00	6.00	0.00	0.0029	0.0173	0.0637	22.11	1.64

GRAIN SIZE DISTRIBUTION CURVES

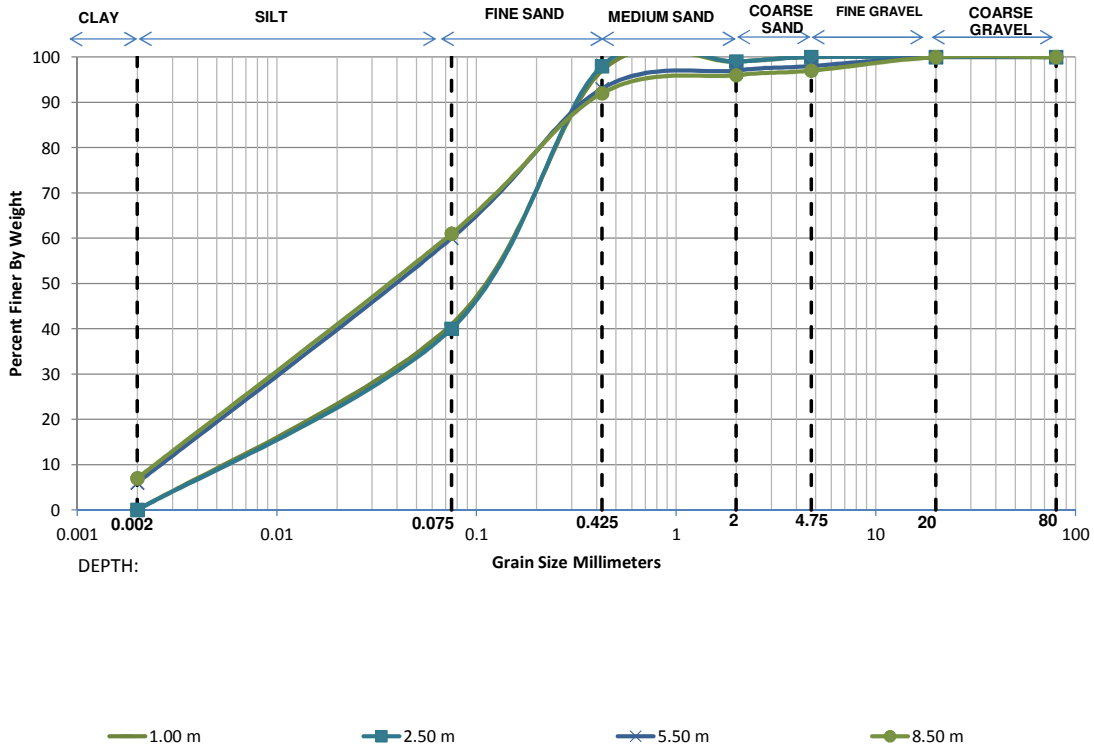
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	55+910 Major Bridge
B.H. No.	BH-A2



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
2.50 m	0.00	18.00	75.00	3.00	4.00	0.00	0.00	0.0338	0.1208	0.2209	6.53	1.95
5.50 m	0.00	26.00	67.00	5.00	1.00	1.00	0.00	0.0174	0.0892	0.1967	11.28	2.32
8.50 m	0.00	34.00	60.00	4.00	2.00	0.00	0.00	0.0107	0.0624	0.1680	15.68	2.17
11.50 m	0.00	32.00	64.00	1.00	2.00	1.00	0.00	0.0120	0.0685	0.1708	14.21	2.29
14.50 m	0.00	27.00	69.00	3.00	1.00	0.00	0.00	0.0164	0.0854	0.1875	11.44	2.37
17.50 m	11.00	61.00	22.00	2.00	1.00	3.00	0.00	-	0.0126	0.0510	-	-
20.50 m	8.00	45.00	33.00	2.00	1.00	11.00	0.00	0.0030	0.0243	0.1033	34.76	1.92
23.50 m	6.00	48.00	34.00	2.00	1.00	7.00	2.00	0.0045	0.0259	0.0969	21.71	1.55
26.50 m	7.00	61.00	28.00	2.00	1.00	1.00	0.00	0.0035	0.0176	0.0588	17.01	1.53
31.00 m	8.00	44.40	26.00	3.00	2.00	9.00	7.60	0.0030	0.0243	0.1171	39.43	1.70
35.50 m	6.00	46.00	34.00	3.00	2.00	9.00	0.00	0.0045	0.0274	0.1078	23.83	1.54

GRAIN SIZE DISTRIBUTION CURVES

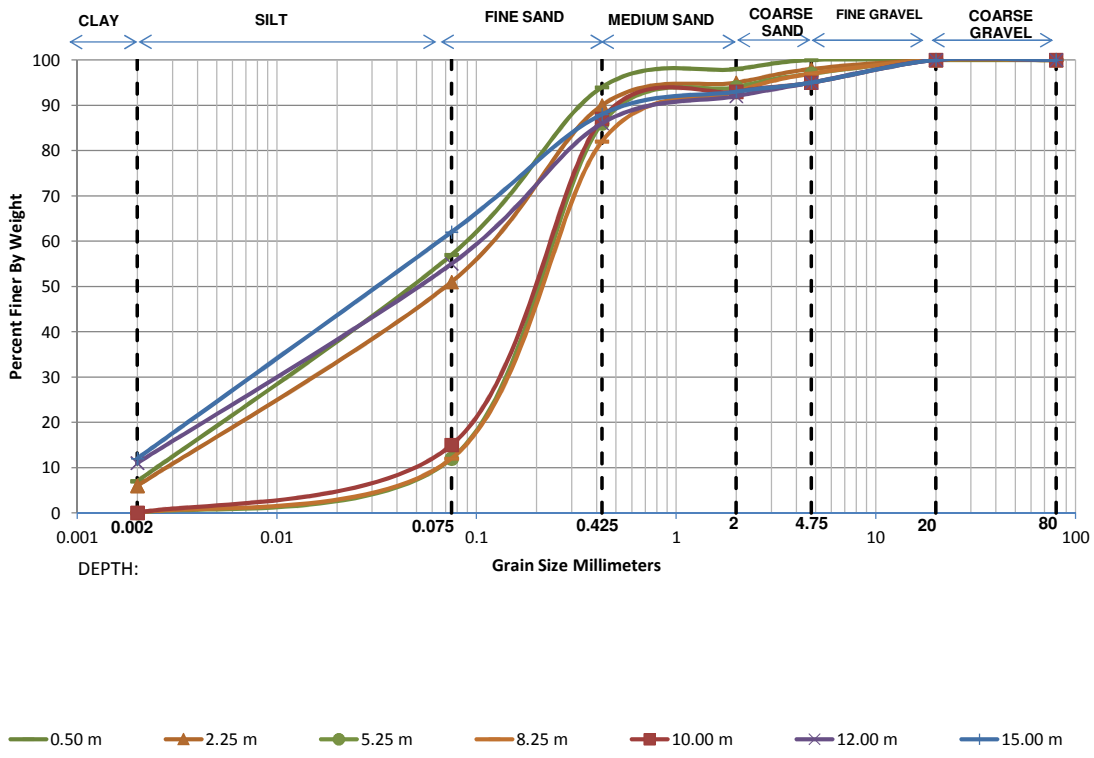
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	56+403 km
B.H. No.	BH-C/L



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
1.00 m	0.00	41.00	56.00	2.00	1.00	0.00	0.00	0.0078	0.0457	0.1387	17.78	1.93
2.50 m	0.00	40.00	58.00	1.00	1.00	0.00	0.00	0.0082	0.0478	0.1409	17.28	1.99
5.50 m	6.00	54.00	33.00	4.00	1.00	2.00	0.00	0.0043	0.0222	0.0750	17.37	1.52
8.50 m	7.00	54.00	31.00	4.00	1.00	3.00	0.00	0.0035	0.0204	0.0726	20.55	1.63

GRAIN SIZE DISTRIBUTION CURVES

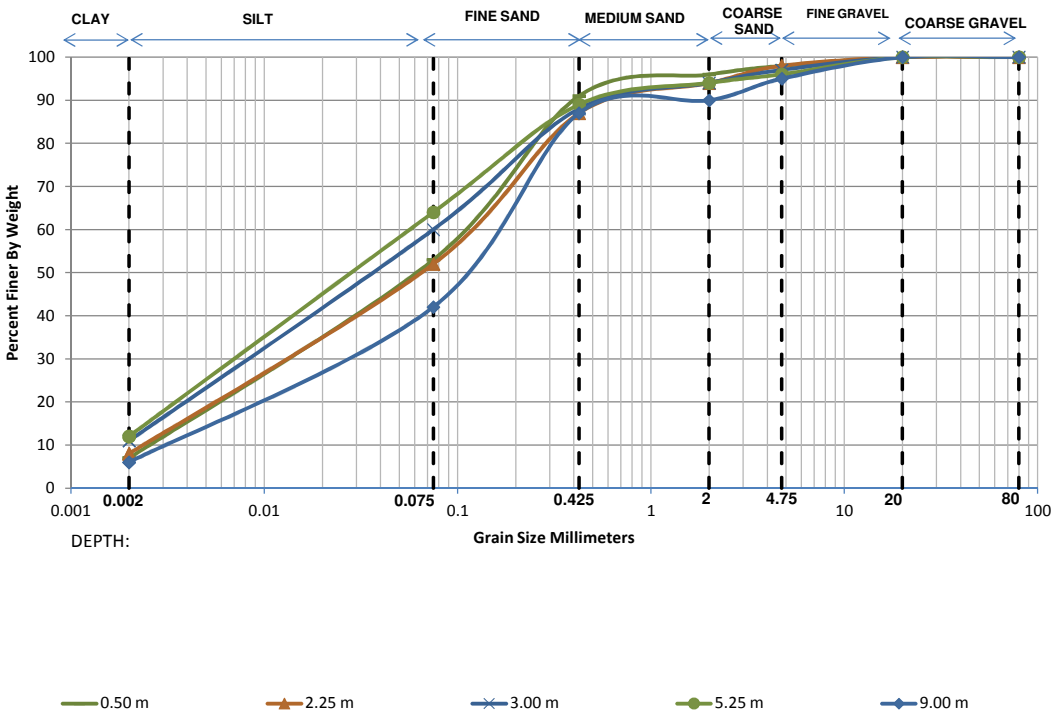
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	56+701 Minor Bridge
B.H. No.	BH-CL



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
0.50 m	7.00	50.00	37.00	4.00	2.00	0.00	0.00	0.0036	0.0229	0.0838	23.31	1.74
2.25 m	6.00	45.00	39.00	5.00	3.00	2.00	0.00	0.0046	0.0286	0.1091	23.84	1.64
5.25 m	0.00	12.00	74.00	8.00	3.00	3.00	0.00	0.0622	0.1513	0.2562	4.12	1.44
8.25 m	0.00	12.00	70.00	11.00	4.00	3.00	0.00	0.0620	0.1538	0.2691	4.34	1.42
10.00 m	0.00	15.00	72.00	6.00	2.00	5.00	0.00	0.0453	0.1364	0.2444	5.40	1.68
12.00 m	11.00	44.00	31.00	6.00	3.00	5.00	0.00	-	0.0196	0.0949	-	-
15.00 m	12.00	50.00	26.00	5.00	2.00	5.00	0.00	-	0.0149	0.0698	-	-

GRAIN SIZE DISTRIBUTION CURVES

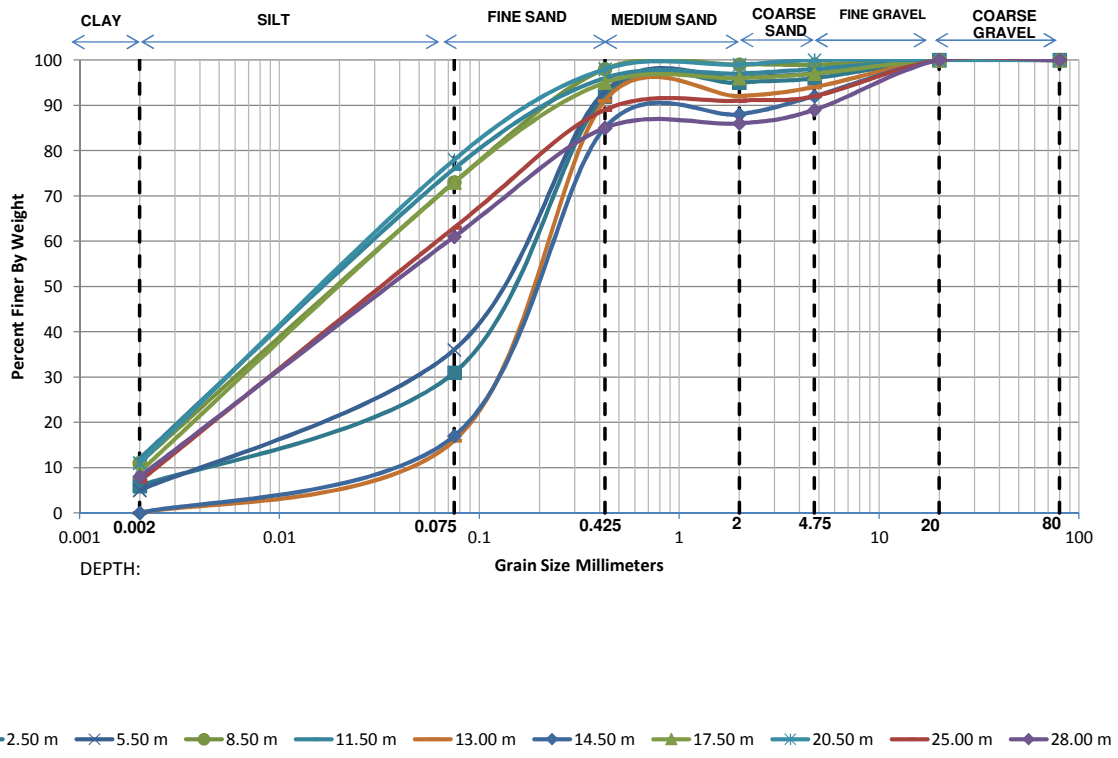
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	56+978
B.H. No.	BH-CL



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
0.50 m	7.00	46.00	38.00	5.00	2.00	2.00	0.00	0.0037	0.0257	0.1000	27.29	1.80
2.25 m	8.00	44.00	35.00	7.00	4.00	2.00	0.00	0.0030	0.0252	0.1080	36.21	1.98
3.00 m	11.00	49.00	28.00	6.00	3.00	3.00	0.00	-	0.0167	0.0750	-	-
5.25 m	12.00	52.00	25.00	5.00	2.00	4.00	0.00	-	0.0141	0.0652	-	-
9.00 m	6.00	36.00	45.00	3.00	5.00	5.00	0.00	0.0050	0.0404	0.1528	30.31	2.12

GRAIN SIZE DISTRIBUTION CURVES

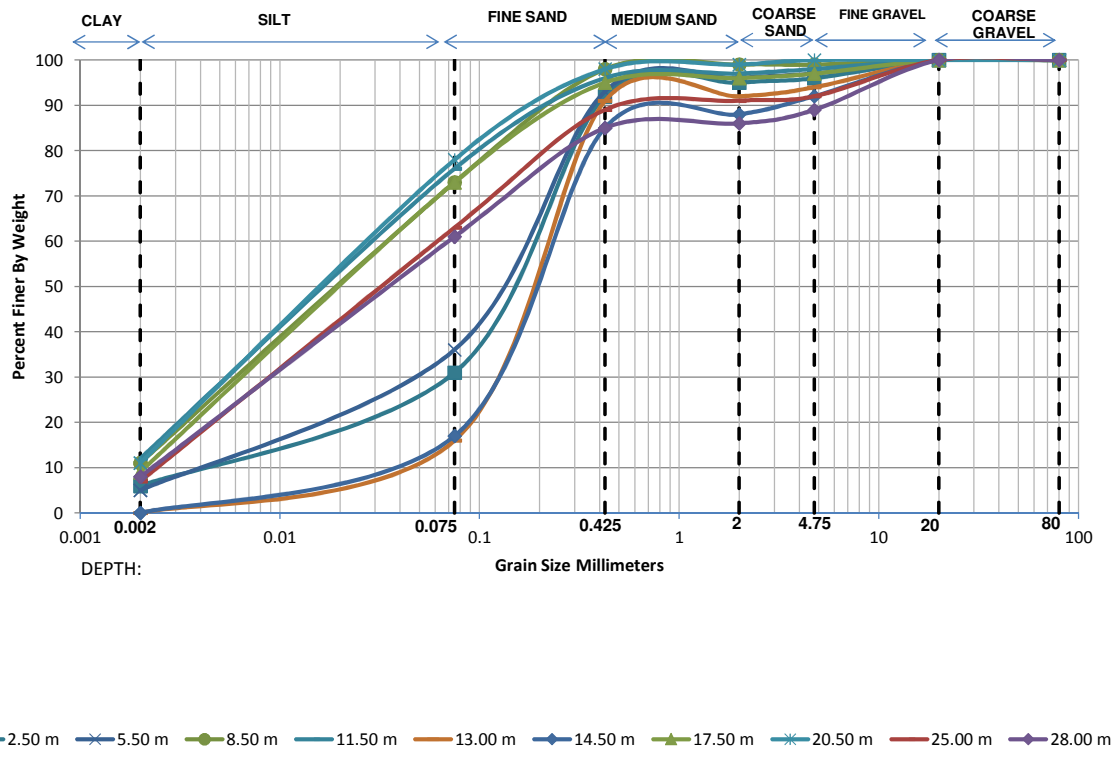
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	57+400 Major Bridge
B.H. No.	BH-A1



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
2.50 m	6.00	25.00	61.00	3.00	1.00	4.00	0.00	0.0066	0.0711	0.1859	28.09	4.11
5.50 m	5.00	31.00	57.00	3.00	1.00	3.00	0.00	0.0072	0.0552	0.1653	22.99	2.57
8.50 m	11.00	62.00	25.00	1.00	0.00	1.00	0.00	-	0.0125	0.0498	-	-
11.50 m	12.00	64.00	20.00	1.00	1.00	2.00	0.00	-	0.0110	0.0452	-	-
13.00 m	0.00	16.00	75.00	1.00	2.00	6.00	0.00	0.0411	0.1300	0.2304	5.61	1.78
14.50 m	0.00	17.00	68.00	3.00	4.00	8.00	0.00	0.0367	0.1278	0.2432	6.62	1.83
17.50 m	9.00	64.00	22.00	1.00	1.00	3.00	0.00	0.0024	0.0141	0.0504	21.17	1.66
20.50 m	11.00	67.00	20.00	1.00	1.00	0.00	0.00	-	0.0114	0.0434	-	-
25.00 m	7.00	56.00	26.00	2.00	1.00	8.00	0.00	0.0035	0.0193	0.0681	19.43	1.57
28.00 m	8.00	53.00	24.00	1.00	3.00	11.00	0.00	0.0029	0.0190	0.0725	24.96	1.72

GRAIN SIZE DISTRIBUTION CURVES

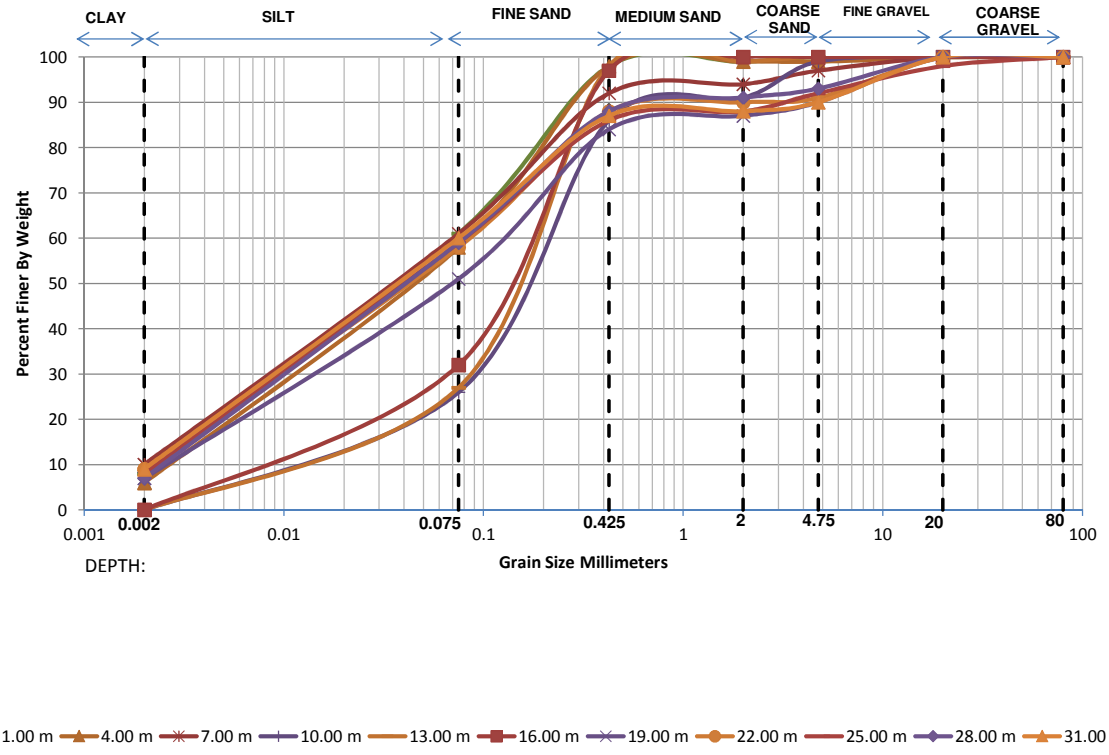
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	57+400 Major Bridge
B.H. No.	BH-P2



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
2.50 m	7.00	51.00	36.00	2.00	3.00	1.00	0.00	0.0036	0.0222	0.0806	22.51	1.72
5.50 m	9.00	67.00	11.00	4.00	3.00	6.00	0.00	0.0024	0.0132	0.0460	19.38	1.58
8.50 m	7.00	52.00	33.00	2.00	3.00	3.00	0.00	0.0036	0.0215	0.0777	21.81	1.68
11.50 m	8.00	56.00	30.00	1.00	1.00	4.00	0.00	0.0029	0.0180	0.0660	22.81	1.71
14.50 m	11.00	50.00	32.00	4.00	2.00	1.00	0.00	-	0.0164	0.0724	-	-
17.50 m	10.00	60.00	26.00	1.00	1.00	2.00	0.00	0.0020	0.0141	0.0546	27.29	1.81
20.50 m	6.00	56.00	33.00	1.00	2.00	2.00	0.00	0.0043	0.0212	0.0704	16.46	1.50
23.50 m	7.00	56.00	29.00	5.00	1.00	2.00	0.00	0.0035	0.0195	0.0681	19.43	1.59
26.50 m	9.00	62.00	25.00	2.00	0.00	2.00	0.00	0.0024	0.0147	0.0534	22.38	1.69
29.50 m	7.00	52.00	27.00	1.00	3.00	10.00	0.00	0.0036	0.0212	0.0778	21.91	1.63

GRAIN SIZE DISTRIBUTION CURVES

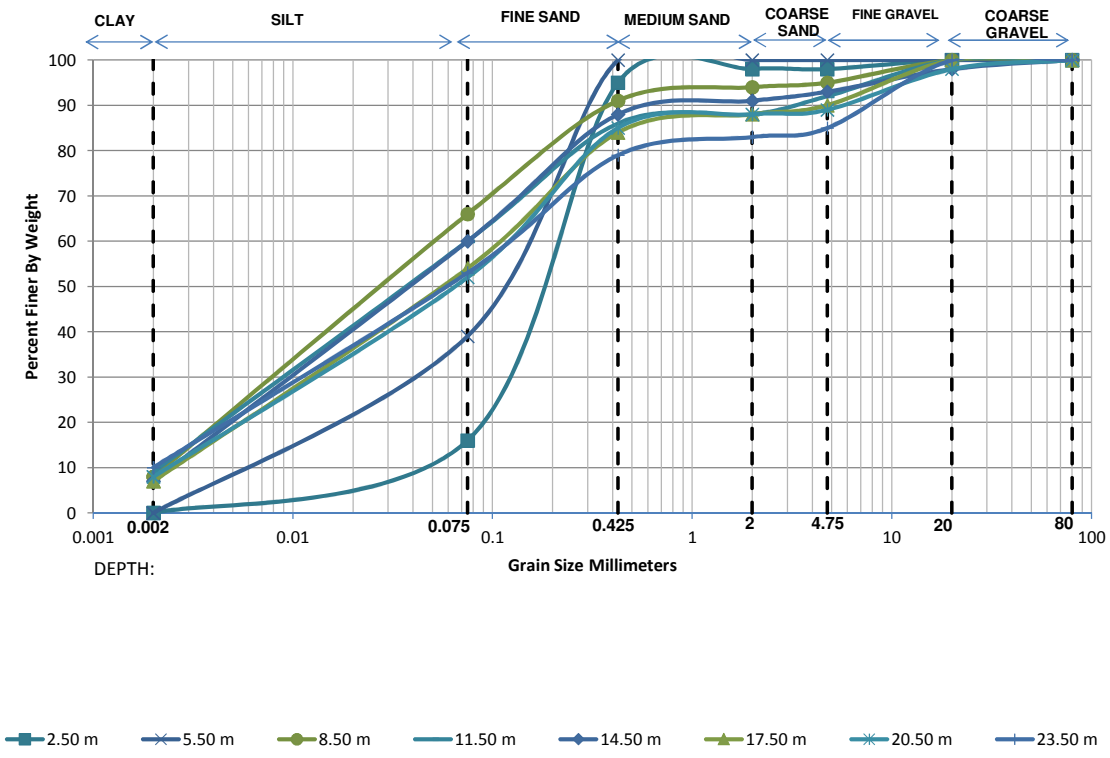
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	57+400 Major Bridge
B.H. No.	BH-P3



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
1.00 m	8.00	53.00	37.00	1.00	1.00	0.00	0.00	0.0029	0.0196	0.0726	24.93	1.82
4.00 m	6.00	52.00	40.00	1.00	0.00	1.00	0.00	0.0044	0.0236	0.0803	18.33	1.59
7.00 m	10.00	51.00	31.00	2.00	3.00	3.00	0.00	0.0020	0.0174	0.0725	36.24	2.08
10.00 m	0.00	26.00	60.00	5.00	8.00	1.00	0.00	0.0171	0.0898	0.2134	12.46	2.21
13.00 m	0.00	27.00	71.00	1.00	1.00	0.00	0.00	0.0165	0.0852	0.1839	11.16	2.40
16.00 m	0.00	32.00	65.00	3.00	0.00	0.00	0.00	0.0120	0.0685	0.1698	14.09	2.30
19.00 m	7.00	44.00	33.00	3.00	3.00	10.00	0.00	0.0037	0.0271	0.1154	31.25	1.72
22.00 m	9.00	49.00	30.00	2.00	1.00	9.00	0.00	0.0024	0.0198	0.0812	33.72	2.00
25.00 m	8.00	51.00	27.00	2.00	4.00	6.00	2.00	0.0029	0.0201	0.0779	26.68	1.79
28.00 m	7.00	52.00	29.00	3.00	2.00	7.00	0.00	0.0036	0.0213	0.0778	21.88	1.65
31.00 m	9.00	51.00	27.00	1.00	2.00	10.00	0.00	0.0024	0.0186	0.0750	31.21	1.92

GRAIN SIZE DISTRIBUTION CURVES

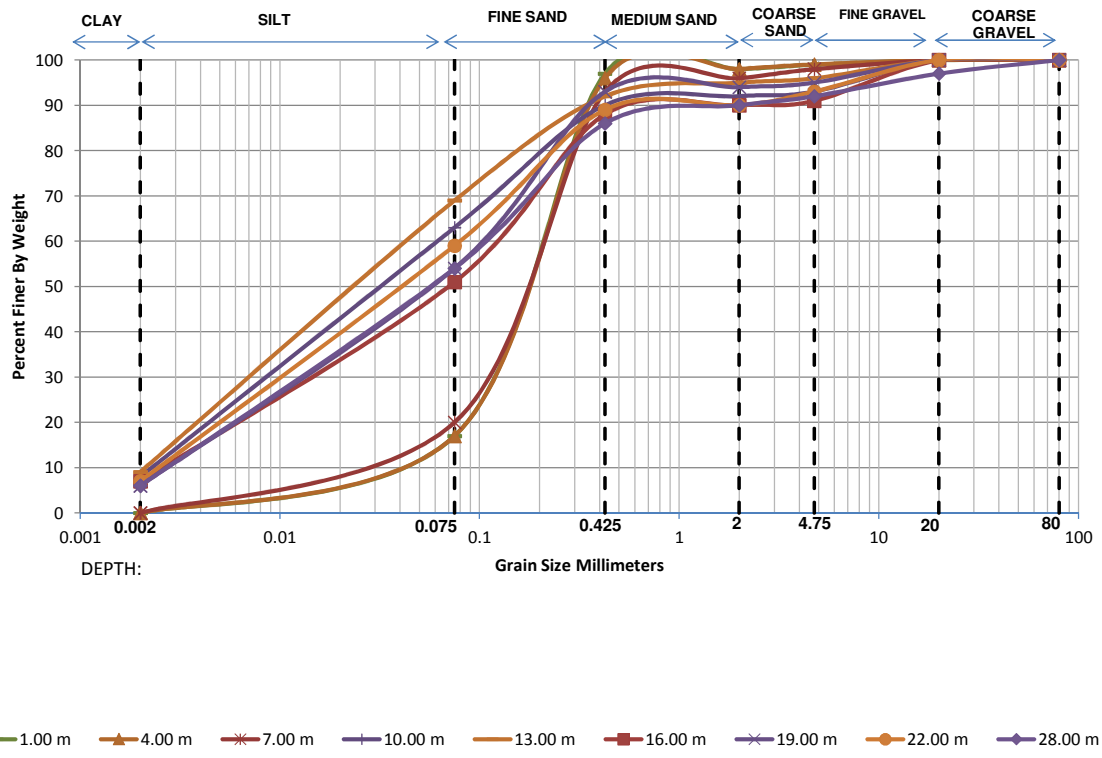
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	57+400 Major Bridge
B.H. No.	BH-P4



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
2.50 m	0.00	16.00	79.00	3.00	0.00	2.00	0.00	0.0414	0.1287	0.2232	5.40	1.80
5.50 m	0.00	39.00	61.00	0.00	0.00	0.00	0.00	0.0086	0.0501	0.1964	22.95	1.49
8.50 m	8.00	58.00	25.00	3.00	1.00	5.00	0.00	0.0029	0.0171	0.0619	21.51	1.64
11.50 m	9.00	51.00	26.00	2.00	4.00	8.00	0.00	0.0024	0.0186	0.0750	31.21	1.91
14.50 m	7.00	53.00	28.00	3.00	2.00	5.00	2.00	0.0035	0.0208	0.0750	21.18	1.63
17.50 m	7.00	47.00	30.00	4.00	2.00	10.00	0.00	0.0036	0.0245	0.1002	27.58	1.65
20.50 m	8.00	44.00	33.00	3.00	1.00	9.00	2.00	0.0030	0.0251	0.1094	36.68	1.93
23.50 m	10.00	43.00	26.00	4.00	2.00	15.00	0.00	0.0020	0.0217	0.1129	56.43	2.09

GRAIN SIZE DISTRIBUTION CURVES

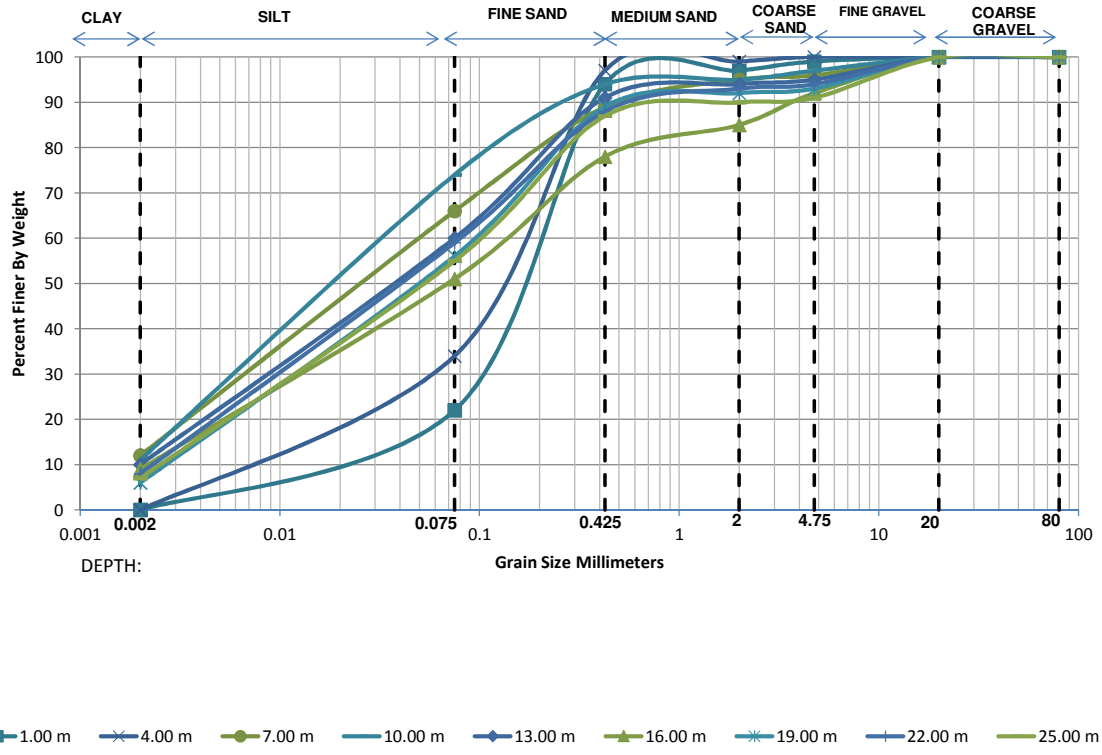
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	57+400 Major Bridge
B.H. No.	BH-P5



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
1.00 m	0.00	17.00	80.00	1.00	1.00	1.00	0.00	0.0376	0.1238	0.2162	5.76	1.89
4.00 m	0.00	17.00	79.00	2.00	1.00	1.00	0.00	0.0375	0.1241	0.2182	5.82	1.88
7.00 m	0.00	20.00	73.00	3.00	2.00	2.00	0.00	0.0281	0.1125	0.2148	7.63	2.10
10.00 m	8.00	55.00	27.00	2.00	1.00	7.00	0.00	0.0029	0.0183	0.0680	23.48	1.70
13.00 m	9.00	60.00	23.00	3.00	1.00	4.00	0.00	0.0024	0.0151	0.0563	23.61	1.70
16.00 m	7.00	44.00	37.00	2.00	1.00	9.00	0.00	0.0037	0.0273	0.1106	29.87	1.82
19.00 m	6.00	48.00	39.00	1.00	1.00	5.00	0.00	0.0045	0.0262	0.0945	21.10	1.62
22.00 m	7.00	52.00	30.00	1.00	3.00	7.00	0.00	0.0036	0.0214	0.0777	21.85	1.65
28.00 m	6.00	48.00	32.00	4.00	2.00	5.00	3.00	0.0045	0.0258	0.0984	22.08	1.51

GRAIN SIZE DISTRIBUTION CURVES

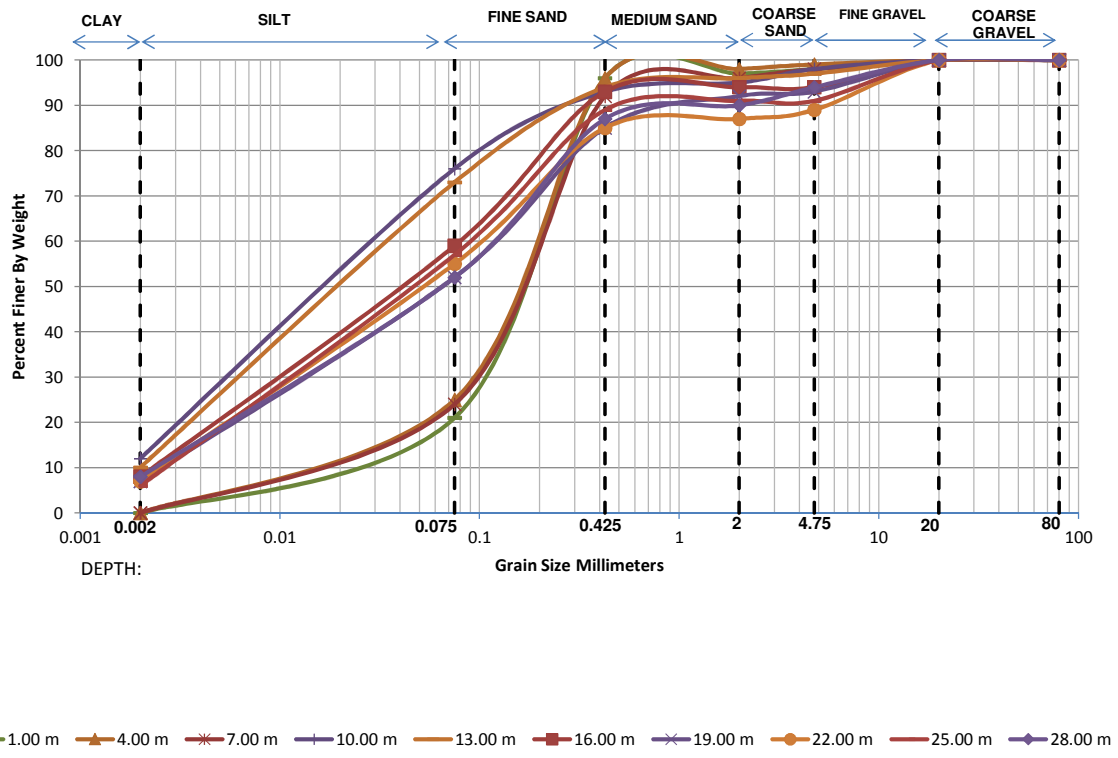
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	57+400 Major Bridge
B.H. No.	BH-P6



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
1.00 m	0.00	22.00	72.00	3.00	2.00	1.00	0.00	0.0238	0.1043	0.2068	8.70	2.22
4.00 m	0.00	34.00	63.00	2.00	1.00	0.00	0.00	0.0108	0.0626	0.1629	15.08	2.23
7.00 m	12.00	54.00	23.00	6.00	1.00	4.00	0.00	-	0.0134	0.0609	-	-
10.00 m	11.00	63.00	20.00	1.00	2.00	3.00	0.00	-	0.0121	0.0481	-	-
13.00 m	10.00	50.00	31.00	3.00	1.00	5.00	0.00	0.0020	0.0178	0.0750	37.50	2.12
16.00 m	9.00	42.00	27.00	7.00	7.00	8.00	0.00	0.0024	0.0245	0.1290	53.15	1.91
19.00 m	6.00	50.00	33.00	3.00	1.00	7.00	0.00	0.0044	0.0245	0.0882	20.02	1.54
22.00 m	8.00	51.00	29.00	5.00	1.00	6.00	0.00	0.0029	0.0202	0.0778	26.65	1.80
25.00 m	7.00	48.00	32.00	3.00	1.00	9.00	0.00	0.0036	0.0239	0.0933	25.79	1.69

GRAIN SIZE DISTRIBUTION CURVES

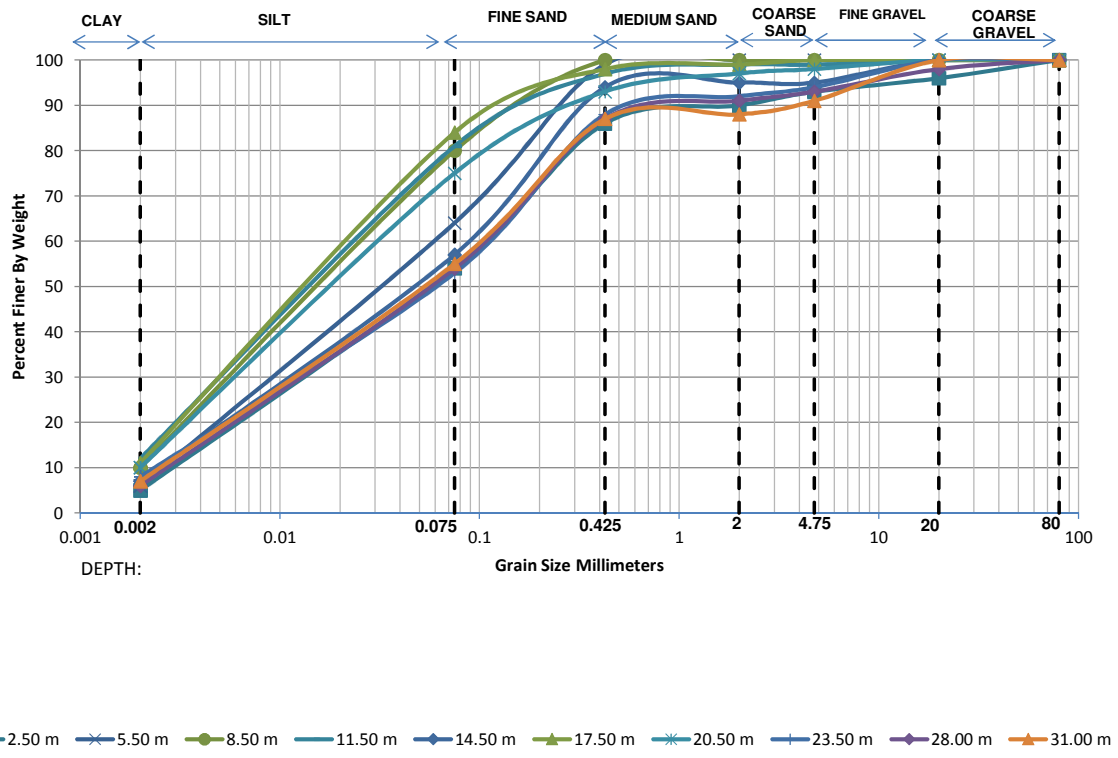
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	57+400 Major Bridge
B.H. No.	BH-P7



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
1.00 m	0.00	21.00	75.00	1.00	1.00	2.00	0.00	0.0260	0.1078	0.2057	7.93	2.18
4.00 m	0.00	25.00	71.00	2.00	1.00	1.00	0.00	0.0189	0.0926	0.1936	10.25	2.34
7.00 m	0.00	24.00	68.00	4.00	2.00	2.00	0.00	0.0202	0.0969	0.2048	10.15	2.27
10.00 m	12.00	64.00	17.00	2.00	3.00	2.00	0.00	-	0.0109	0.0450	-	-
13.00 m	10.00	63.00	21.00	2.00	1.00	3.00	0.00	0.0020	0.0132	0.0499	24.97	1.74
16.00 m	8.00	51.00	34.00	1.00	0.00	6.00	0.00	0.0029	0.0205	0.0777	26.56	1.85
19.00 m	7.00	45.00	33.00	7.00	1.00	7.00	0.00	0.0037	0.0262	0.1099	29.91	1.70
22.00 m	7.00	48.00	30.00	2.00	2.00	11.00	0.00	0.0036	0.0238	0.0943	26.08	1.66
25.00 m	6.00	51.00	32.00	2.00	0.00	9.00	0.00	0.0044	0.0238	0.0844	19.26	1.53
28.00 m	8.00	44.00	35.00	3.00	4.00	6.00	0.00	0.0030	0.0252	0.1074	35.98	1.99

GRAIN SIZE DISTRIBUTION CURVES

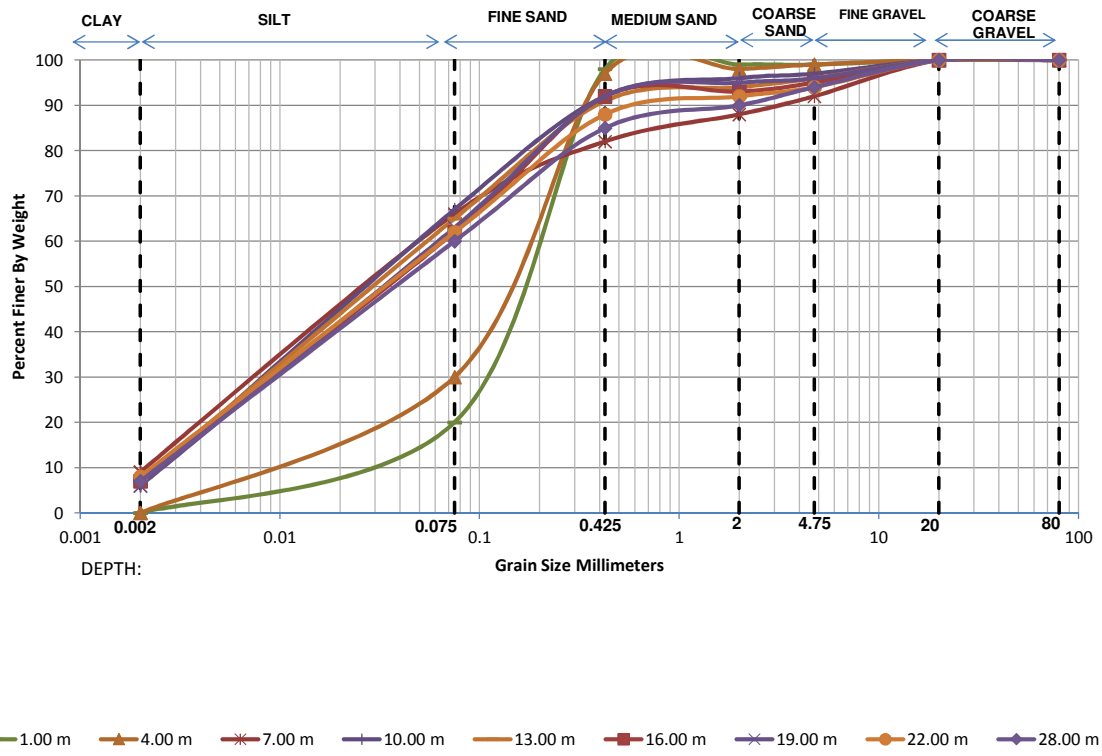
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	57+400 Major Bridge
B.H. No.	BH-P9



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
2.50 m	5.00	49.00	32.00	4.00	3.00	3.00	4.00	0.0055	0.0270	0.0982	17.97	1.36
5.50 m	6.00	58.00	35.00	1.00	0.00	0.00	0.00	0.0042	0.0205	0.0664	15.63	1.49
8.50 m	10.00	70.00	20.00	0.00	0.00	0.00	0.00	0.0020	0.0119	0.0418	20.91	1.68
11.50 m	12.00	69.00	16.00	2.00	0.00	1.00	0.00	-	0.0101	0.0396	-	-
14.50 m	7.00	50.00	37.00	1.00	0.00	5.00	0.00	0.0036	0.0229	0.0837	23.29	1.74
17.50 m	11.00	73.00	14.00	1.00	1.00	0.00	0.00	-	0.0104	0.0374	-	-
20.50 m	10.00	65.00	18.00	4.00	1.00	2.00	0.00	0.0020	0.0127	0.0472	23.59	1.71
23.50 m	8.00	45.00	35.00	4.00	2.00	6.00	0.00	0.0030	0.0244	0.1021	34.32	1.97
28.00 m	6.00	48.00	33.00	4.00	2.00	5.00	2.00	0.0045	0.0258	0.0978	21.91	1.53
31.00 m	7.00	48.00	32.00	1.00	3.00	9.00	0.00	0.0036	0.0239	0.0931	25.74	1.69

GRAIN SIZE DISTRIBUTION CURVES

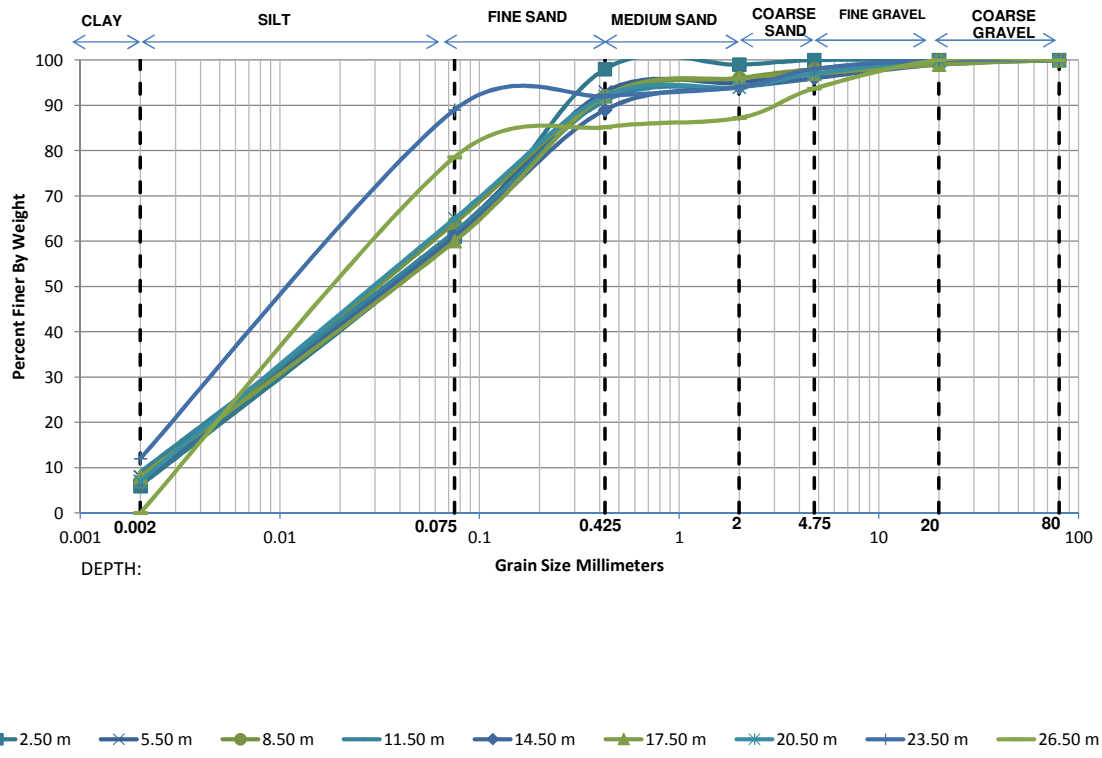
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	57+400 Major Bridge
B.H. No.	BH-P10



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
1.00 m	0.00	20.00	78.00	1.00	0.00	1.00	0.00	0.0284	0.1114	0.2055	7.23	2.12
4.00 m	0.00	30.00	67.00	1.00	1.00	1.00	0.00	0.0135	0.0750	0.1758	12.98	2.36
7.00 m	9.00	57.00	16.00	6.00	4.00	8.00	0.00	0.0024	0.0158	0.0613	25.66	1.70
10.00 m	6.00	61.00	25.00	4.00	1.00	3.00	0.00	0.0042	0.0190	0.0606	14.50	1.42
13.00 m	7.00	58.00	26.00	3.00	2.00	4.00	0.00	0.0035	0.0186	0.0640	18.38	1.55
16.00 m	7.00	55.00	30.00	1.00	2.00	5.00	0.00	0.0035	0.0199	0.0703	19.98	1.61
19.00 m	6.00	57.00	29.00	3.00	1.00	4.00	0.00	0.0043	0.0206	0.0683	16.05	1.47
22.00 m	8.00	54.00	26.00	4.00	2.00	6.00	0.00	0.0029	0.0187	0.0702	24.20	1.72
28.00 m	7.00	53.00	25.00	5.00	4.00	6.00	0.00	0.0035	0.0206	0.0750	21.20	1.60

GRAIN SIZE DISTRIBUTION CURVES

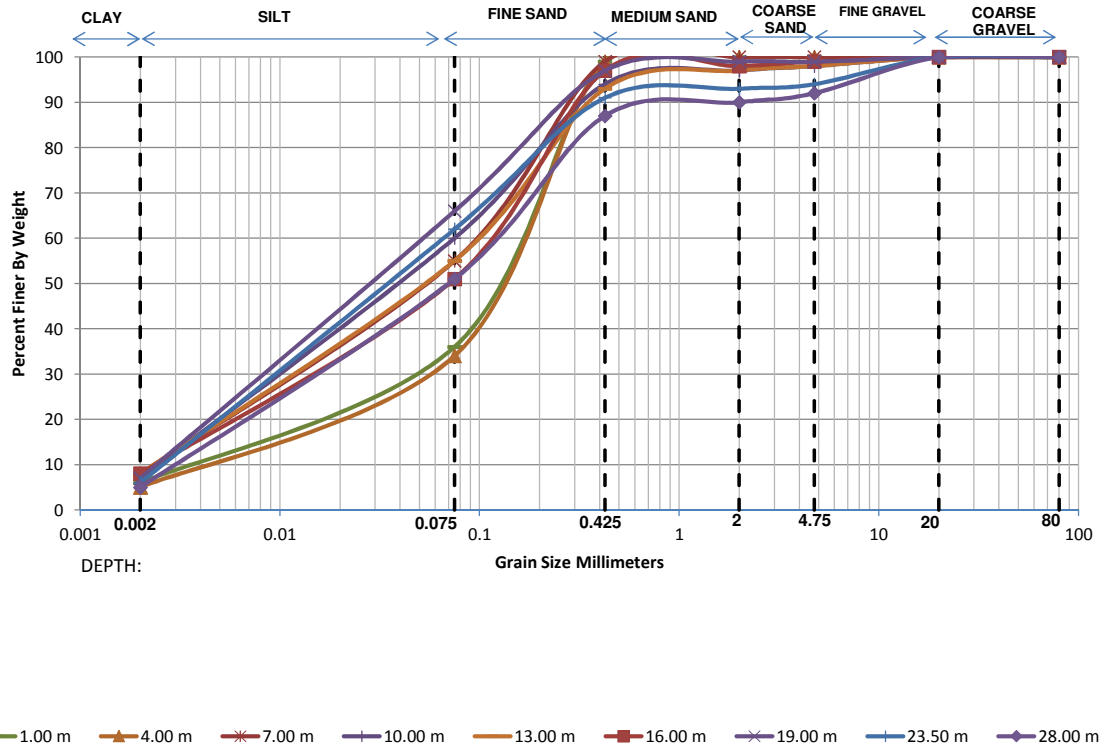
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	57+400 Major Bridge
B.H. No.	BH-P11



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
2.50 m	6.00	55.00	37.00	1.00	1.00	0.00	0.00	0.0043	0.0219	0.0727	16.88	1.53
5.50 m	8.00	54.00	31.00	2.00	3.00	2.00	0.00	0.0029	0.0189	0.0703	24.20	1.75
8.50 m	7.00	57.00	28.00	4.00	2.00	2.00	0.00	0.0035	0.0190	0.0661	18.90	1.57
11.50 m	9.00	53.00	29.00	3.00	2.00	4.00	0.00	0.0024	0.0178	0.0701	29.23	1.88
14.50 m	7.00	54.00	28.00	5.00	2.00	3.00	1.00	0.0035	0.0203	0.0726	20.57	1.61
17.50 m	8.00	52.00	32.00	4.00	1.00	2.00	1.00	0.0029	0.0199	0.0750	25.72	1.81
20.50 m	7.00	58.00	27.00	2.00	3.00	3.00	0.00	0.0035	0.0186	0.0641	18.39	1.55
23.50 m	12.00	77.00	3.00	2.00	4.00	2.00	0.00	-	0.0090	0.0325	-	-
26.50 m	0.00	78.55	6.60	2.05	6.50	6.30	0.00	0.0032	0.0129	0.0449	13.96	1.15

GRAIN SIZE DISTRIBUTION CURVES

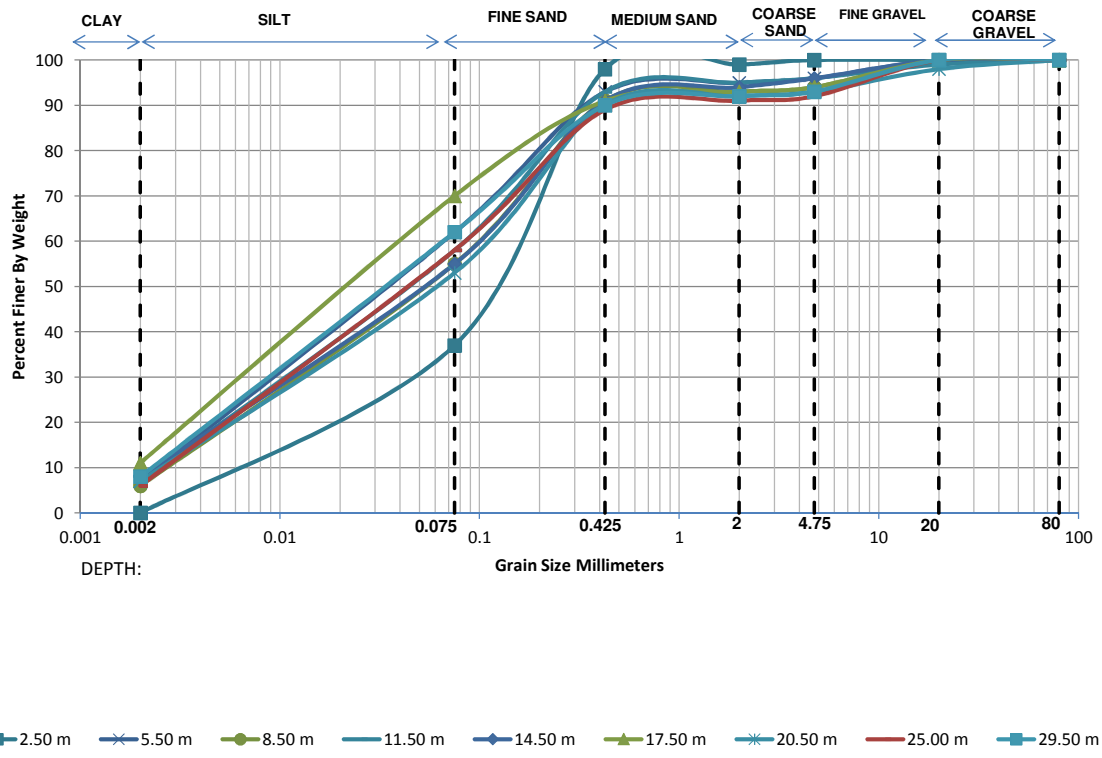
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	57+400 Major Bridge
B.H. No.	BH-P12



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
1.00 m	6.00	30.00	63.00	1.00	0.00	0.00	0.00	0.0057	0.0550	0.1571	27.35	3.35
4.00 m	5.00	29.00	65.00	1.00	0.00	0.00	0.00	0.0077	0.0613	0.1633	21.27	3.00
7.00 m	8.00	47.00	44.00	1.00	0.00	0.00	0.00	0.0030	0.0235	0.0898	30.30	2.07
10.00 m	7.00	53.00	34.00	3.00	1.00	2.00	0.00	0.0035	0.0211	0.0750	21.13	1.67
13.00 m	8.00	47.00	38.00	4.00	1.00	2.00	0.00	0.0030	0.0231	0.0913	30.87	1.98
16.00 m	8.00	43.00	46.00	1.00	1.00	1.00	0.00	0.0030	0.0268	0.1047	34.83	2.28
19.00 m	7.00	59.00	31.00	2.00	0.00	1.00	0.00	0.0035	0.0184	0.0623	17.92	1.56
23.50 m	6.00	56.00	29.00	2.00	1.00	6.00	0.00	0.0043	0.0211	0.0704	16.48	1.48
28.00 m	5.00	46.00	36.00	3.00	2.00	8.00	0.00	0.0056	0.0297	0.1113	19.81	1.41

GRAIN SIZE DISTRIBUTION CURVES

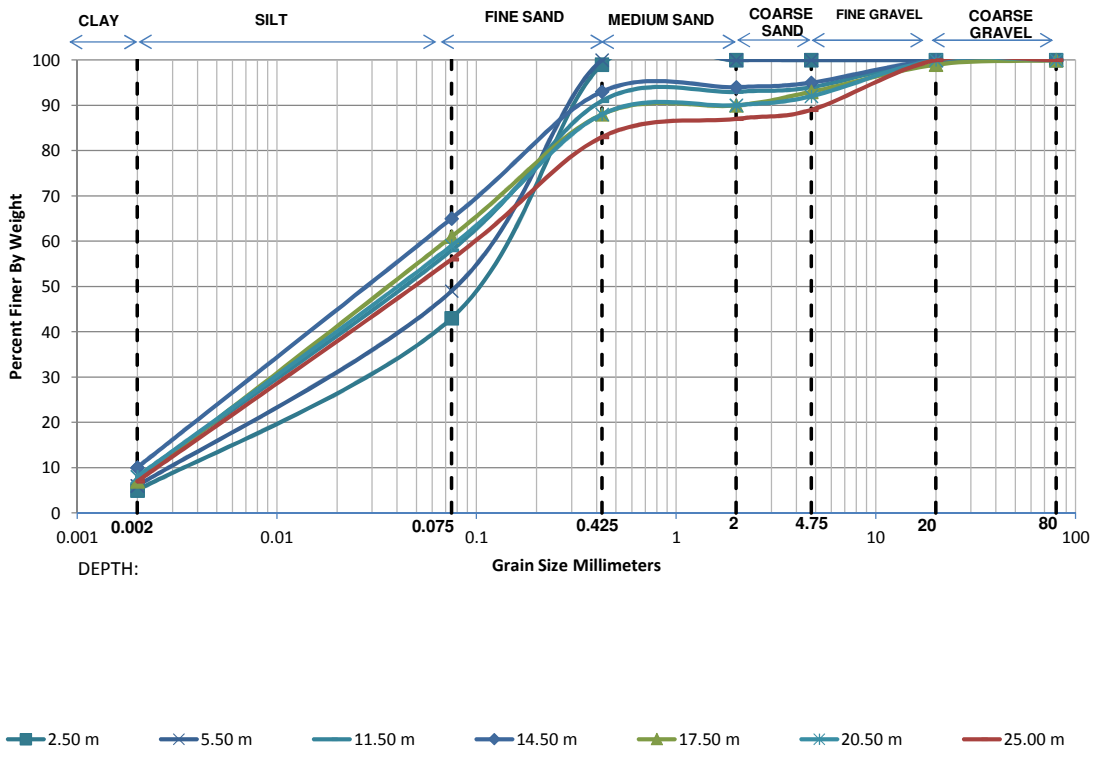
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	57+400 Major Bridge
B.H. No.	BH-P13



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
2.50 m	0.00	37.00	61.00	1.00	1.00	0.00	0.00	0.0093	0.0546	0.1512	16.22	2.12
5.50 m	7.00	55.00	31.00	2.00	1.00	4.00	0.00	0.0035	0.0200	0.0703	19.98	1.61
8.50 m	6.00	49.00	36.00	2.00	1.00	6.00	0.00	0.0044	0.0253	0.0915	20.59	1.57
11.50 m	7.00	51.00	35.00	2.00	1.00	3.00	1.00	0.0036	0.0222	0.0806	22.53	1.71
14.50 m	8.00	47.00	36.00	3.00	2.00	4.00	0.00	0.0030	0.0230	0.0919	31.08	1.95
17.50 m	11.00	59.00	21.00	2.00	1.00	6.00	0.00	-	0.0130	0.0540	-	-
20.50 m	7.00	46.00	37.00	2.00	1.00	5.00	2.00	0.0037	0.0257	0.1003	27.37	1.79
25.00 m	6.00	52.00	31.00	2.00	1.00	8.00	0.00	0.0044	0.0232	0.0809	18.56	1.52
29.50 m	8.00	54.00	28.00	2.00	1.00	7.00	0.00	0.0029	0.0188	0.0702	24.20	1.73

GRAIN SIZE DISTRIBUTION CURVES

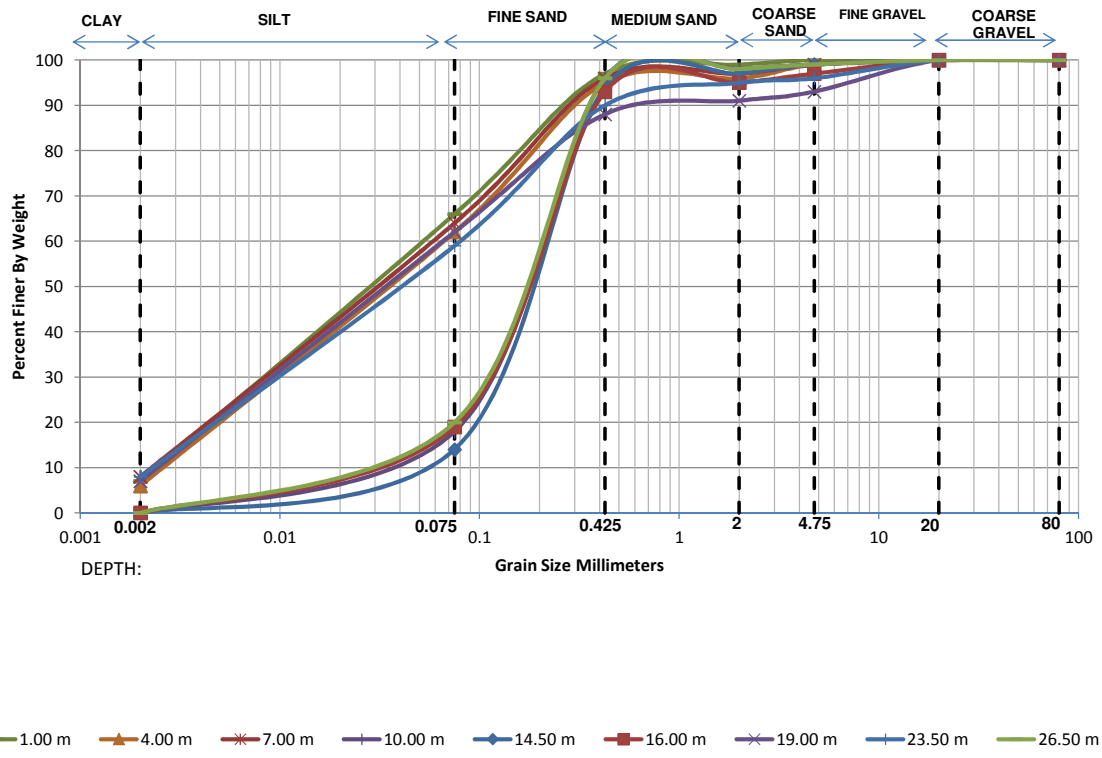
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	57+400 Major Bridge
B.H. No.	BH-P15



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
2.50 m	5.00	38.00	56.00	1.00	0.00	0.00	0.00	0.0063	0.0406	0.1317	20.98	2.00
5.50 m	6.00	43.00	51.00	0.00	0.00	0.00	0.00	0.0047	0.0313	0.1352	28.82	1.55
11.50 m	8.00	50.00	33.00	2.00	1.00	6.00	0.00	0.0029	0.0210	0.0808	27.59	1.86
14.50 m	10.00	55.00	28.00	1.00	1.00	5.00	0.00	0.0020	0.0156	0.0635	31.76	1.93
17.50 m	7.00	54.00	27.00	2.00	3.00	6.00	1.00	0.0035	0.0203	0.0726	20.57	1.60
20.50 m	8.00	51.00	29.00	2.00	2.00	8.00	0.00	0.0029	0.0202	0.0778	26.64	1.80
25.00 m	7.00	49.00	27.00	4.00	2.00	11.00	0.00	0.0036	0.0229	0.0909	25.28	1.61

GRAIN SIZE DISTRIBUTION CURVES

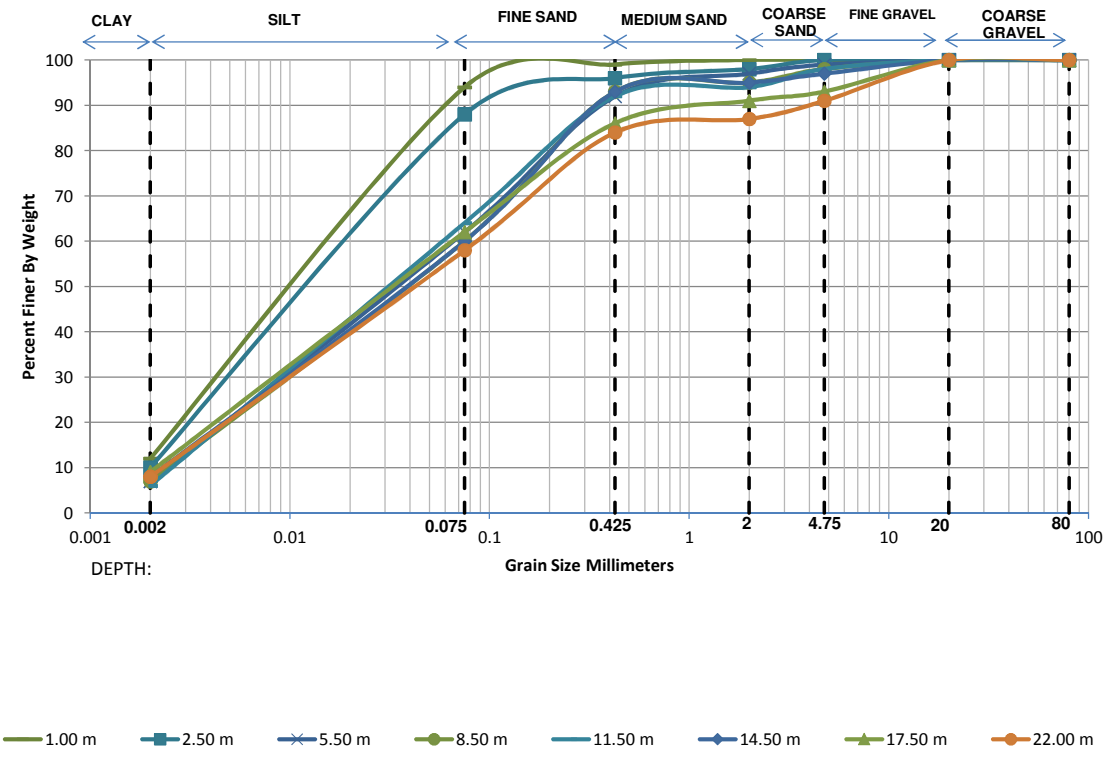
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	57+400 Major Bridge
B.H. No.	BH-P16



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
1.00 m	7.00	59.00	31.00	2.00	1.00	0.00	0.00	0.0035	0.0184	0.0623	17.92	1.56
4.00 m	6.00	56.00	33.00	1.00	3.00	1.00	0.00	0.0043	0.0212	0.0704	16.46	1.50
7.00 m	8.00	56.00	32.00	1.00	2.00	1.00	0.00	0.0029	0.0181	0.0660	22.82	1.72
10.00 m	0.00	18.00	78.00	2.00	1.00	1.00	0.00	0.0340	0.1200	0.2151	6.32	1.97
14.50 m	0.00	14.00	80.00	3.00	2.00	1.00	0.00	0.0508	0.1379	0.2311	4.55	1.62
16.00 m	0.00	19.00	74.00	2.00	2.00	3.00	0.00	0.0308	0.1166	0.2176	7.06	2.03
19.00 m	7.00	55.00	26.00	3.00	2.00	7.00	0.00	0.0035	0.0198	0.0703	19.99	1.58
23.50 m	8.00	51.00	31.00	5.00	1.00	4.00	0.00	0.0029	0.0204	0.0778	26.61	1.82
26.50 m	0.00	20.00	76.00	2.00	1.00	1.00	0.00	0.0283	0.1118	0.2090	7.38	2.11

GRAIN SIZE DISTRIBUTION CURVES

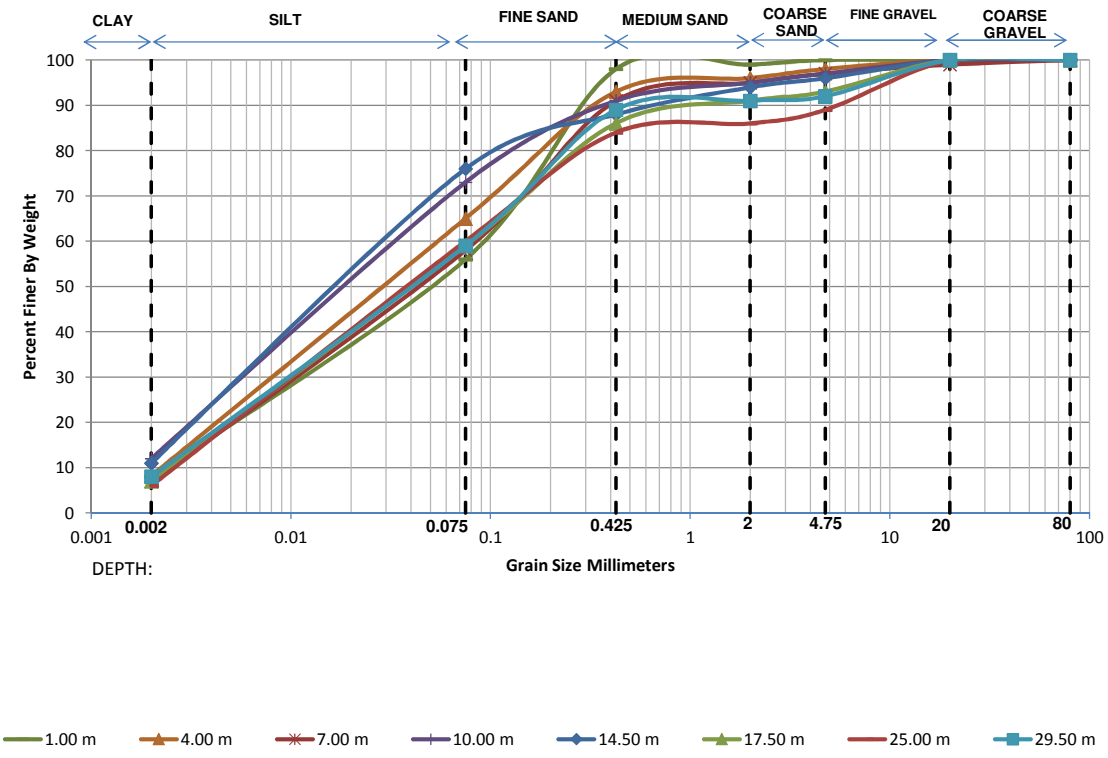
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	57+400 Major Bridge
B.H. No.	BH-P17



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
1.00 m	12.00	82.00	5.00	1.00	0.00	0.00	0.00	-	0.0087	0.0296	-	-
2.50 m	10.00	78.00	8.00	2.00	2.00	0.00	0.00	0.0020	0.0106	0.0346	17.29	1.62
5.50 m	7.00	55.00	30.00	5.00	2.00	1.00	0.00	0.0035	0.0199	0.0703	19.98	1.61
8.50 m	7.00	53.00	33.00	2.00	3.00	2.00	0.00	0.0035	0.0210	0.0750	21.14	1.66
11.50 m	6.00	58.00	28.00	2.00	4.00	2.00	0.00	0.0042	0.0202	0.0662	15.64	1.45
14.50 m	8.00	52.00	33.00	2.00	2.00	3.00	0.00	0.0029	0.0199	0.0750	25.71	1.82
17.50 m	9.00	53.00	24.00	5.00	2.00	7.00	0.00	0.0024	0.0176	0.0701	29.21	1.84
22.00 m	8.00	50.00	26.00	3.00	4.00	9.00	0.00	0.0029	0.0206	0.0817	27.91	1.78

GRAIN SIZE DISTRIBUTION CURVES

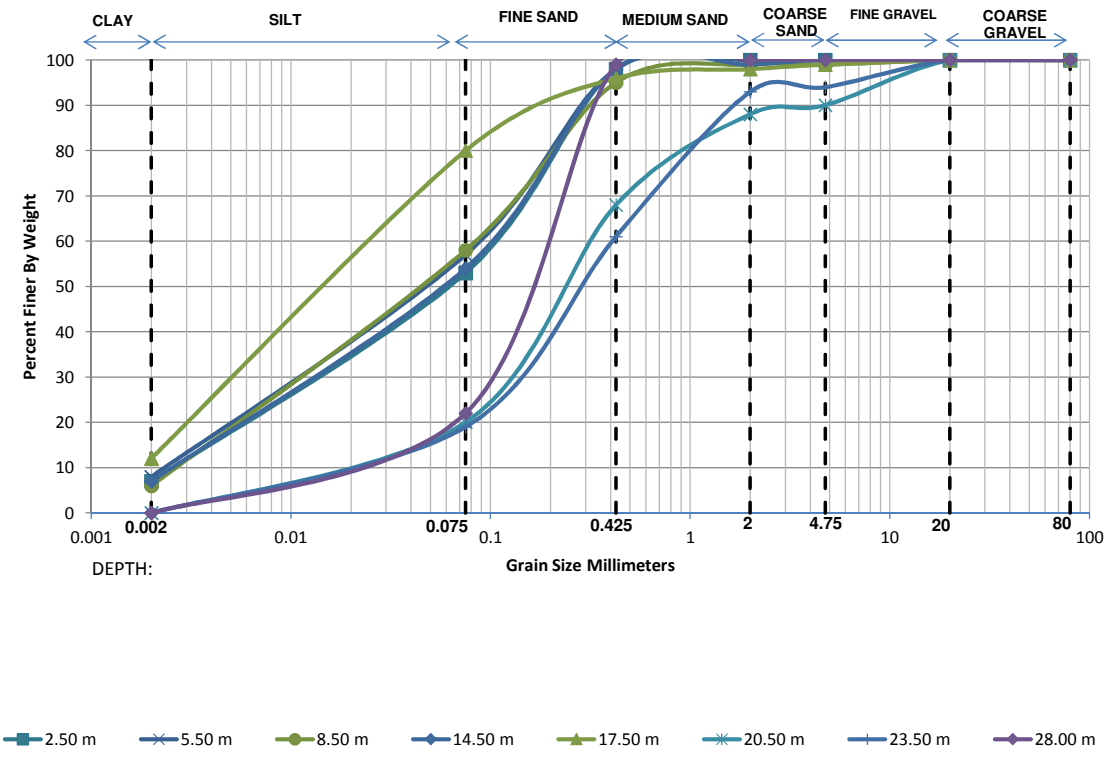
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	57+400 Major Bridge
B.H. No.	BH-P18



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
1.00 m	8.00	48.00	42.00	1.00	1.00	0.00	0.00	0.0030	0.0227	0.0866	29.34	2.01
4.00 m	8.20	56.80	28.00	3.00	2.00	2.00	0.00	0.0028	0.0174	0.0639	22.99	1.70
7.00 m	7.00	51.00	33.00	4.00	2.00	2.00	1.00	0.0036	0.0221	0.0808	22.60	1.69
10.00 m	12.00	61.00	18.00	4.00	2.00	3.00	0.00	-	0.0115	0.0490	-	-
14.50 m	11.00	65.00	12.00	6.00	2.00	4.00	0.00	-	0.0115	0.0452	-	-
17.50 m	7.00	52.00	27.00	5.00	2.00	7.00	0.00	0.0036	0.0212	0.0779	21.92	1.63
25.00 m	6.00	54.00	24.00	2.00	3.00	11.00	0.00	0.0043	0.0217	0.0750	17.45	1.47
29.50 m	8.00	51.00	30.00	2.00	1.00	8.00	0.00	0.0029	0.0203	0.0778	26.62	1.81

GRAIN SIZE DISTRIBUTION CURVES

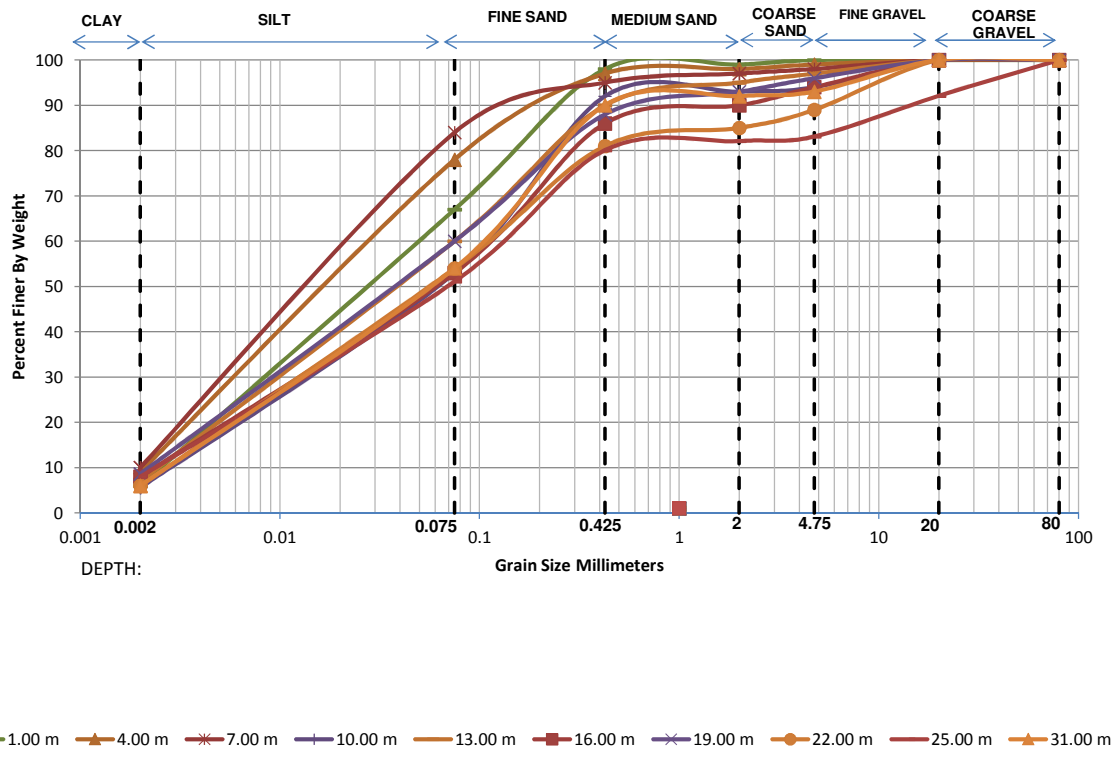
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	57+400 Major Bridge
B.H. No.	BH-P19



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
2.50 m	7.00	46.00	45.00	2.00	0.00	0.00	0.00	0.0037	0.0261	0.0968	26.31	1.92
5.50 m	8.00	49.00	41.00	2.00	0.00	0.00	0.00	0.0029	0.0220	0.0834	28.34	1.97
8.50 m	6.00	52.00	37.00	4.00	0.00	1.00	0.00	0.0044	0.0235	0.0804	18.40	1.57
14.50 m	7.00	47.00	44.00	1.00	1.00	0.00	0.00	0.0037	0.0253	0.0932	25.48	1.88
17.50 m	12.00	68.00	16.00	2.00	1.00	1.00	0.00	-	0.0103	0.0406	-	-
20.50 m	0.00	20.00	48.00	20.00	2.00	10.00	0.00	0.0263	0.1227	0.3303	12.54	1.73
23.50 m	0.00	19.00	42.00	32.00	1.00	6.00	0.00	0.0283	0.1357	0.4110	14.54	1.58
28.00 m	0.00	22.00	77.00	1.00	0.00	0.00	0.00	0.0240	0.1034	0.1979	8.24	2.25

GRAIN SIZE DISTRIBUTION CURVES

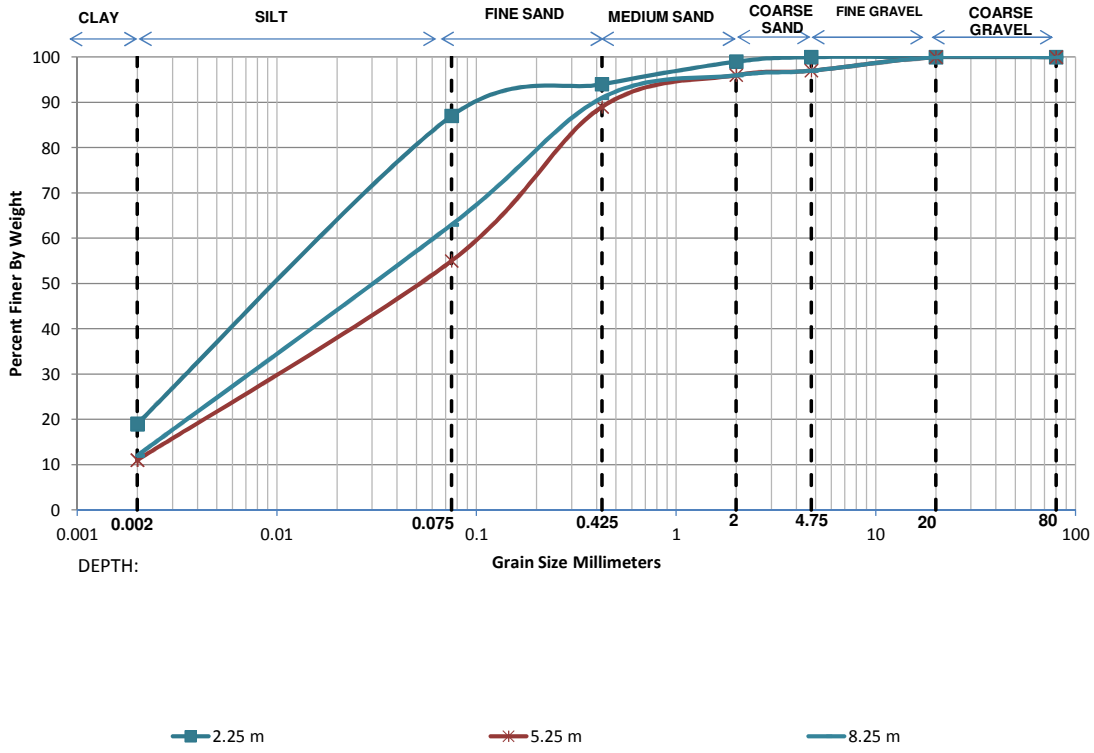
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	57+400 Major Bridge
B.H. No.	BH-A2



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
1.00 m	6.00	61.00	31.00	1.00	1.00	0.00	0.00	0.0042	0.0192	0.0608	14.52	1.45
4.00 m	9.00	69.00	19.00	1.00	1.00	1.00	0.00	0.0024	0.0130	0.0443	18.66	1.61
7.00 m	10.00	74.00	11.00	2.00	1.00	2.00	0.00	0.0020	0.0111	0.0377	18.86	1.64
10.00 m	5.60	47.40	39.00	1.00	1.00	6.00	0.00	0.0049	0.0274	0.0988	20.17	1.56
13.00 m	7.00	53.00	30.00	5.00	2.00	3.00	0.00	0.0035	0.0209	0.0750	21.16	1.64
16.00 m	8.00	45.00	33.00	4.00	4.00	6.00	0.00	0.0030	0.0243	0.1036	34.87	1.92
19.00 m	8.60	51.40	28.00	5.00	3.00	4.00	0.00	0.0026	0.0191	0.0750	28.91	1.87
22.00 m	6.00	48.00	27.00	4.00	4.00	11.00	0.00	0.0044	0.0254	0.1030	23.19	1.41
25.00 m	8.00	43.10	29.00	2.00	1.00	9.00	7.90	0.0030	0.0256	0.1214	40.64	1.81
31.00 m	6.00	48.00	36.00	2.00	1.00	7.00	0.00	0.0045	0.0260	0.0959	21.45	1.58

GRAIN SIZE DISTRIBUTION CURVES

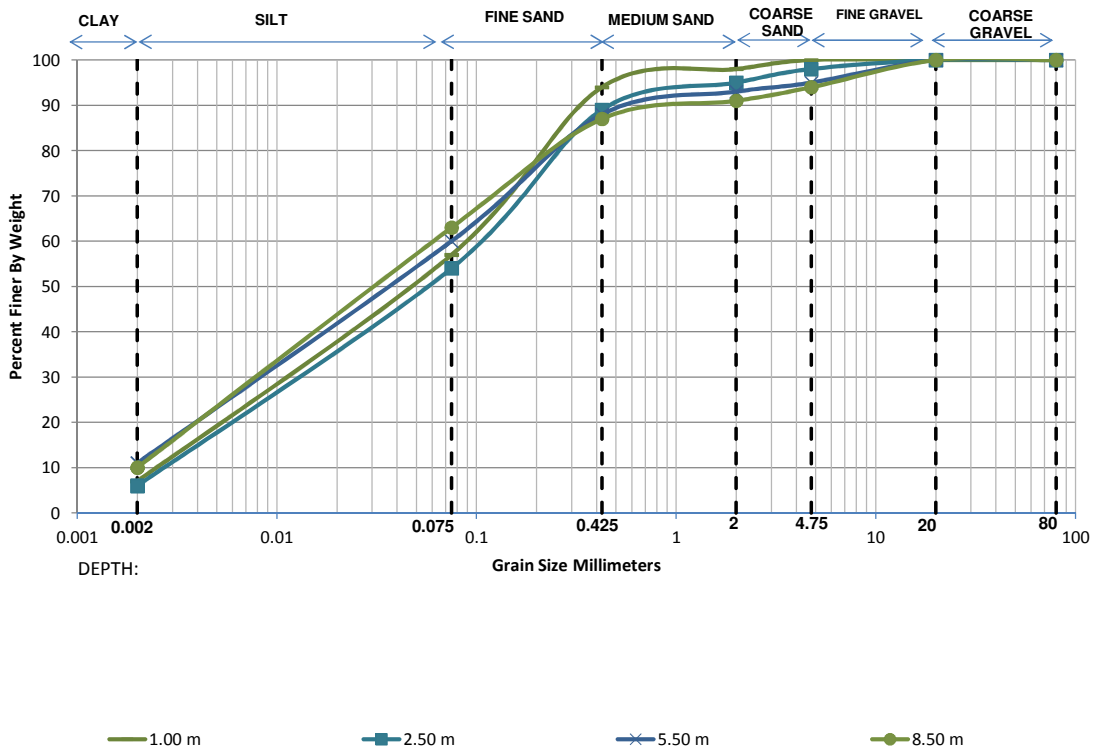
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	57+980
B.H. No.	CL



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
2.25 m	19.00	68.00	7.00	5.00	1.00	0.00	0.00	-	0.0055	0.0302	-	-
5.25 m	11.00	44.00	34.00	7.00	1.00	3.00	0.00	-	0.0198	0.0935	-	-
8.25 m	12.00	51.00	28.00	5.00	1.00	3.00	0.00	-	0.0146	0.0675	-	-

GRAIN SIZE DISTRIBUTION CURVES

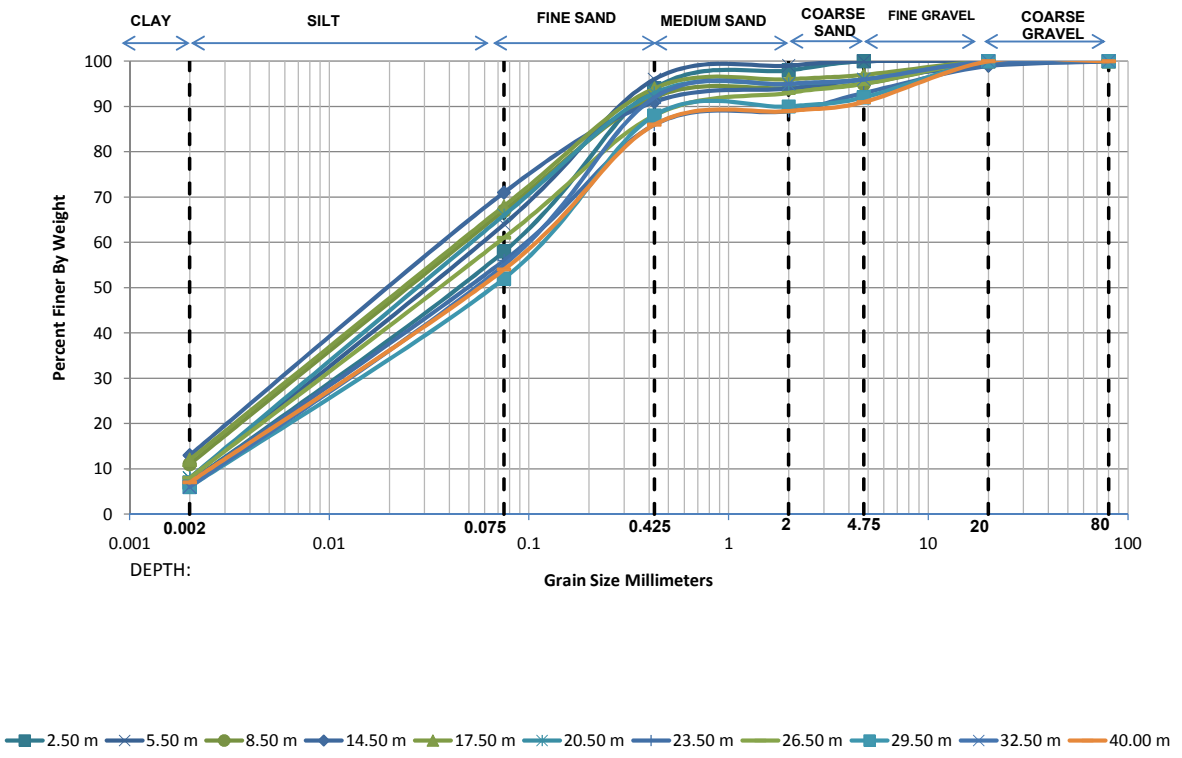
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	58+191
B.H. No.	BH-CL



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
1.00 m	7.00	50.00	37.00	4.00	2.00	0.00	0.00	0.0036	0.0229	0.0838	23.31	1.74
2.50 m	6.00	48.00	35.00	6.00	3.00	2.00	0.00	0.0045	0.0259	0.0968	21.66	1.56
5.50 m	11.00	49.00	28.00	5.00	2.00	5.00	0.00	-	0.0167	0.0750	-	-
8.50 m	10.00	53.00	24.00	4.00	3.00	6.00	0.00	0.0020	0.0162	0.0677	33.83	1.94

GRAIN SIZE DISTRIBUTION CURVES

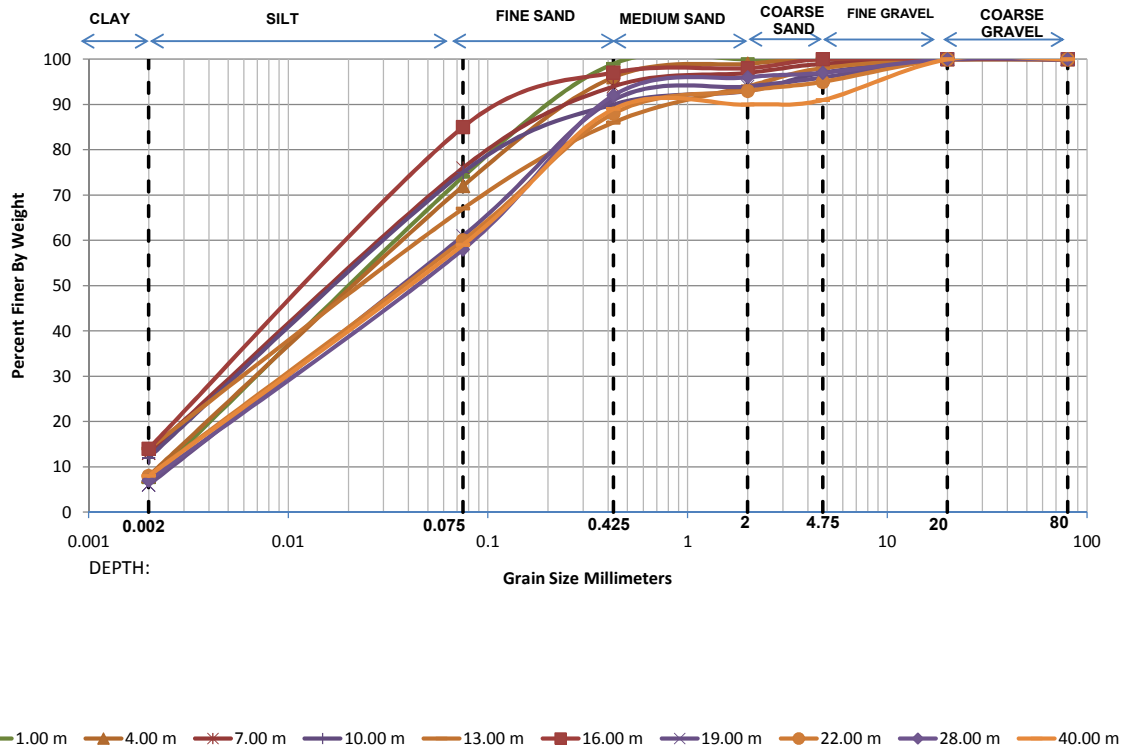
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	58+497 Major Bridge
B.H. No.	BH-A1



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
2.50 m	7.00	51.00	36.00	4.00	2.00	0.00	0.00	0.0036	0.0222	0.0806	22.51	1.72
5.50 m	8.00	56.00	32.00	3.00	1.00	0.00	0.00	0.0029	0.0181	0.0660	22.82	1.72
8.50 m	11.00	56.00	25.00	2.00	1.00	5.00	0.00	-	0.0140	0.0593	-	-
14.50 m	13.00	58.00	20.00	3.00	2.00	3.00	1.00	-	0.0112	0.0516	-	-
17.50 m	12.00	56.00	26.00	2.00	1.00	3.00	0.00	-	0.0129	0.0573	-	-
20.50 m	8.00	58.00	27.00	2.00	1.00	4.00	0.00	0.0029	0.0172	0.0620	21.53	1.66
23.50 m	7.00	49.00	30.00	3.00	4.00	6.00	1.00	0.0036	0.0231	0.0894	24.84	1.66
26.50 m	8.00	53.00	27.00	5.00	2.00	5.00	0.00	0.0029	0.0192	0.0725	24.95	1.74
29.50 m	6.00	46.00	36.00	2.00	2.00	8.00	0.00	0.0045	0.0276	0.1058	23.36	1.58
32.50 m	6.00	49.00	37.00	3.00	1.00	4.00	0.00	0.0044	0.0253	0.0912	20.52	1.58
40.00 m	7.00	47.00	32.00	3.00	2.00	9.00	0.00	0.0036	0.0246	0.0985	27.09	1.69

GRAIN SIZE DISTRIBUTION CURVES

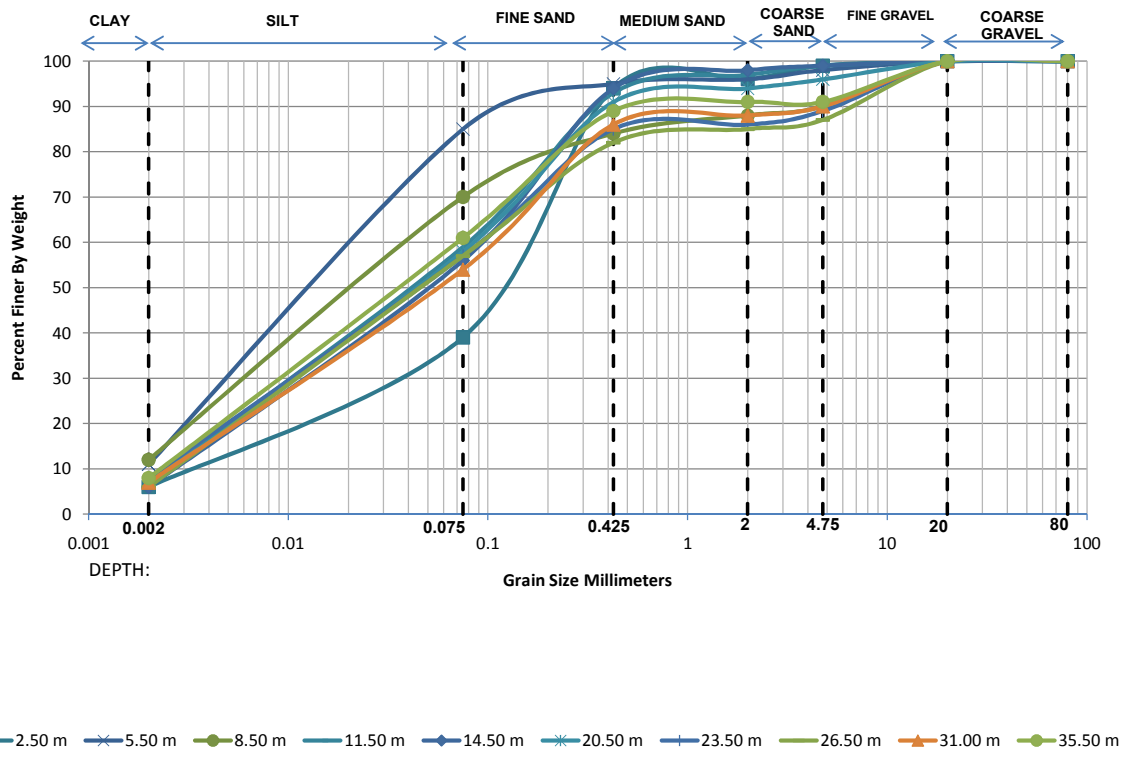
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	58+497 Major Bridge
B.H. No.	BH-P1



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
1.00 m	6.60	67.40	25.00	1.00	0.00	0.00	0.00	0.0037	0.0163	0.0503	13.73	1.45
4.00 m	8.00	64.00	24.00	3.00	1.00	0.00	0.00	0.0029	0.0153	0.0523	18.33	1.58
7.00 m	13.00	63.00	18.00	3.00	2.00	1.00	0.00	-	0.0102	0.0446	-	-
10.00 m	12.00	63.00	15.00	3.00	4.00	3.00	0.00	-	0.0110	0.0461	-	-
13.00 m	14.00	53.00	19.00	8.00	4.00	2.00	0.00	-	0.0113	0.0582	-	-
16.00 m	14.00	71.00	12.00	1.00	2.00	0.00	0.00	-	0.0083	0.0348	-	-
19.00 m	6.00	55.00	30.00	3.00	2.00	4.00	0.00	0.0043	0.0216	0.0726	16.93	1.49
22.00 m	8.00	52.00	28.00	5.00	2.00	5.00	0.00	0.0029	0.0197	0.0750	25.74	1.78
28.00 m	7.00	51.00	34.00	4.00	1.00	3.00	0.00	0.0036	0.0221	0.0807	22.57	1.70
40.00 m	8.00	51.00	30.00	1.00	1.00	9.00	0.00	0.0029	0.0203	0.0778	26.62	1.81

GRAIN SIZE DISTRIBUTION CURVES

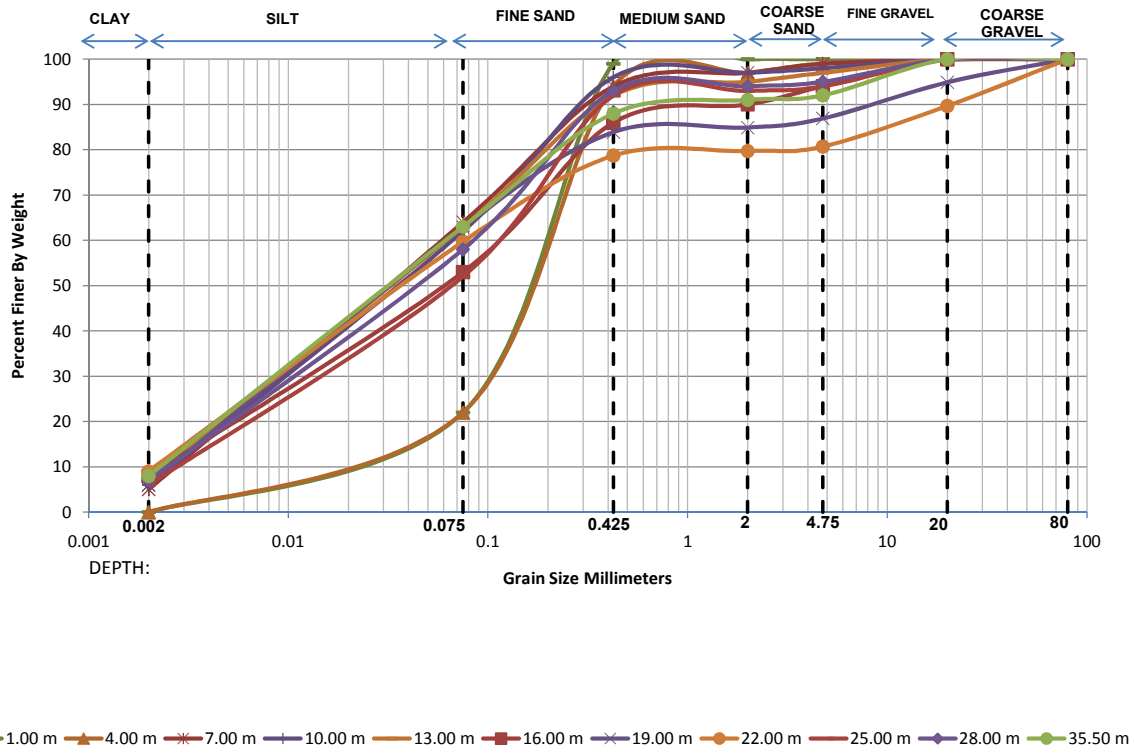
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	58+497 Major Bridge
B.H. No.	BH-P2



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
2.50 m	6.00	33.00	55.00	2.00	3.00	1.00	0.00	0.0053	0.0471	0.1529	28.58	2.71
5.50 m	11.00	74.00	10.00	1.00	2.00	2.00	0.00	-	0.0102	0.0363	-	-
8.50 m	12.00	58.00	14.00	4.00	2.00	10.00	0.00	-	0.0120	0.0532	-	-
11.50 m	7.00	52.00	34.00	4.00	2.00	1.00	0.00	0.0036	0.0216	0.0776	21.79	1.68
14.50 m	6.00	50.00	38.00	4.00	1.00	1.00	0.00	0.0044	0.0247	0.0871	19.70	1.59
20.50 m	7.00	51.00	33.00	3.00	2.00	4.00	0.00	0.0036	0.0221	0.0808	22.60	1.69
23.50 m	8.00	49.00	28.00	1.00	3.00	11.00	0.00	0.0029	0.0213	0.0854	29.12	1.81
26.50 m	6.00	51.00	25.00	3.00	2.00	13.00	0.00	0.0044	0.0234	0.0863	19.78	1.45
31.00 m	7.00	47.00	32.00	2.00	2.00	10.00	0.00	0.0036	0.0246	0.0984	27.05	1.69
35.50 m	8.00	53.00	28.00	2.00	0.00	9.00	0.00	0.0029	0.0192	0.0725	24.95	1.75

GRAIN SIZE DISTRIBUTION CURVES

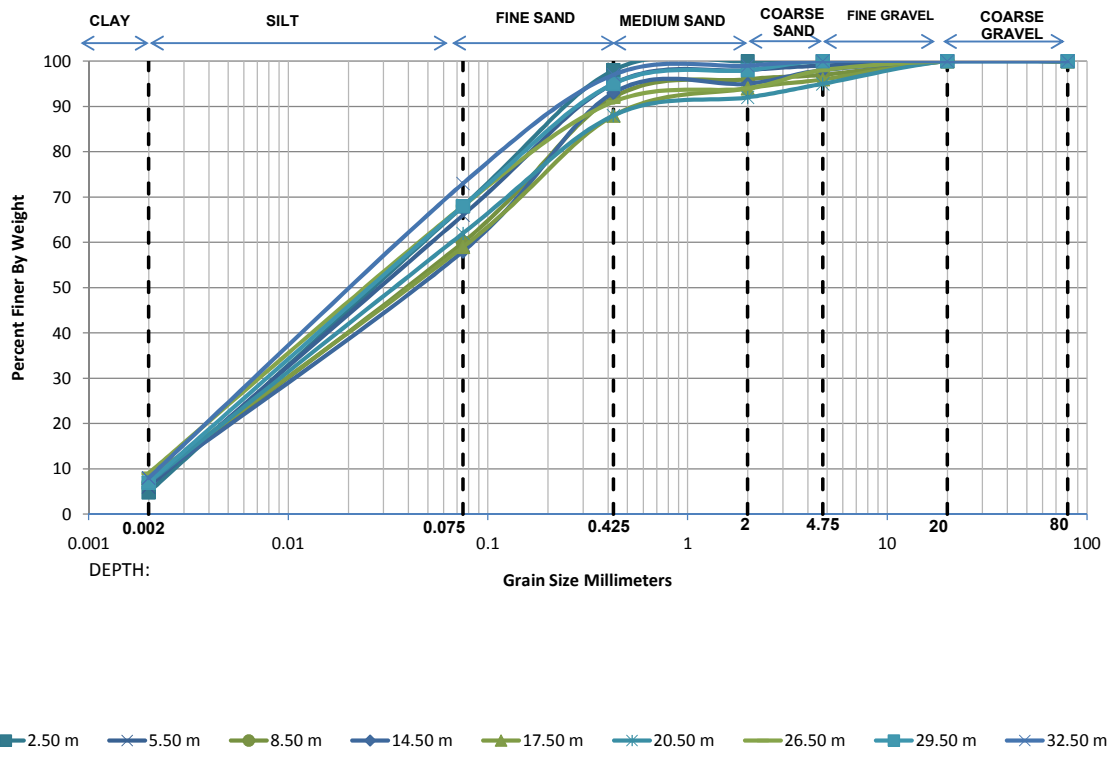
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	58+497 Major Bridge
B.H. No.	BH-P3



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
1.00 m	0.00	22.00	77.00	1.00	0.00	0.00	0.00	0.0240	0.1034	0.1979	8.24	2.25
4.00 m	0.00	22.00	72.00	3.00	2.00	1.00	0.00	0.0238	0.1043	0.2068	8.70	2.22
7.00 m	5.00	59.00	30.00	3.00	2.00	1.00	0.00	0.0051	0.0216	0.0664	12.90	1.36
10.00 m	6.00	56.00	34.00	1.00	1.00	2.00	0.00	0.0043	0.0213	0.0705	16.46	1.50
13.00 m	7.00	56.00	29.00	3.00	2.00	3.00	0.00	0.0035	0.0195	0.0681	19.43	1.59
16.00 m	8.00	45.00	33.00	4.00	4.00	6.00	0.00	0.0030	0.0243	0.1036	34.87	1.92
19.00 m	6.00	56.90	21.00	1.00	2.00	8.00	5.10	0.0042	0.0203	0.0683	16.12	1.42
22.00 m	9.00	50.70	19.00	1.00	1.00	9.00	10.30	0.0024	0.0184	0.0759	31.58	1.85
25.00 m	6.00	46.00	40.00	1.00	1.00	6.00	0.00	0.0045	0.0278	0.1029	22.64	1.65
28.00 m	7.00	51.00	35.00	1.00	1.00	5.00	0.00	0.0036	0.0222	0.0806	22.53	1.71
35.50 m	8.00	55.00	25.00	3.00	1.00	8.00	0.00	0.0029	0.0182	0.0679	23.47	1.69

GRAIN SIZE DISTRIBUTION CURVES

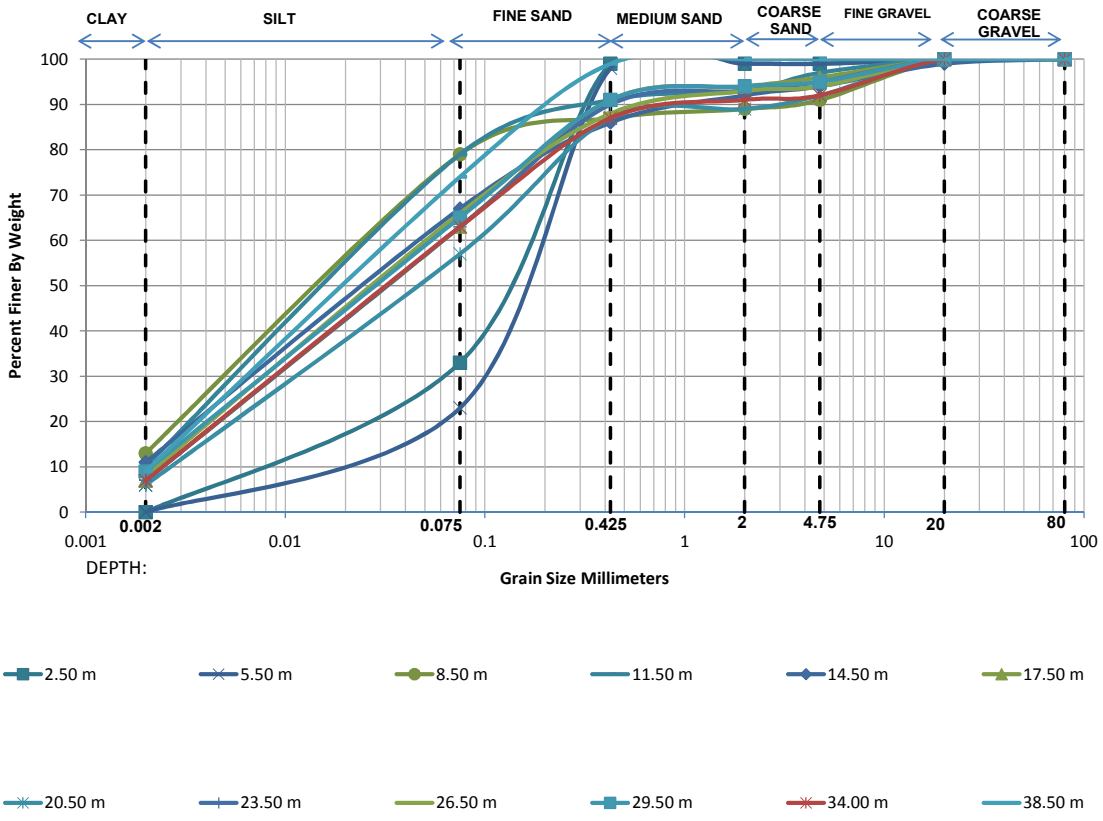
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	58+497 Major Bridge
B.H. No.	BH-P4



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
2.50 m	4.80	63.20	30.00	2.00	0.00	0.00	0.00	0.0053	0.0204	0.0595	11.32	1.34
5.50 m	6.00	60.00	29.00	3.00	1.00	1.00	0.00	0.0042	0.0195	0.0625	14.87	1.45
8.50 m	7.00	53.00	32.00	4.00	1.00	3.00	0.00	0.0035	0.0210	0.0750	21.15	1.65
14.50 m	7.00	51.00	35.00	2.00	3.00	2.00	0.00	0.0036	0.0222	0.0806	22.53	1.71
17.50 m	8.00	51.00	29.00	6.00	2.00	4.00	0.00	0.0029	0.0202	0.0778	26.65	1.80
20.50 m	7.00	55.00	26.00	4.00	3.00	5.00	0.00	0.0035	0.0198	0.0703	19.99	1.58
26.50 m	9.00	59.00	23.00	3.00	4.00	2.00	0.00	0.0024	0.0154	0.0580	24.29	1.72
29.50 m	7.00	61.00	27.00	3.00	2.00	0.00	0.00	0.0035	0.0176	0.0588	17.00	1.52
32.50 m	8.00	65.00	24.00	2.00	1.00	0.00	0.00	0.0028	0.0151	0.0509	17.88	1.57

GRAIN SIZE DISTRIBUTION CURVES

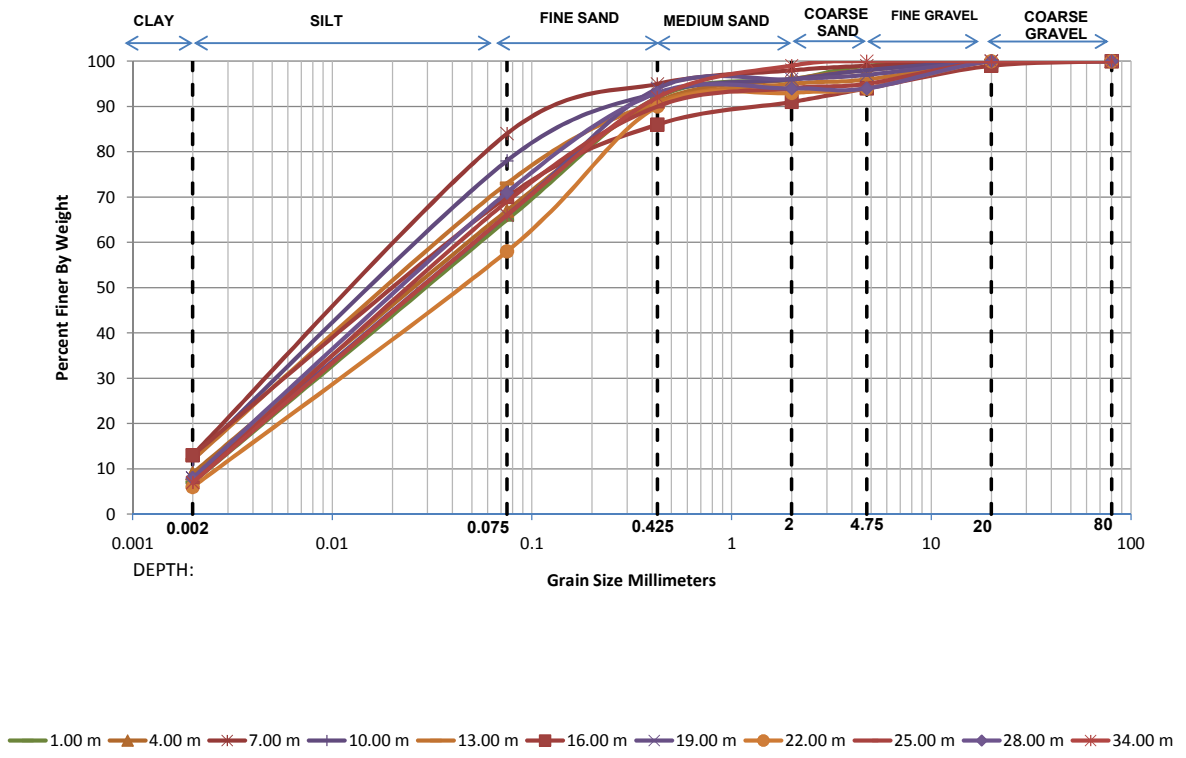
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	58+497 Major Bridge
B.H. No.	BH-P5



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
2.50 m	0.00	33.00	66.00	0.00	0.00	1.00	0.00	0.0115	0.0656	0.2322	20.28	1.62
5.50 m	0.00	23.00	75.00	1.00	0.00	1.00	0.00	0.0221	0.0998	0.1963	8.88	2.29
8.50 m	13.00	66.00	8.00	2.00	2.00	9.00	0.00	-	0.0096	0.0406	-	-
11.50 m	10.00	69.00	12.00	2.00	4.00	3.00	0.00	0.0020	0.0118	0.0423	21.17	1.65
14.50 m	11.00	56.00	19.00	6.00	2.00	5.00	1.00	-	0.0138	0.0591	-	-
17.50 m	7.00	56.00	28.00	3.00	2.00	4.00	0.00	0.0035	0.0194	0.0681	19.43	1.58
20.50 m	6.00	51.00	30.00	2.00	3.00	8.00	0.00	0.0044	0.0237	0.0848	19.37	1.51
23.50 m	7.00	56.00	27.00	3.00	2.00	5.00	0.00	0.0035	0.0194	0.0681	19.43	1.57
26.50 m	8.00	58.00	22.00	5.00	1.00	6.00	0.00	0.0029	0.0170	0.0618	21.48	1.62
29.50 m	9.00	56.00	26.00	3.00	1.00	5.00	0.00	0.0024	0.0165	0.0637	26.59	1.79
34.00 m	7.00	56.00	24.00	4.00	1.00	8.00	0.00	0.0035	0.0192	0.0680	19.43	1.56
38.50 m	9.00	65.00	25.00	1.00	0.00	0.00	0.00	0.0024	0.0140	0.0493	20.70	1.66

GRAIN SIZE DISTRIBUTION CURVES

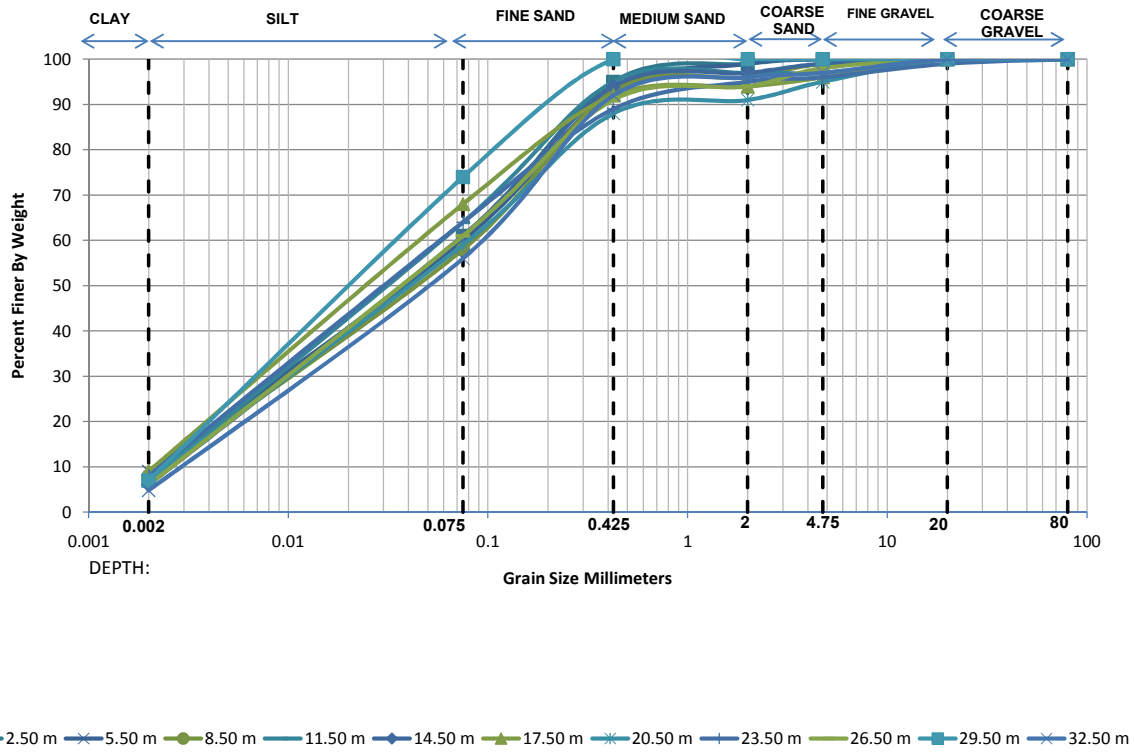
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	58+497 Major Bridge
B.H. No.	BH-P6



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
1.00 m	7.00	58.00	27.00	4.00	3.00	1.00	0.00	0.0035	0.0186	0.0641	18.39	1.55
4.00 m	9.00	58.00	24.00	5.00	2.00	2.00	0.00	0.0024	0.0158	0.0598	25.02	1.74
7.00 m	13.00	71.00	11.00	3.00	1.00	1.00	0.00	-	0.0090	0.0361	-	-
10.00 m	12.00	66.00	15.00	3.00	2.00	2.00	0.00	-	0.0105	0.0426	-	-
13.00 m	12.00	61.00	18.00	4.00	1.00	4.00	0.00	-	0.0115	0.0490	-	-
16.00 m	13.00	57.00	16.00	5.00	3.00	5.00	1.00	-	0.0113	0.0530	-	-
19.00 m	8.00	58.00	28.00	2.00	1.00	3.00	0.00	0.0029	0.0172	0.0620	21.54	1.66
22.00 m	6.00	52.00	32.00	3.00	1.00	6.00	0.00	0.0044	0.0232	0.0808	18.54	1.53
25.00 m	7.00	62.00	21.00	4.00	1.00	5.00	0.00	0.0034	0.0171	0.0569	16.53	1.49
28.00 m	8.00	63.00	22.00	1.00	0.00	6.00	0.00	0.0029	0.0155	0.0536	18.77	1.58
34.00 m	7.00	59.00	26.00	7.00	1.00	0.00	0.00	0.0035	0.0182	0.0622	17.90	1.54

GRAIN SIZE DISTRIBUTION CURVES

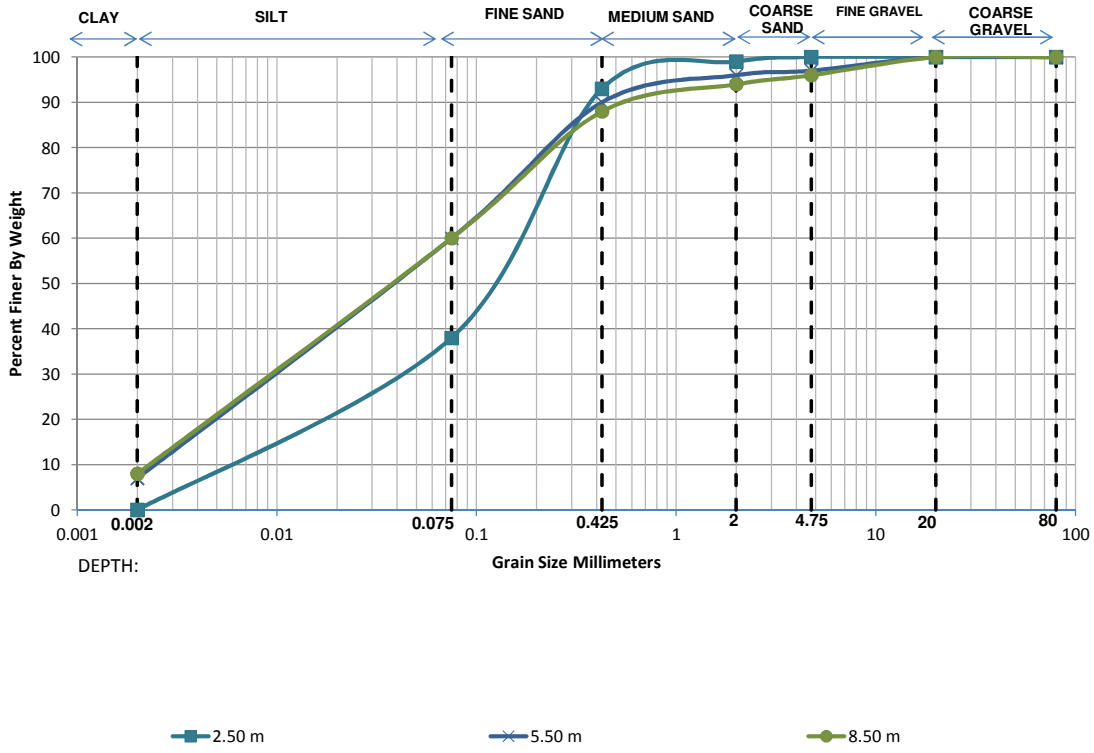
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	58+497 Major Bridge
B.H. No.	BH-A2



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
2.50 m	7.00	54.00	34.00	4.00	1.00	0.00	0.00	0.0035	0.0206	0.0726	20.53	1.65
5.50 m	9.00	51.00	33.00	6.00	1.00	0.00	0.00	0.0024	0.0189	0.0750	31.19	1.98
8.50 m	8.00	50.00	35.00	3.00	3.00	1.00	0.00	0.0029	0.0211	0.0807	27.53	1.88
11.50 m	7.00	57.00	31.00	2.00	0.00	3.00	0.00	0.0035	0.0192	0.0661	18.90	1.59
14.50 m	6.00	55.00	33.00	3.00	2.00	1.00	0.00	0.0043	0.0217	0.0727	16.90	1.51
17.50 m	9.00	59.00	24.00	2.00	2.00	4.00	0.00	0.0024	0.0155	0.0581	24.31	1.72
20.50 m	7.00	52.00	29.00	3.00	4.00	5.00	0.00	0.0036	0.0213	0.0778	21.88	1.65
23.50 m	8.00	56.00	25.00	6.00	1.00	3.00	1.00	0.0029	0.0178	0.0658	22.79	1.67
26.50 m	6.00	55.00	30.00	3.00	4.00	2.00	0.00	0.0043	0.0216	0.0726	16.93	1.49
29.50 m	7.00	67.00	26.00	0.00	0.00	0.00	0.00	0.0034	0.0159	0.0502	14.72	1.49
32.50 m	4.80	51.20	36.00	4.00	1.00	3.00	0.00	0.0056	0.0262	0.0874	15.51	1.39

GRAIN SIZE DISTRIBUTION CURVES

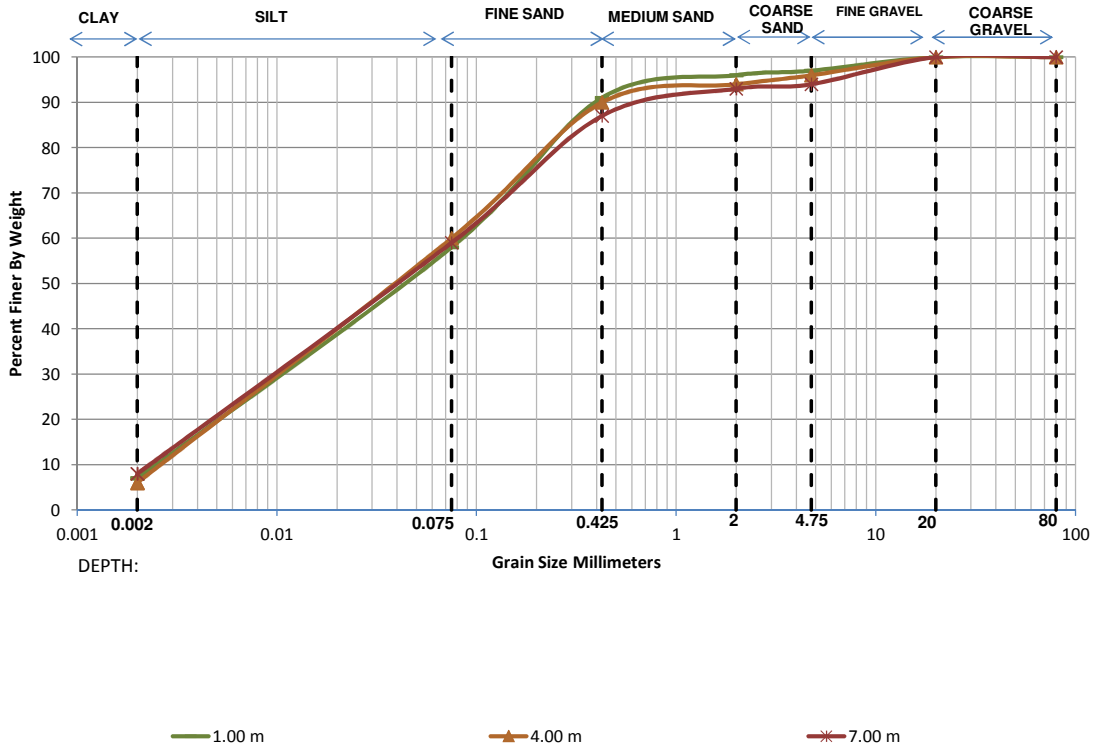
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	58+837 Minor Bridge
B.H. No.	BH-CL



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
2.50 m	0.00	38.00	55.00	6.00	1.00	0.00	0.00	0.0088	0.0519	0.1560	17.76	1.97
5.50 m	7.00	53.00	30.00	6.00	1.00	3.00	0.00	0.0035	0.0209	0.0750	21.16	1.64
8.50 m	8.00	52.00	28.00	6.00	2.00	4.00	0.00	0.0029	0.0197	0.0750	25.74	1.78

GRAIN SIZE DISTRIBUTION CURVES

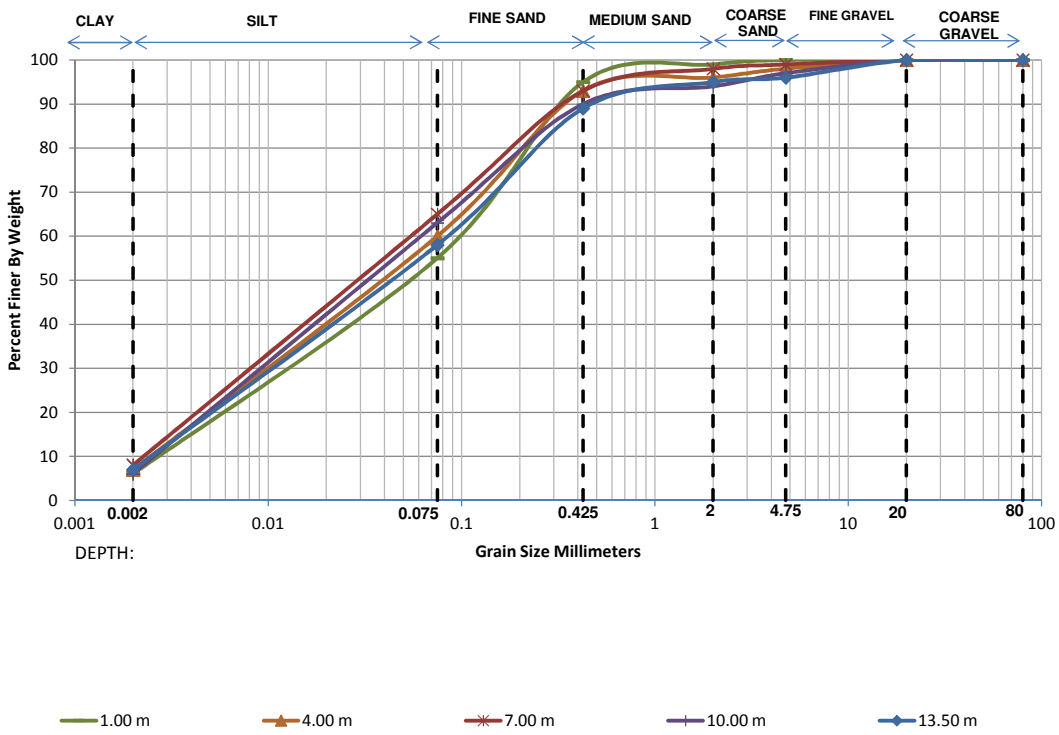
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	59+071 Minor Bridge
B.H. No.	BH-CL



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
1.00 m	7.00	51.00	33.00	5.00	1.00	3.00	0.00	0.0036	0.0221	0.0808	22.61	1.69
4.00 m	6.00	54.00	30.00	4.00	2.00	4.00	0.00	0.0043	0.0220	0.0750	17.39	1.50
7.00 m	8.00	51.00	28.00	6.00	1.00	6.00	0.00	0.0029	0.0202	0.0779	26.67	1.79

GRAIN SIZE DISTRIBUTION CURVES

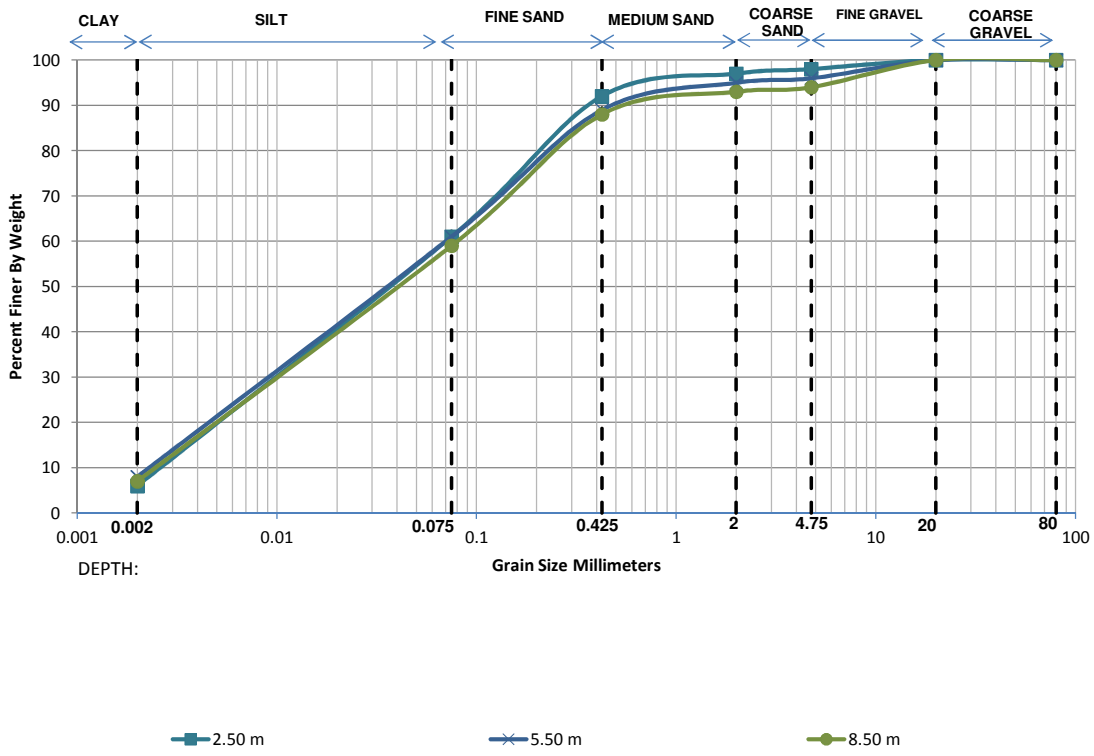
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	59+206 Minor Bridge
B.H. No.	BH-CL



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
1.00 m	6.00	49.00	40.00	4.00	1.00	0.00	0.00	0.0045	0.0255	0.0904	20.30	1.62
4.00 m	7.00	53.00	33.00	3.00	2.00	2.00	0.00	0.0035	0.0210	0.0750	21.14	1.66
7.00 m	8.00	57.00	28.00	5.00	1.00	1.00	0.00	0.0029	0.0176	0.0639	22.15	1.68
10.00 m	6.00	57.00	27.00	4.00	3.00	3.00	0.00	0.0042	0.0205	0.0682	16.05	1.46
13.50 m	7.00	51.00	31.00	6.00	1.00	4.00	0.00	0.0036	0.0220	0.0810	22.68	1.67

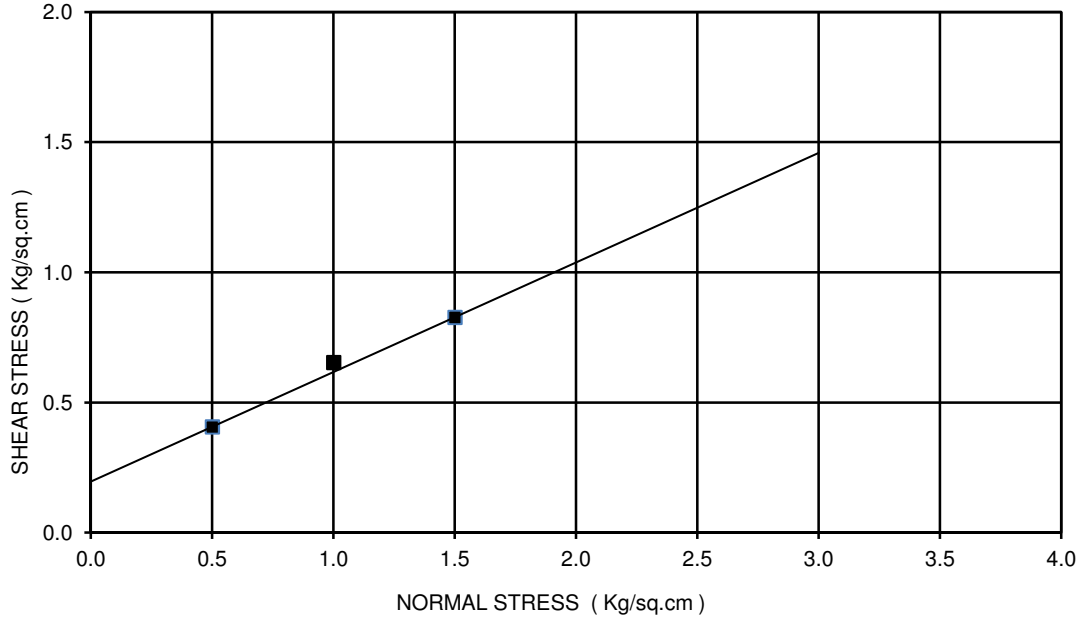
GRAIN SIZE DISTRIBUTION CURVES

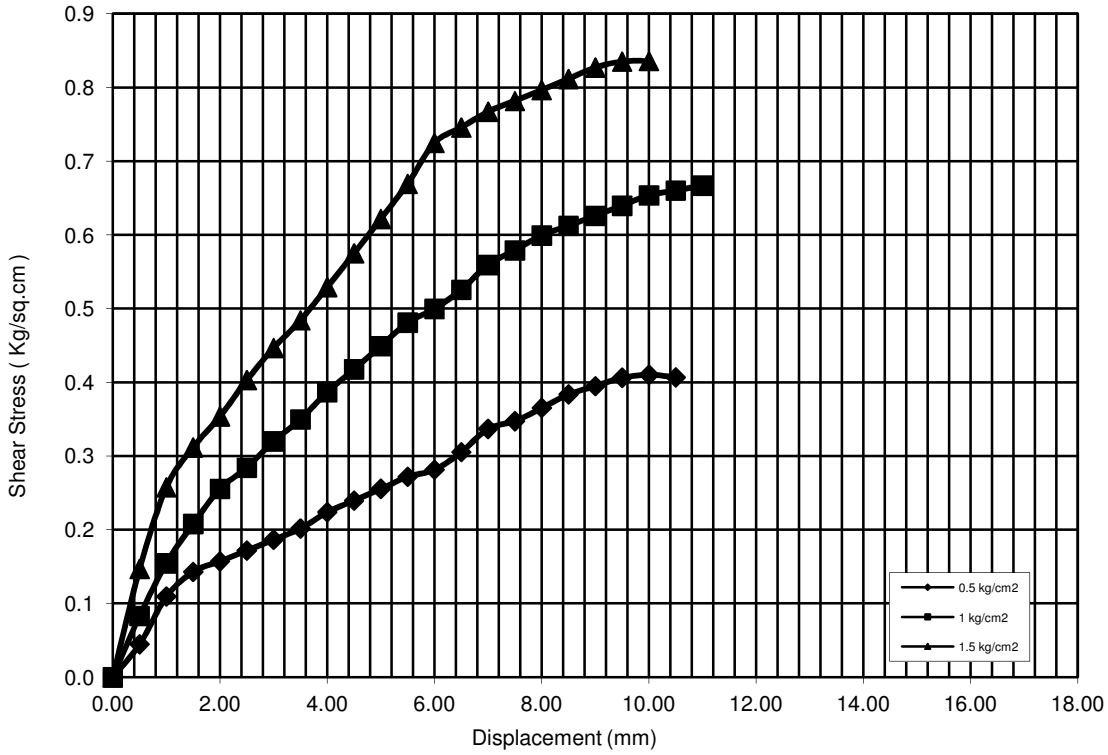
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	59+270 Minor Bridge
B.H. No.	BH-CL



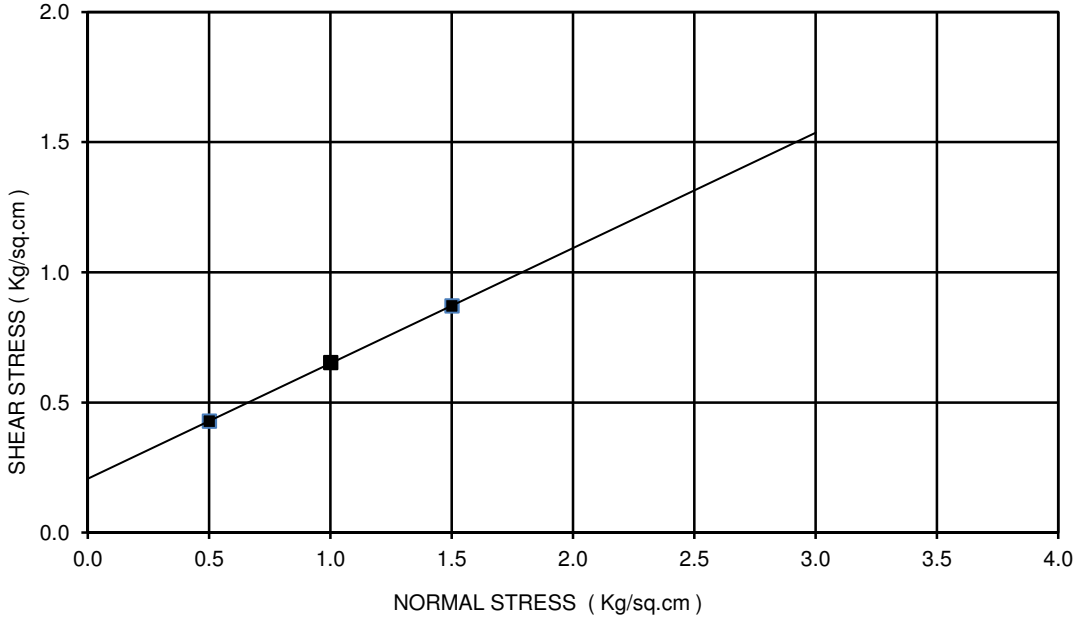
Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
2.50 m	6.00	55.00	31.00	5.00	1.00	2.00	0.00	0.0043	0.0216	0.0726	16.92	1.50
5.50 m	8.00	53.00	28.00	6.00	1.00	4.00	0.00	0.0029	0.0192	0.0725	24.95	1.75
8.50 m	7.00	52.00	29.00	5.00	1.00	6.00	0.00	0.0036	0.0213	0.0778	21.88	1.65

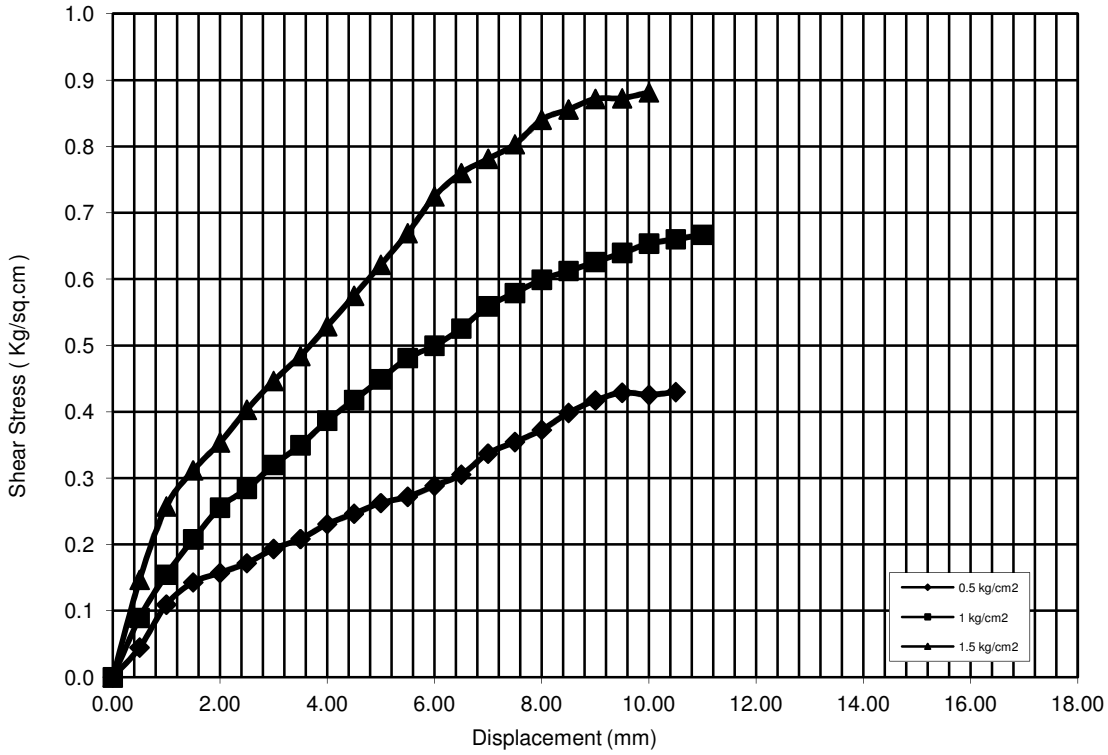
Ch. 52+518
BORE HOLE NO: BH-A1
SAMPLE NO.: UDS-4
DEPTH: 13.00 m
COHESION(C)= 0.08 kg/sq.cm
ANGLE OF FRICTION(Phi): 26 deg
TYPE OF THE TEST: DST



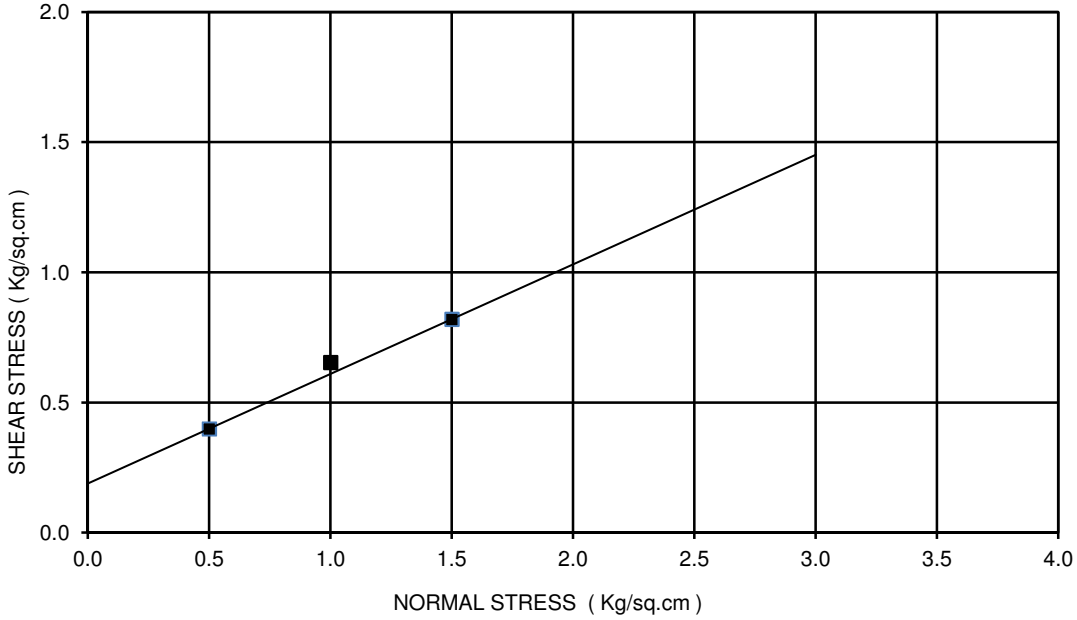


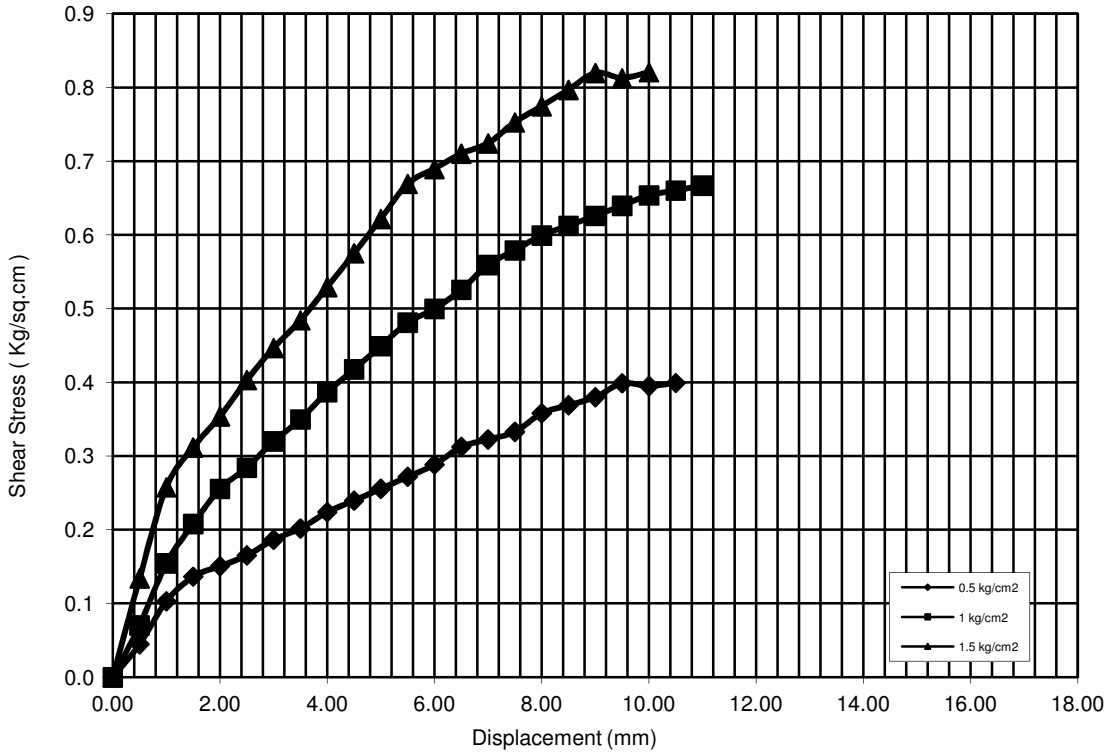
Ch. 52+518
BORE HOLE NO: BH-A1
SAMPLE NO.: UDS-4
DEPTH: 13.00 m
COHESION(C)= 0.08 kg/sq.cm
ANGLE OF FRICTION(Phi): 26 deg
TYPE OF THE TEST: DST



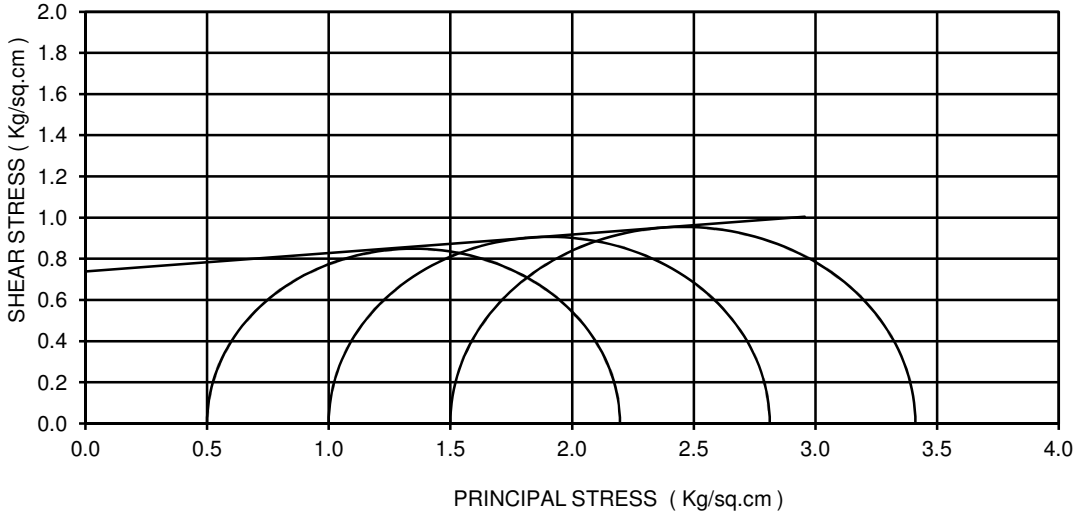


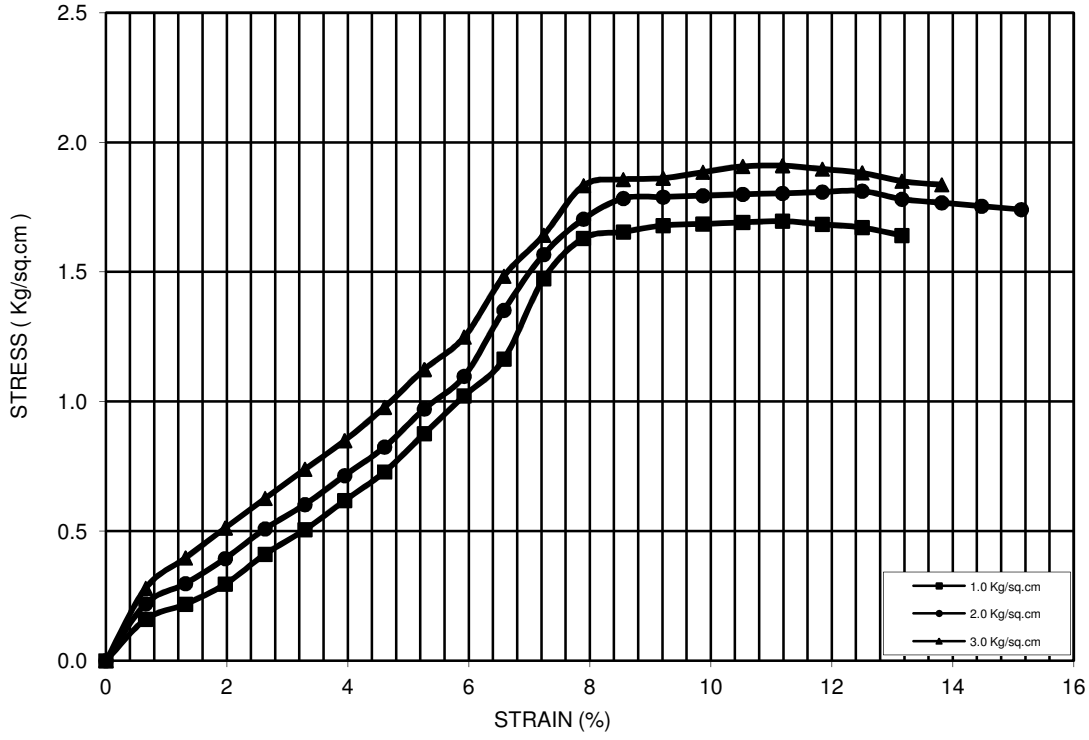
Ch. 52+518
BORE HOLE NO: BH-A2
SAMPLE NO.: UDS-4
DEPTH: 13.00 m
COHESION(C)= 0.08 kg/sq.cm
ANGLE OF FRICTION(Phi): 26 deg
TYPE OF THE TEST: DST



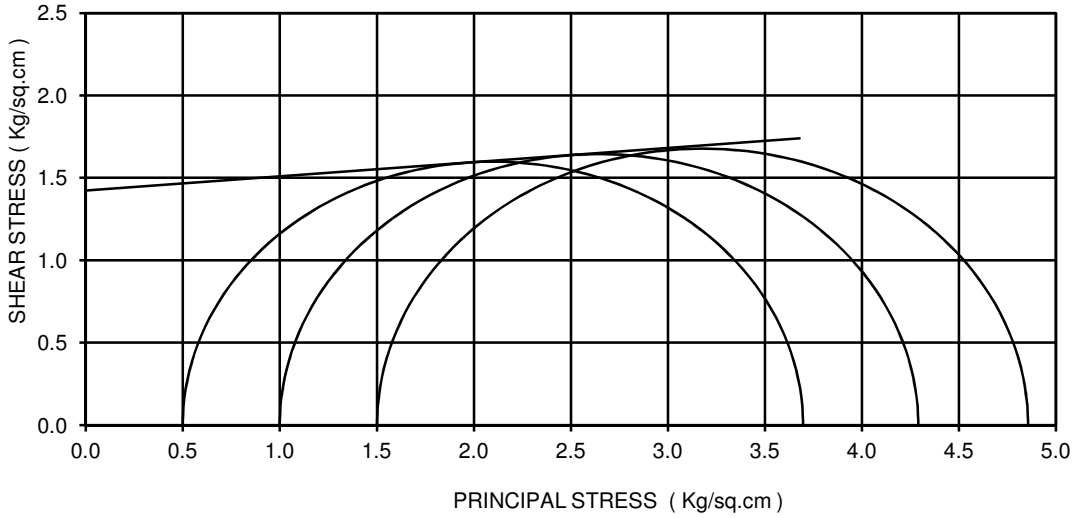


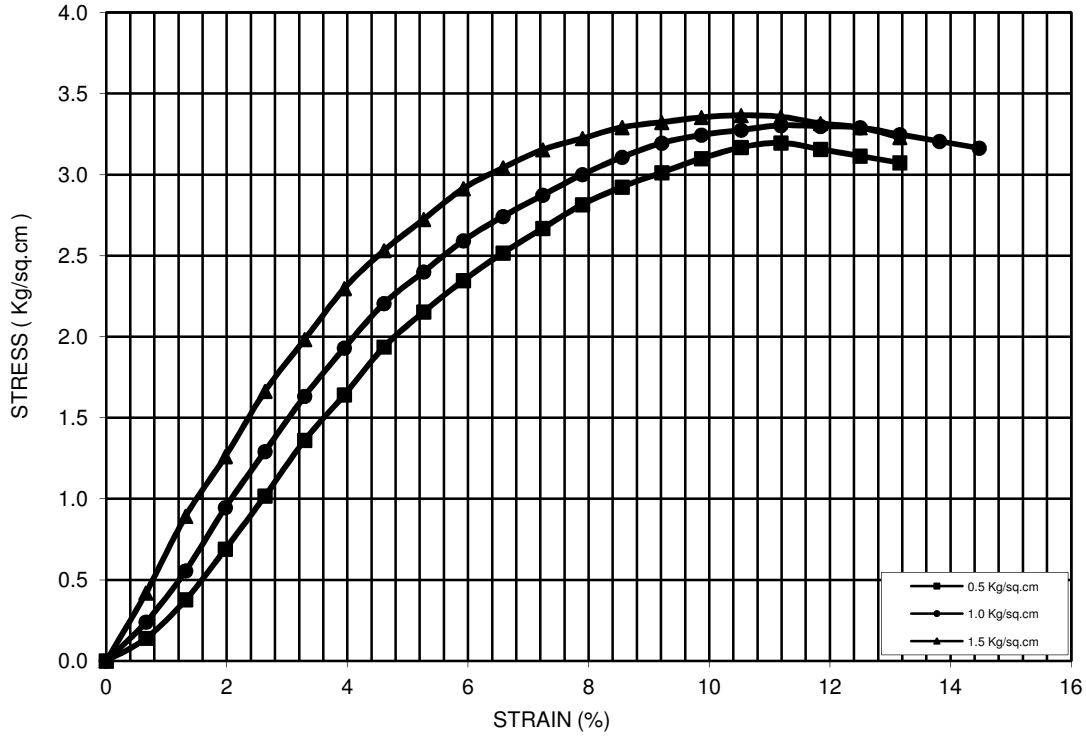
Ch. 52+518
BORE HOLE NO: BH-A2
SAMPLE NO.: UDS-5
DEPTH: 16.00 m
COHESION(C)= 0.62 kg/sq.cm
ANGLE OF FRICTION(Phi): 11 deg
TYPE OF THE TEST: UUT



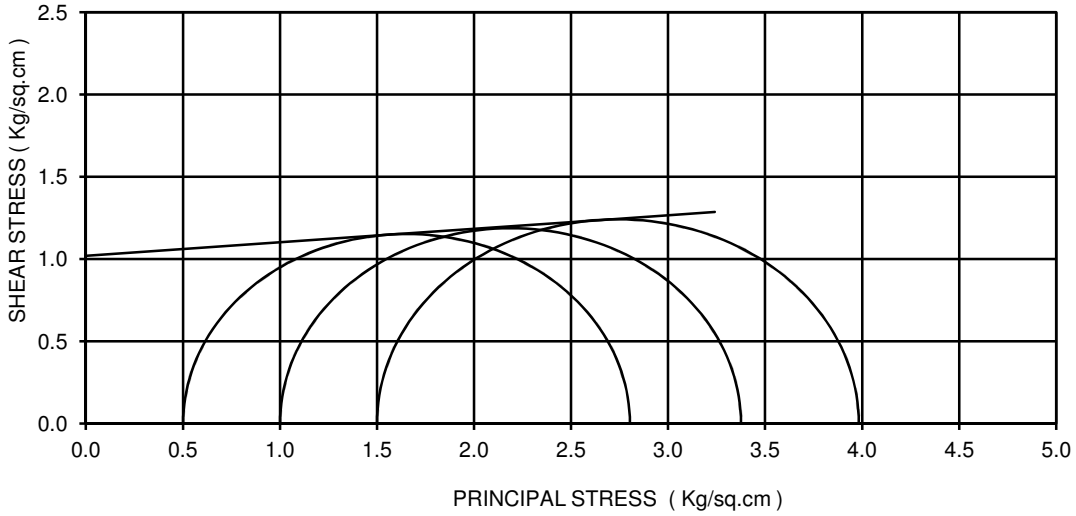


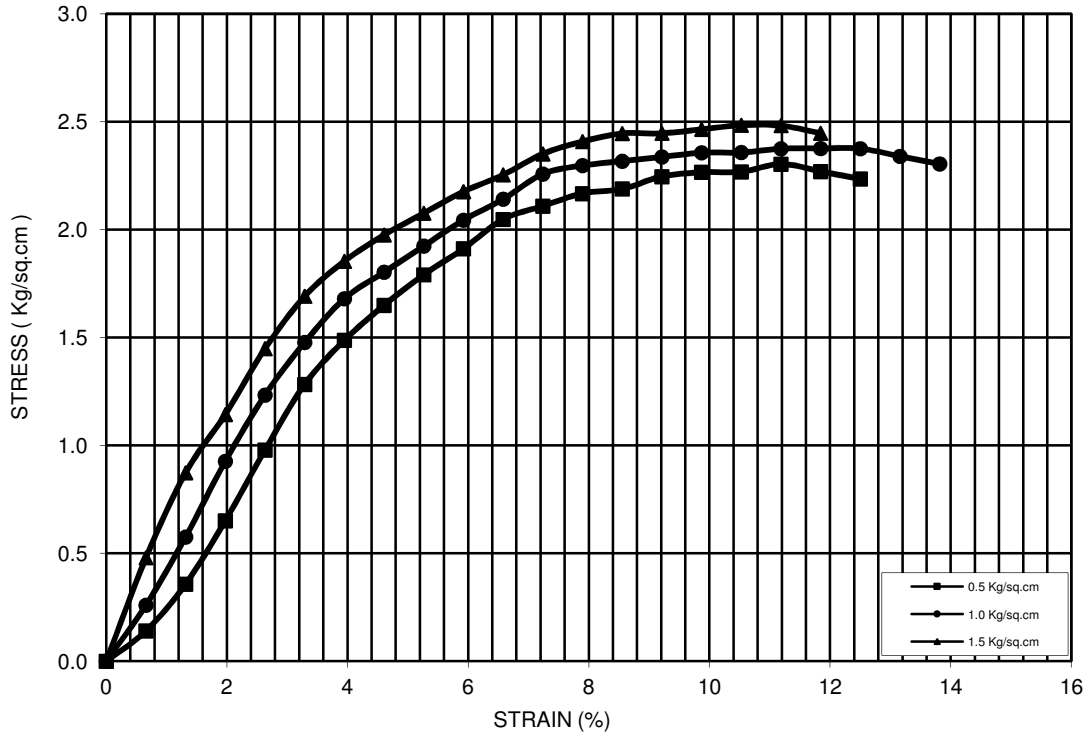
Ch. 53+107
BORE HOLE NO: BH-CL
SAMPLE NO.: UDS-1
DEPTH: 5.25 m
COHESION(C)= 1.42 kg/sq.cm
ANGLE OF FRICTION(Phi): 5 deg
TYPE OF THE TEST: UUT



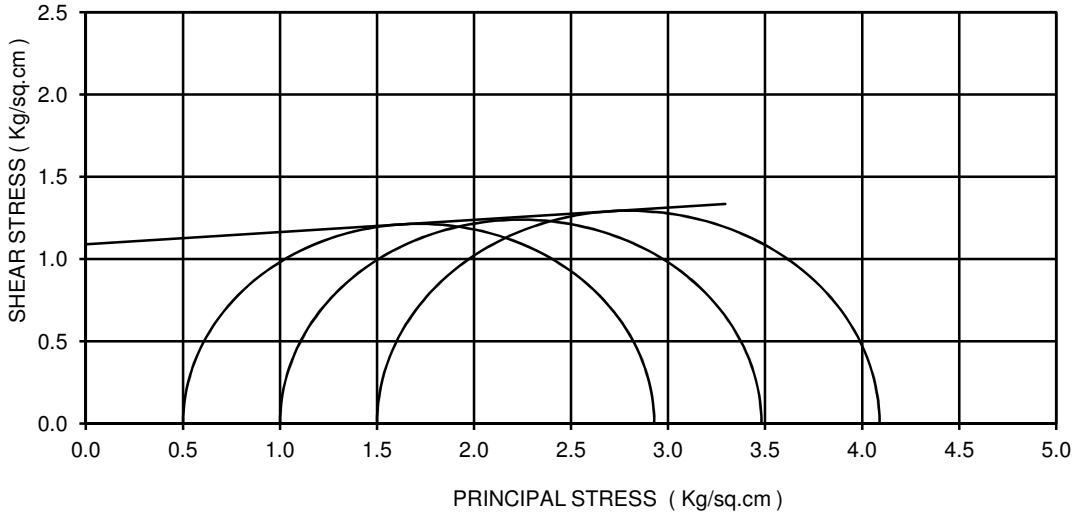


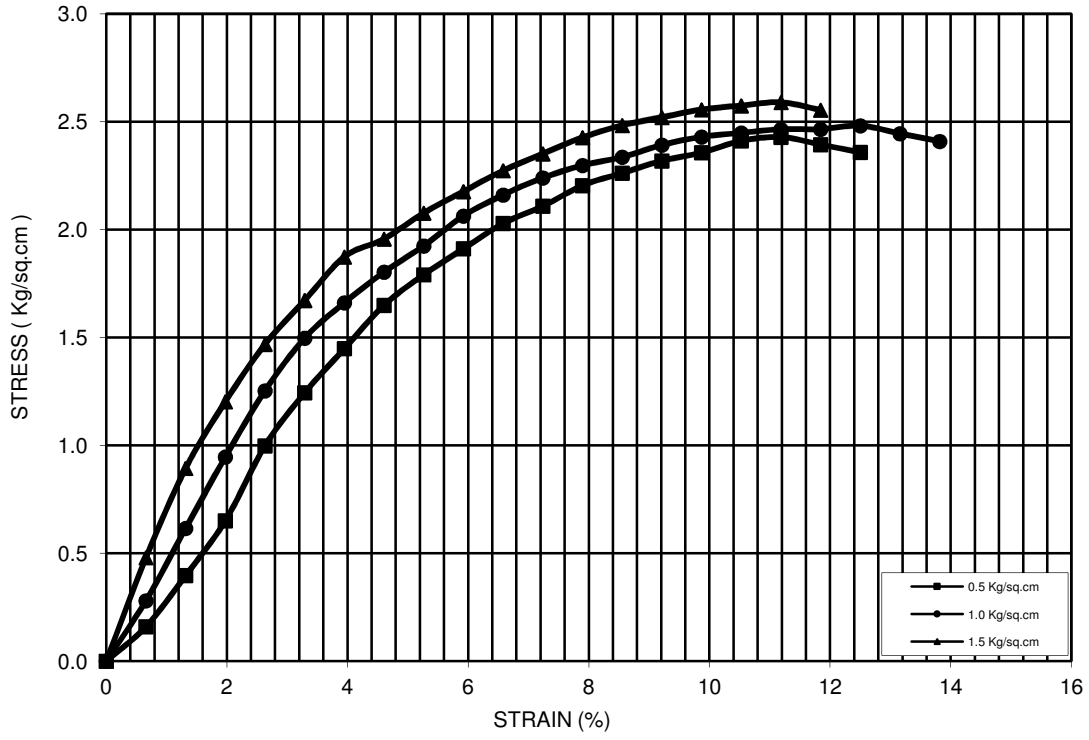
Ch. 53+282
BORE HOLE NO: BH-CL
SAMPLE NO.: UDS-1
DEPTH: 5.25 m
COHESION(C)= 1.02 kg/sq.cm
ANGLE OF FRICTION(Phi): 5 deg
TYPE OF THE TEST: UUT



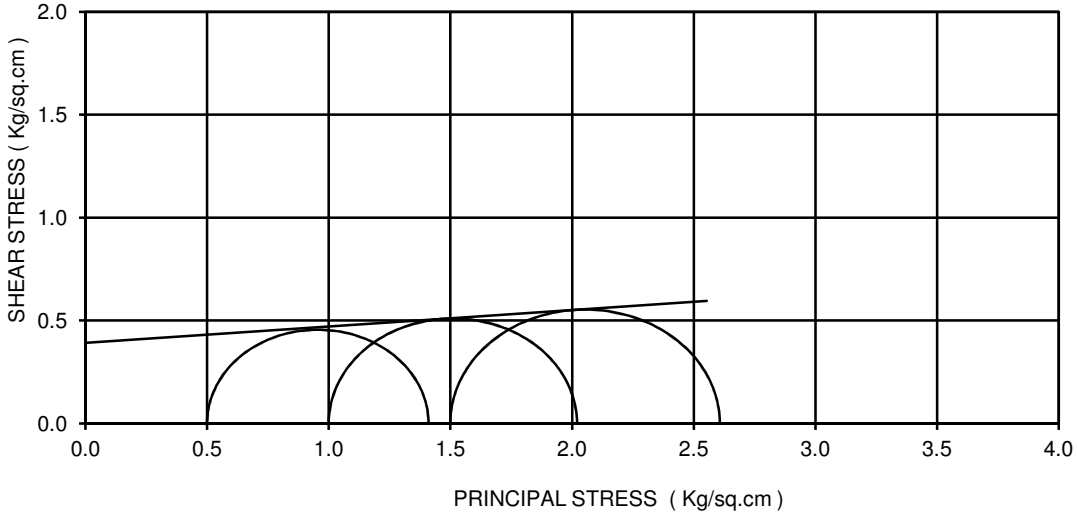


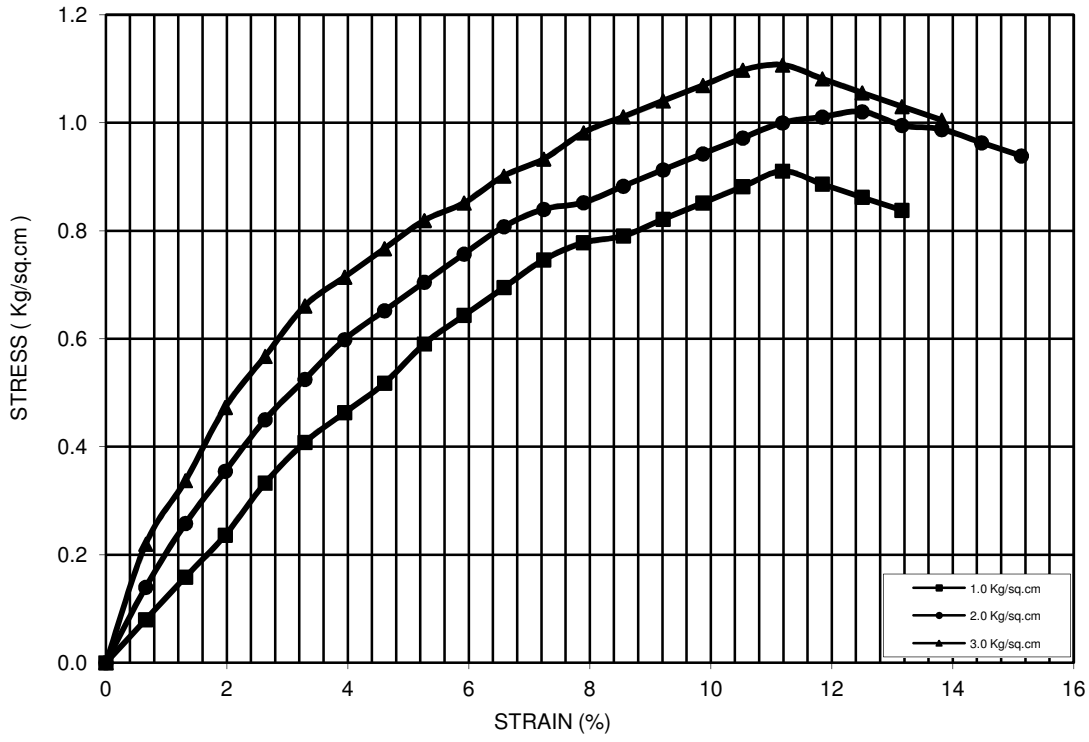
Ch. 53+572
BORE HOLE NO: BH-CL
SAMPLE NO.: UDS-1
DEPTH: 5.25 m
COHESION(C)= 1.09 kg/sq.cm
ANGLE OF FRICTION(Phi): 4 deg
TYPE OF THE TEST: UUT



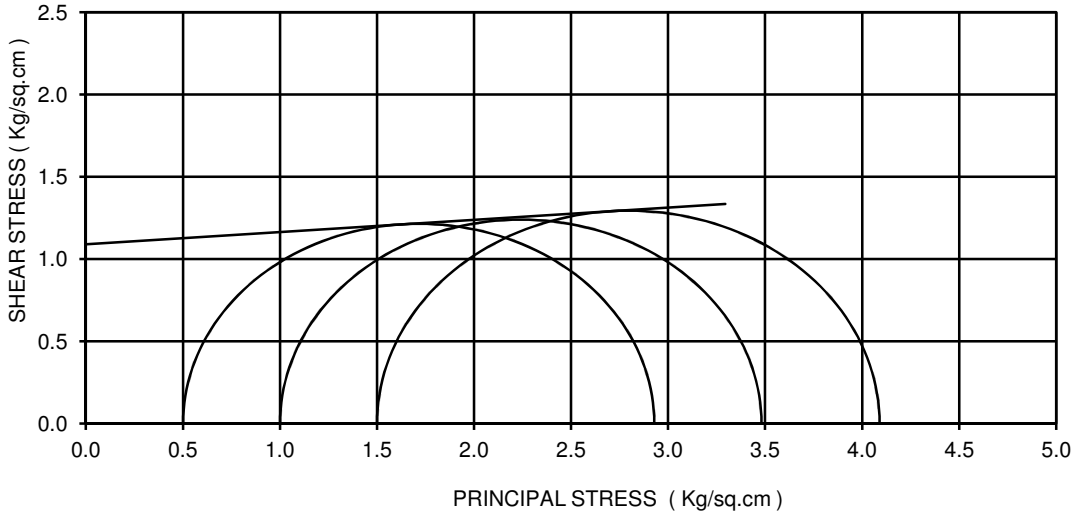


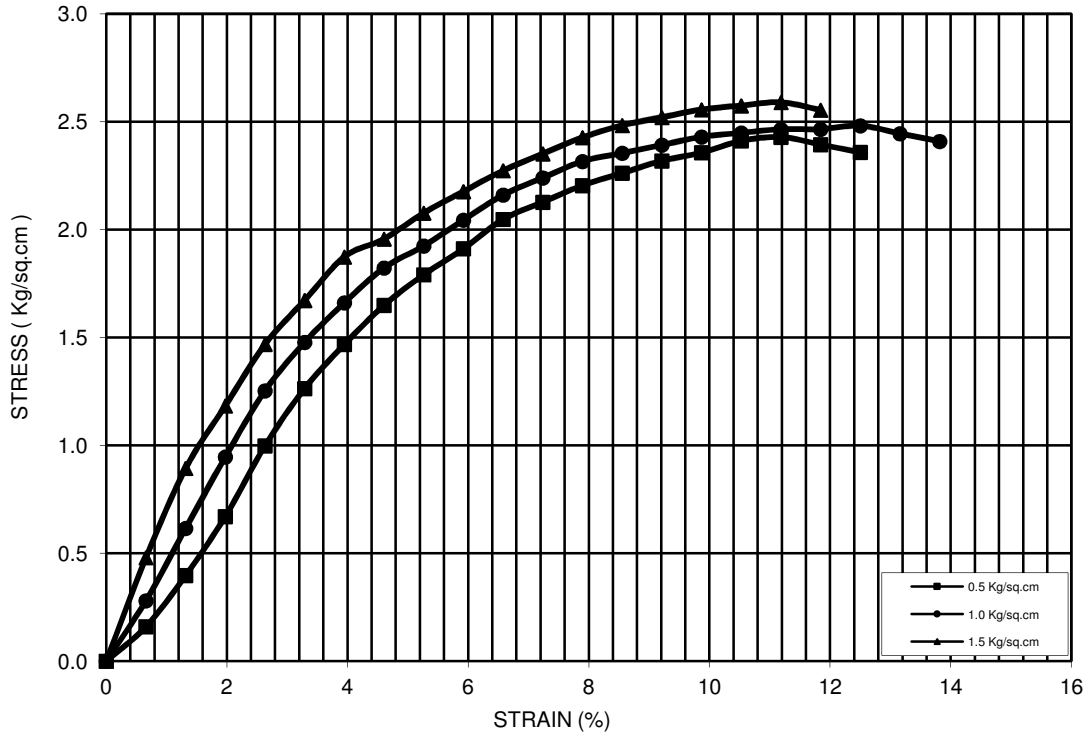
Ch. 53+982
BORE HOLE NO: BH-CL
SAMPLE NO.: UDS-1
DEPTH: 2.25 m
COHESION(C)= 0.39 kg/sq.cm
ANGLE OF FRICTION(Phi): 5 deg
TYPE OF THE TEST: UUT



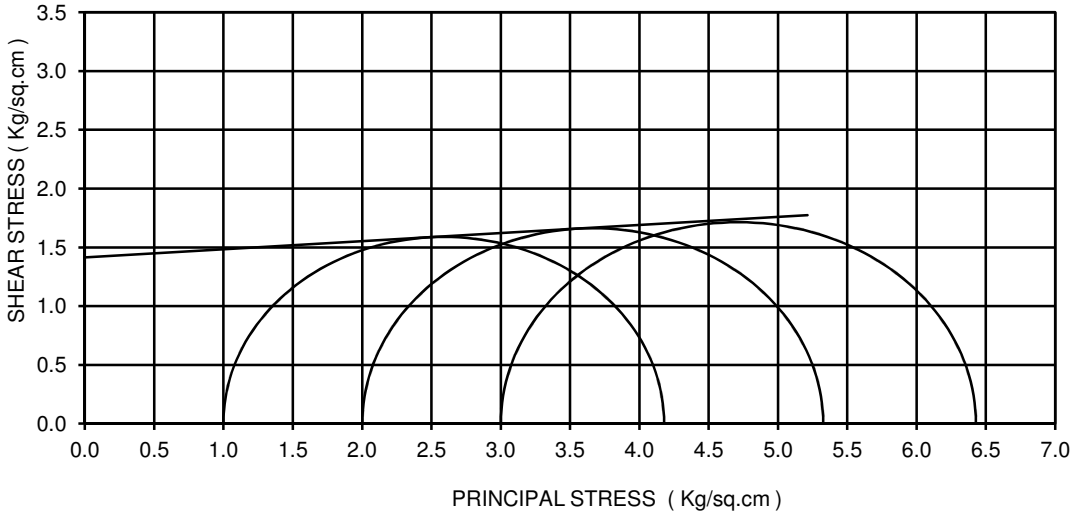


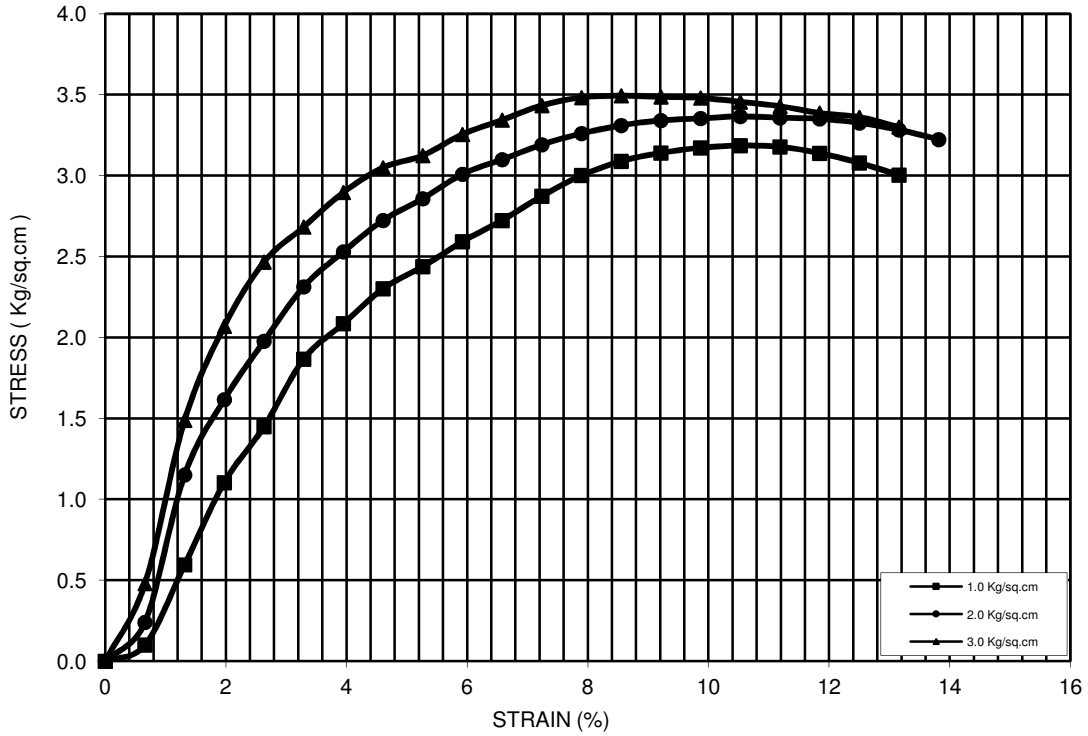
Ch. 54+363
BORE HOLE NO: BH-CL
SAMPLE NO.: UDS-1
DEPTH: 5.25 m
COHESION(C)= 1.09 kg/sq.cm
ANGLE OF FRICTION(Phi): 4 deg
TYPE OF THE TEST: UUT



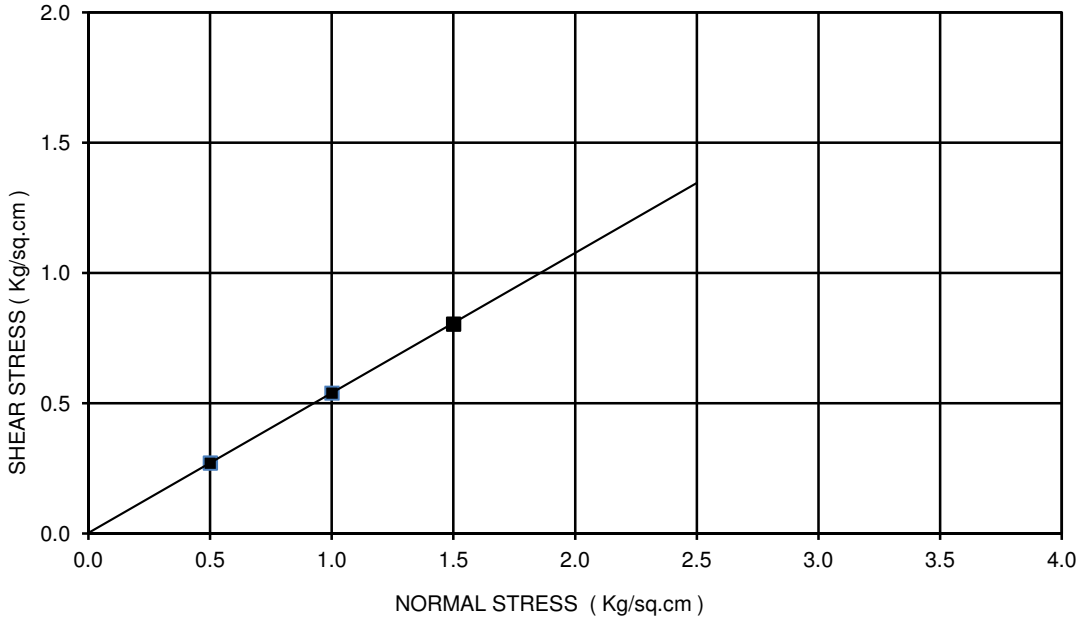


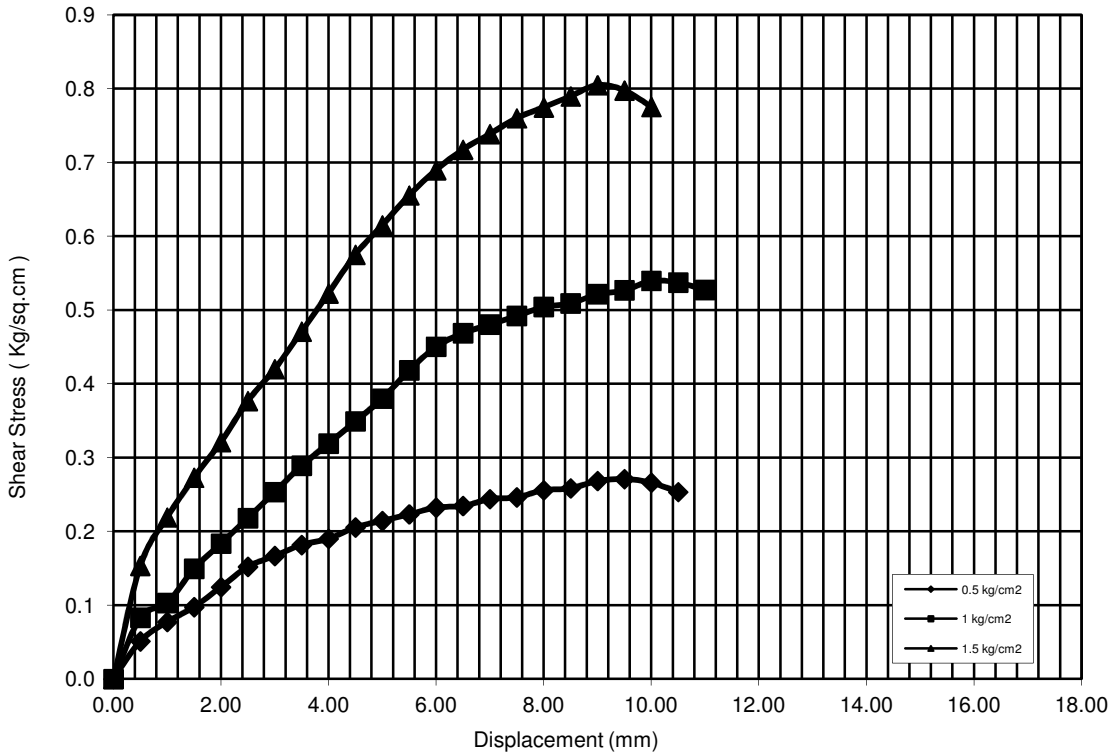
Ch. 54+496
BORE HOLE NO: BH-CL
SAMPLE NO.: UDS-3
DEPTH: 11.25 m
COHESION(C)= 1.42 kg/sq.cm
ANGLE OF FRICTION(Phi): 4 deg
TYPE OF THE TEST: UUT



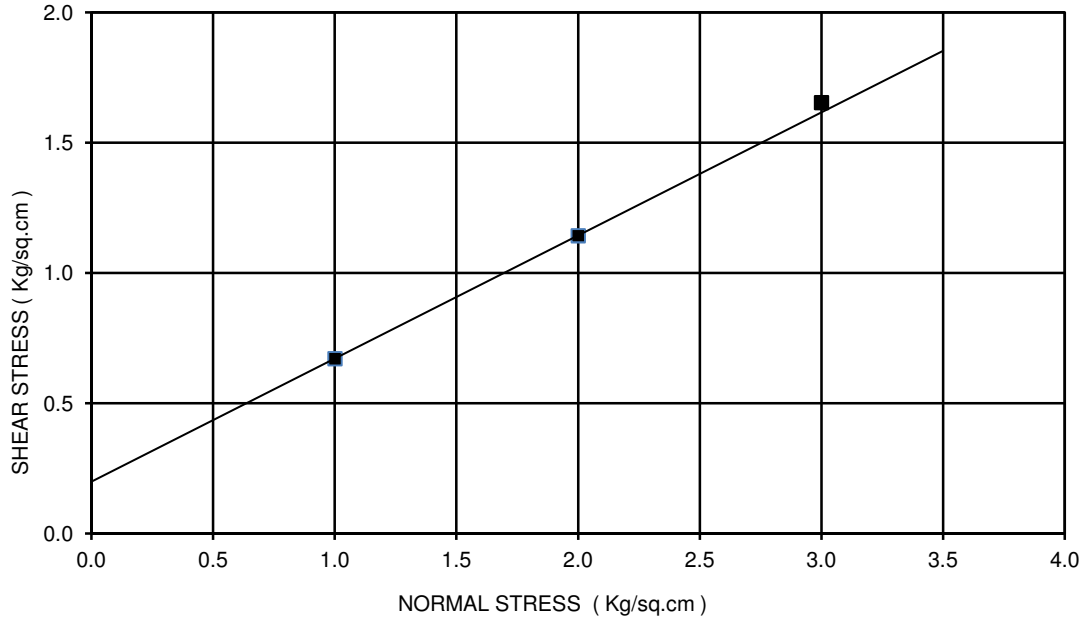


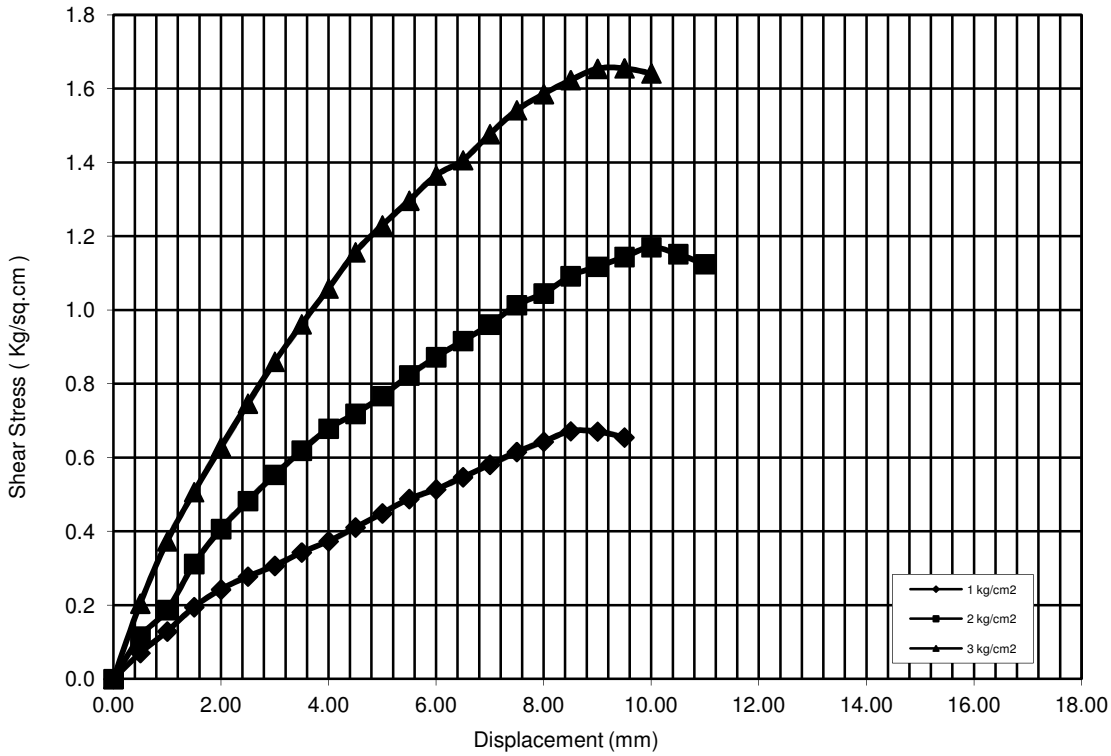
Ch. 55+910
BORE HOLE NO: BH-A1
SAMPLE NO.: UDS-1
DEPTH: 2.5 m
COHESION(C)= 0.09 kg/sq.cm
ANGLE OF FRICTION(Phi): 26 deg
TYPE OF THE TEST: DST



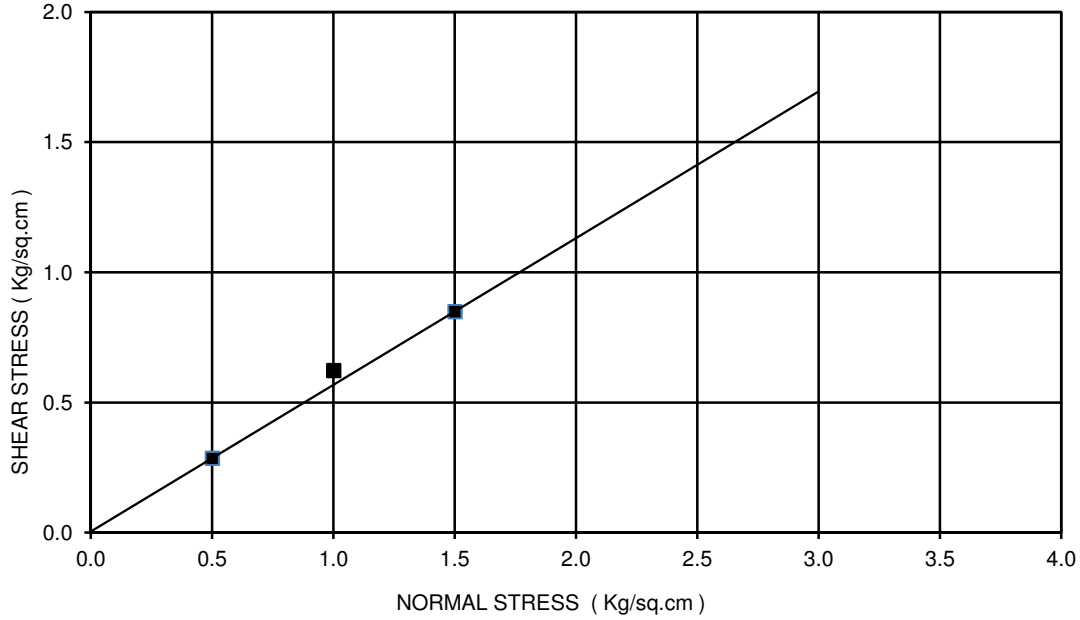


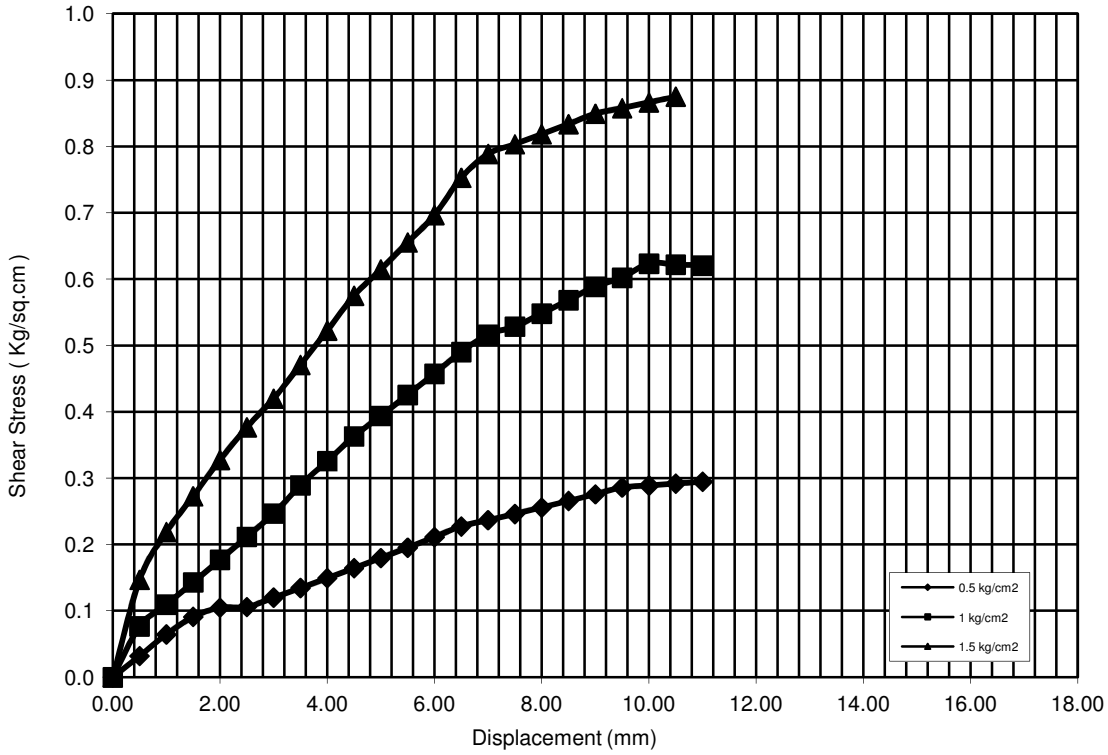
Ch. 55+910
BORE HOLE NO: BH-A1
SAMPLE NO.: UDS-4
DEPTH: 13.00 m
COHESION(C)= 0.08 kg/sq.cm
ANGLE OF FRICTION(Phi): 26 deg
TYPE OF THE TEST: DST



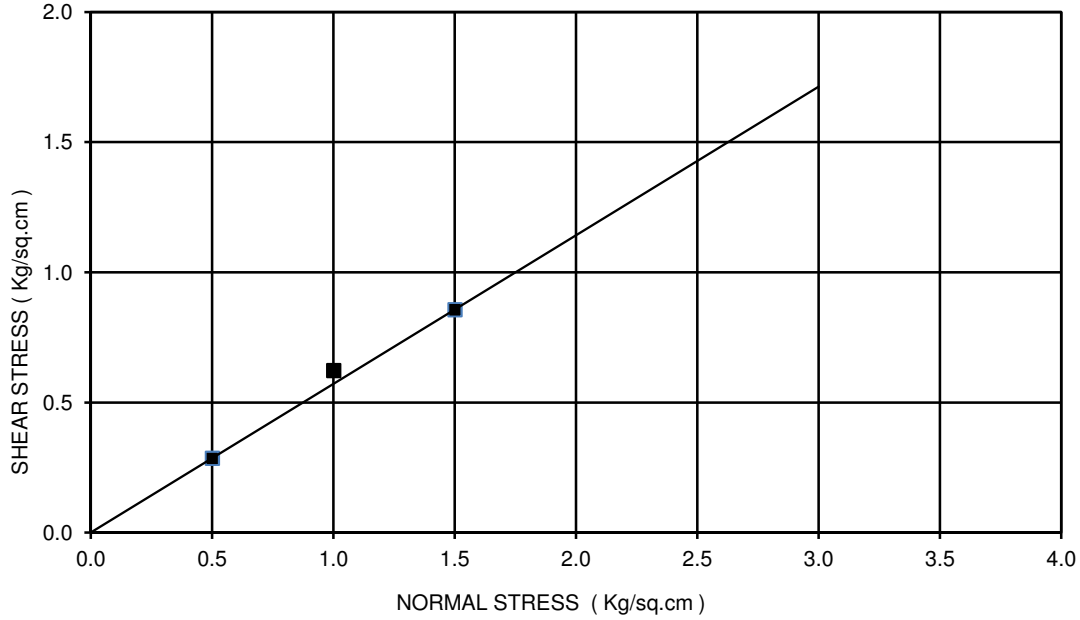


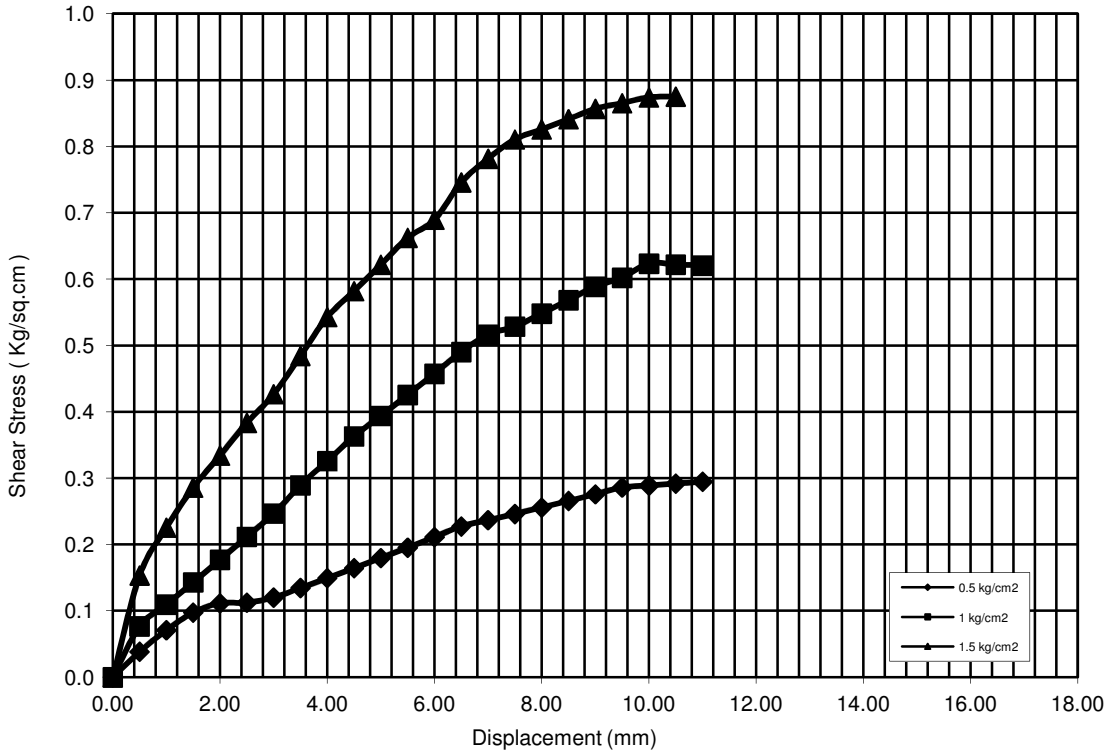
Ch. 55+910
BORE HOLE NO: BH-A2
SAMPLE NO.: UDS-1
DEPTH: 4.00 m
COHESION(C)= 0.08 kg/sq.cm
ANGLE OF FRICTION(Phi): 27 deg
TYPE OF THE TEST: DST



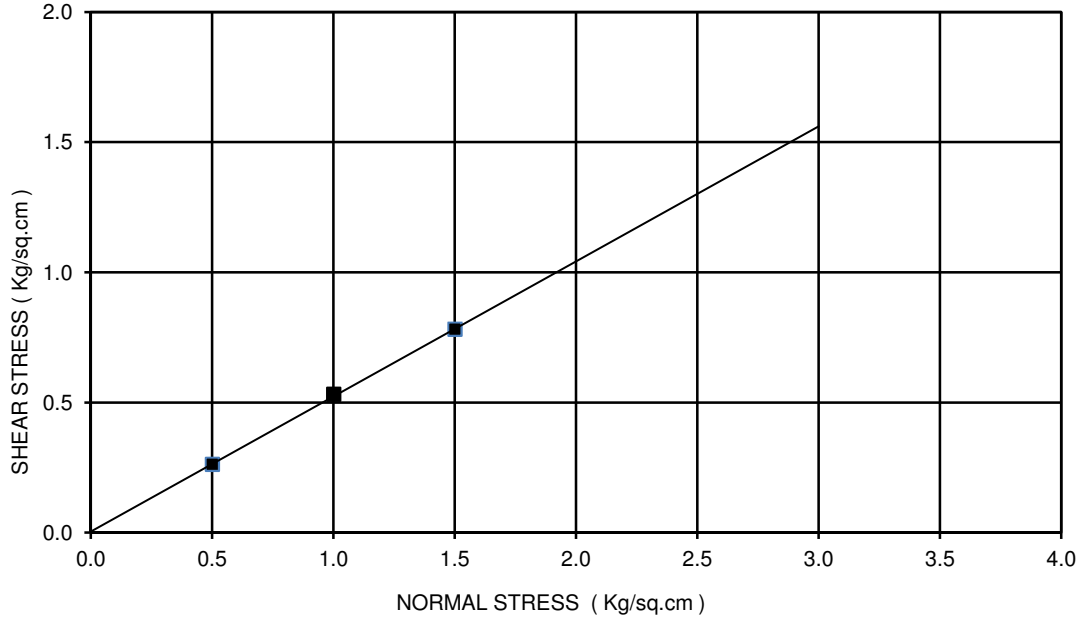


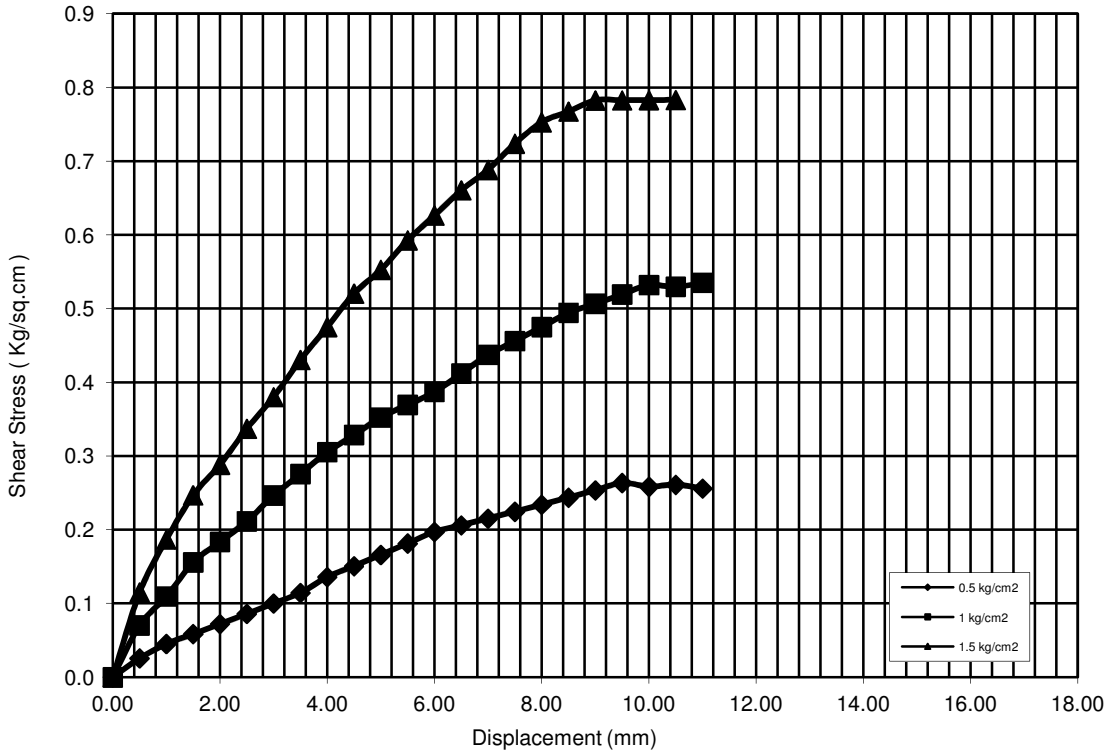
Ch. 55+910
BORE HOLE NO: BH-A2
SAMPLE NO.: UDS-1
DEPTH: 4.00 m
COHESION(C)= 0.08 kg/sq.cm
ANGLE OF FRICTION(Phi): 27 deg
TYPE OF THE TEST: DST



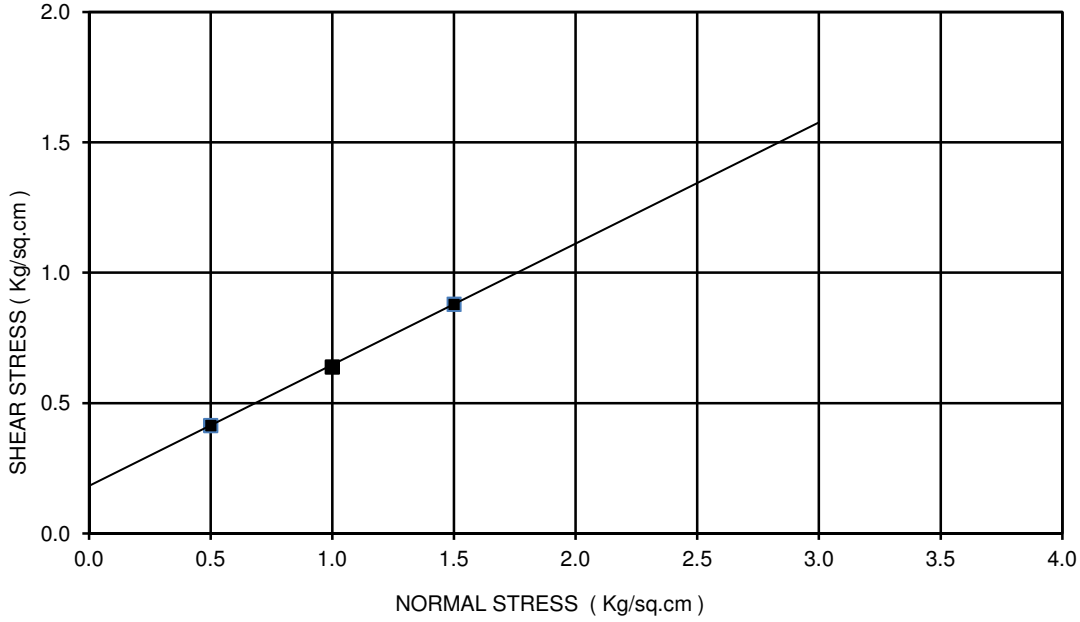


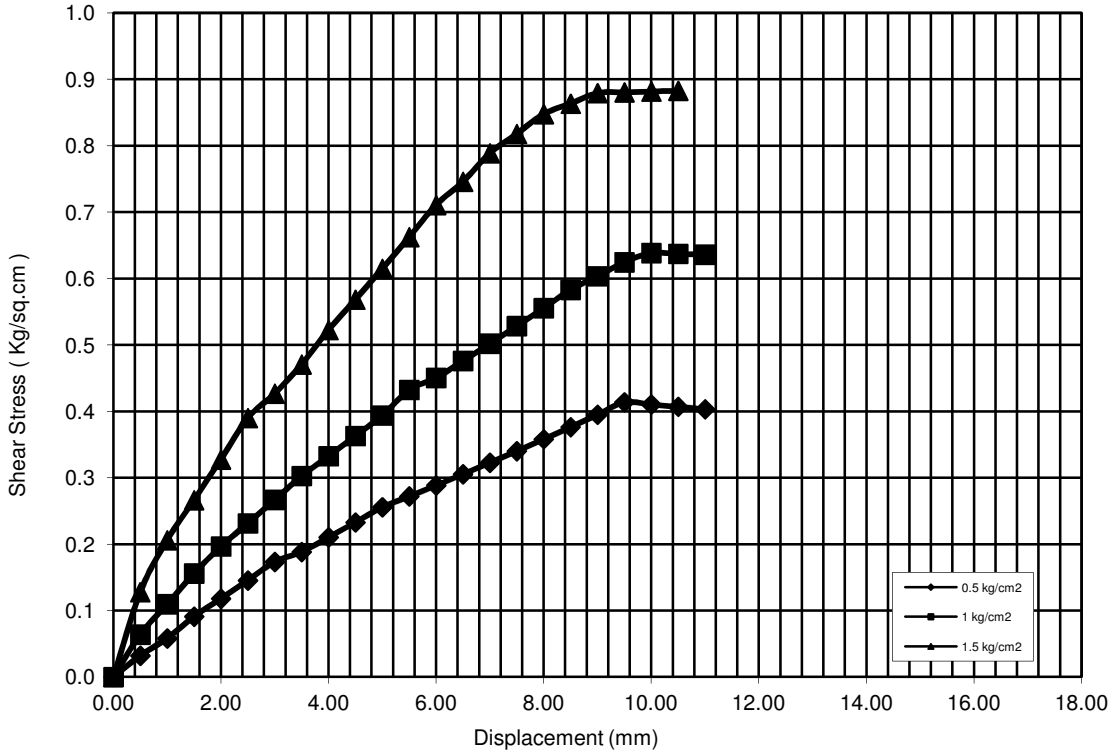
Ch. 56+403
BORE HOLE NO: BH-CL
SAMPLE NO.: UDS-1
DEPTH: 2.50 m
COHESION(C)= 0.00 kg/sq.cm
ANGLE OF FRICTION(Phi): 27 deg
TYPE OF THE TEST: DST



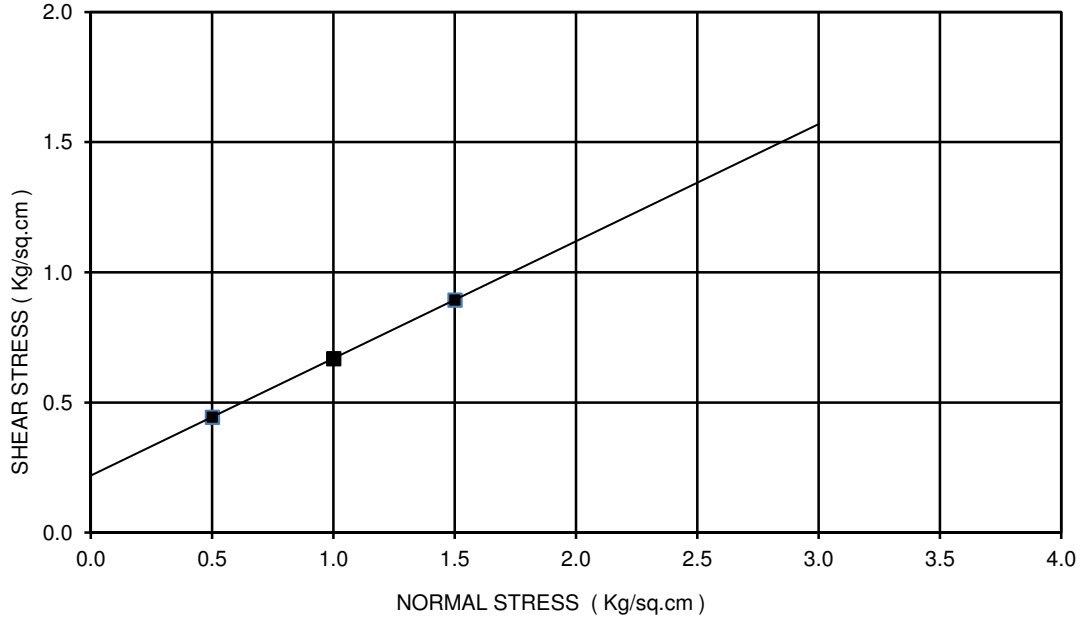


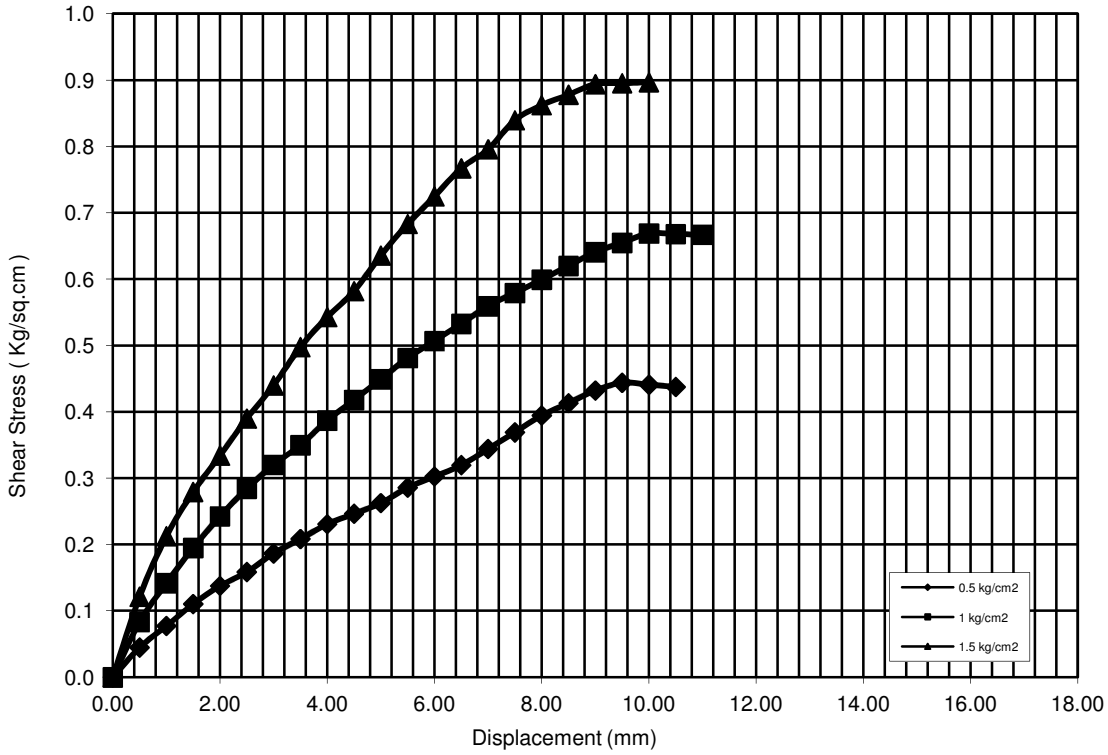
Ch. 56+701
BORE HOLE NO: BH-CL
SAMPLE NO.: UDS-1
DEPTH: 2.25 m
COHESION(C)= 0.18 kg/sq.cm
ANGLE OF FRICTION(Phi): 25 deg
TYPE OF THE TEST: DST



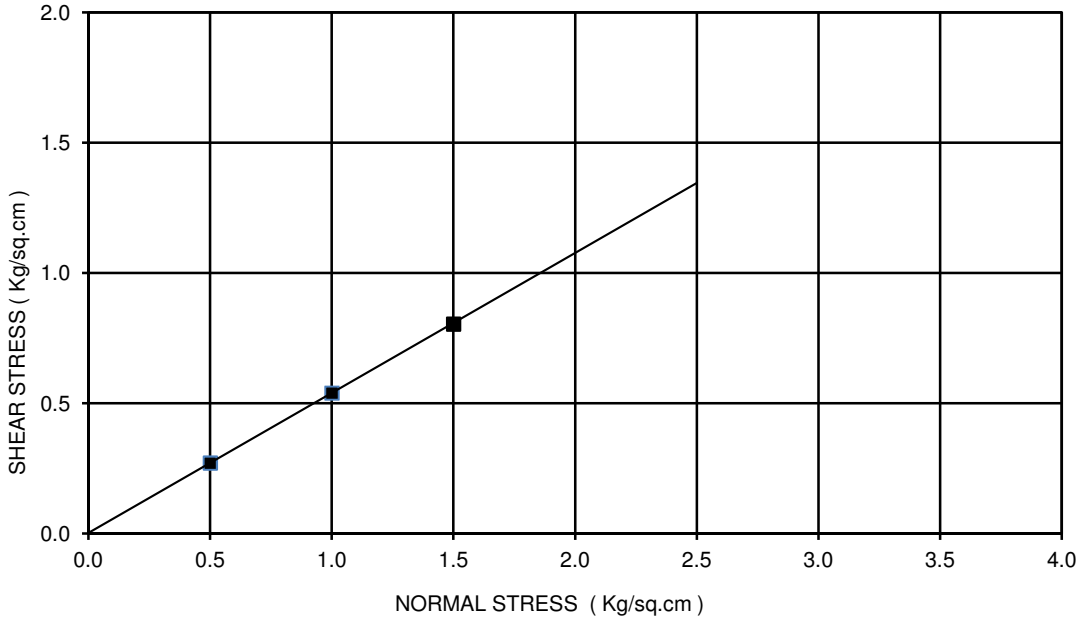


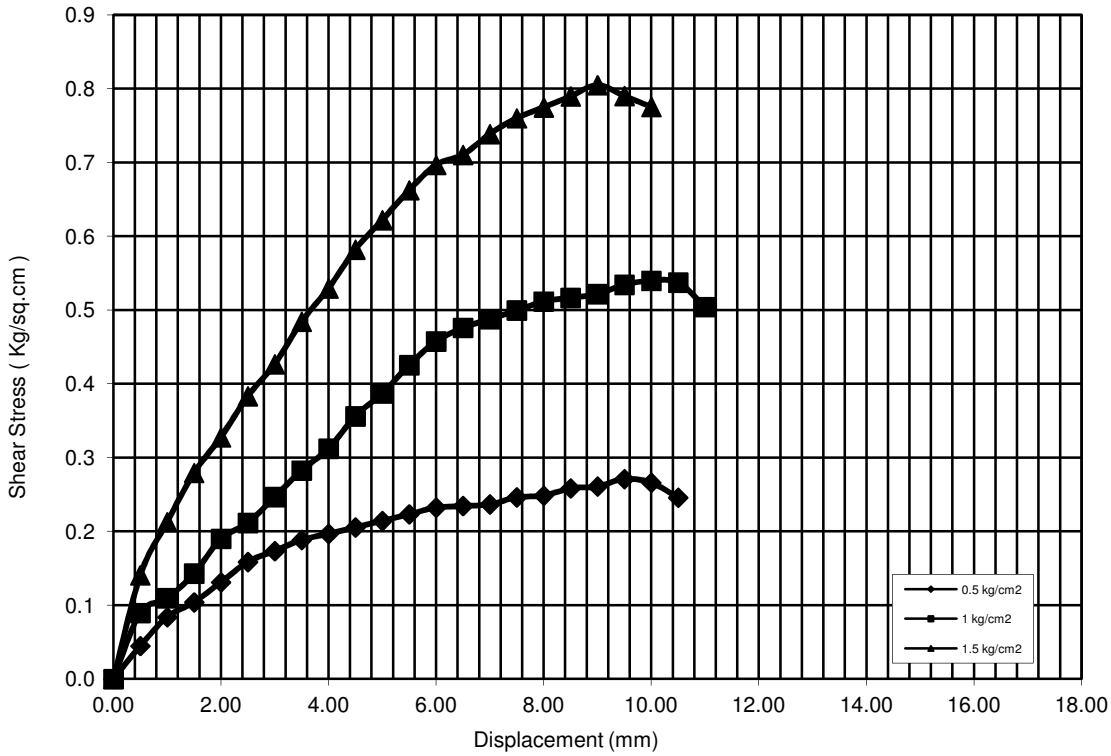
Ch. 56+978
BORE HOLE NO: BH-CL
SAMPLE NO.: UDS-1
DEPTH: 2.25 m
COHESION(C)= 0.22 kg/sq.cm
ANGLE OF FRICTION(Phi): 24 deg
TYPE OF THE TEST: DST



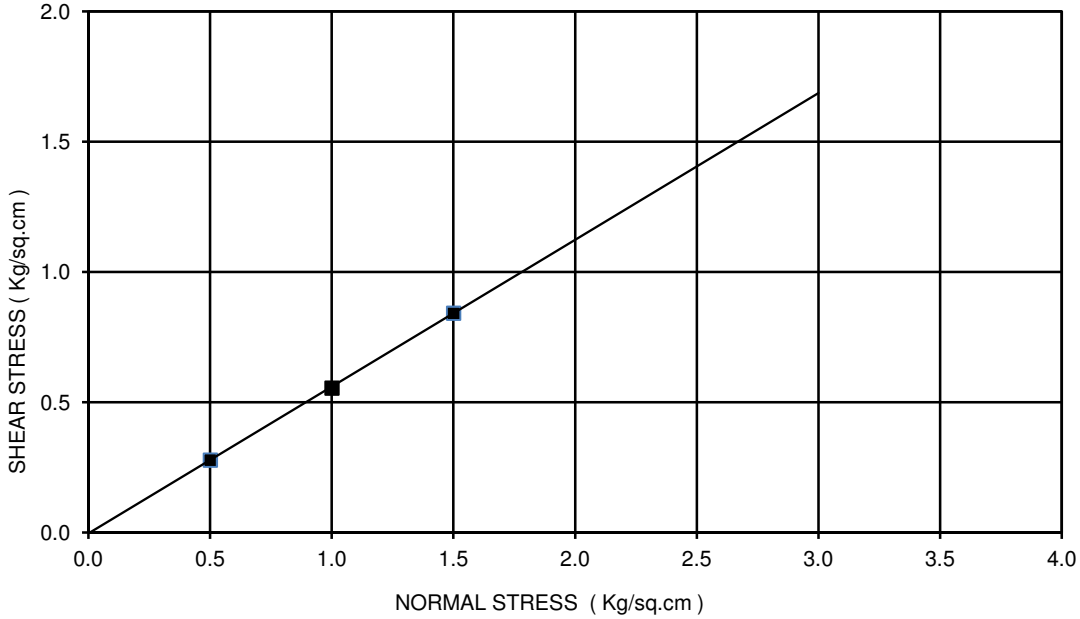


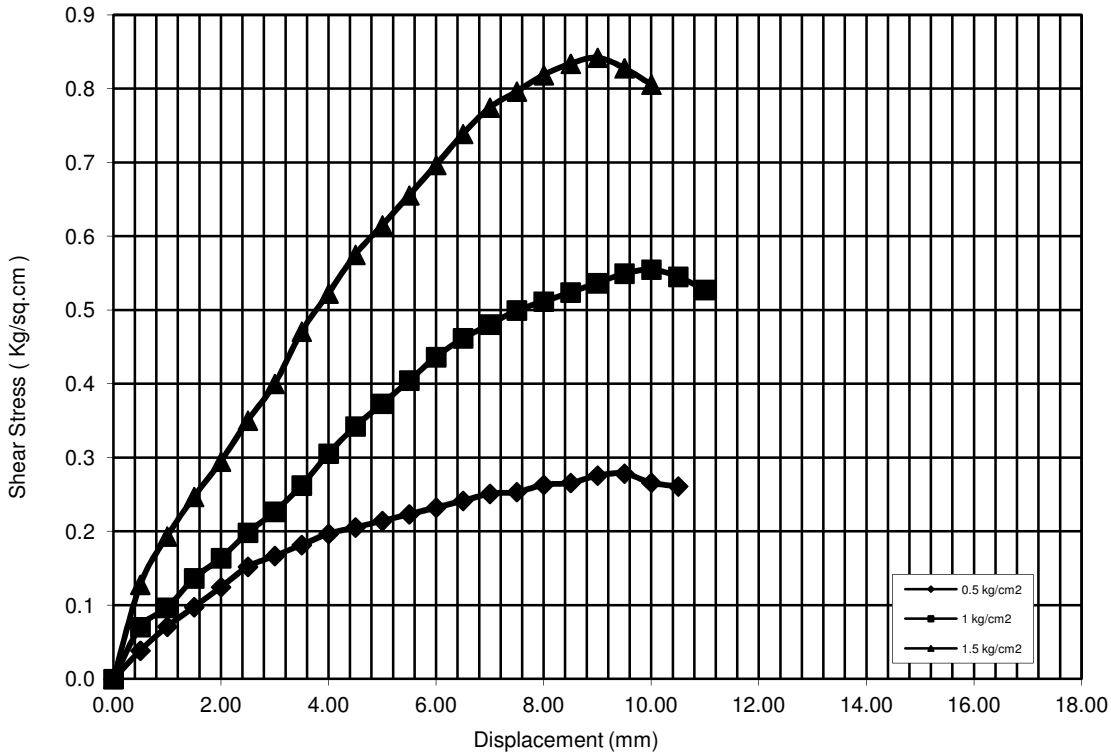
Ch. 57+400
BORE HOLE NO: P5
SAMPLE NO.: UDS-1
DEPTH: 2.5 m
COHESION(C)= 0.09 kg/sq.cm
ANGLE OF FRICTION(Phi): 26 deg
TYPE OF THE TEST: DST



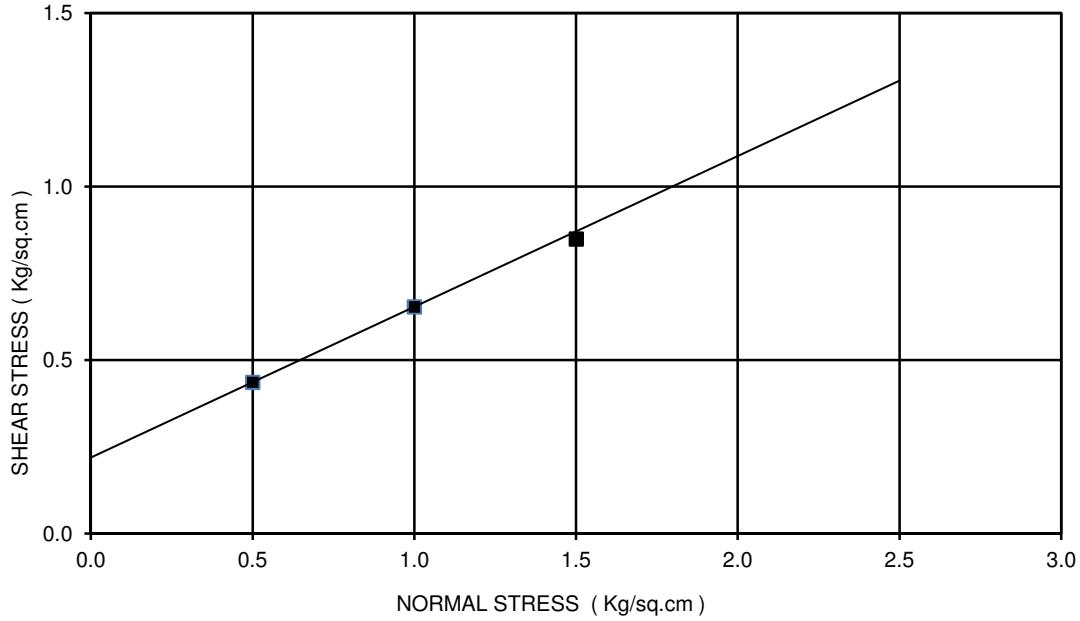


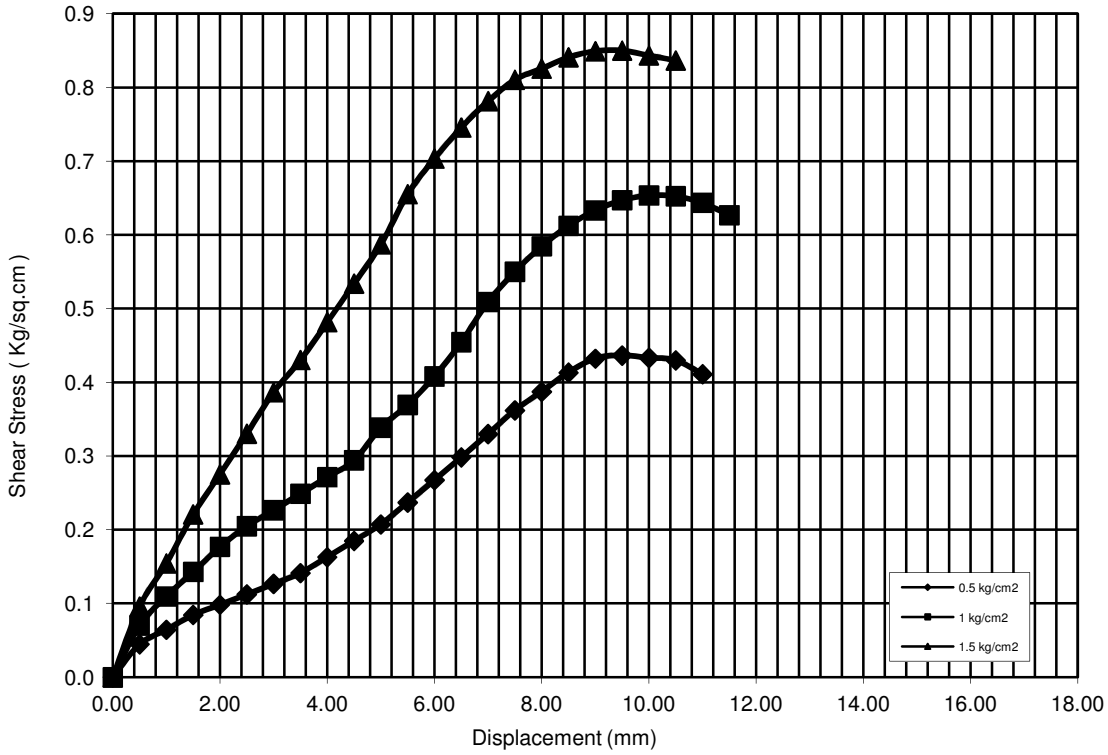
Ch. 57+400
BORE HOLE NO: BH-P5
SAMPLE NO.: UDS-1
DEPTH: 4.00 m
COHESION(C)= 0.08 kg/sq.cm
ANGLE OF FRICTION(Phi): 27 deg
TYPE OF THE TEST: DST



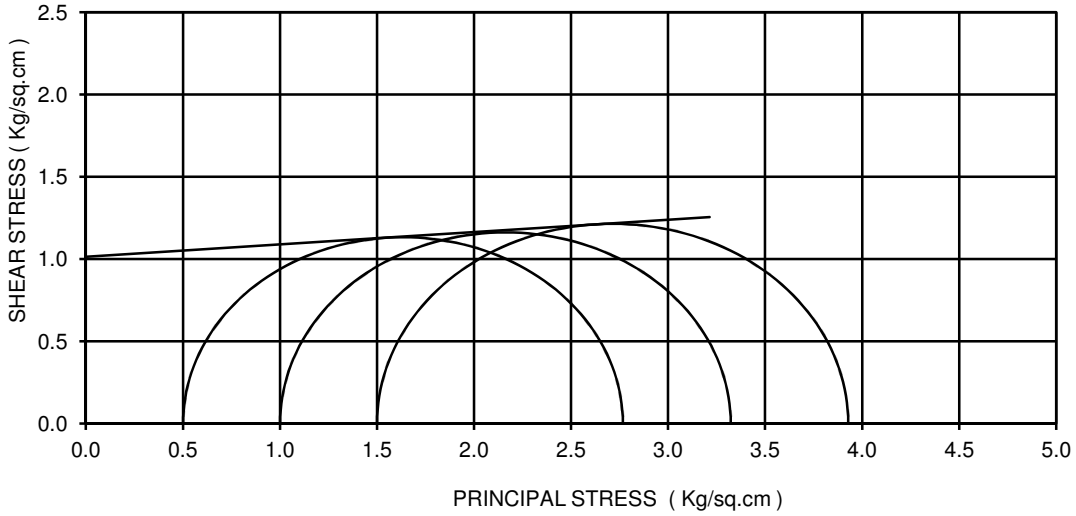


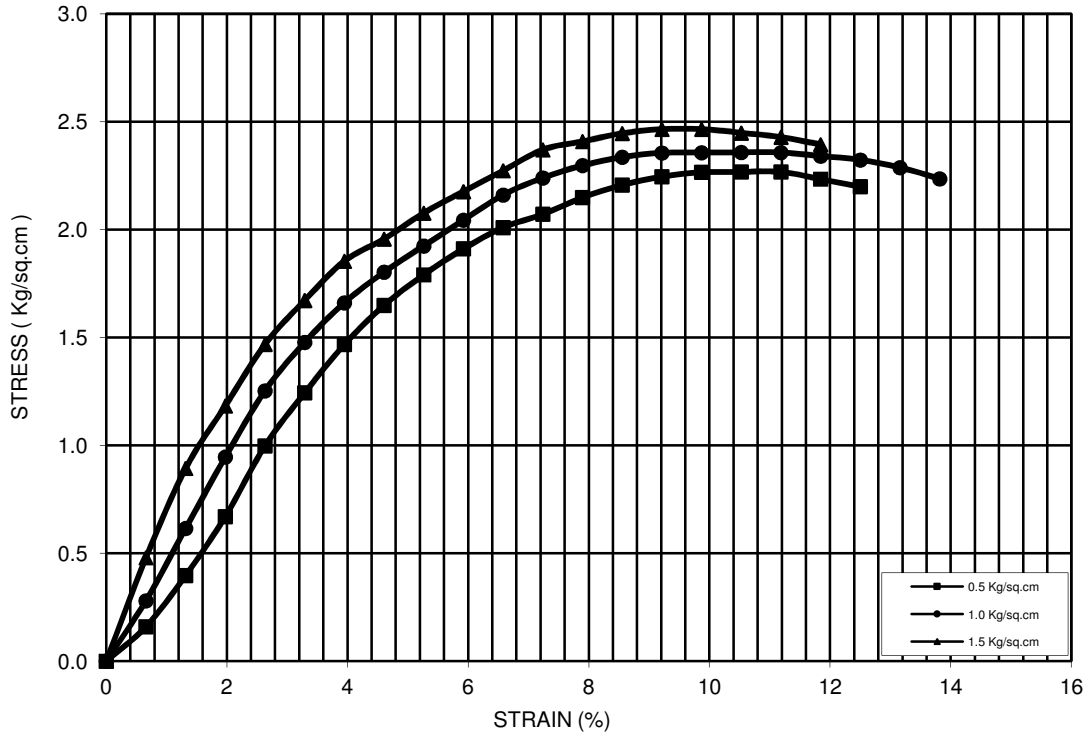
Ch. 57+400
BORE HOLE NO: BH-P9
SAMPLE NO.: UDS-1
DEPTH: 4.00 m
COHESION(C)= 0.06 kg/sq.cm
ANGLE OF FRICTION(Phi): 23 deg
TYPE OF THE TEST: DST



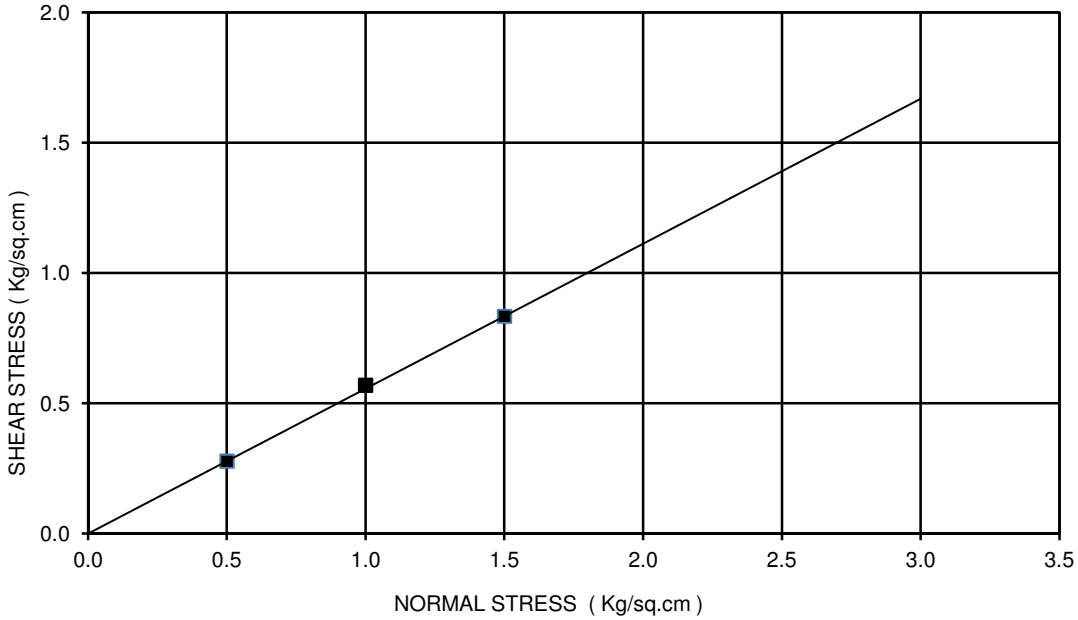


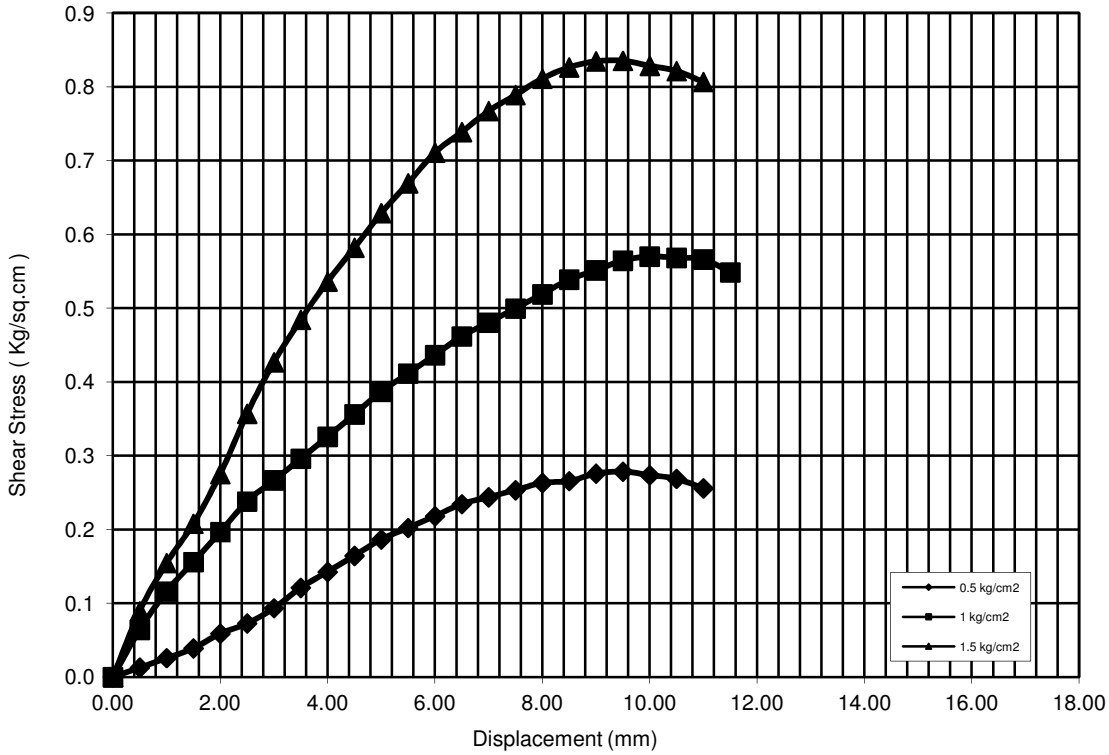
Ch. 57+400
BORE HOLE NO: BH-P9
SAMPLE NO.: UDS-3
DEPTH: 10.00 m
COHESION(C)= 1.39 kg/sq.cm
ANGLE OF FRICTION(Phi): 5 deg
TYPE OF THE TEST: UUT



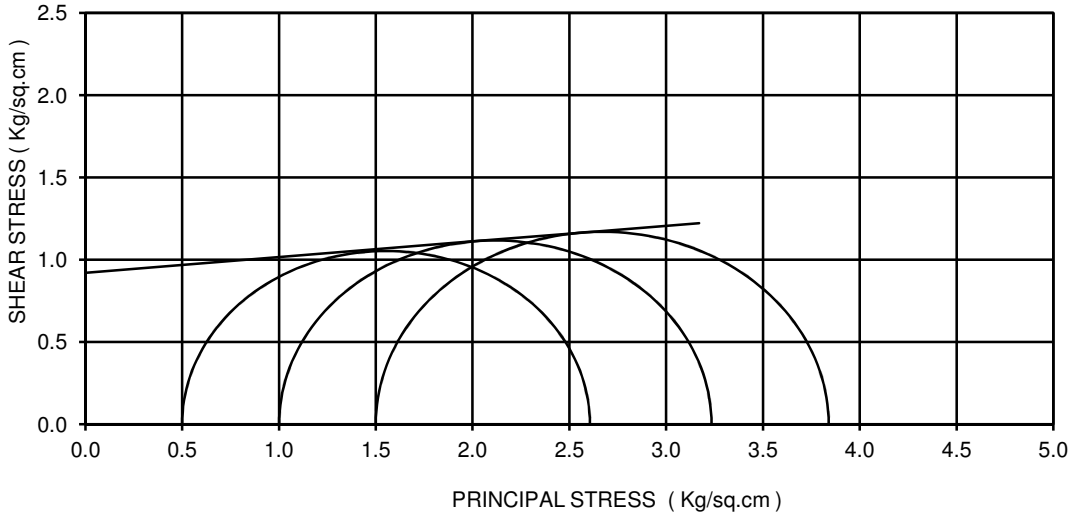


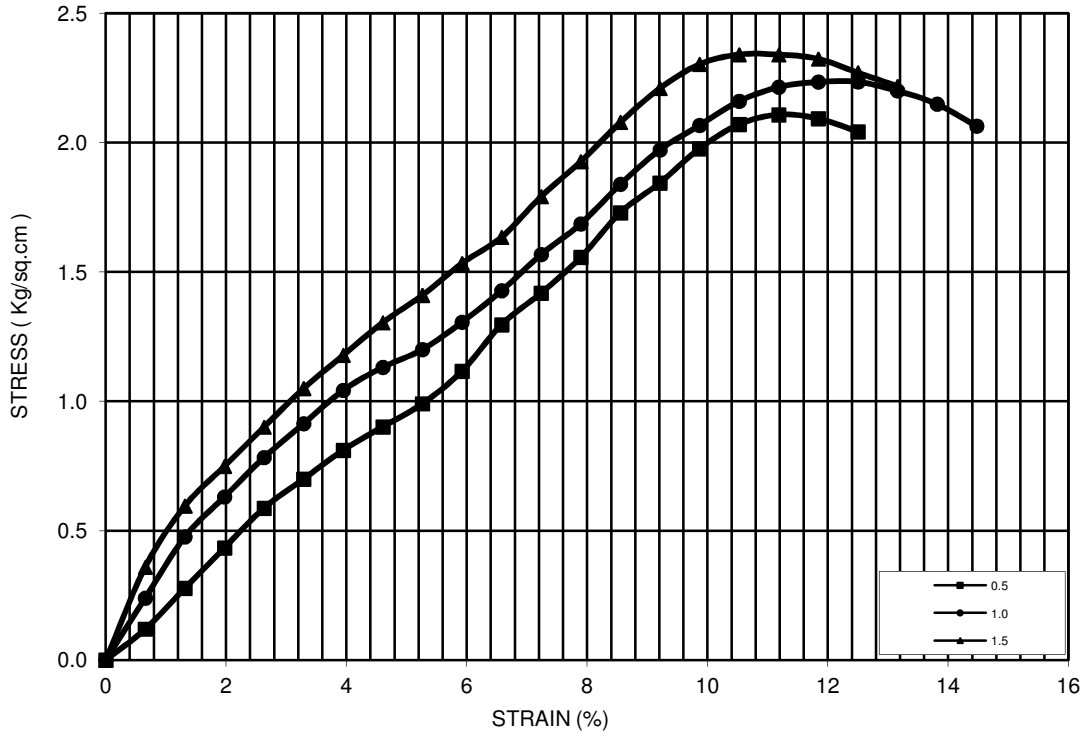
Ch. 57+400
BORE HOLE NO: BH-P10
SAMPLE NO.: UDS-5
DEPTH: 16.00 m
COHESION(C)= 0 kg/sq.cm
ANGLE OF FRICTION(Phi): 30 deg
TYPE OF THE TEST: DST



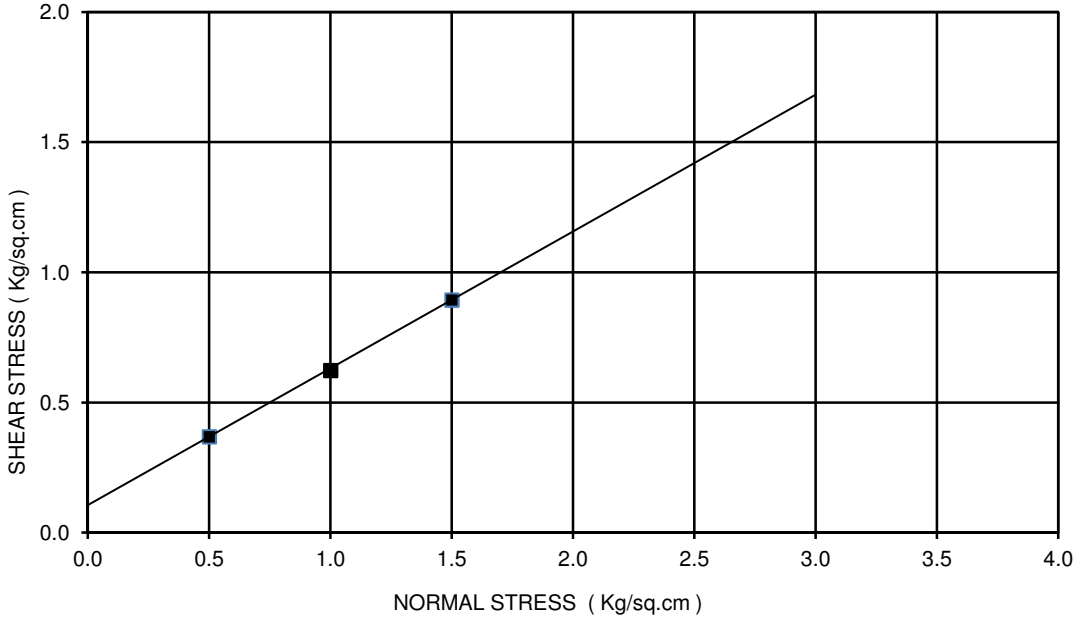


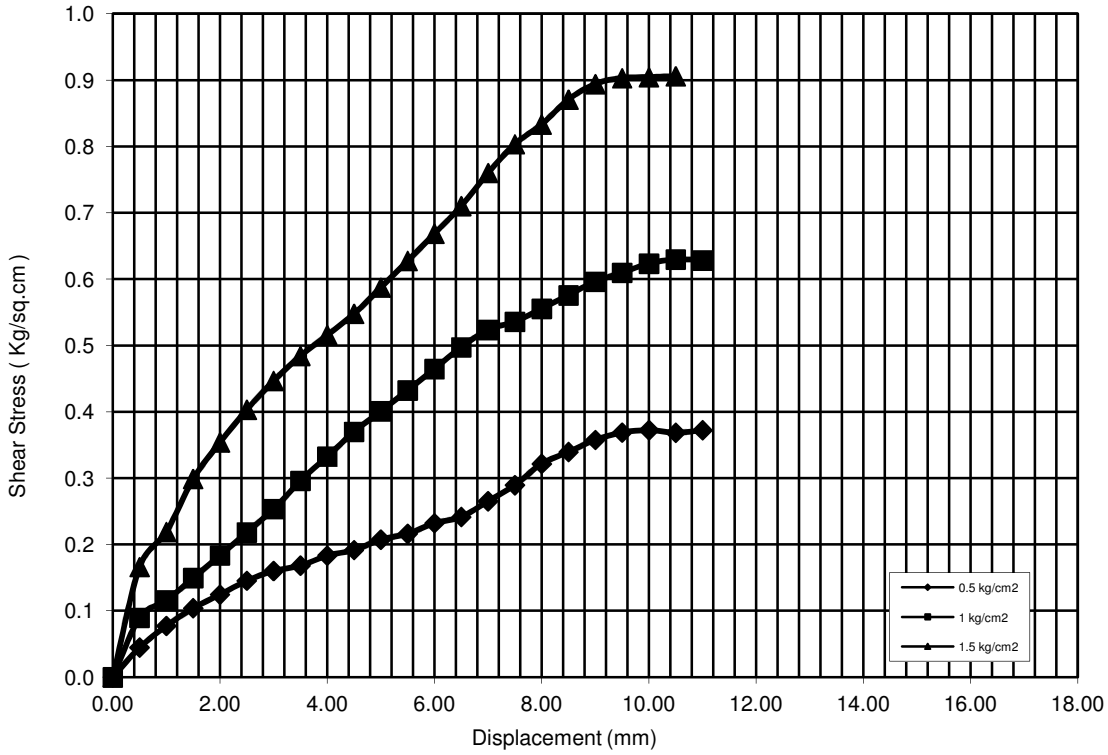
Ch. 57+400
BORE HOLE NO: BH-P10
SAMPLE NO.: UDS-2
DEPTH: 7.00 m
COHESION(C)= 0.78 kg/sq.cm
ANGLE OF FRICTION(Phi): 5 deg
TYPE OF THE TEST: UUT



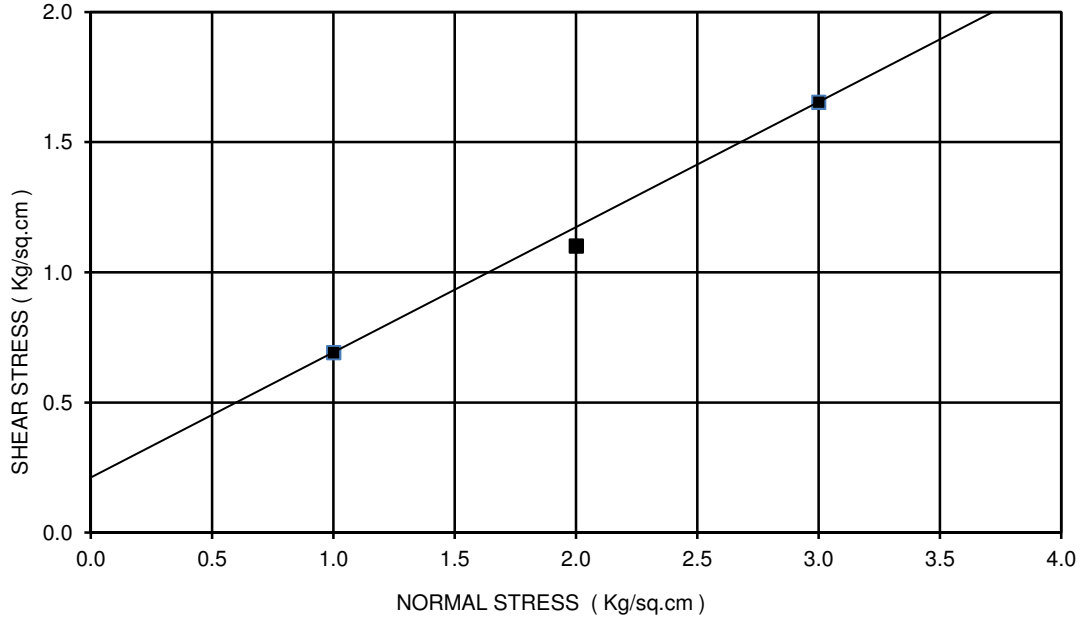


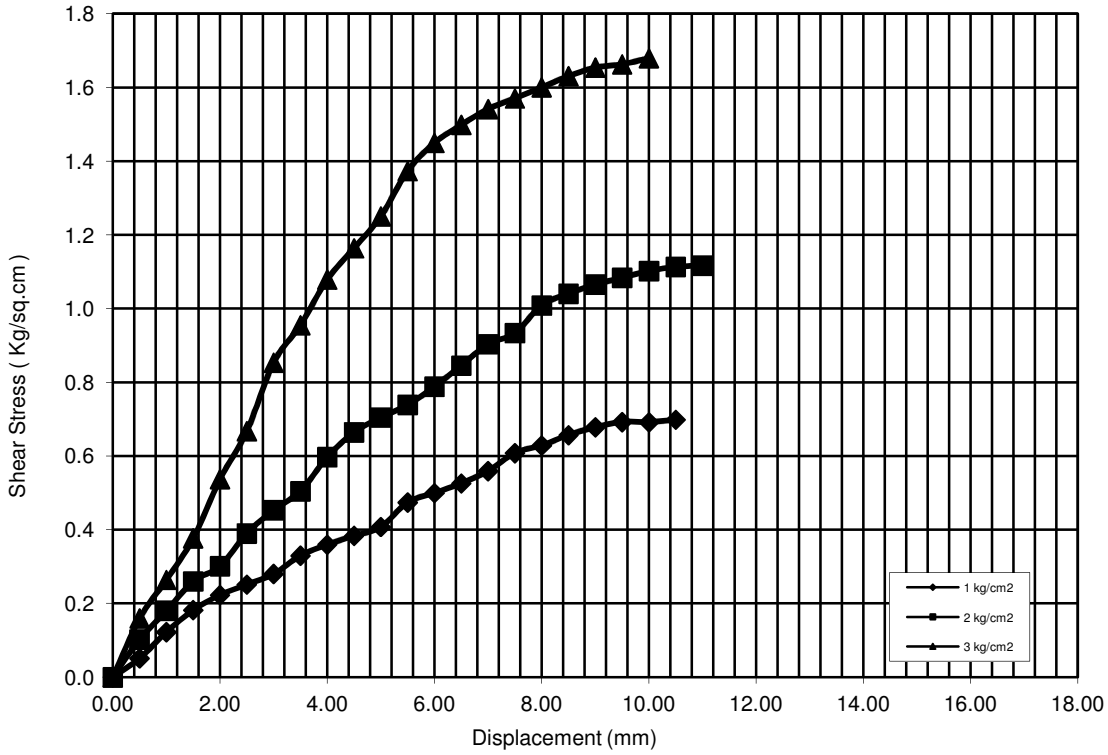
Ch. 57+400
BORE HOLE NO: BH-P12
SAMPLE NO.: UDS-1
DEPTH: 4.00 m
COHESION(C)= 0.08 kg/sq.cm
ANGLE OF FRICTION(Phi): 27 deg
TYPE OF THE TEST: DST



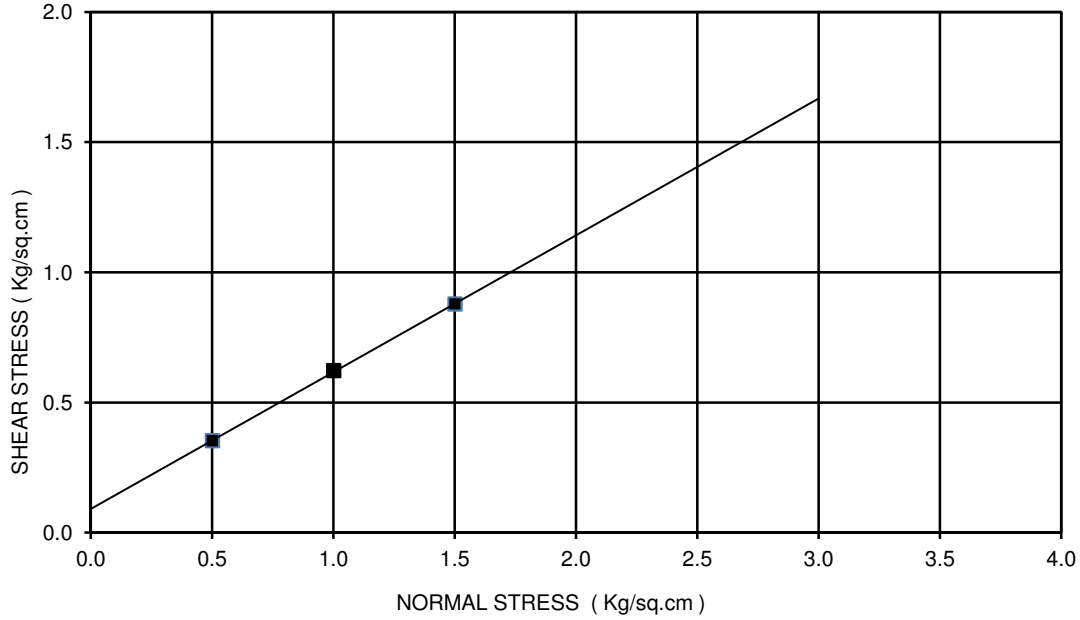


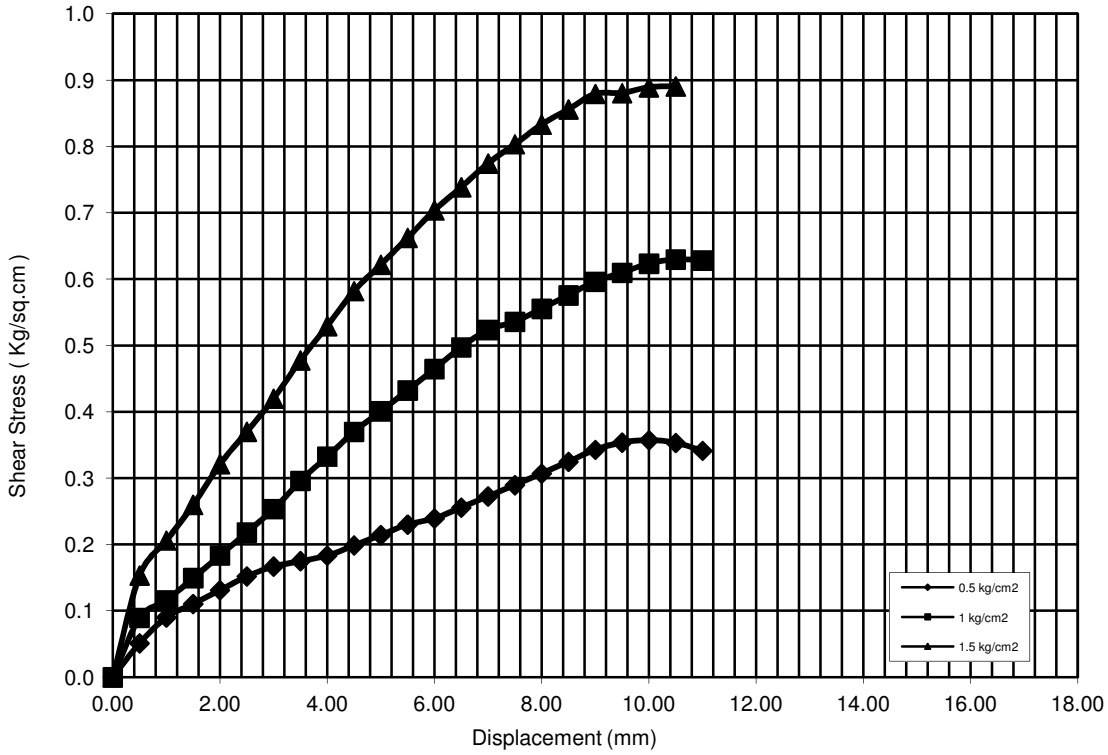
Ch. 57+400
BORE HOLE NO: BH-P12
SAMPLE NO.: UDS-4
DEPTH: 13.00 m
COHESION(C)= 0.08 kg/sq.cm
ANGLE OF FRICTION(Phi): 26 deg
TYPE OF THE TEST: DST



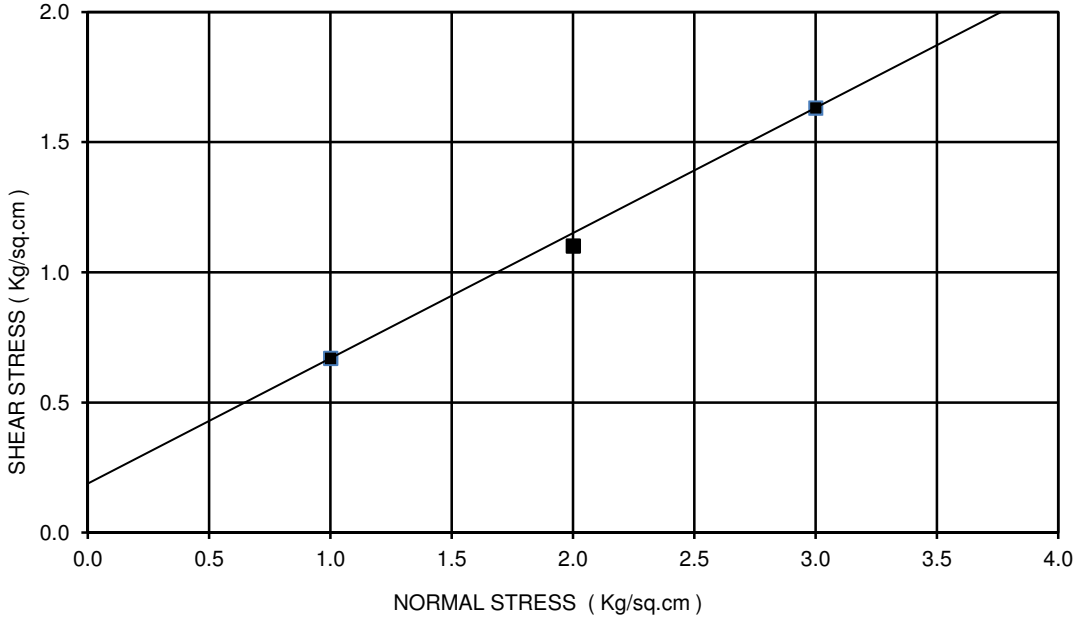


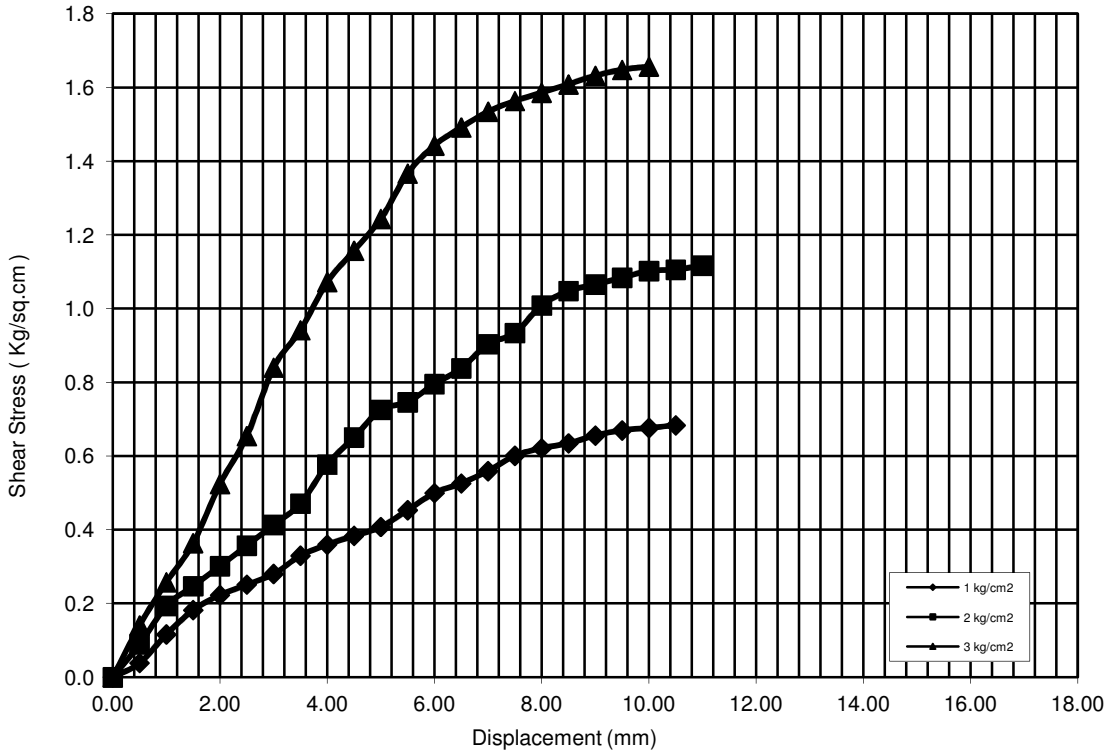
Ch. 57+400
BORE HOLE NO: BH-P15
SAMPLE NO.: UDS-1
DEPTH: 4.00 m
COHESION(C)= 0.08 kg/sq.cm
ANGLE OF FRICTION(Phi): 27 deg
TYPE OF THE TEST: DST



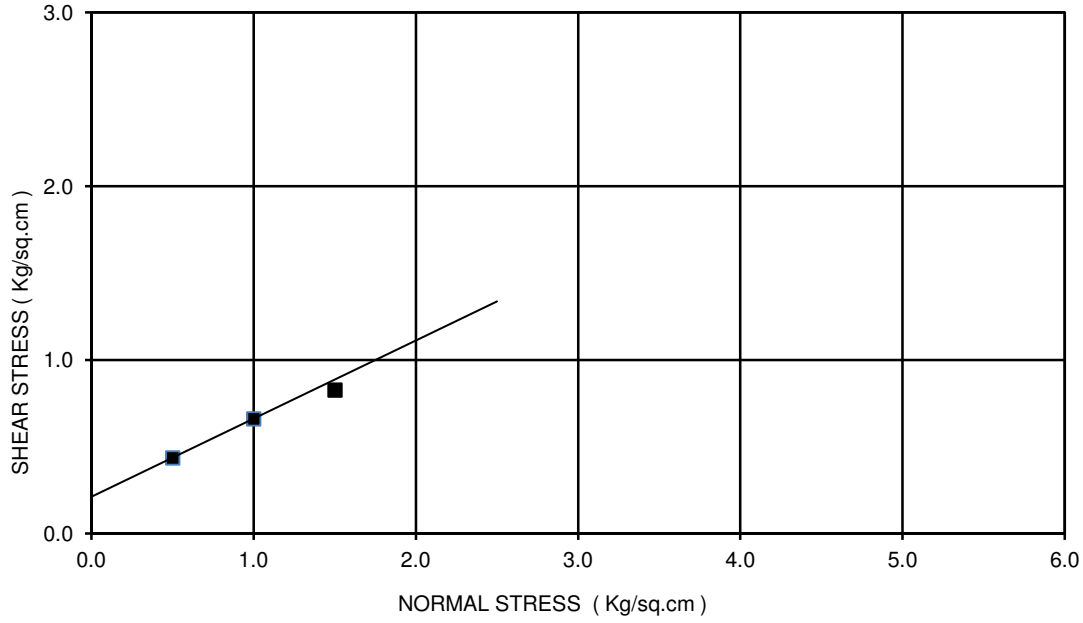


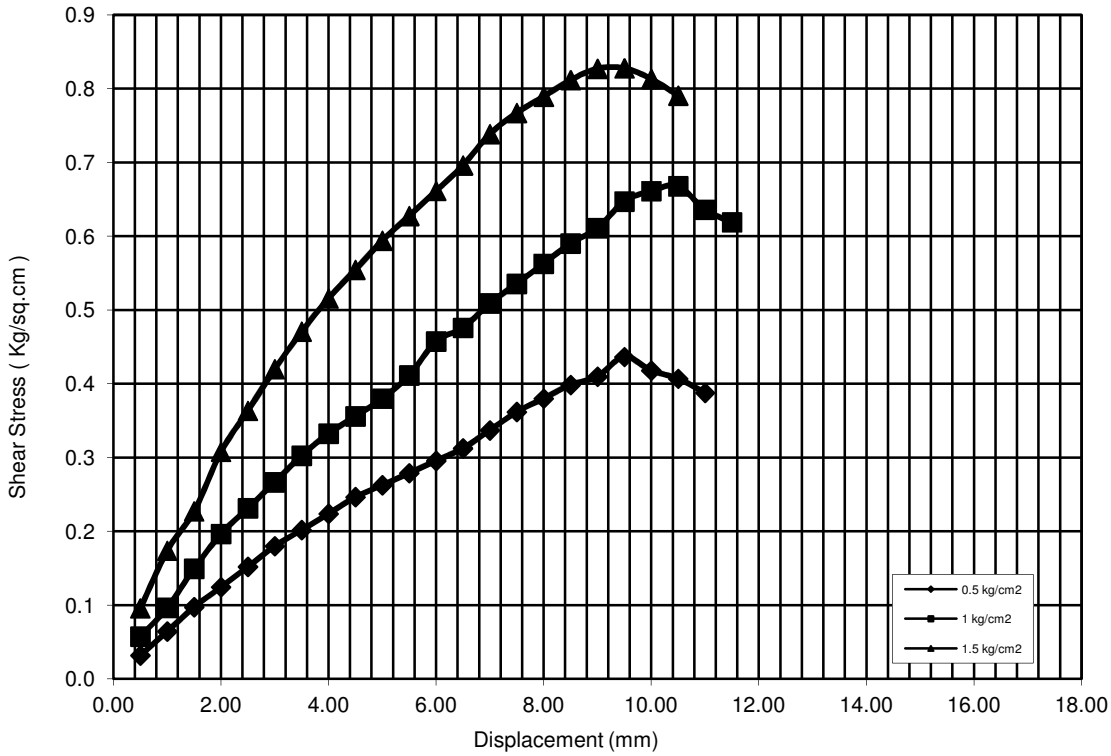
Ch. 57+400
BORE HOLE NO: BH-P15
SAMPLE NO.: UDS-4
DEPTH: 13.00 m
COHESION(C)= 0.08 kg/sq.cm
ANGLE OF FRICTION(Phi): 26 deg
TYPE OF THE TEST: DST



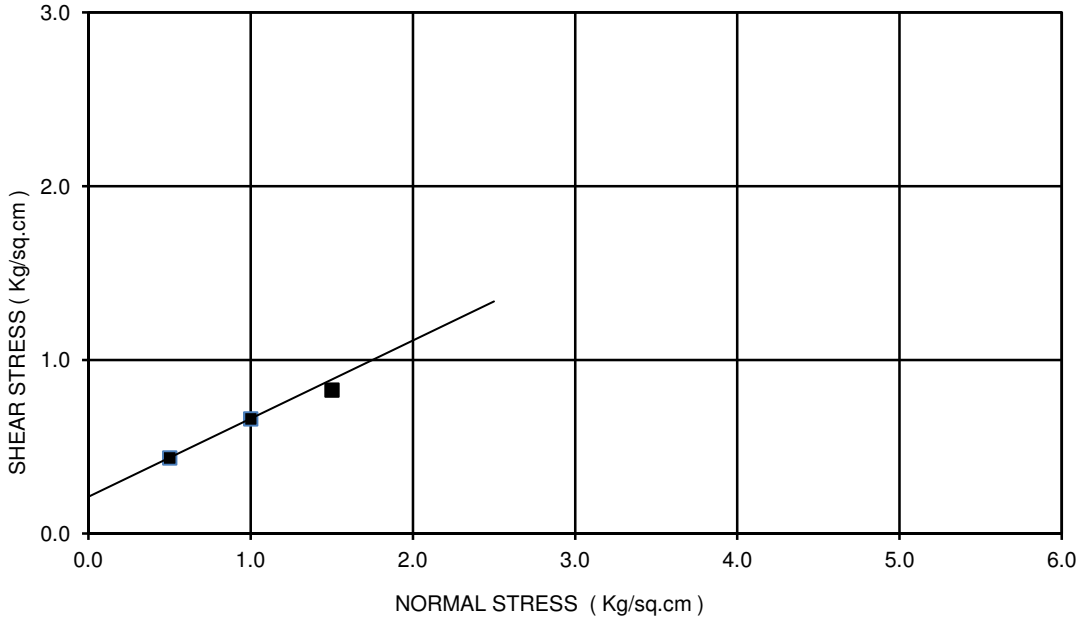


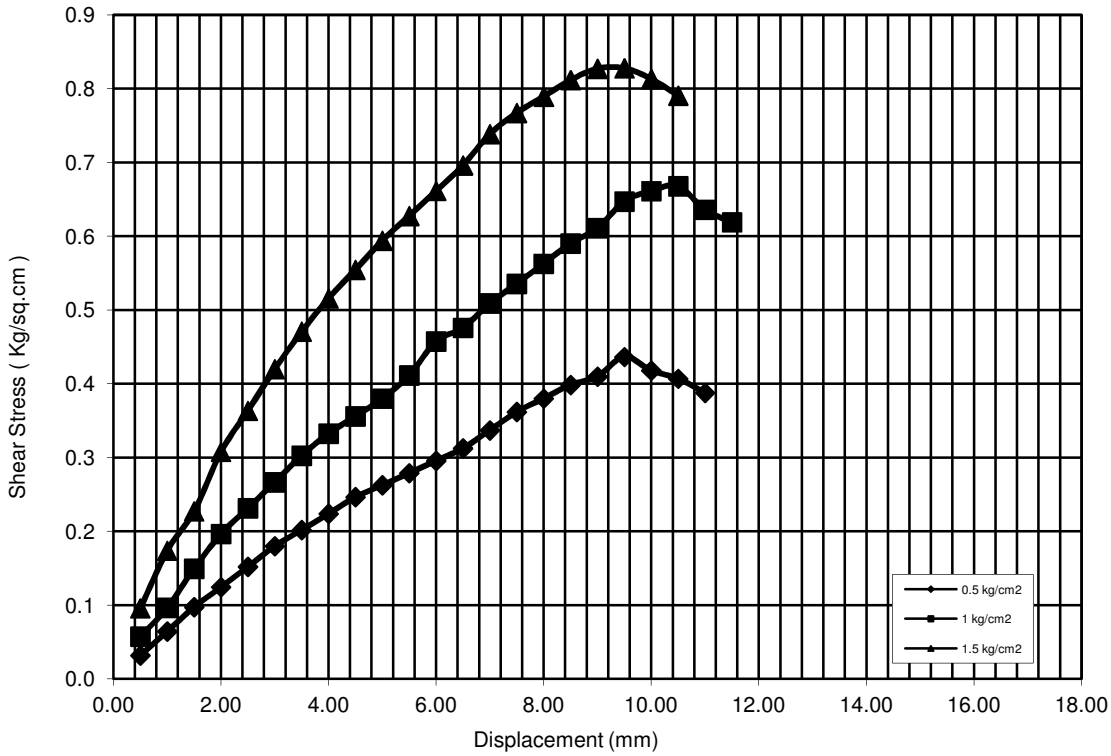
Ch. 57+400
BORE HOLE NO:BH-P16
SAMPLE NO.: UDS-3
DEPTH: 13.00 m
COHESION(C)= 0.14 kg/sq.cm
ANGLE OF FRICTION(Phi): 23 deg
TYPE OF THE TEST: DST



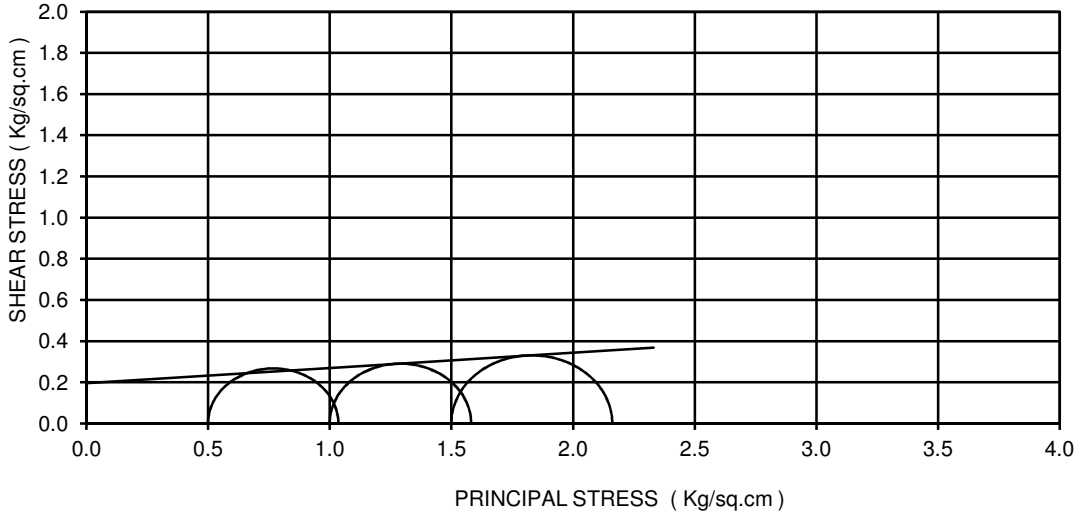


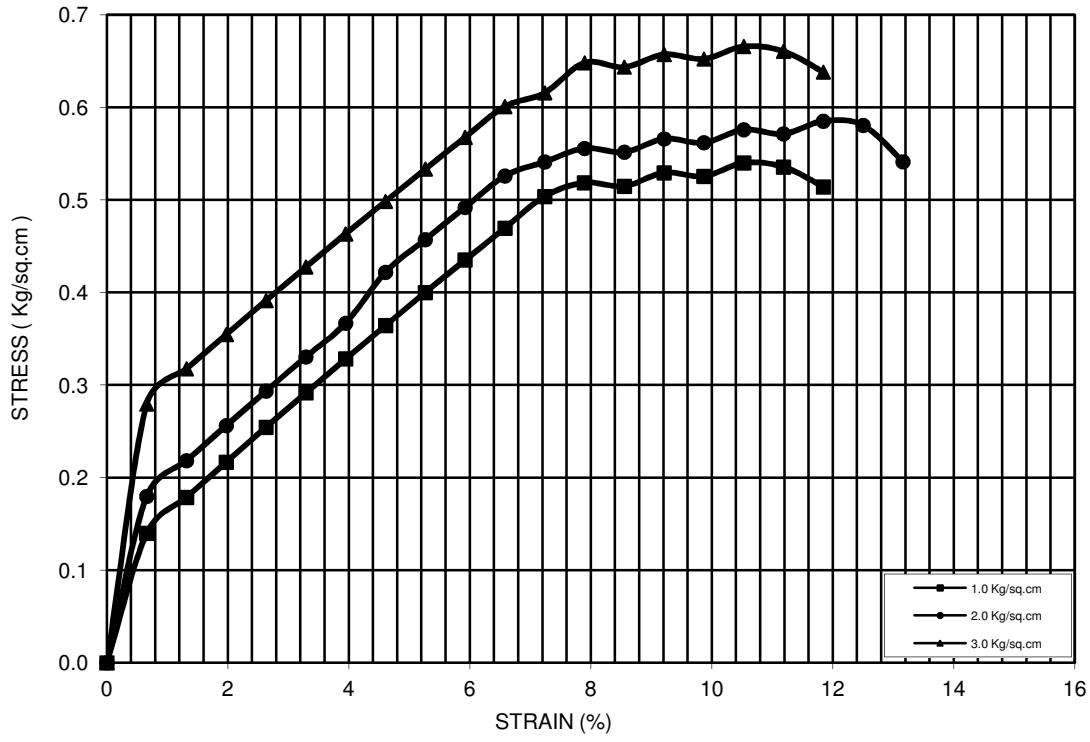
Ch. 57+400
BORE HOLE NO: BH-P16
SAMPLE NO.: UDS-3
DEPTH: 13.00 m
COHESION(C)= 0.14 kg/sq.cm
ANGLE OF FRICTION(Phi): 23 deg
TYPE OF THE TEST: DST



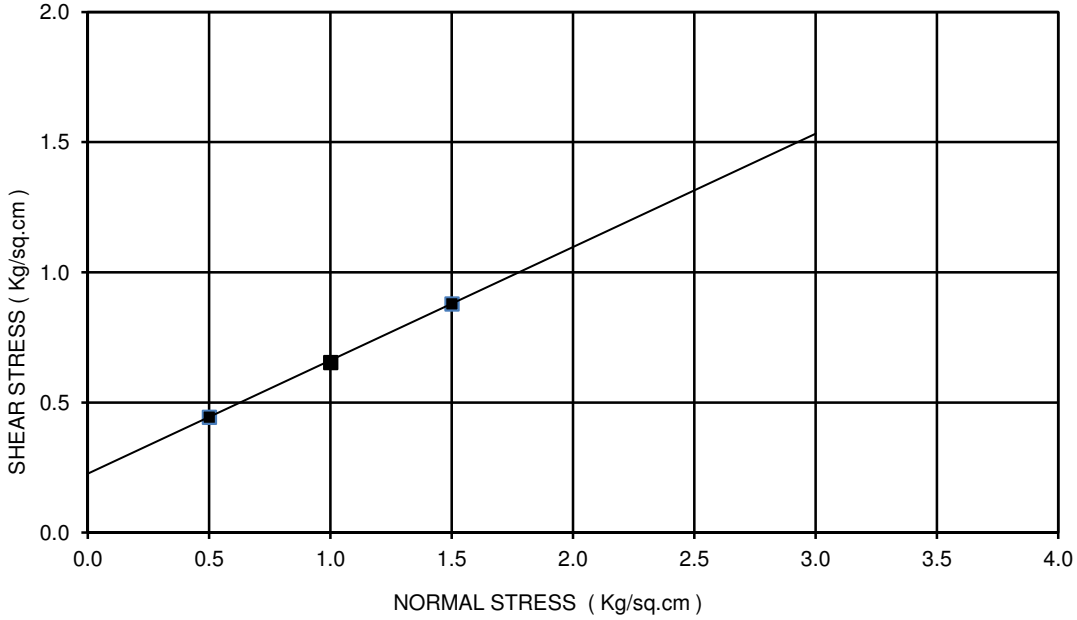


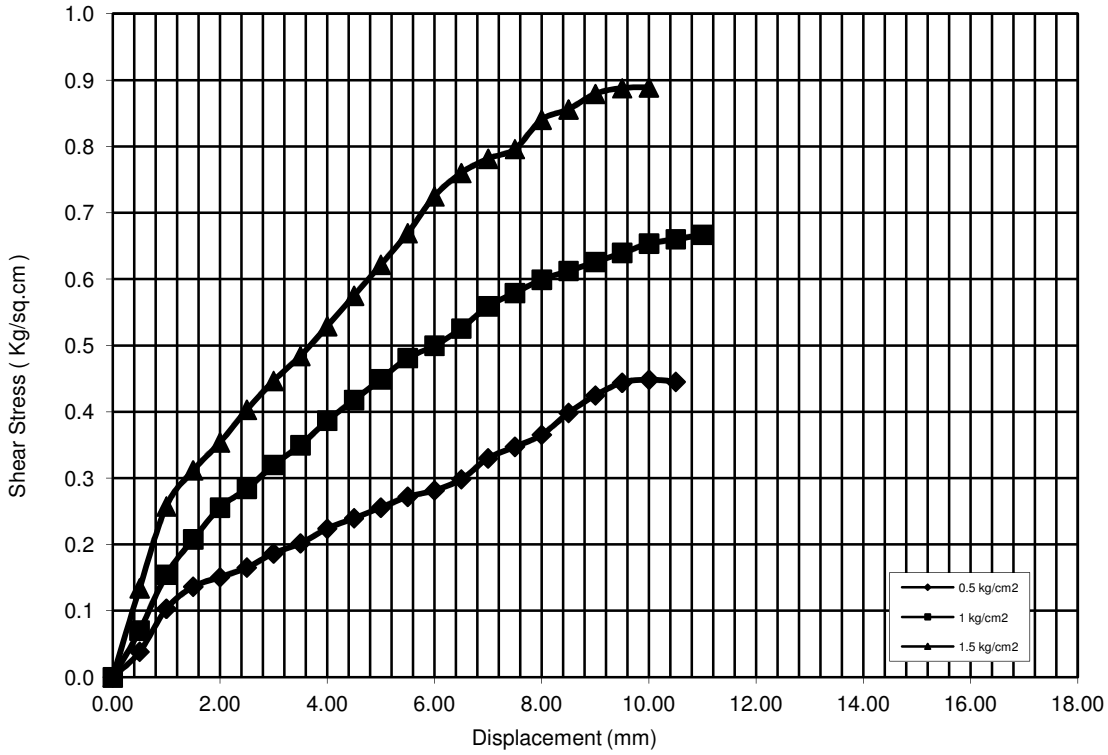
Ch. 57+400
BORE HOLE NO: BH-P17
SAMPLE NO.: UDS-5
DEPTH: 16.00 m
COHESION(C)= 0.62 kg/sq.cm
ANGLE OF FRICTION(Phi): 11 deg
TYPE OF THE TEST: UUT



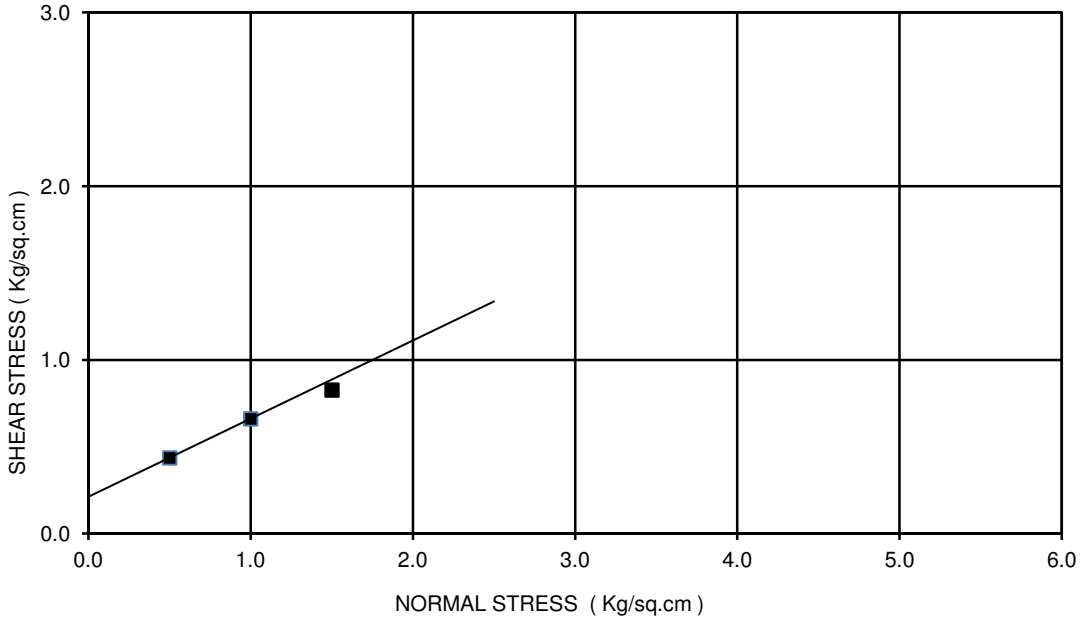


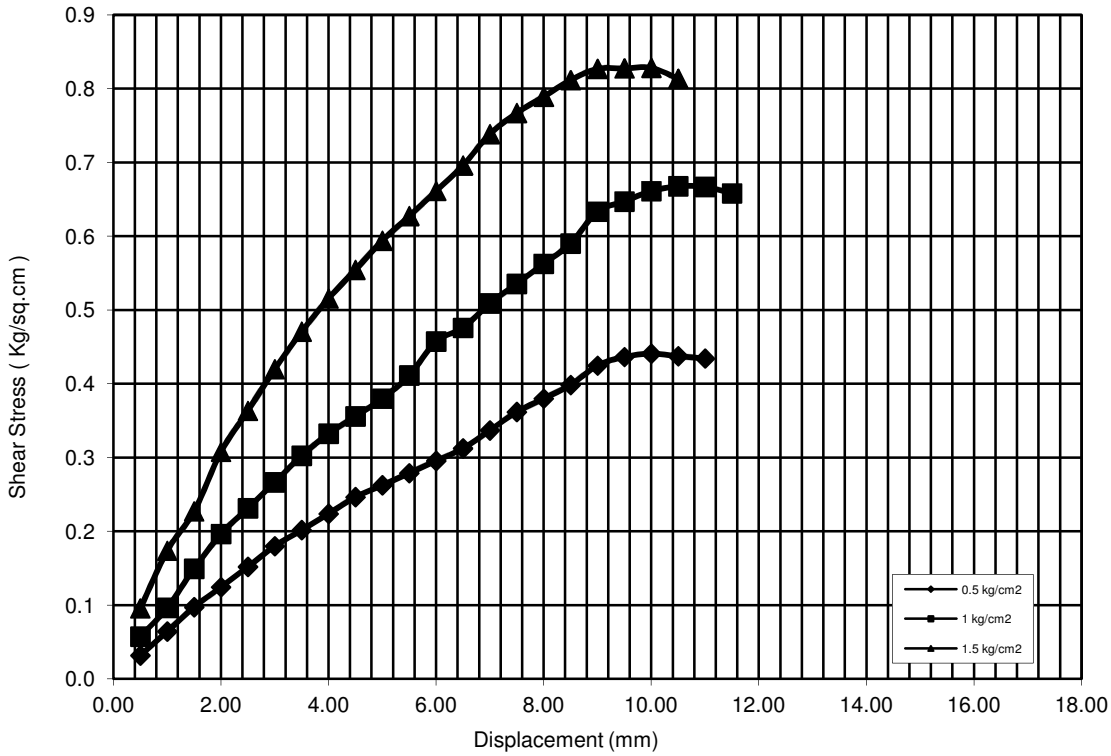
Ch. 57+400
BORE HOLE NO: BH-P17
SAMPLE NO.: UDS-4
DEPTH: 13.00 m
COHESION(C)= 0.08 kg/sq.cm
ANGLE OF FRICTION(Phi): 26 deg
TYPE OF THE TEST: DST



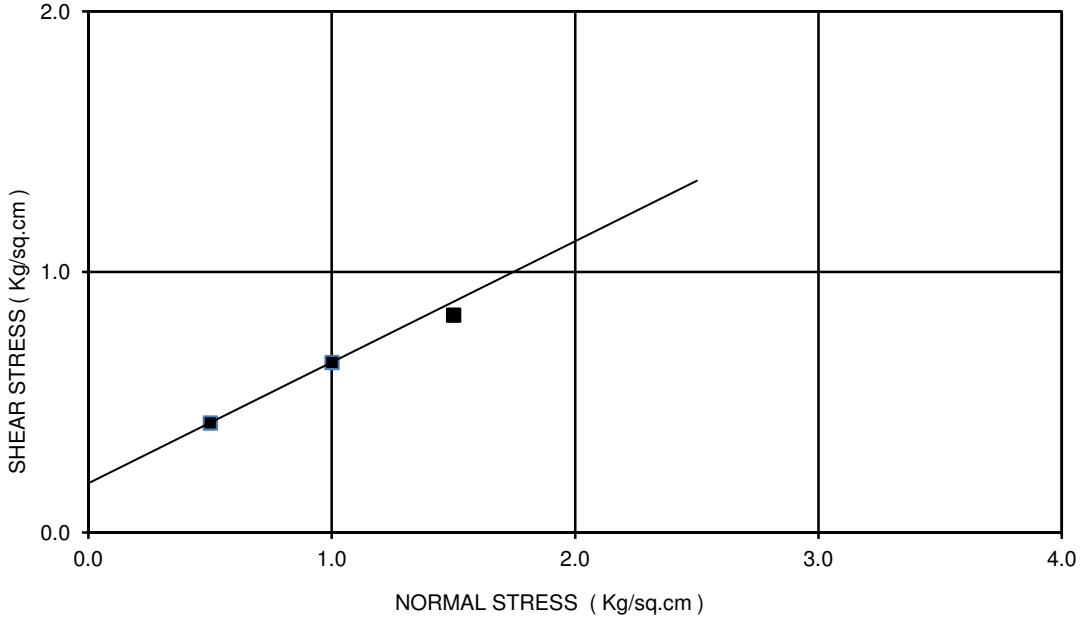


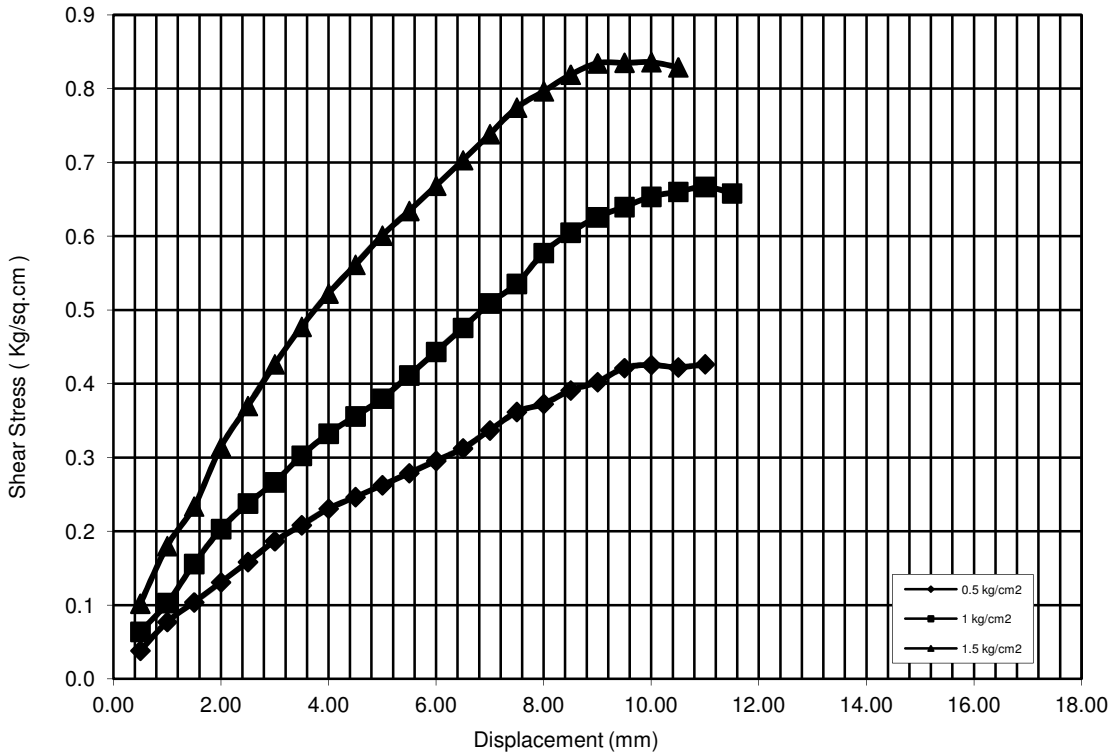
Ch. 57+400
BORE HOLE NO: BH-P18
SAMPLE NO.: UDS-3
DEPTH: 13.00 m
COHESION(C)= 0.14 kg/sq.cm
ANGLE OF FRICTION(Phi): 23 deg
TYPE OF THE TEST: DST



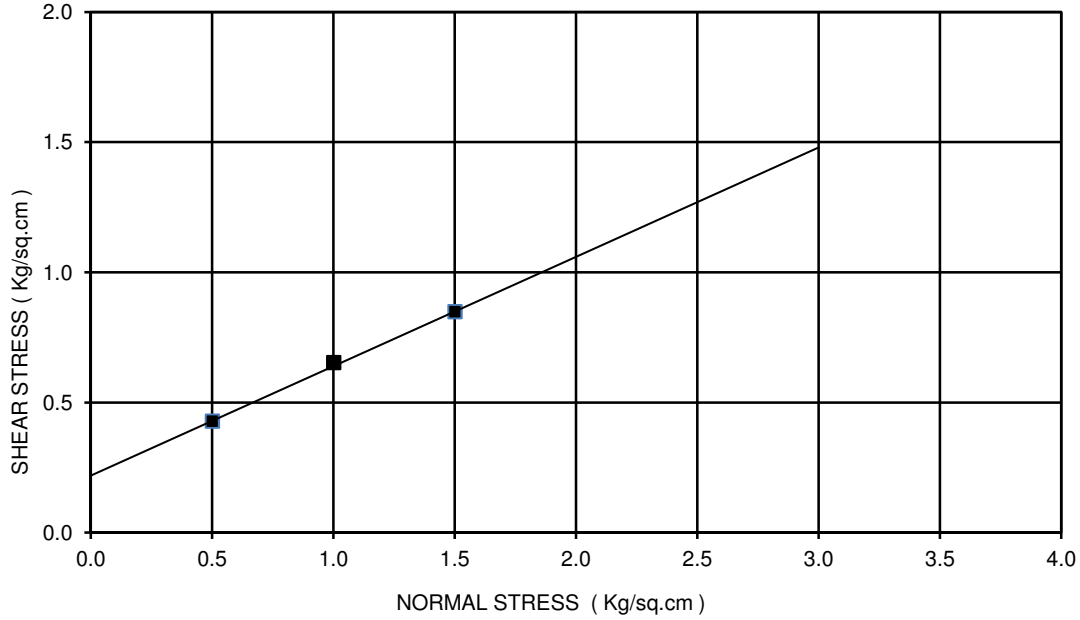


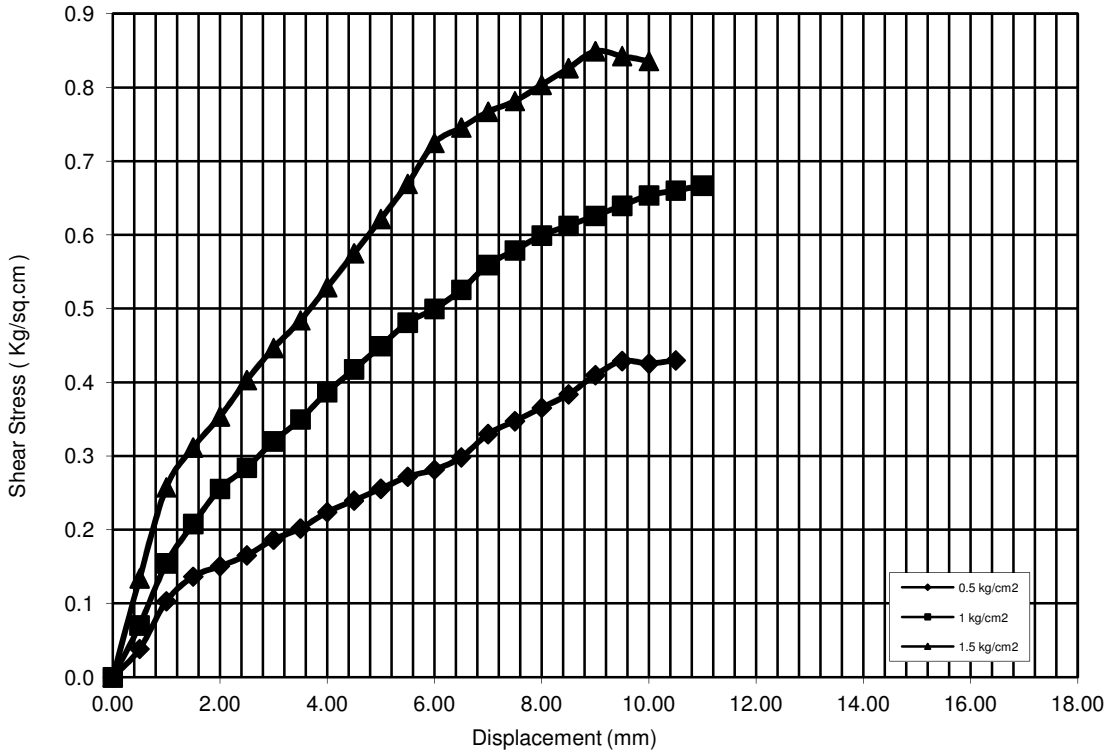
Ch. 57+400
BORE HOLE NO: BH-P18
SAMPLE NO.: UDS-3
DEPTH: 13.00 m
COHESION(C)= 0.14 kg/sq.cm
ANGLE OF FRICTION(Phi): 23 deg
TYPE OF THE TEST: DST



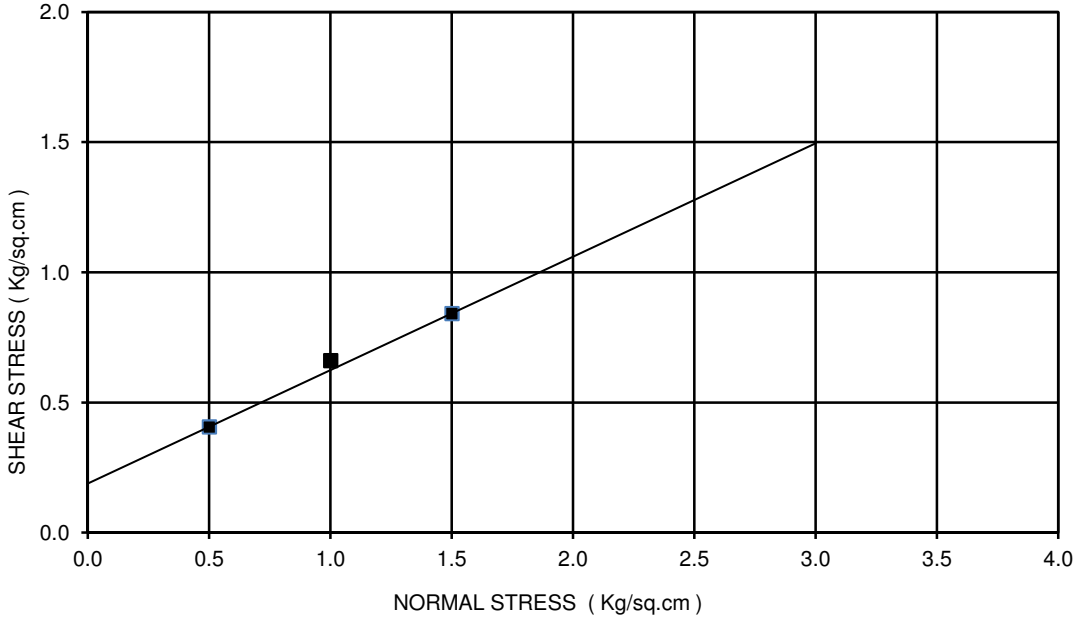


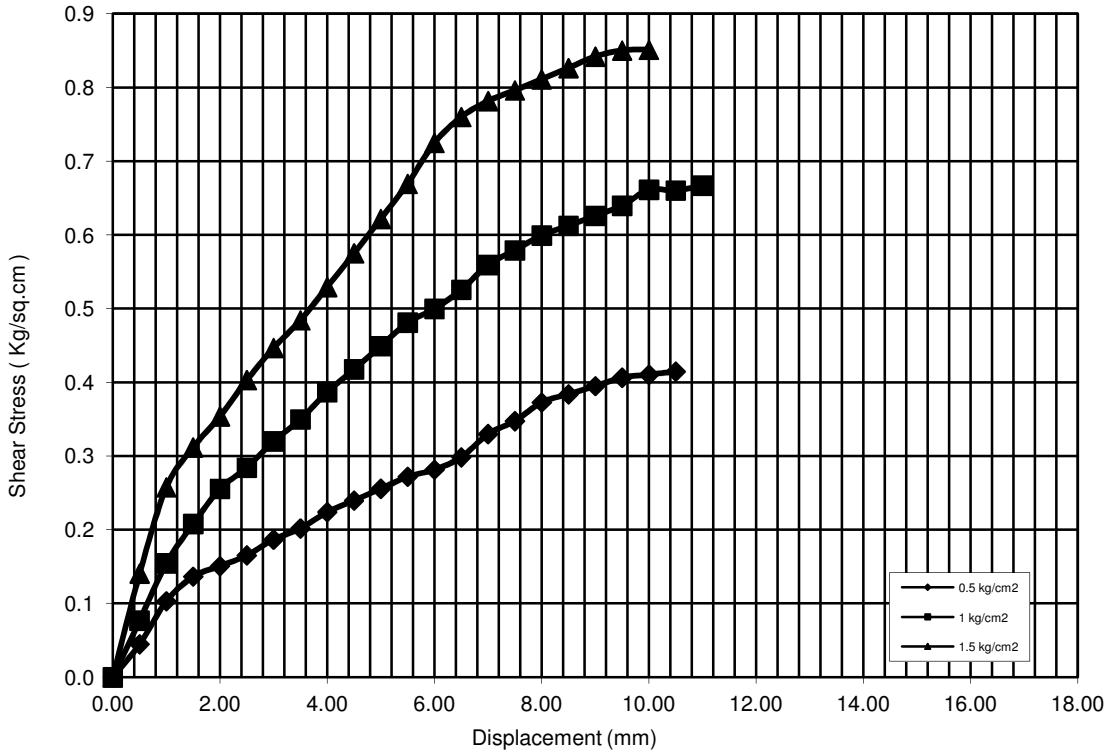
Ch. 57+400
BORE HOLE NO: BH-P19
SAMPLE NO.: UDS-4
DEPTH: 13.00 m
COHESION(C)= 0.08 kg/sq.cm
ANGLE OF FRICTION(Phi): 26 deg
TYPE OF THE TEST: DST



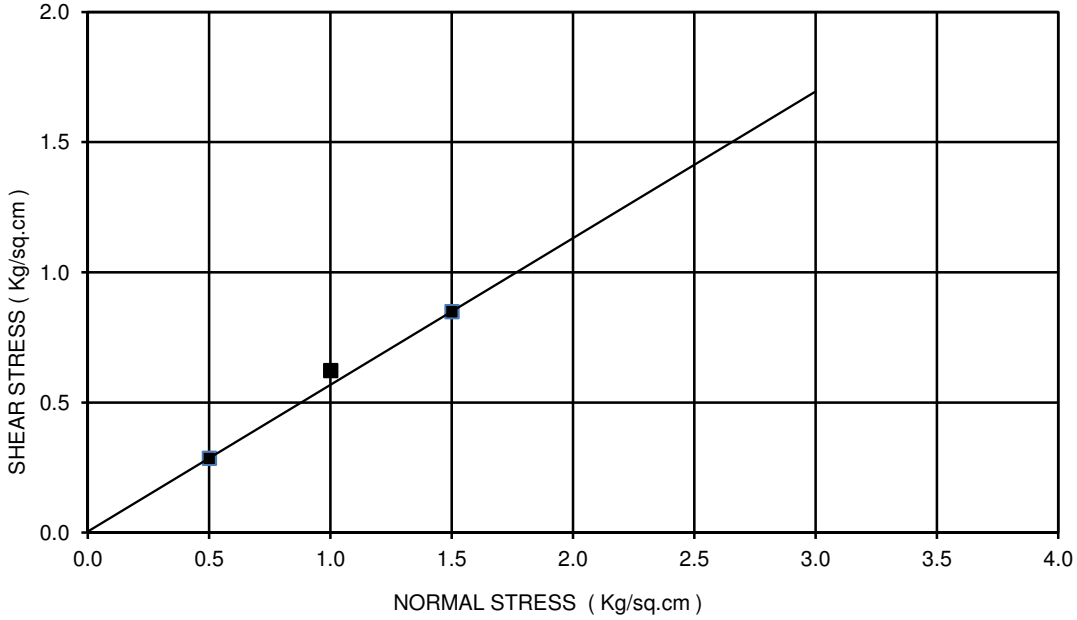


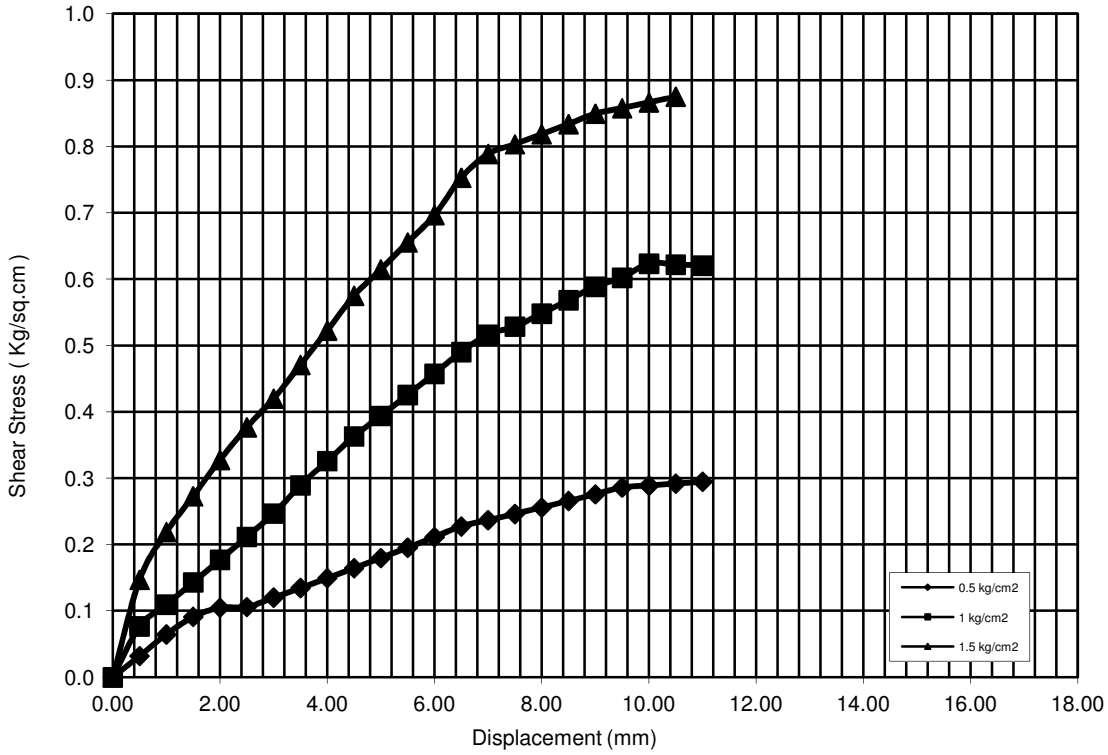
Ch. 57+400
BORE HOLE NO: BH-P19
SAMPLE NO.: UDS-4
DEPTH: 13.00 m
COHESION(C)= 0.08 kg/sq.cm
ANGLE OF FRICTION(Phi): 26 deg
TYPE OF THE TEST: DST



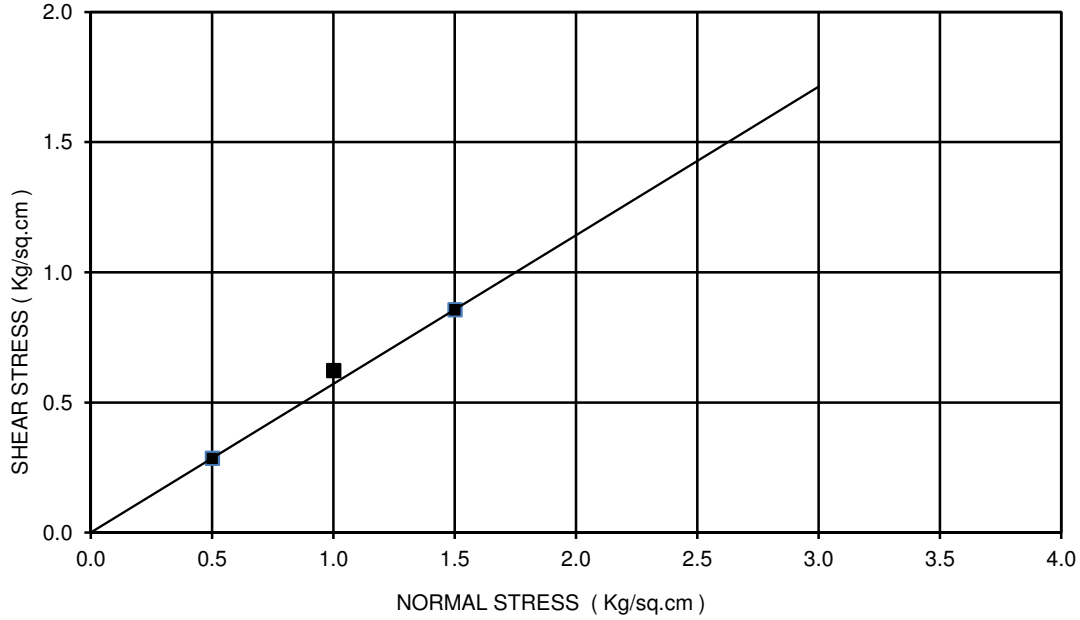


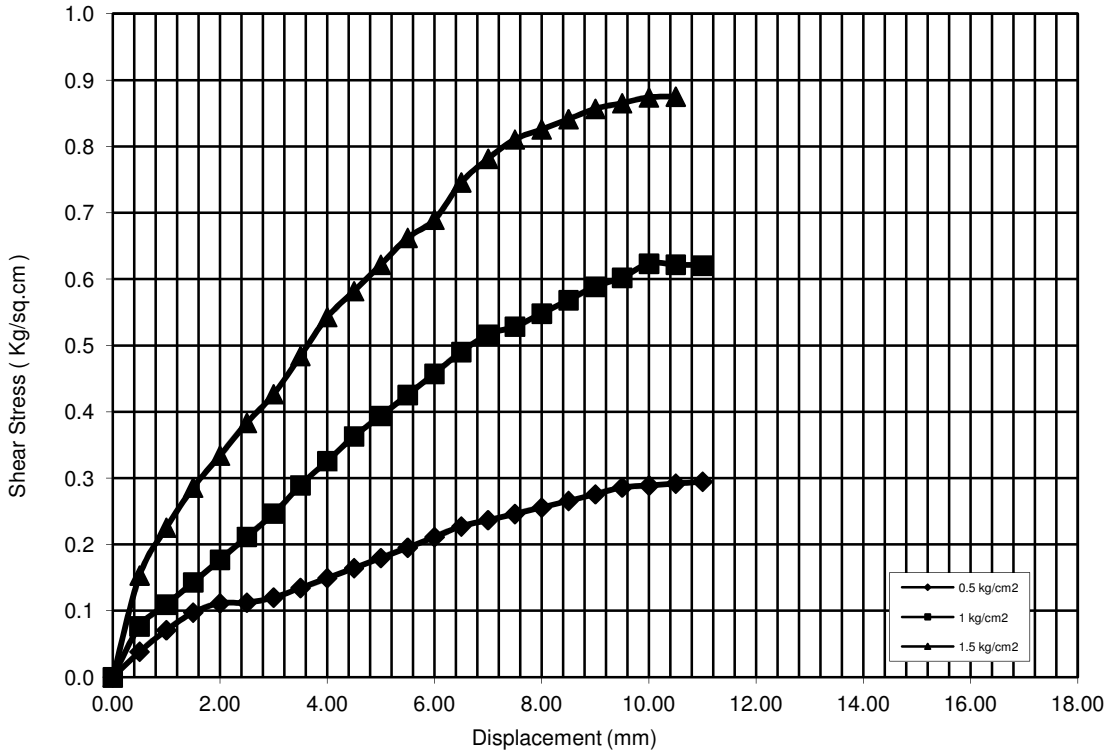
Ch. 57+400
BORE HOLE NO: BH-A2
SAMPLE NO.: UDS-1
DEPTH: 4.00 m
COHESION(C)= 0.08 kg/sq.cm
ANGLE OF FRICTION(Phi): 27 deg
TYPE OF THE TEST: DST



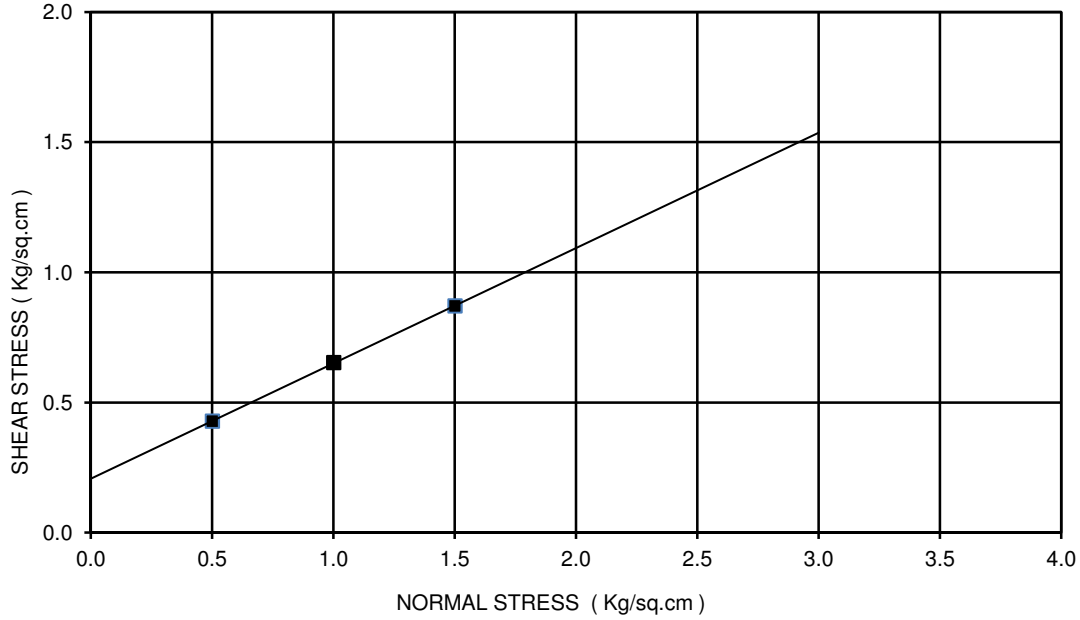


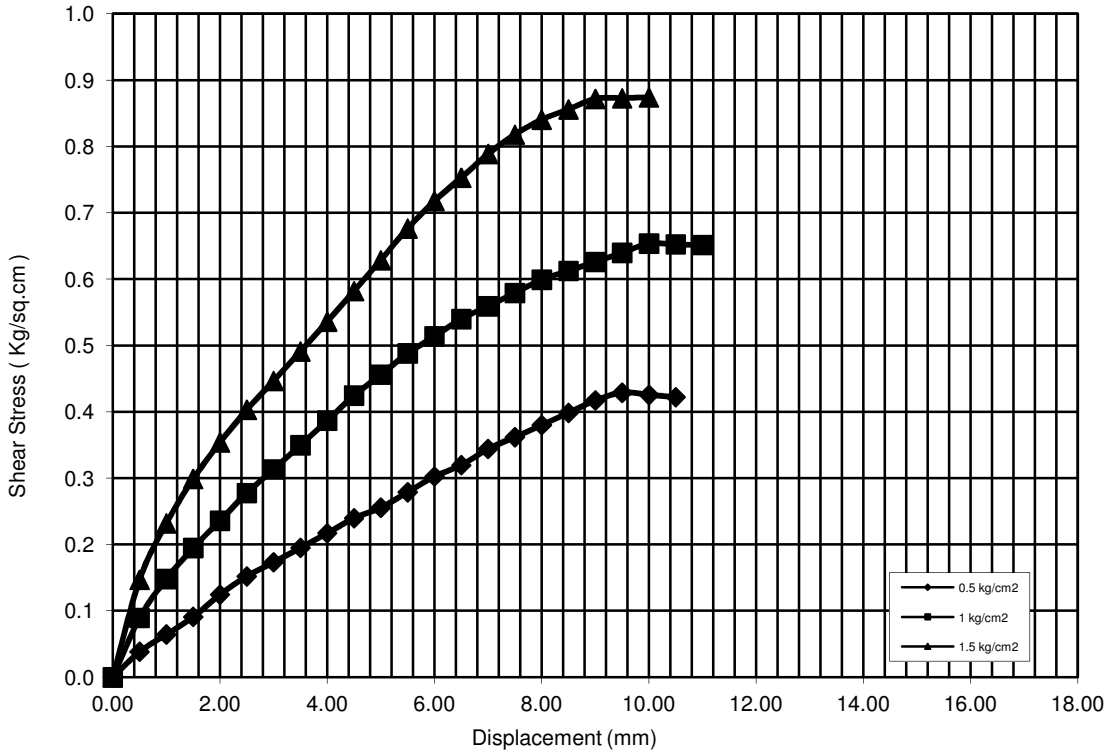
Ch. 57+400
BORE HOLE NO: BH-A2
SAMPLE NO.: UDS-1
DEPTH: 4.00 m
COHESION(C)= 0.08 kg/sq.cm
ANGLE OF FRICTION(Phi): 27 deg
TYPE OF THE TEST: DST



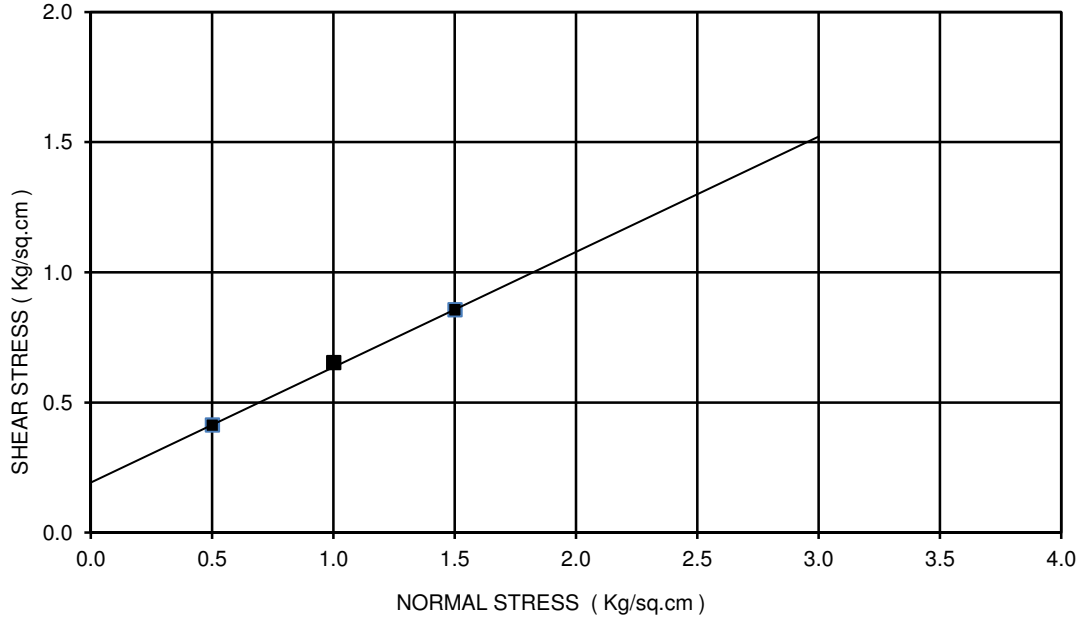


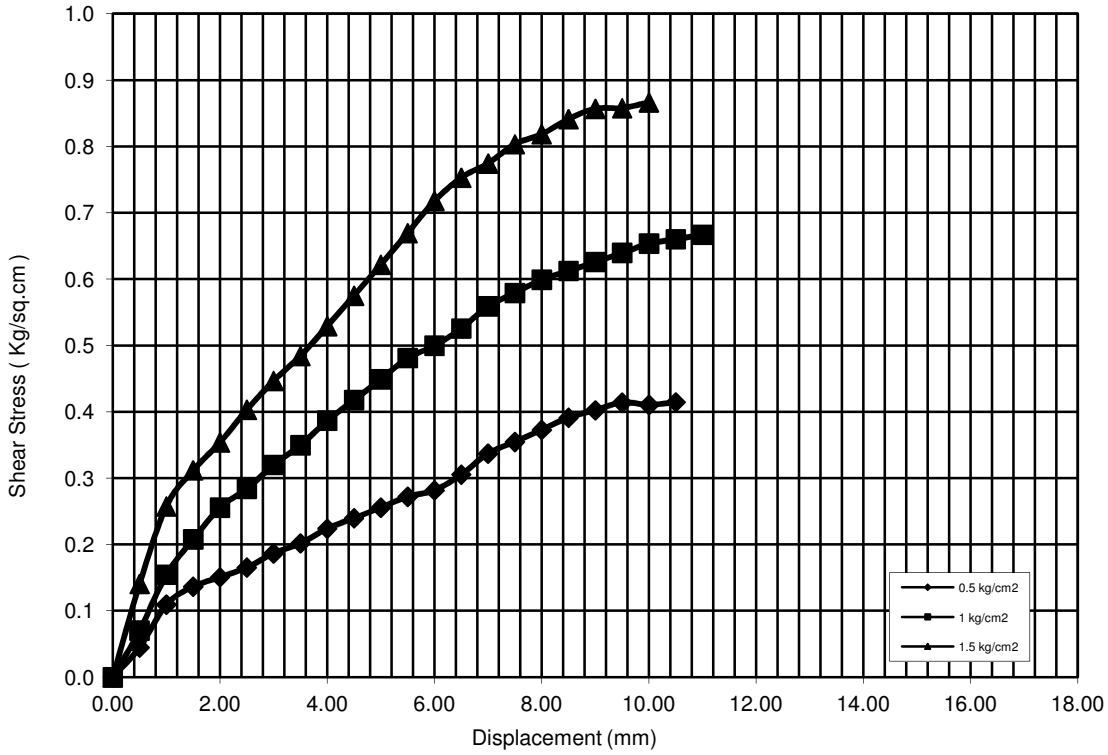
Ch. 58+191
BORE HOLE NO: BH-CL
SAMPLE NO.: UDS-1
DEPTH: 2.50 m
COHESION(C)= 0.21 kg/sq.cm
ANGLE OF FRICTION(Phi): 24 deg
TYPE OF THE TEST: DST



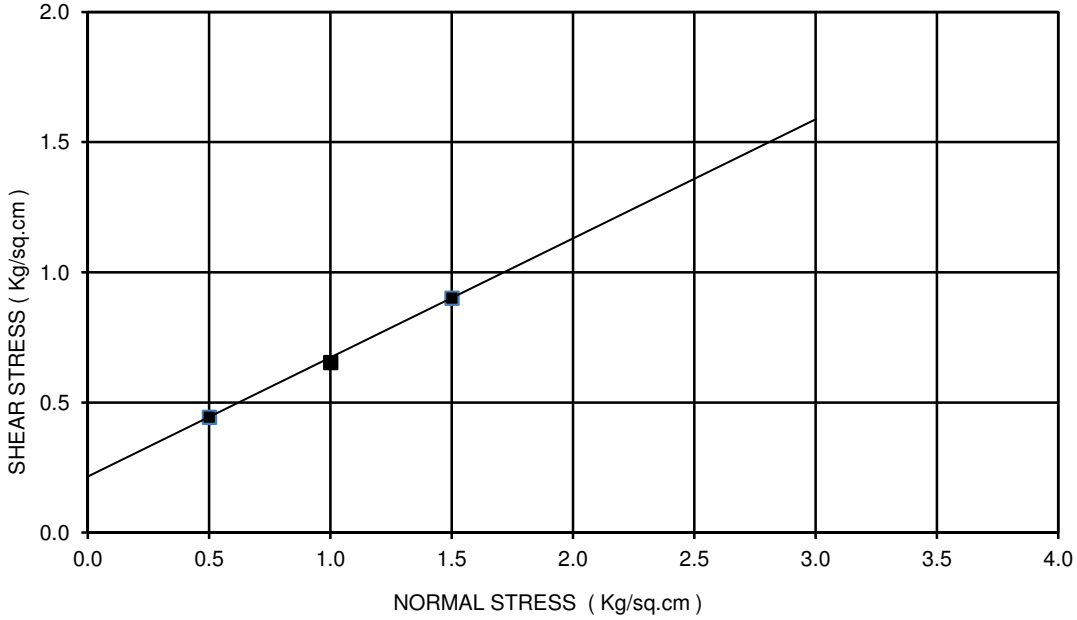


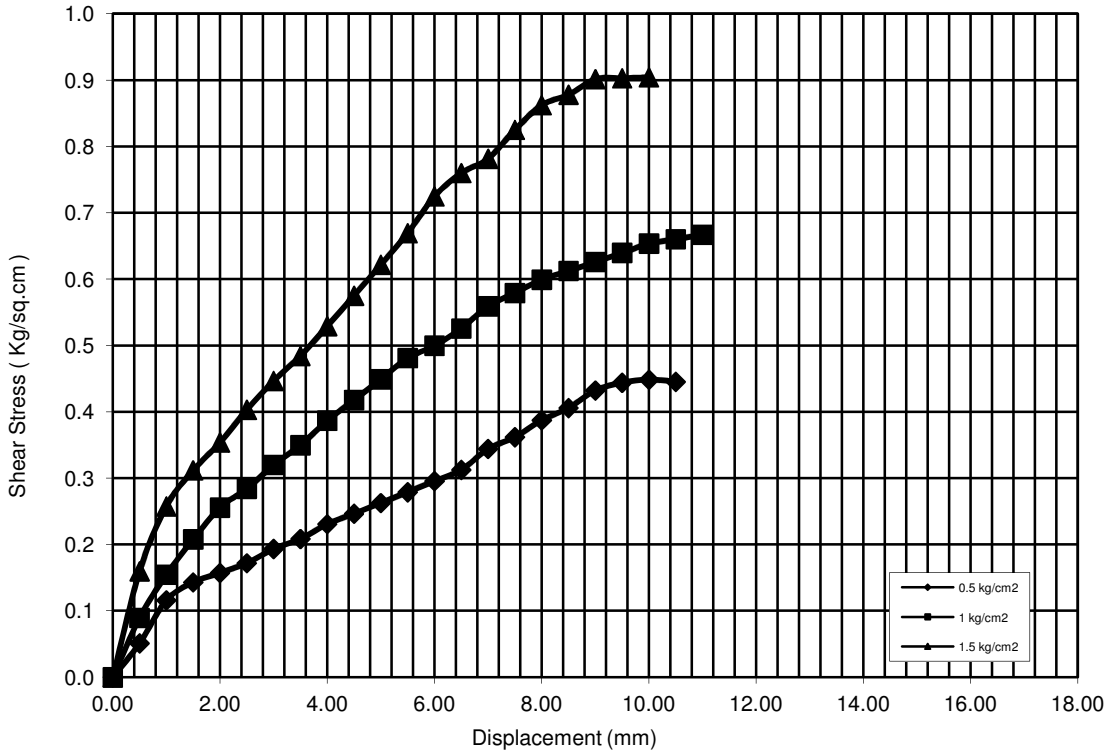
Ch. 58+497
BORE HOLE NO: BH-A1
SAMPLE NO.: UDS-4
DEPTH: 13.00 m
COHESION(C)= 0.08 kg/sq.cm
ANGLE OF FRICTION(Phi): 26 deg
TYPE OF THE TEST: DST



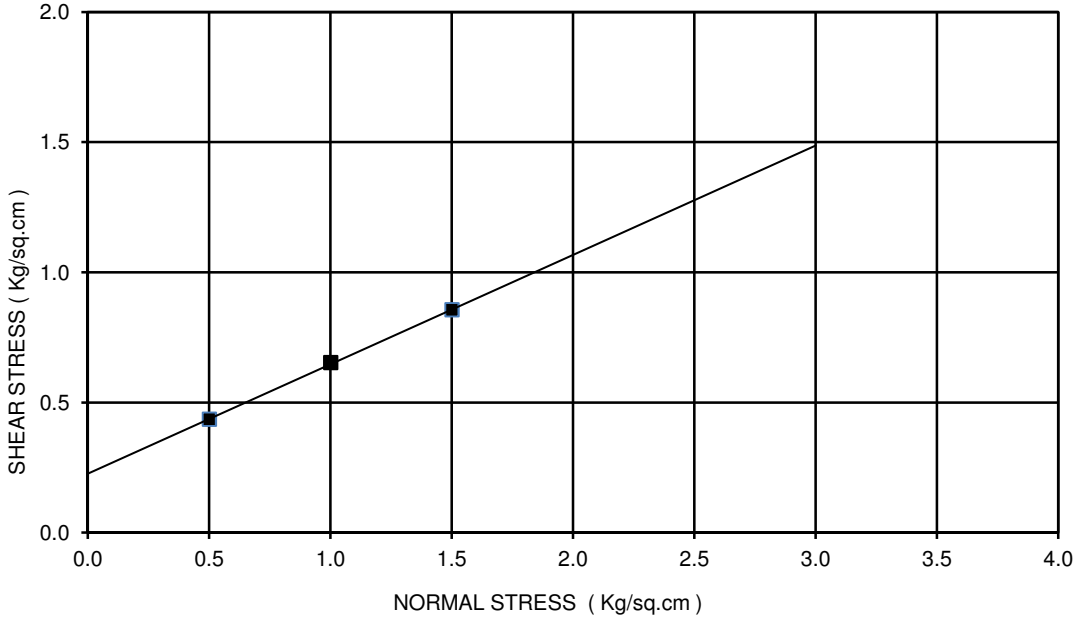


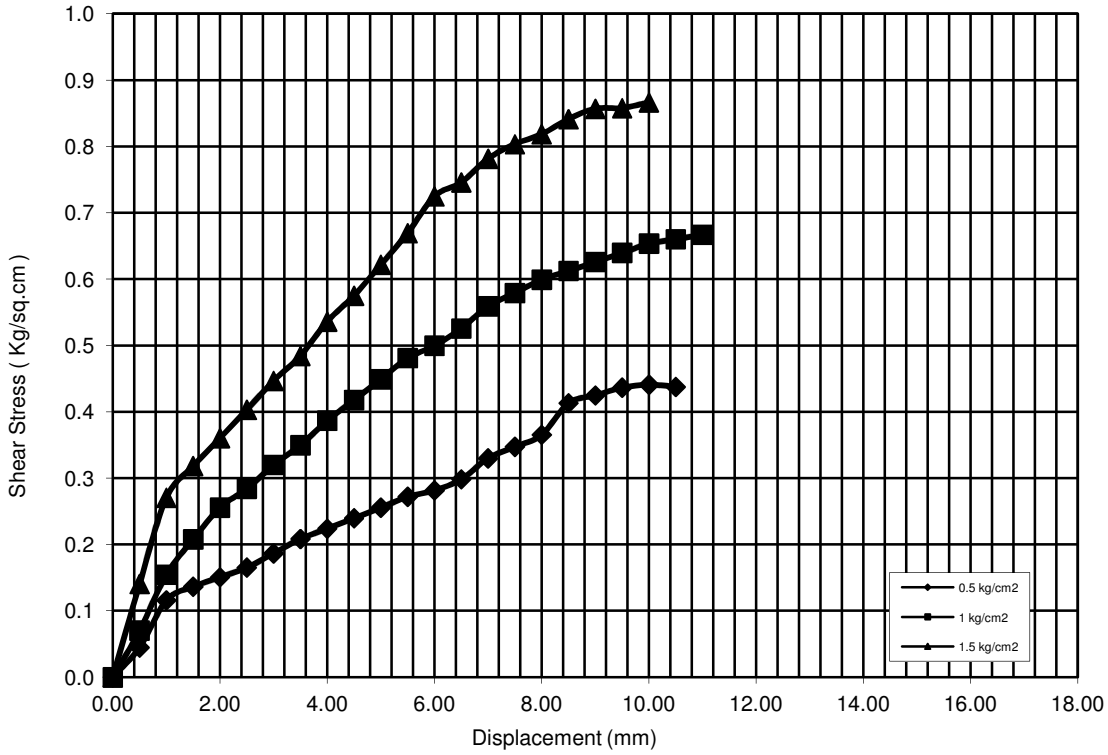
Ch. 58+497
BORE HOLE NO: BH-A1
SAMPLE NO.: UDS-4
DEPTH: 13.00 m
COHESION(C)= 0.08 kg/sq.cm
ANGLE OF FRICTION(Phi): 26 deg
TYPE OF THE TEST: DST



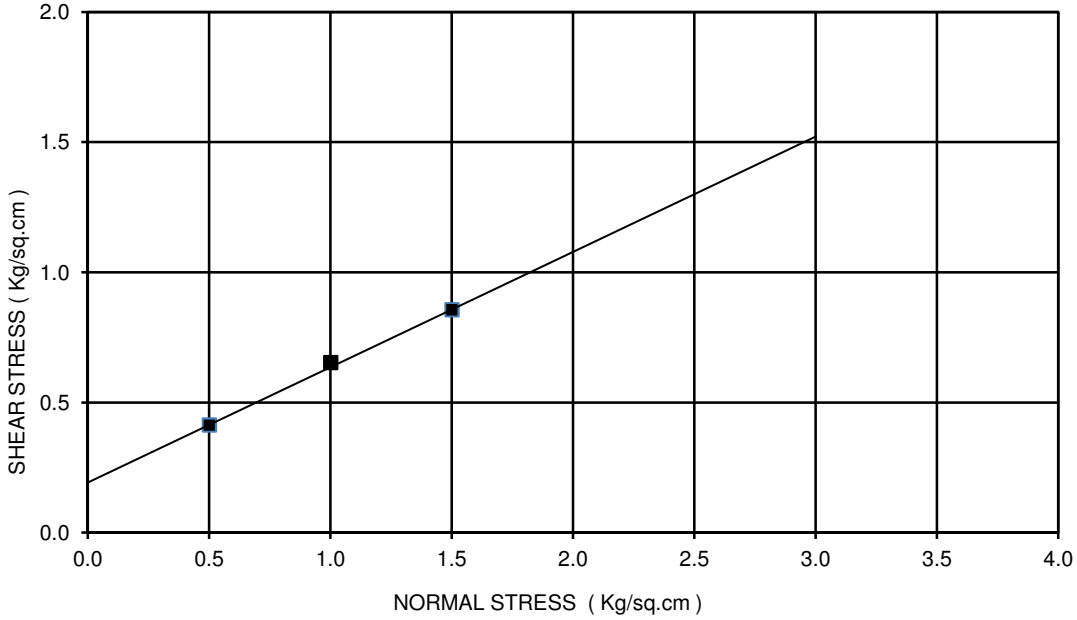


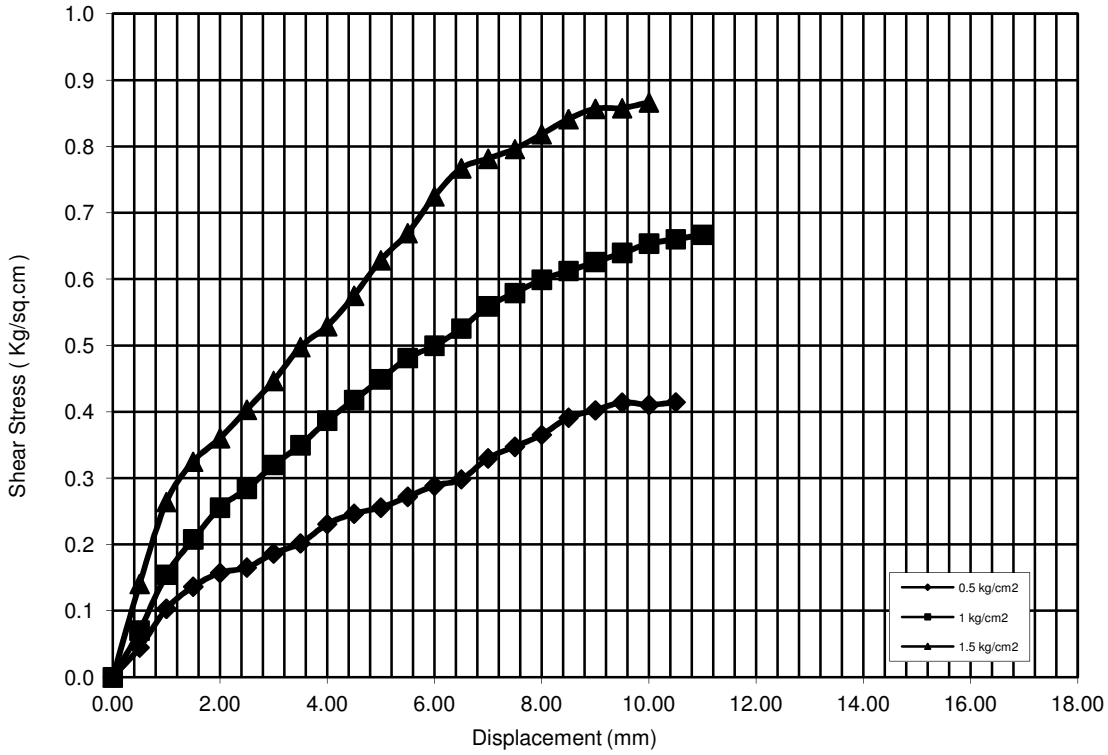
Ch. 58+497
BORE HOLE NO: BH-P1
SAMPLE NO.: UDS-4
DEPTH: 13.00 m
COHESION(C)= 0.08 kg/sq.cm
ANGLE OF FRICTION(Phi): 26 deg
TYPE OF THE TEST: DST



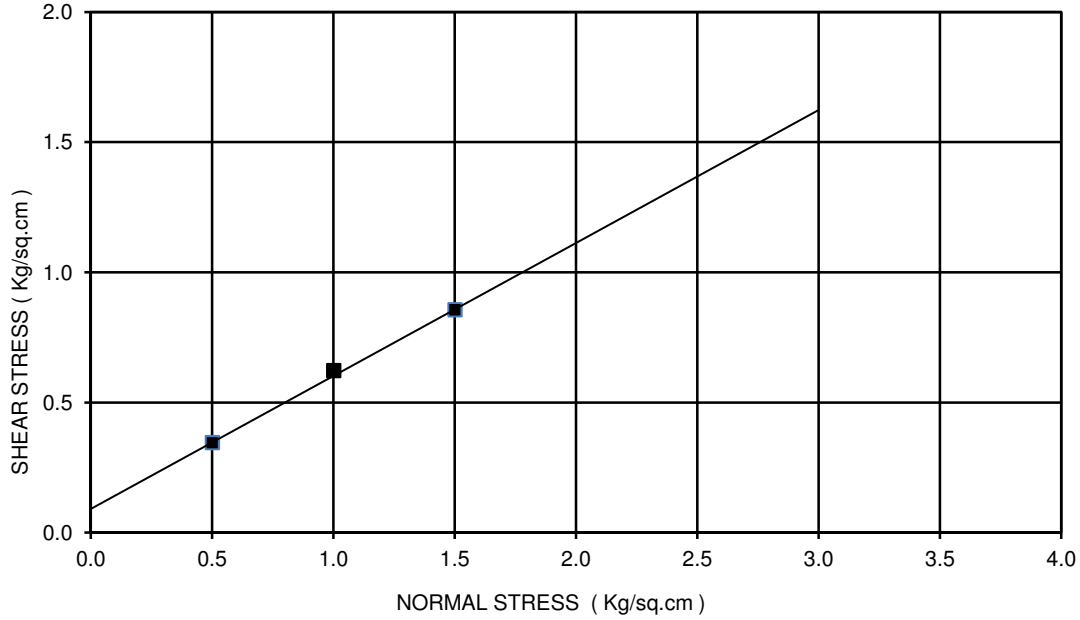


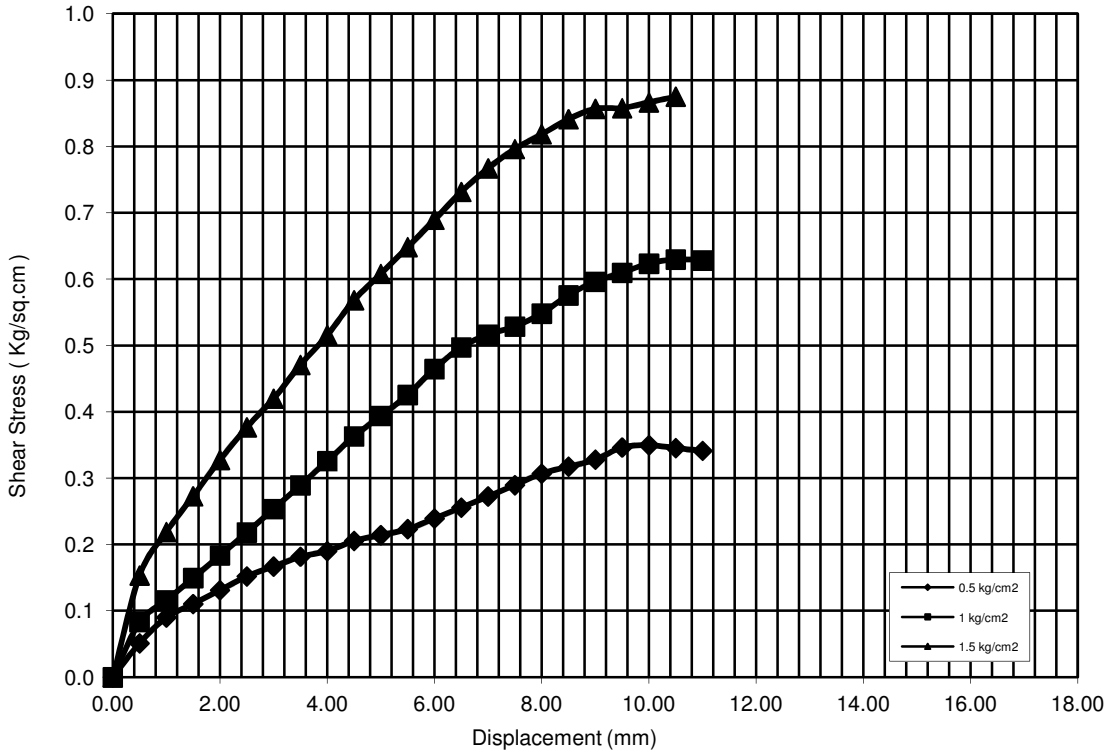
Ch. 58+497
BORE HOLE NO: BH-P1
SAMPLE NO.: UDS-4
DEPTH: 13.00 m
COHESION(C)= 0.08 kg/sq.cm
ANGLE OF FRICTION(Phi): 26 deg
TYPE OF THE TEST: DST



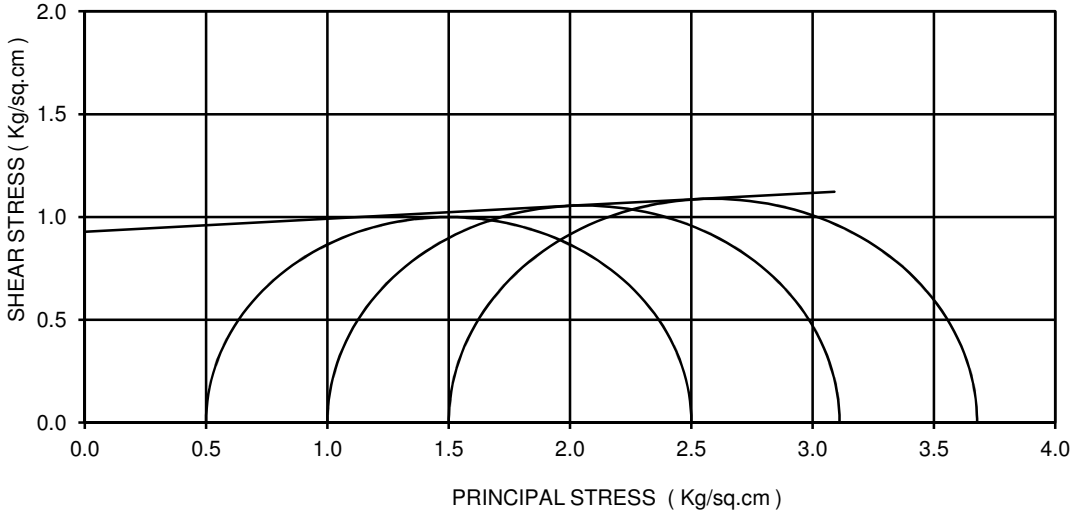


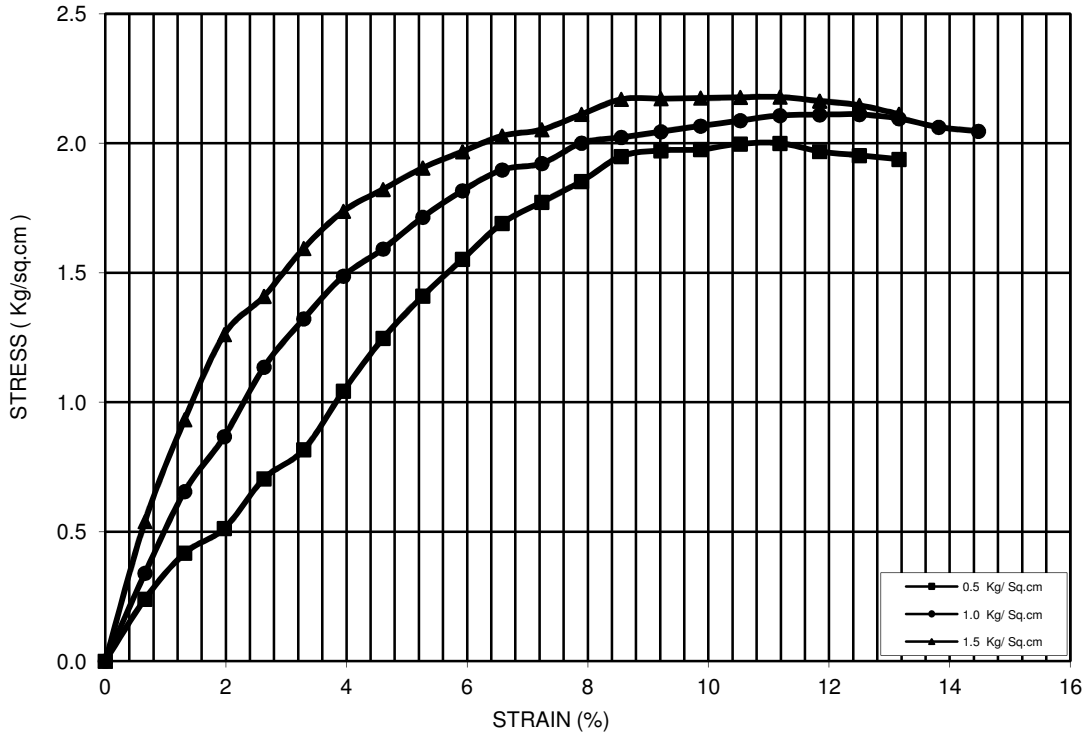
Ch. 58+497
BORE HOLE NO: BH-P2
SAMPLE NO.: UDS-1
DEPTH: 4.00 m
COHESION(C)= 0.08 kg/sq.cm
ANGLE OF FRICTION(Phi): 27 deg
TYPE OF THE TEST: DST



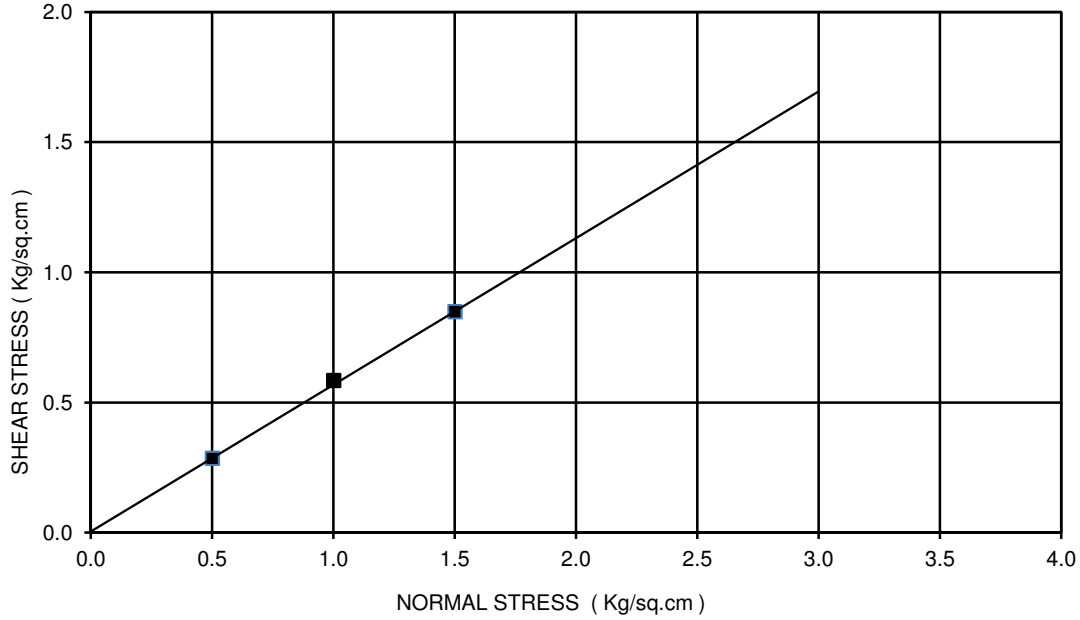


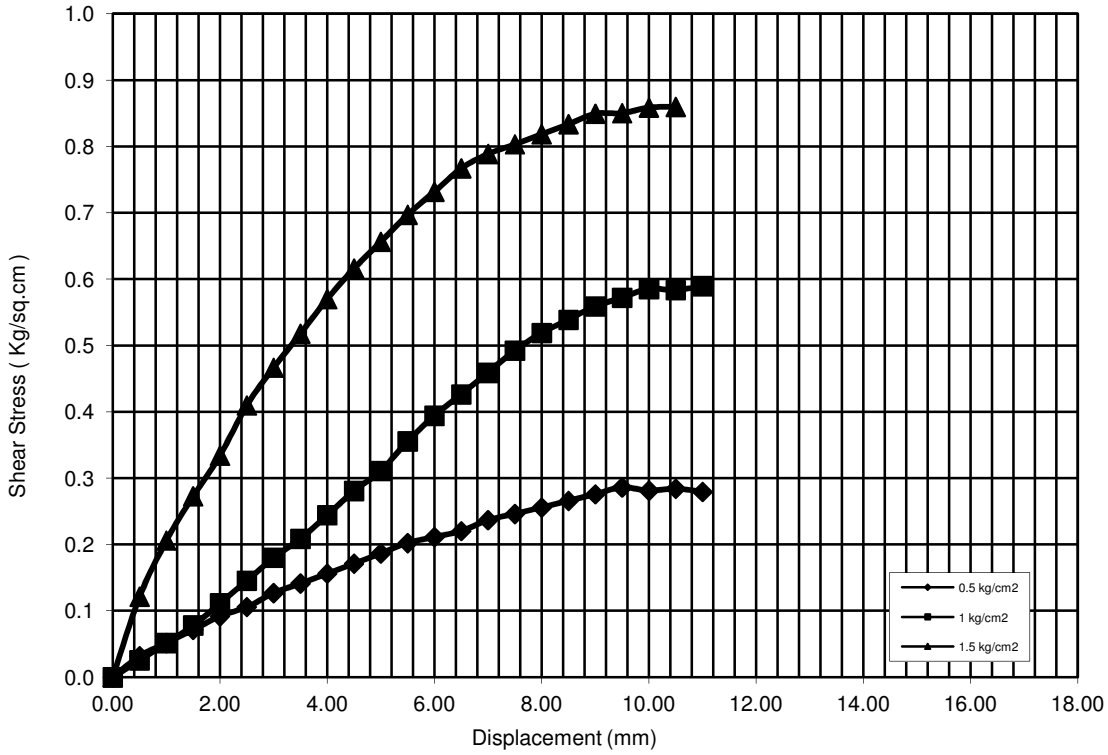
Ch. 58+497
BORE HOLE NO: BH-P2
SAMPLE NO.: UDS-8
DEPTH: 28.00 m
COHESION(C)= 2.65 kg/sq.cm
ANGLE OF FRICTION(Phi): 5 deg
TYPE OF THE TEST: UUT



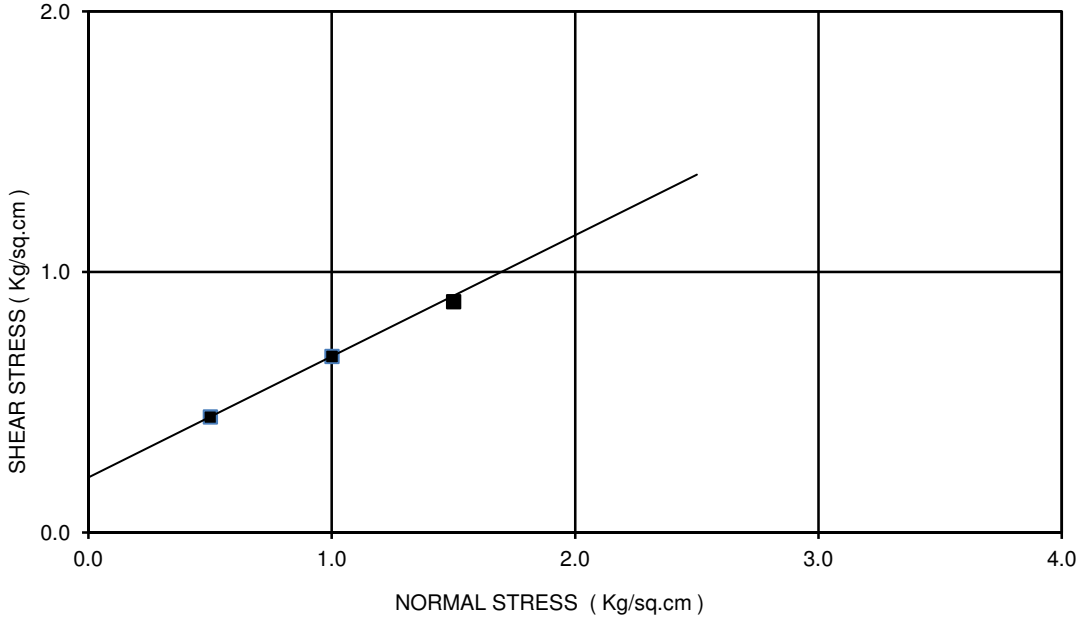


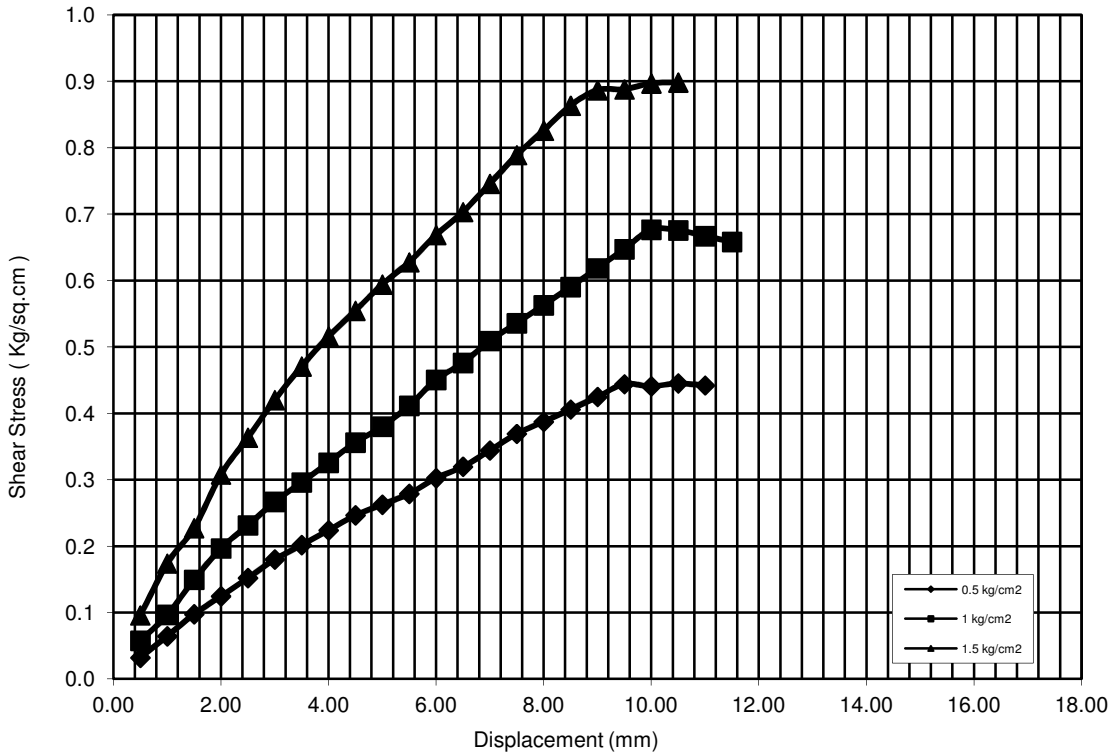
Ch. 58+497
BORE HOLE NO: BH-P3
SAMPLE NO.: UDS-1
DEPTH: 4.00 m
COHESION(C)= 0.08 kg/sq.cm
ANGLE OF FRICTION(Phi): 27 deg
TYPE OF THE TEST: DST



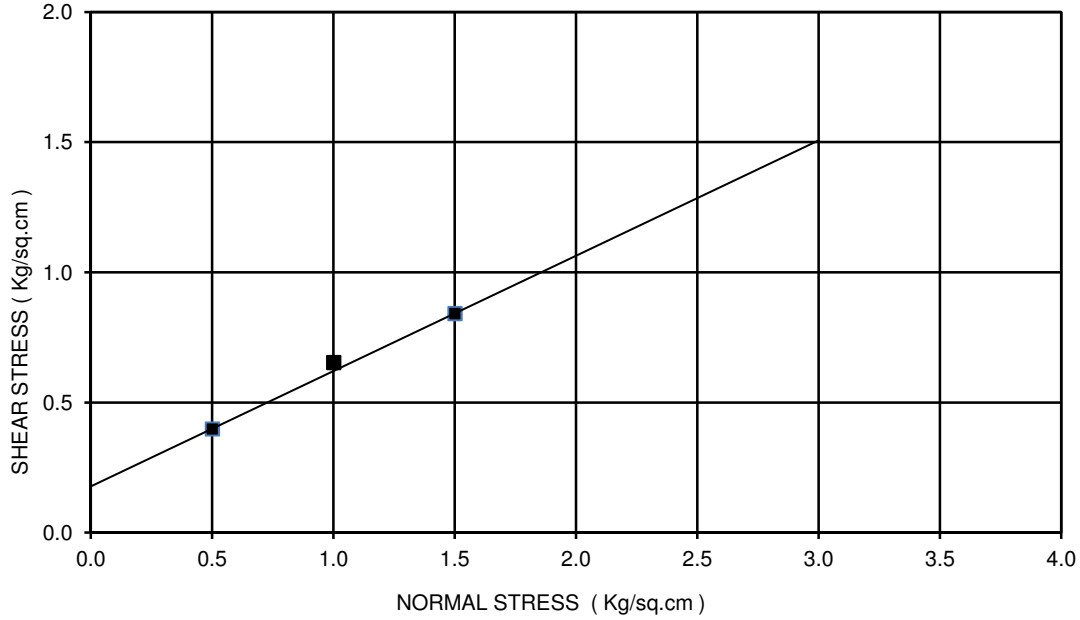


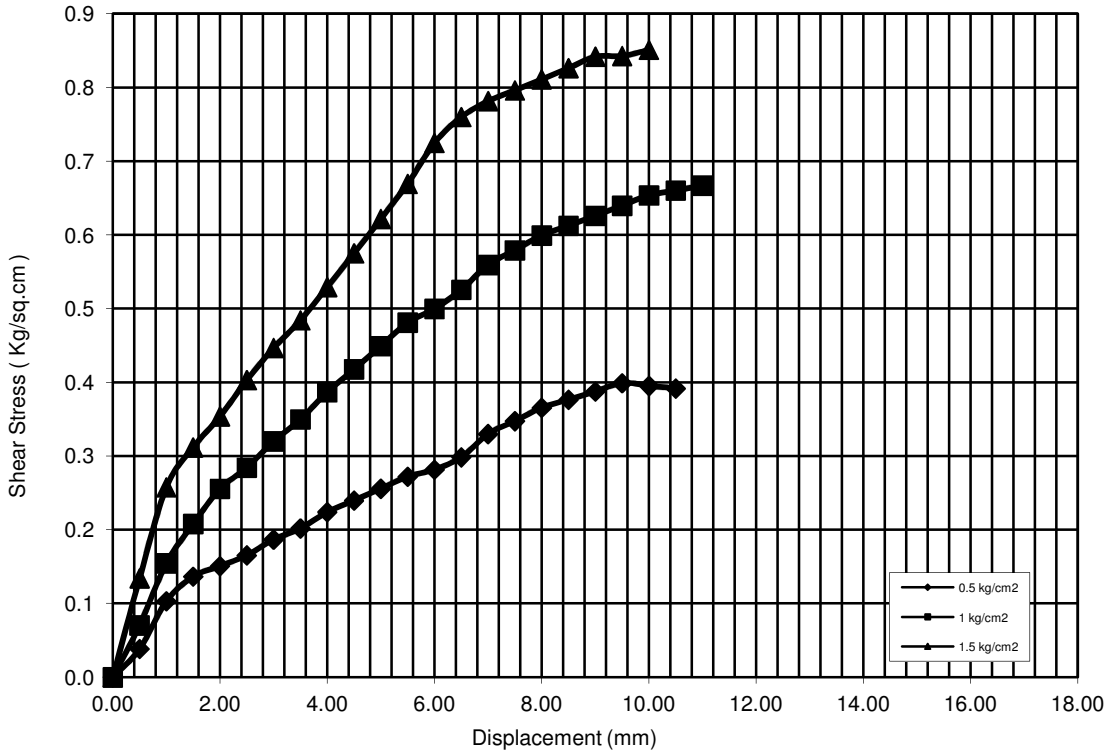
Ch. 58+497
BORE HOLE NO: BH-P3
SAMPLE NO.: UDS-3
DEPTH: 13.00 m
COHESION(C)= 0.14 kg/sq.cm
ANGLE OF FRICTION(Phi): 23 deg
TYPE OF THE TEST: DST



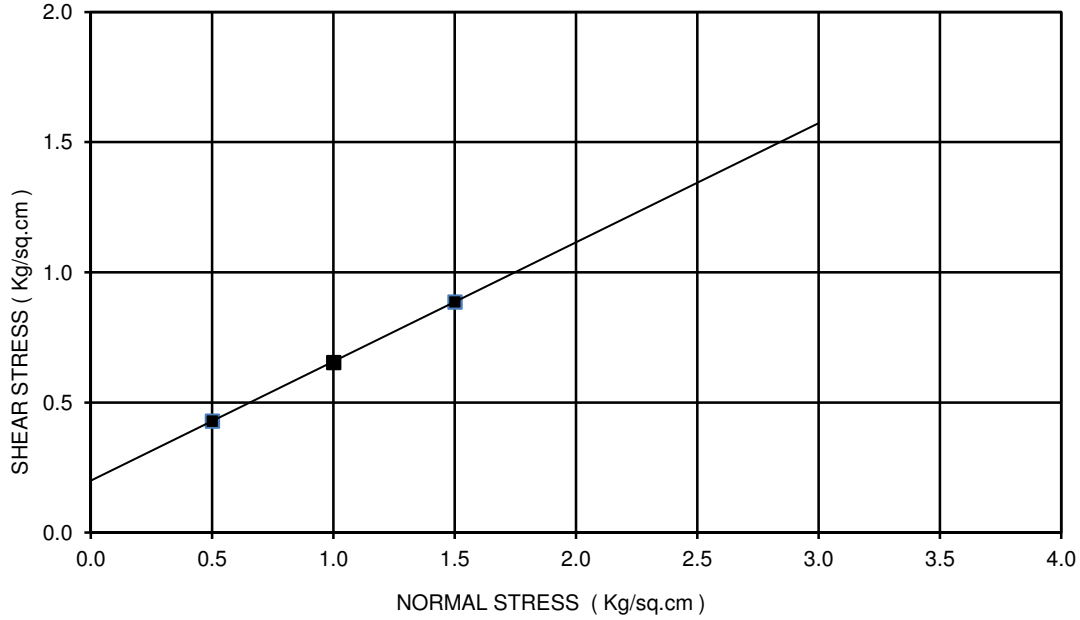


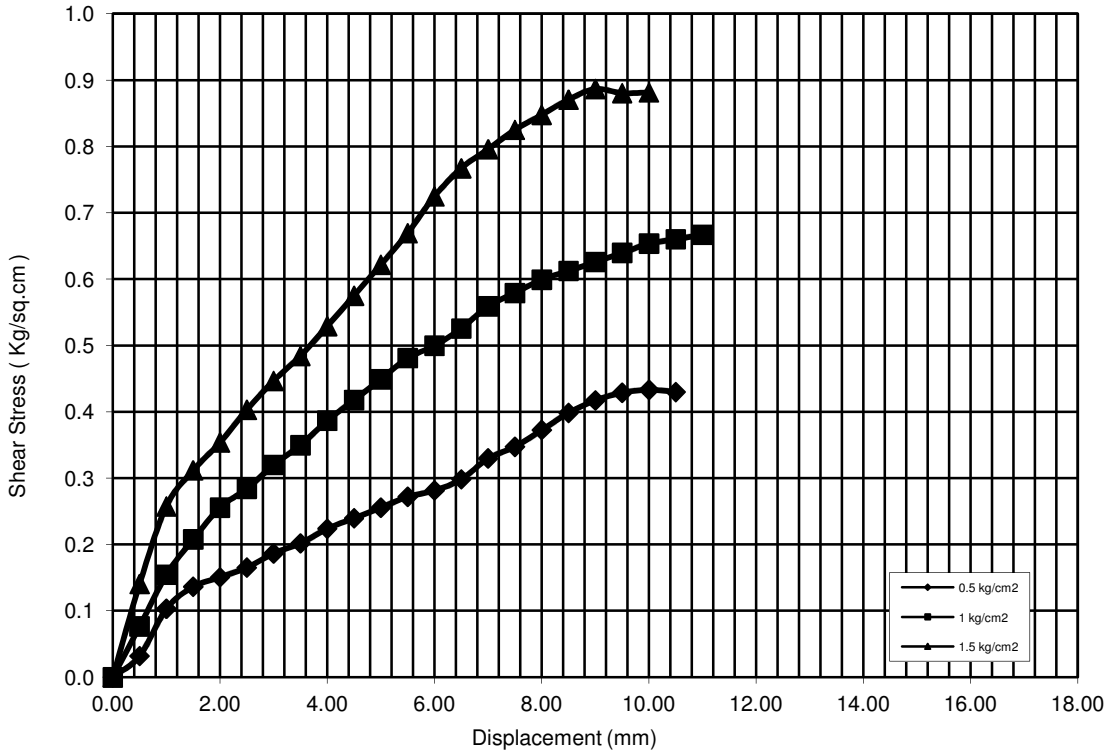
Ch. 58+497
BORE HOLE NO: BH-P4
SAMPLE NO.: UDS-4
DEPTH: 13.00 m
COHESION(C)= 0.08 kg/sq.cm
ANGLE OF FRICTION(Phi): 26 deg
TYPE OF THE TEST: DST



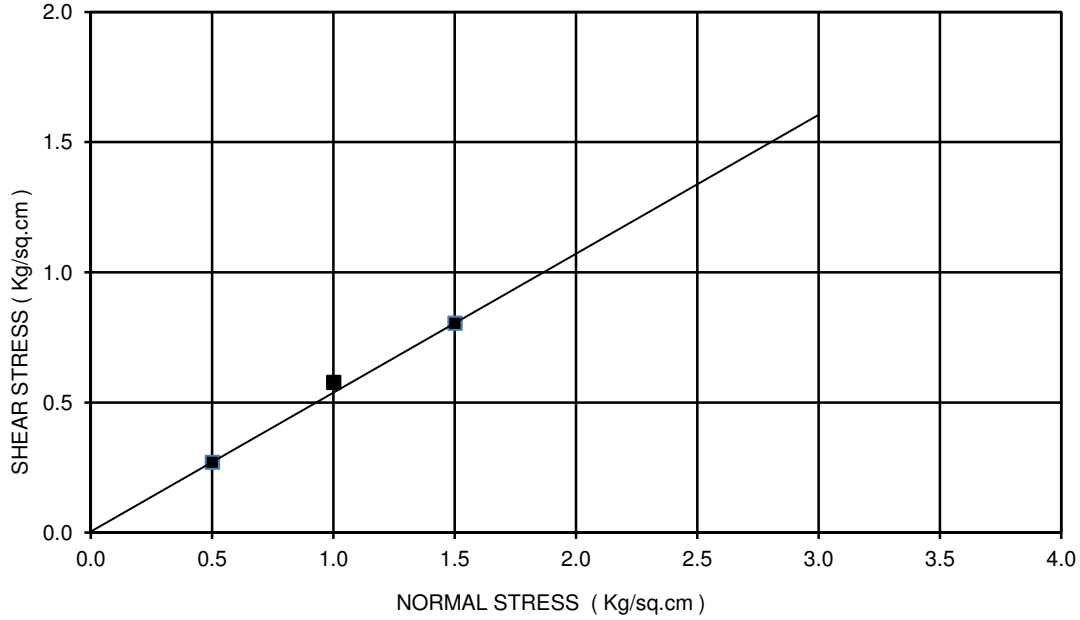


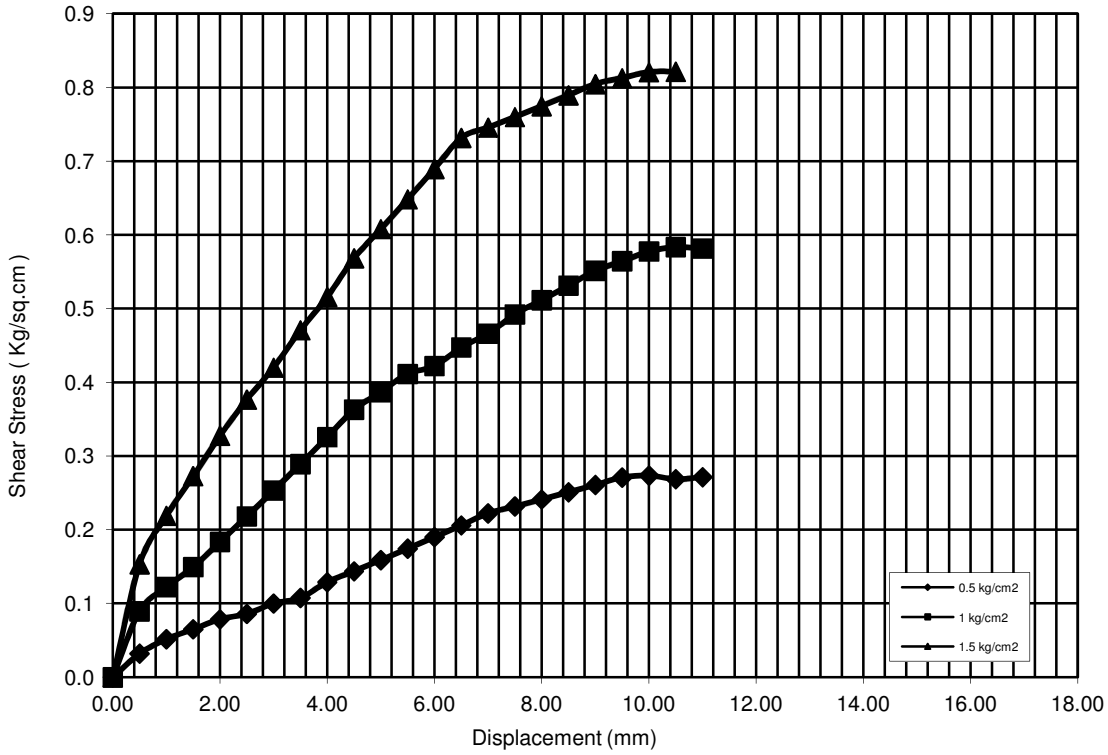
Ch.58+497
BORE HOLE NO: BH-P4
SAMPLE NO.: UDS-4
DEPTH: 13.00 m
COHESION(C)= 0.08 kg/sq.cm
ANGLE OF FRICTION(Phi): 26 deg
TYPE OF THE TEST: DST



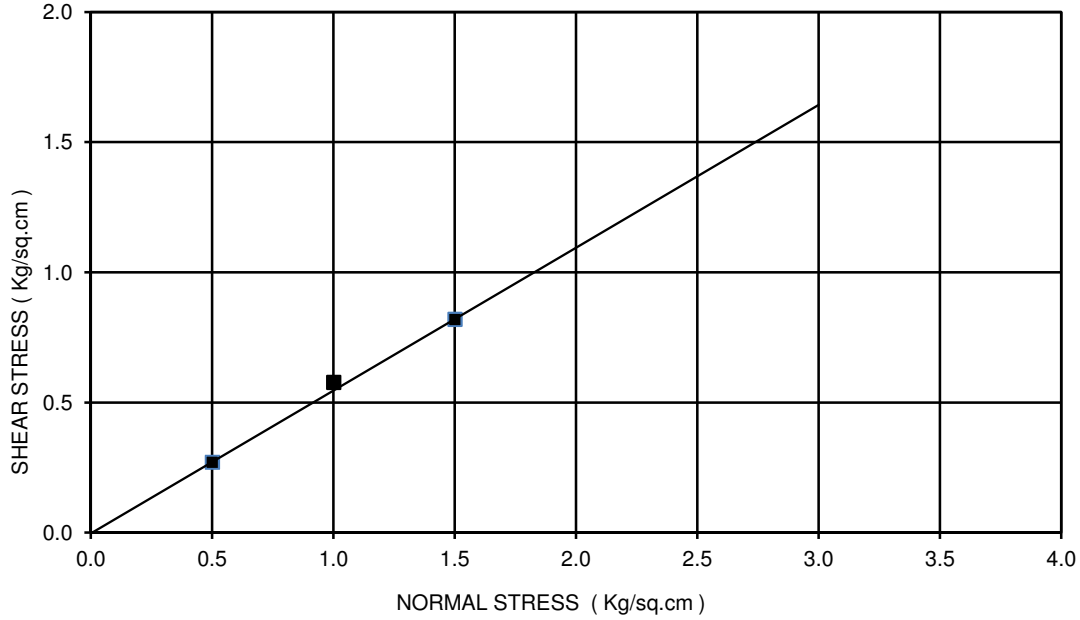


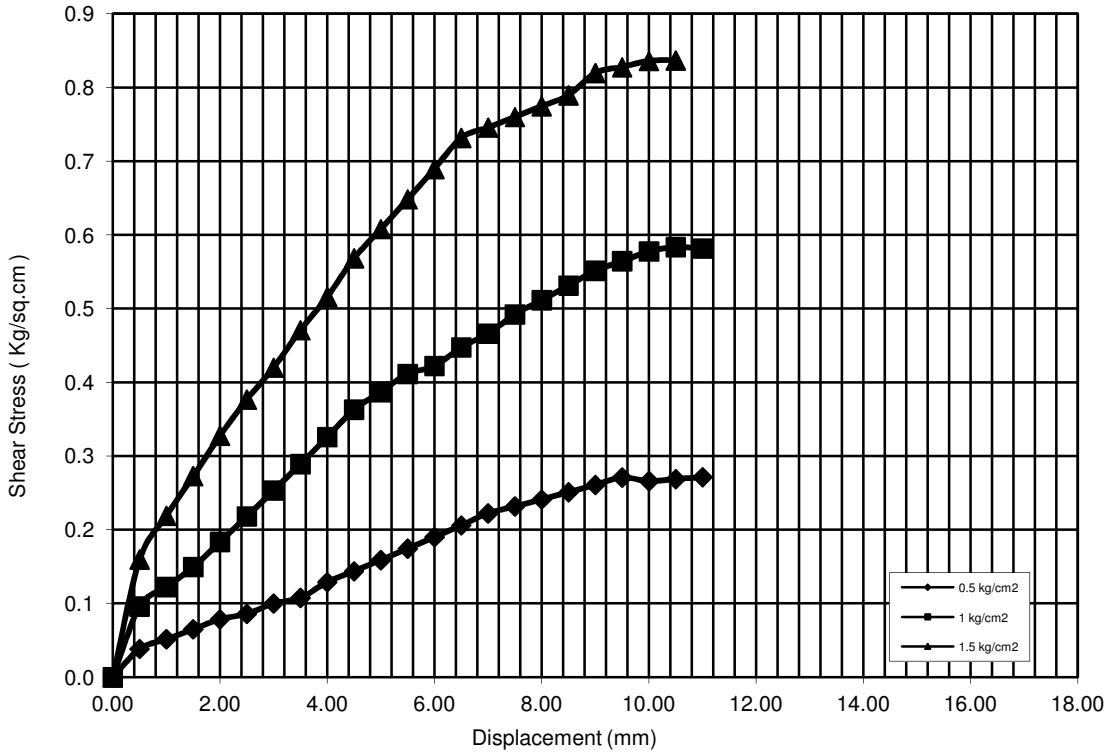
Ch. 58+497
BORE HOLE NO: BH-P5
SAMPLE NO.: UDS-1
DEPTH: 4.00 m
COHESION(C)= 0.08 kg/sq.cm
ANGLE OF FRICTION(Phi): 27 deg
TYPE OF THE TEST: DST



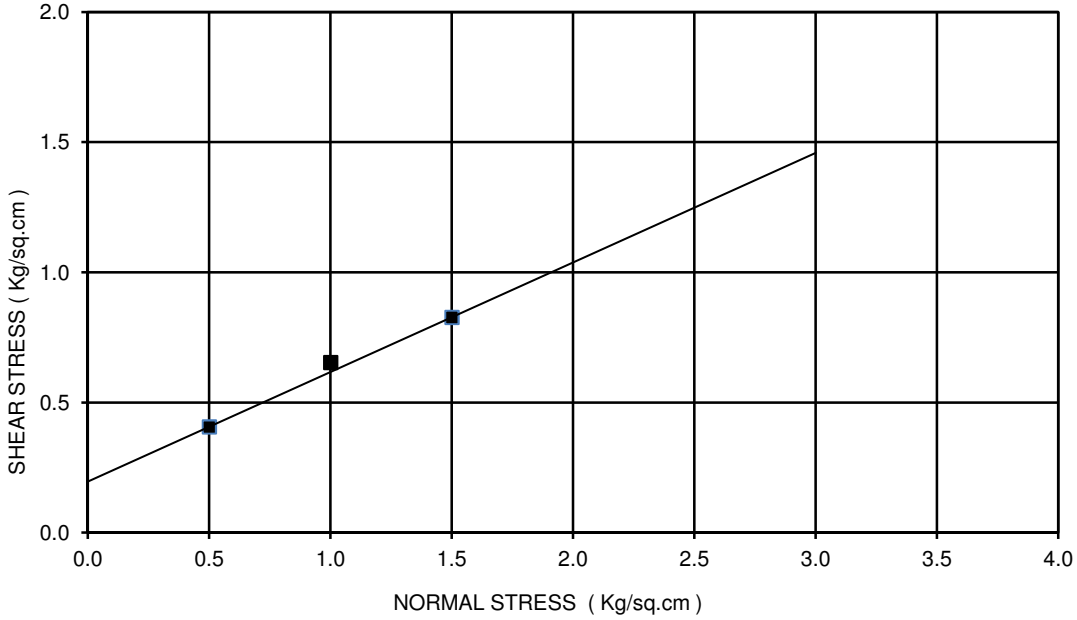


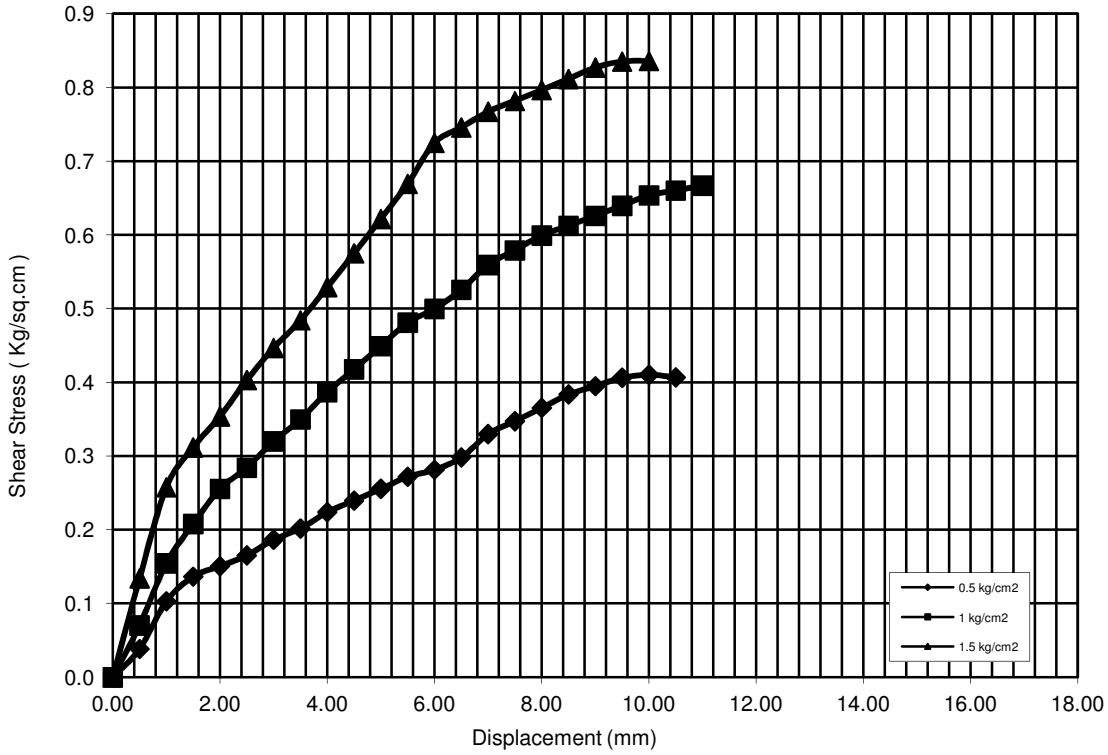
Ch. 58+497
BORE HOLE NO: BH-P5
SAMPLE NO.: UDS-1
DEPTH: 4.00 m
COHESION(C)= 0.08 kg/sq.cm
ANGLE OF FRICTION(Phi): 27 deg
TYPE OF THE TEST: DST



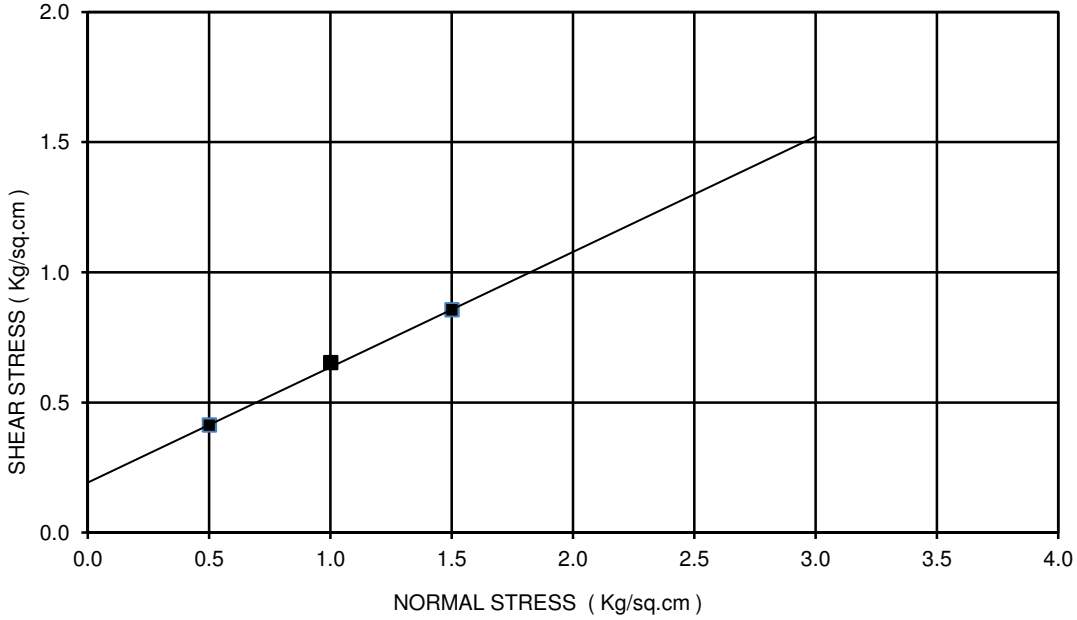


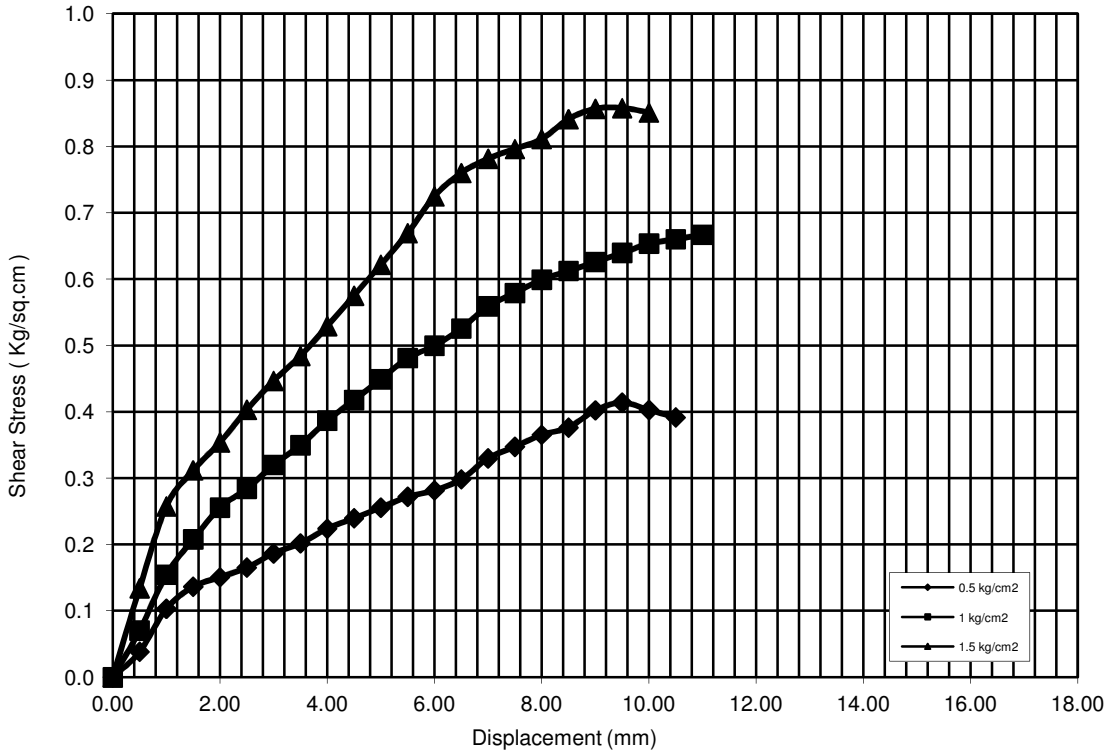
Ch. 58+497
BORE HOLE NO: BH-P6
SAMPLE NO.: UDS-4
DEPTH: 13.00 m
COHESION(C)= 0.08 kg/sq.cm
ANGLE OF FRICTION(Phi): 26 deg
TYPE OF THE TEST: DST



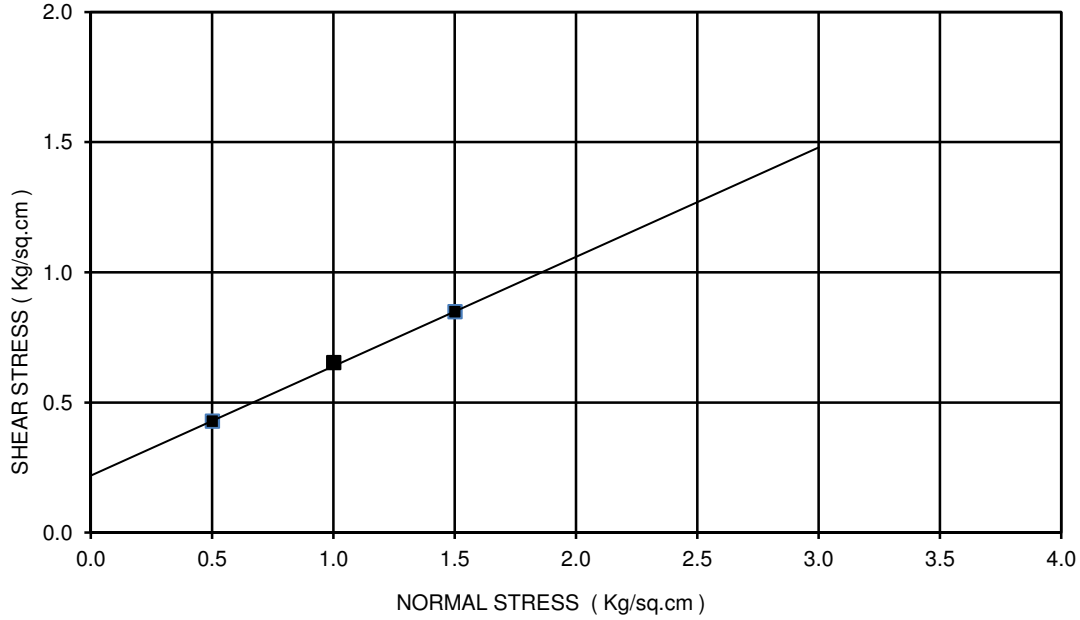


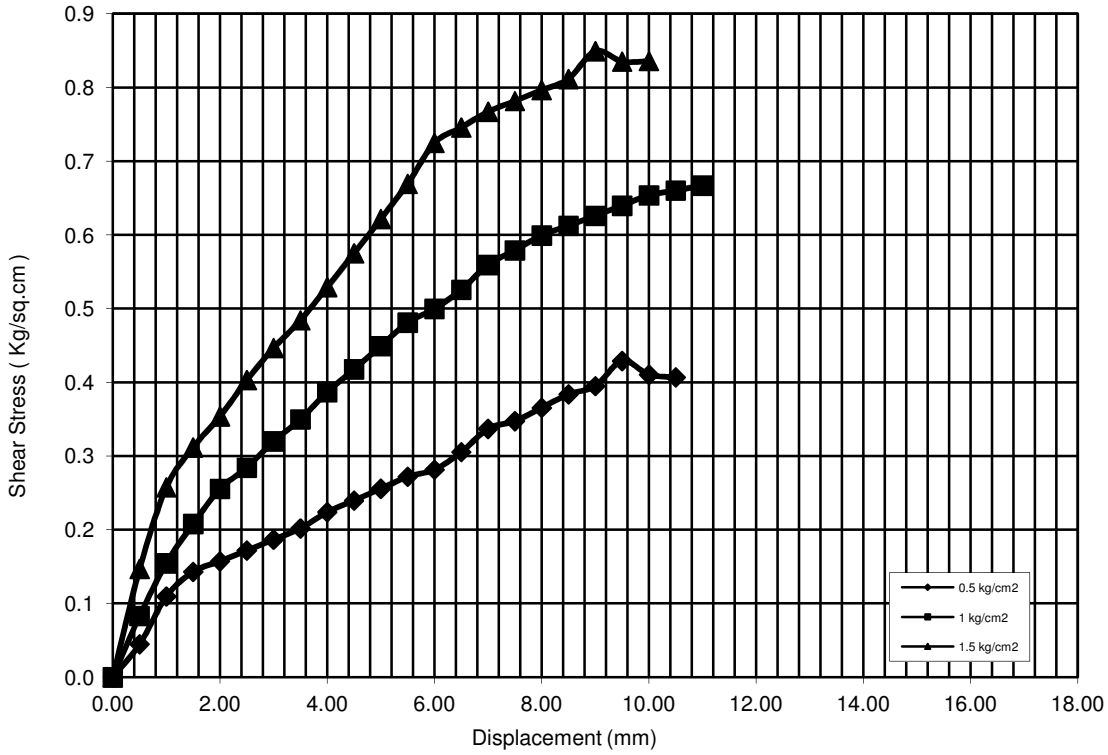
Ch. 58+497
BORE HOLE NO: BH-P6
SAMPLE NO.: UDS-4
DEPTH: 13.00 m
COHESION(C)= 0.08 kg/sq.cm
ANGLE OF FRICTION(Phi): 26 deg
TYPE OF THE TEST: DST



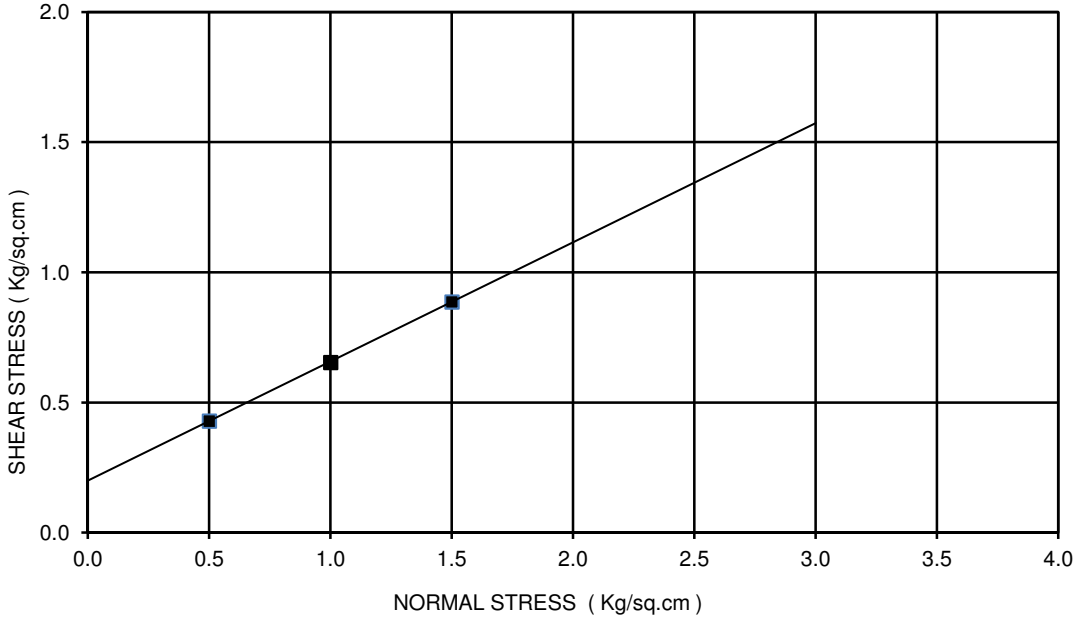


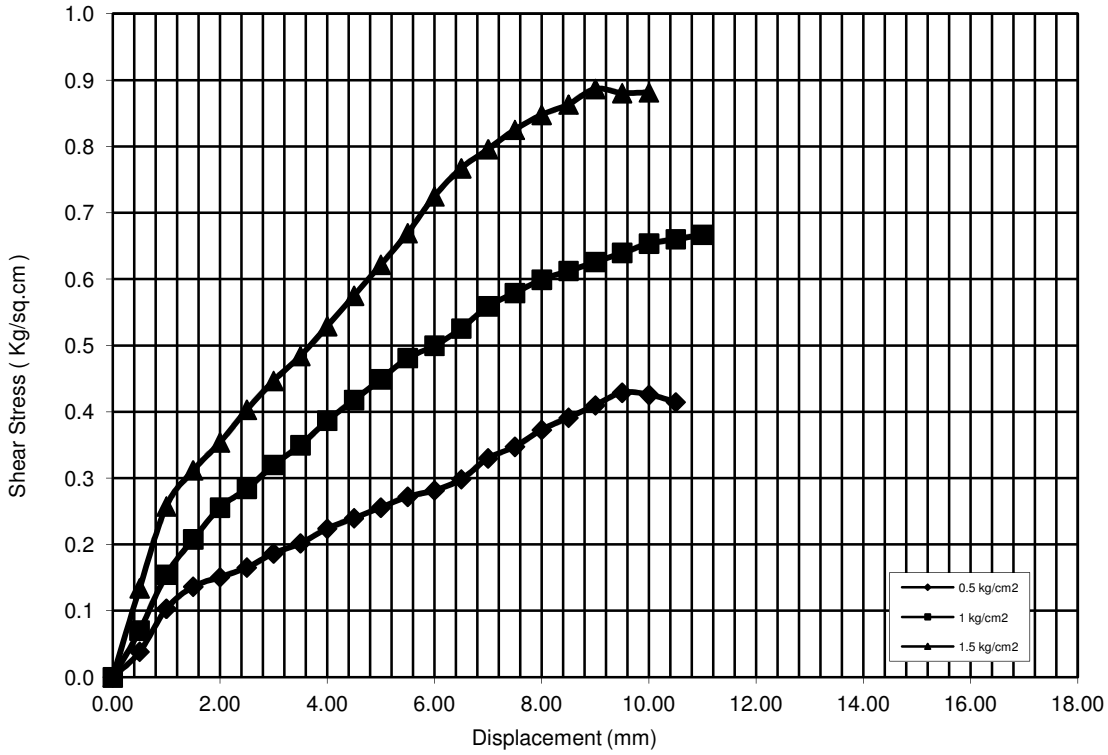
Ch. 58+497
BORE HOLE NO: BH-A2
SAMPLE NO.: UDS-4
DEPTH: 13.00 m
COHESION(C)= 0.08 kg/sq.cm
ANGLE OF FRICTION(Phi): 26 deg
TYPE OF THE TEST: DST



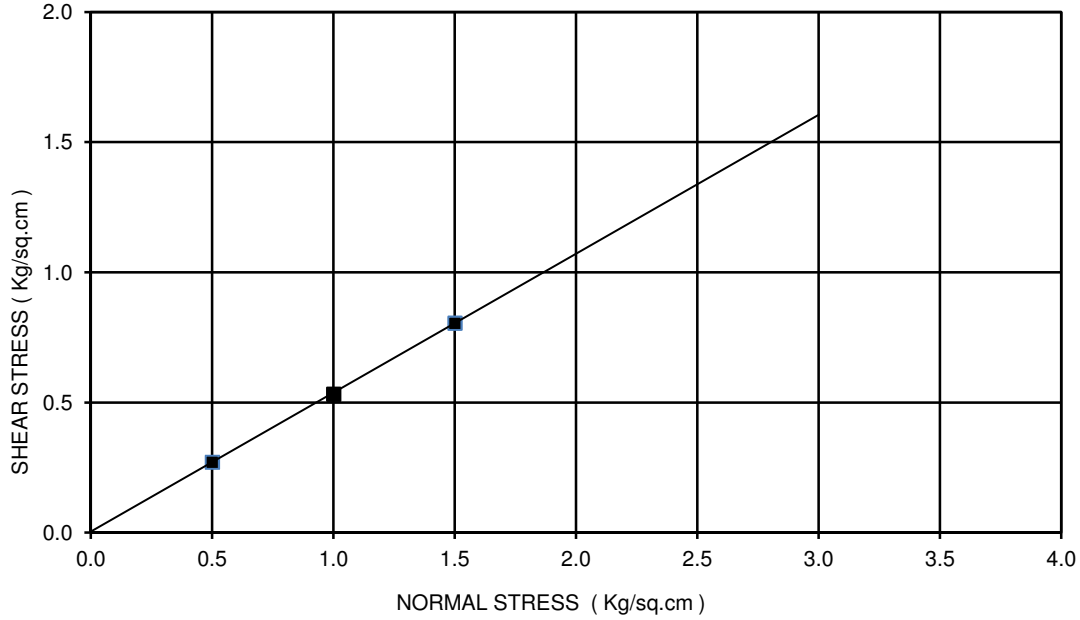


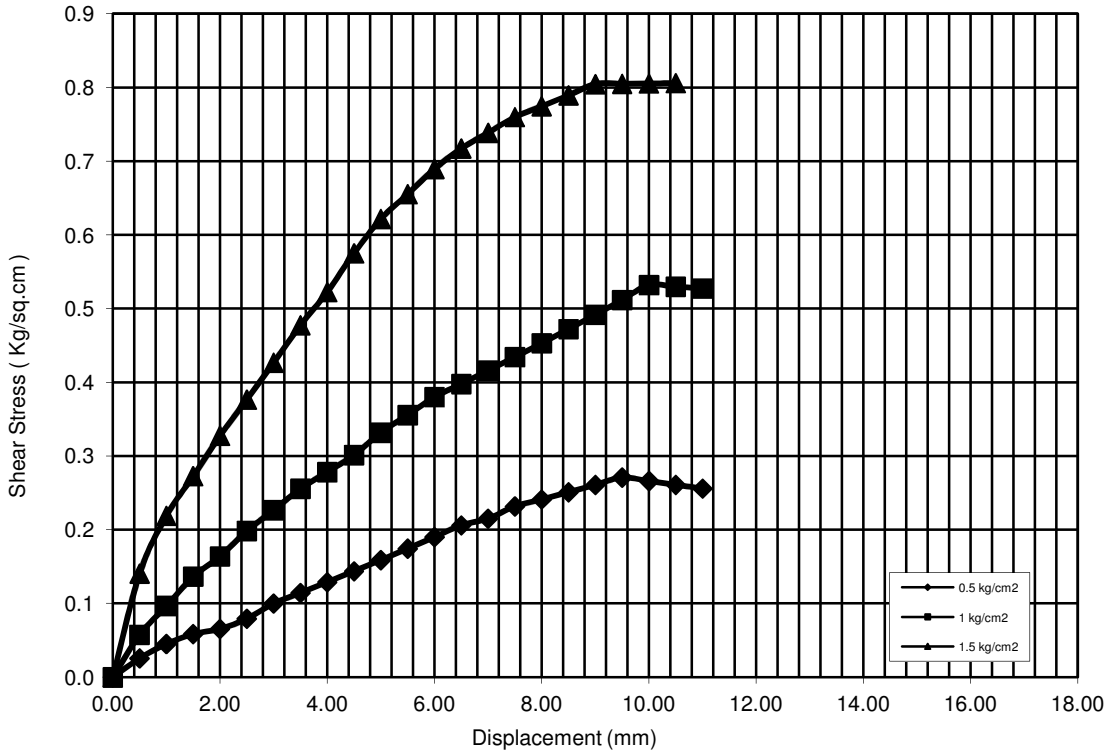
Ch. 58+497
BORE HOLE NO: BH-A2
SAMPLE NO.: UDS-4
DEPTH: 13.00 m
COHESION(C)= 0.08 kg/sq.cm
ANGLE OF FRICTION(Phi): 26 deg
TYPE OF THE TEST: DST



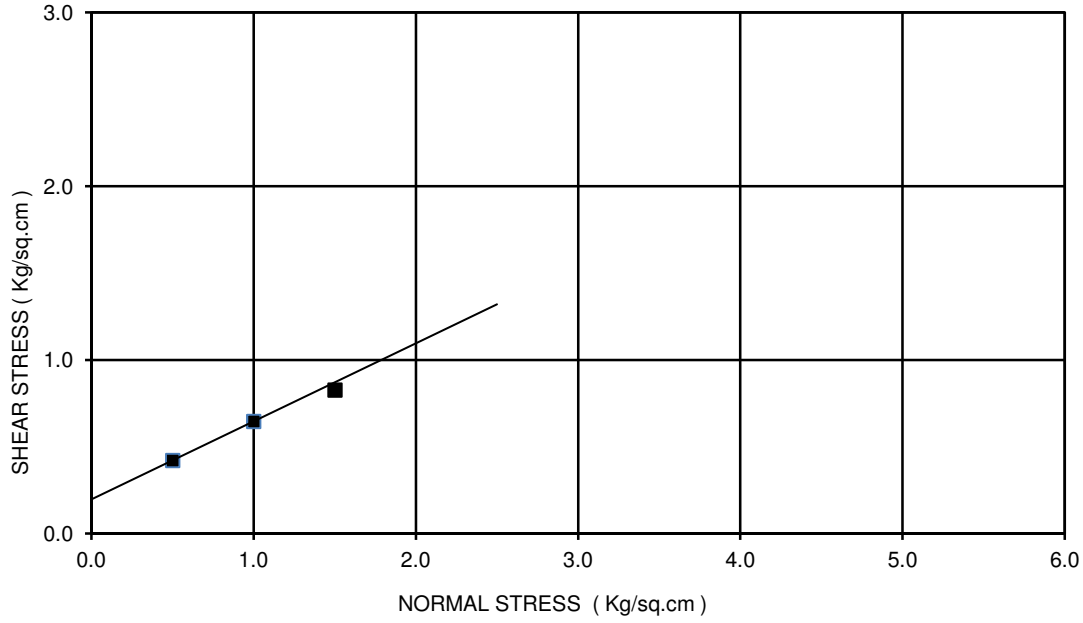


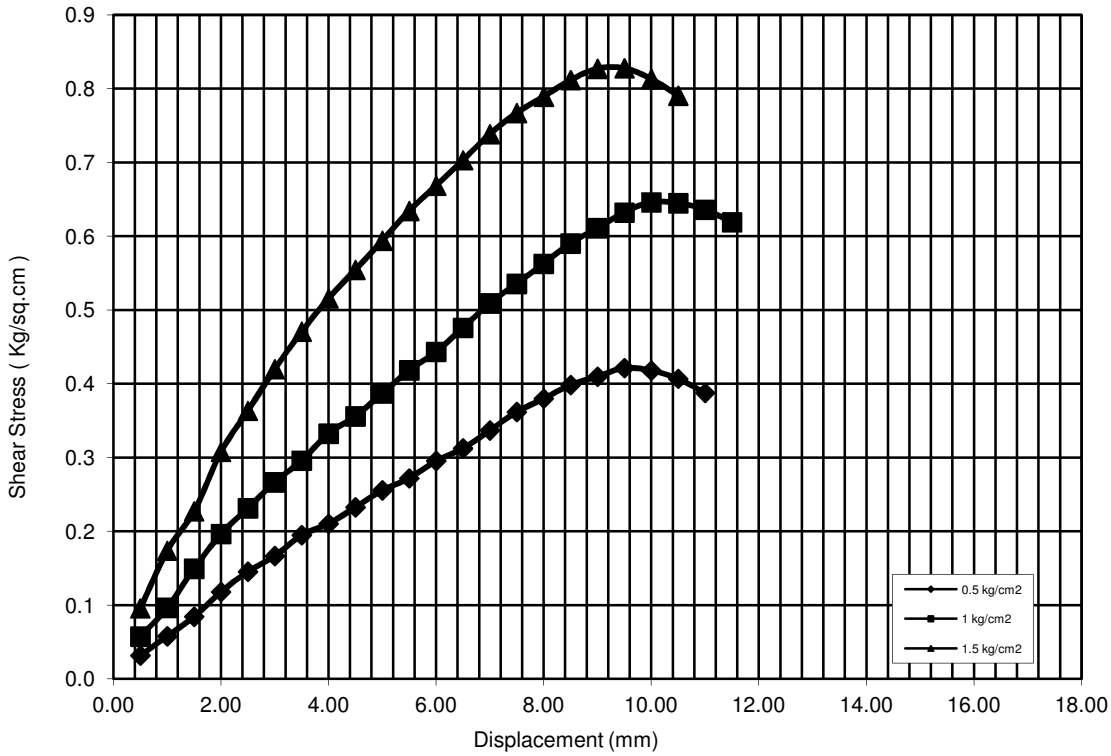
Ch. 58+837
BORE HOLE NO: BH-CL
SAMPLE NO.: UDS-1
DEPTH: 2.50 m
COHESION(C)= 0.00 kg/sq.cm
ANGLE OF FRICTION(Phi): 28 deg
TYPE OF THE TEST: DST



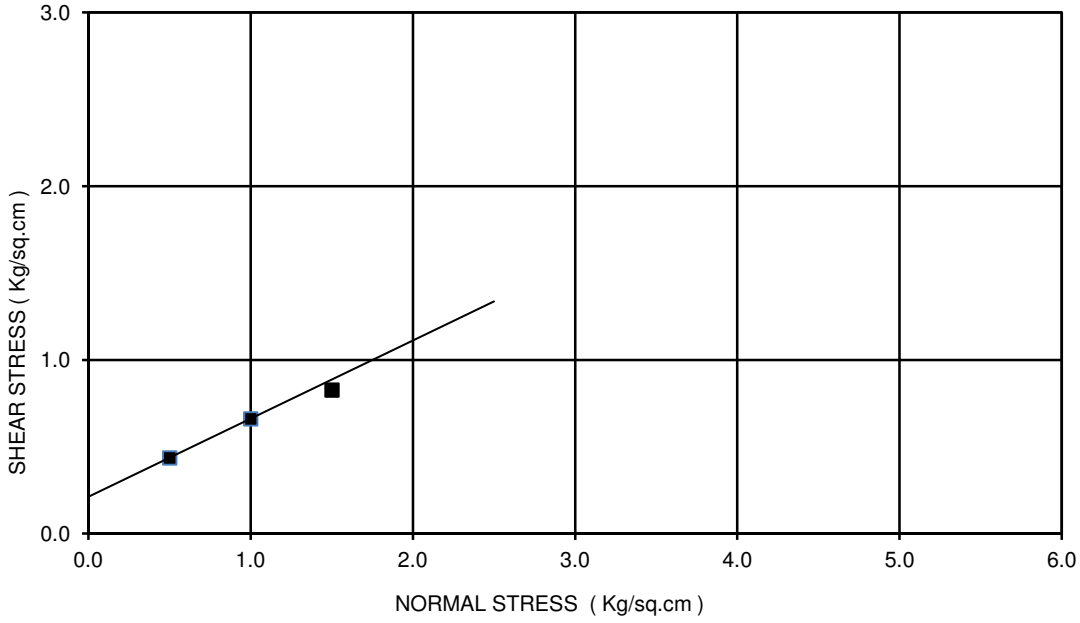


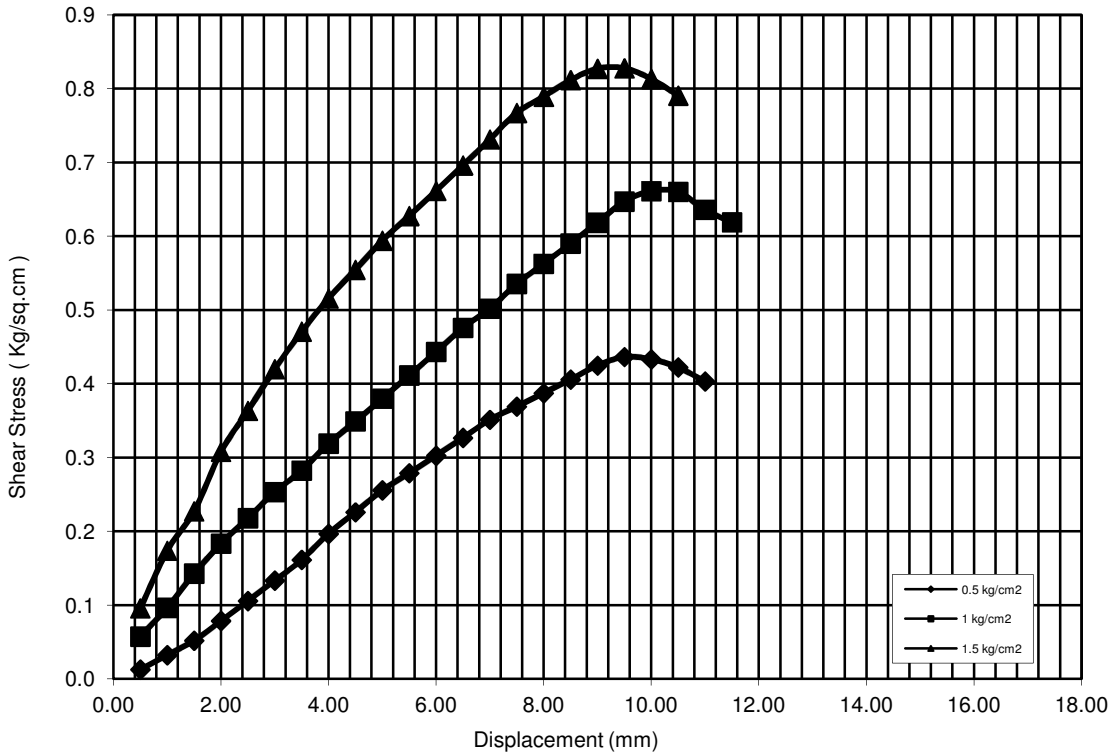
Ch. 59+071
BORE HOLE NO: BH-CL
SAMPLE NO.: UDS-1
DEPTH: 1.00 m
COHESION(C)= 0.20 kg/sq.cm
ANGLE OF FRICTION(Phi): 24 deg
TYPE OF THE TEST: DST



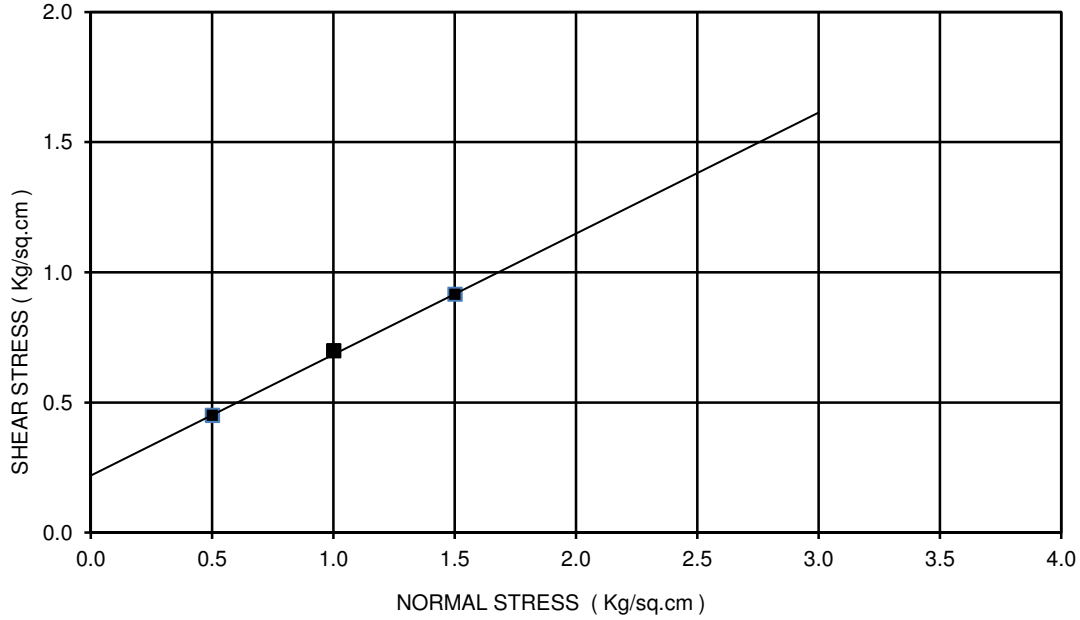


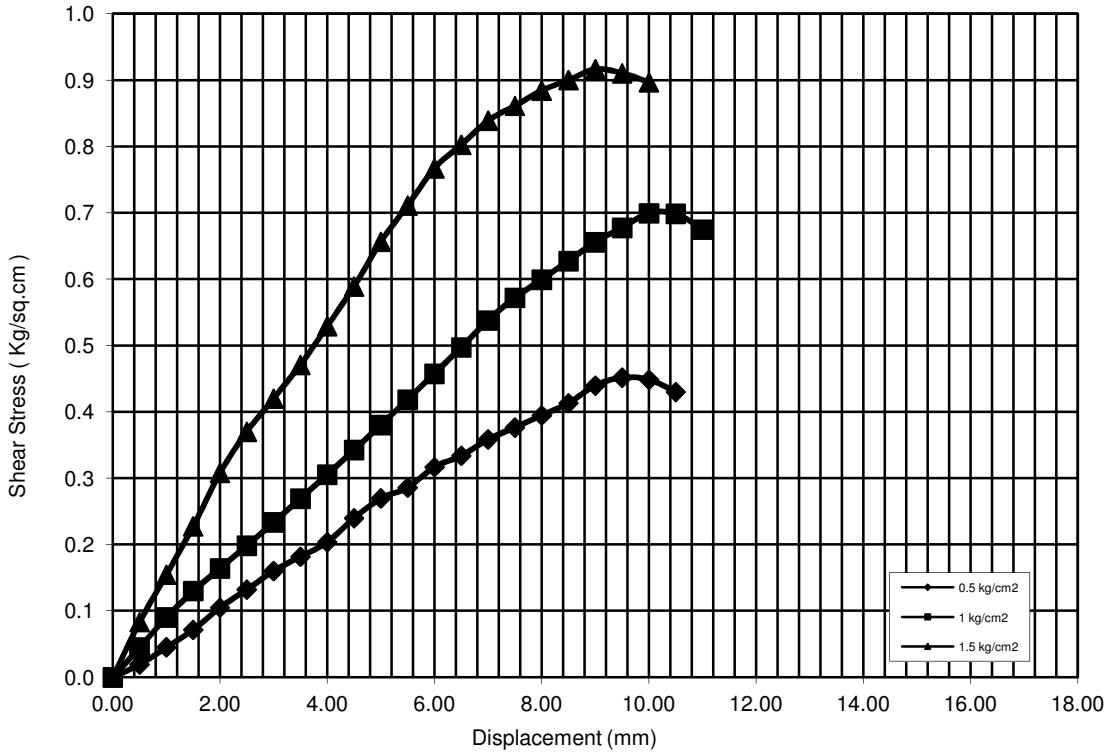
Ch. 59+206
BORE HOLE NO: BH-CL
SAMPLE NO.: UDS-3
DEPTH: 13.00 m
COHESION(C)= 0.14 kg/sq.cm
ANGLE OF FRICTION(Phi): 23 deg
TYPE OF THE TEST: DST



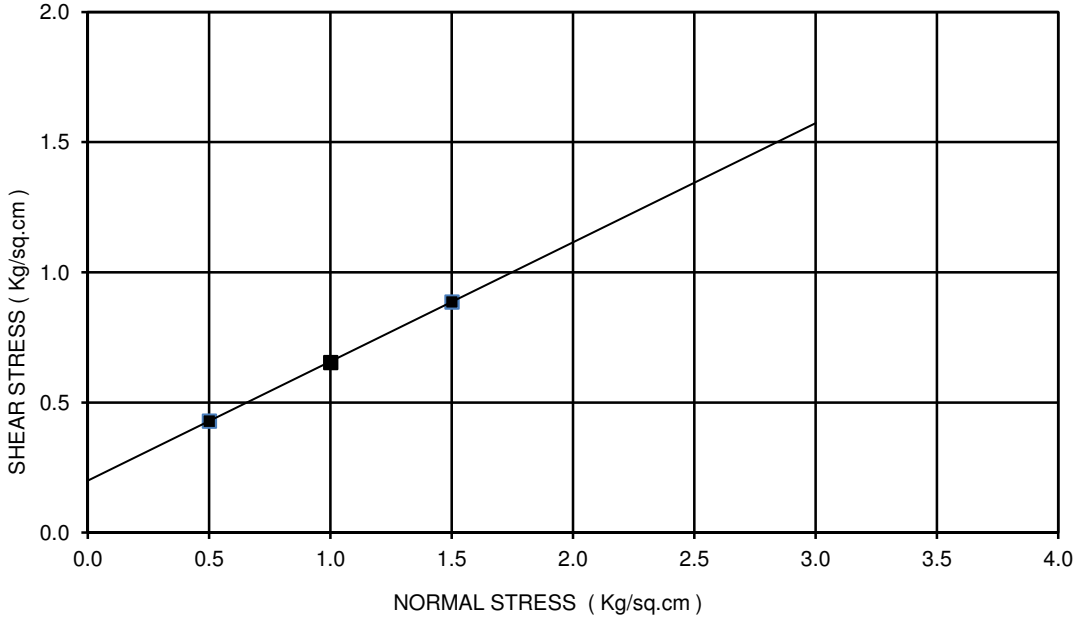


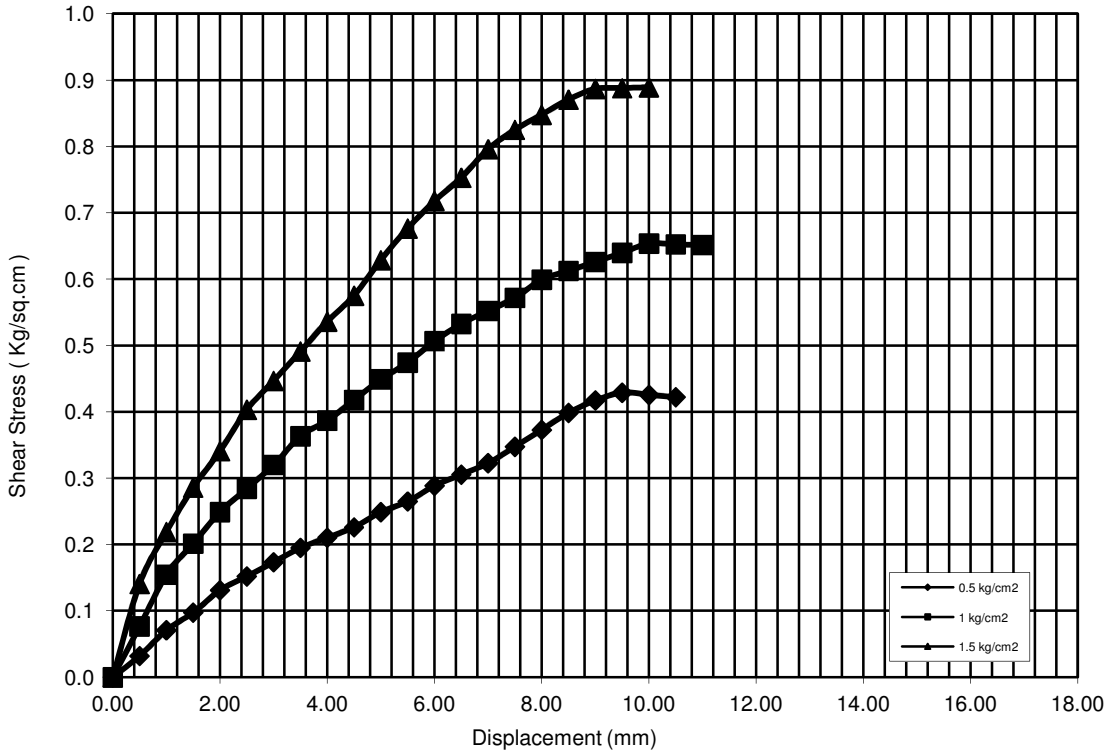
Ch. 59+206
BORE HOLE NO: BH-CL
SAMPLE NO.: UDS-4
DEPTH: 13.00 m
COHESION(C)= 0.08 kg/sq.cm
ANGLE OF FRICTION(Phi): 26 deg
TYPE OF THE TEST: DST



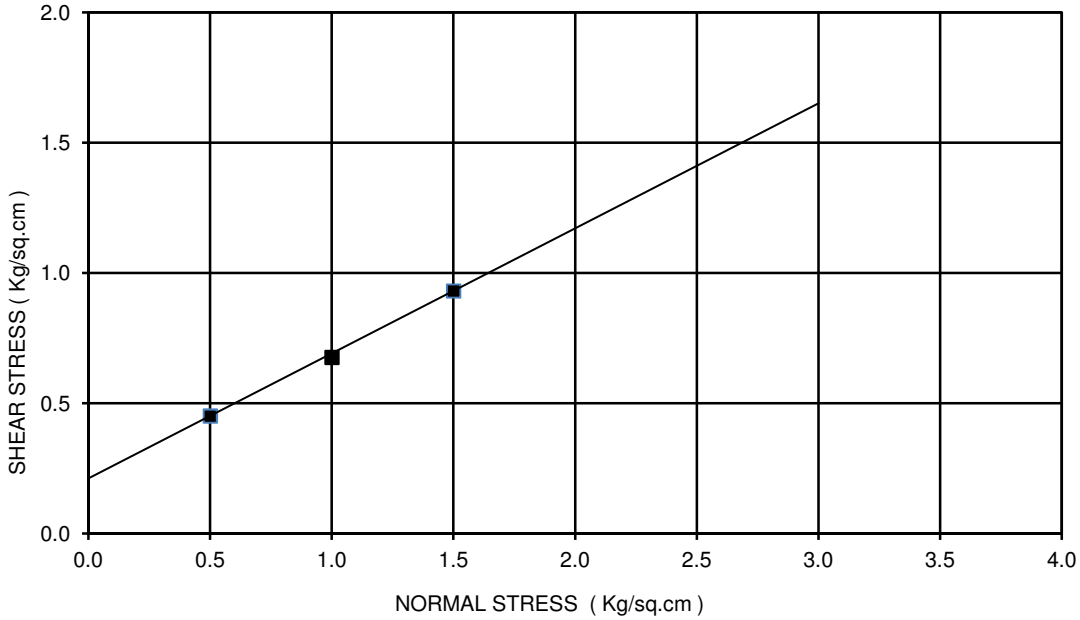


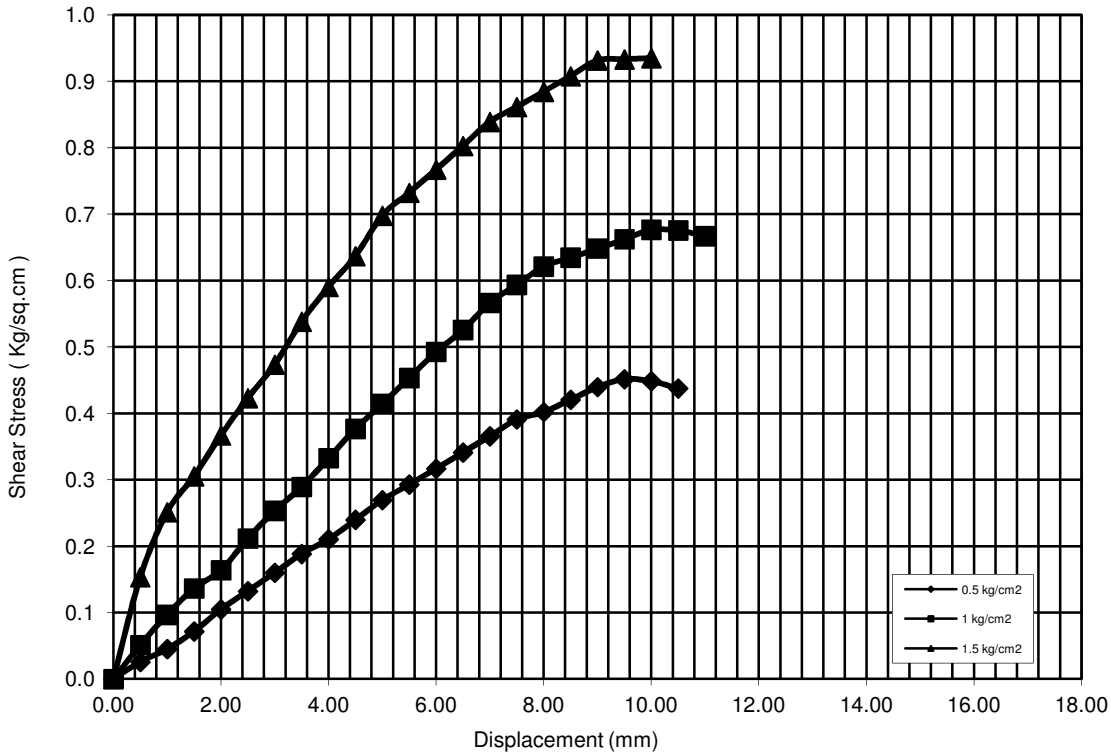
Ch. 59+270
BORE HOLE NO: BH-CL
SAMPLE NO.: UDS-1
DEPTH: 2.50 m
COHESION(C)= 0.20 kg/sq.cm
ANGLE OF FRICTION(Phi): 25 deg
TYPE OF THE TEST: DST

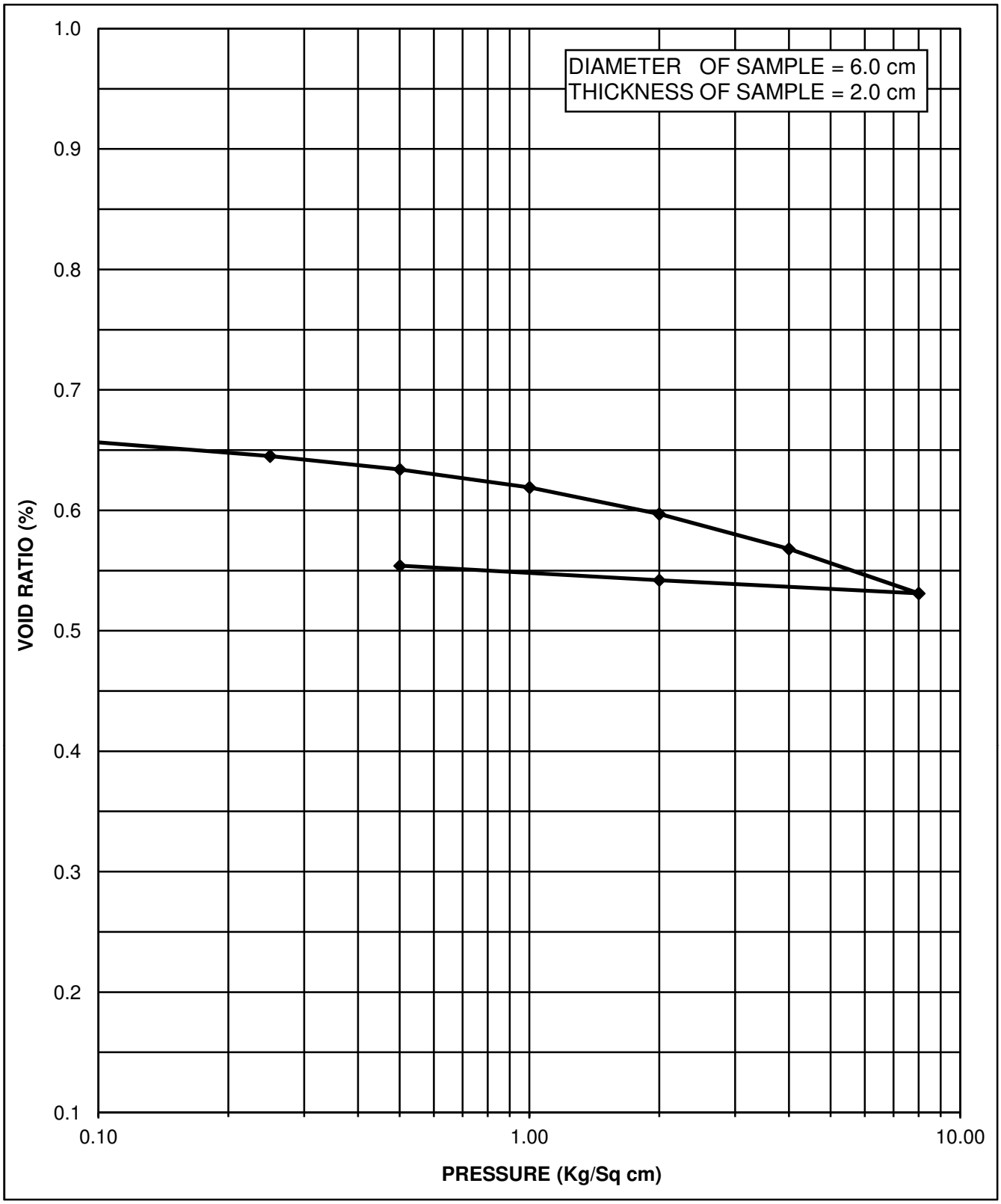




Ch. 59+270
BORE HOLE NO: BH-CL
SAMPLE NO.: UDS-2
DEPTH: 5.50 m
COHESION(C)= 0.21 kg/sq.cm
ANGLE OF FRICTION(Phi): 26 deg
TYPE OF THE TEST: DST







CHAINAGE:-58+497

BORE HOLE NO. = BH-P1

SAMPLE NO. = UDS-3

DEPTH = 7.00 M

TYPE OF SOIL = CL

INITIAL WATER CONTENT = 15.10 %

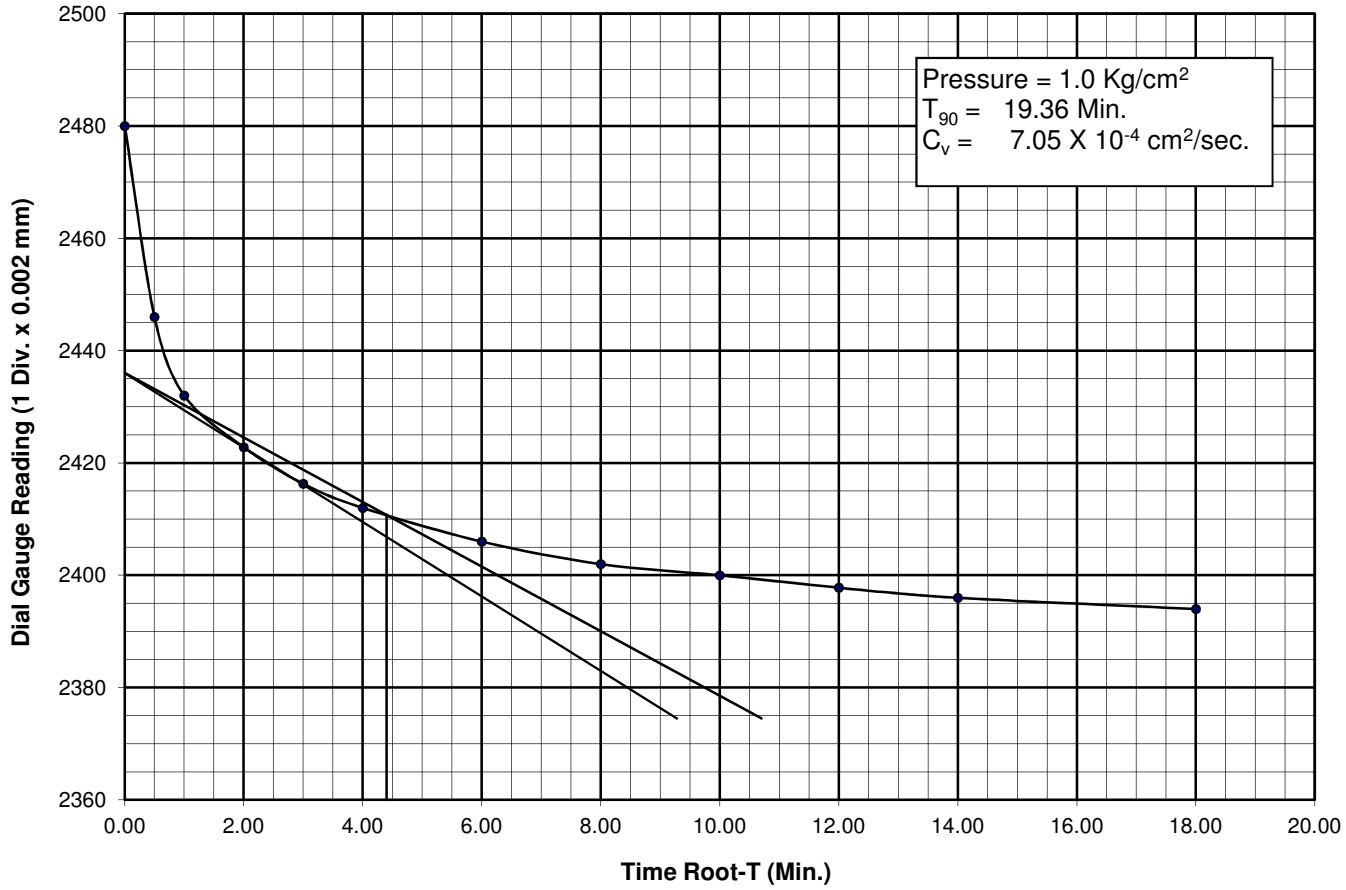
DRY DENSITY = 1.62 gm/cm^3

VOID RATIO (e_o) = 0.655

COMPRESSION INDEX (C_c) = 0.123

FIGURE NO. PRESSURE Vs VOID RATIO CURVE (e-log p)

CHAINAGE	=	58+497
BORE HOLE NO.	=	BH-P1
SAMPLE NO.	=	UDS-3
DEPTH	=	7.00 M



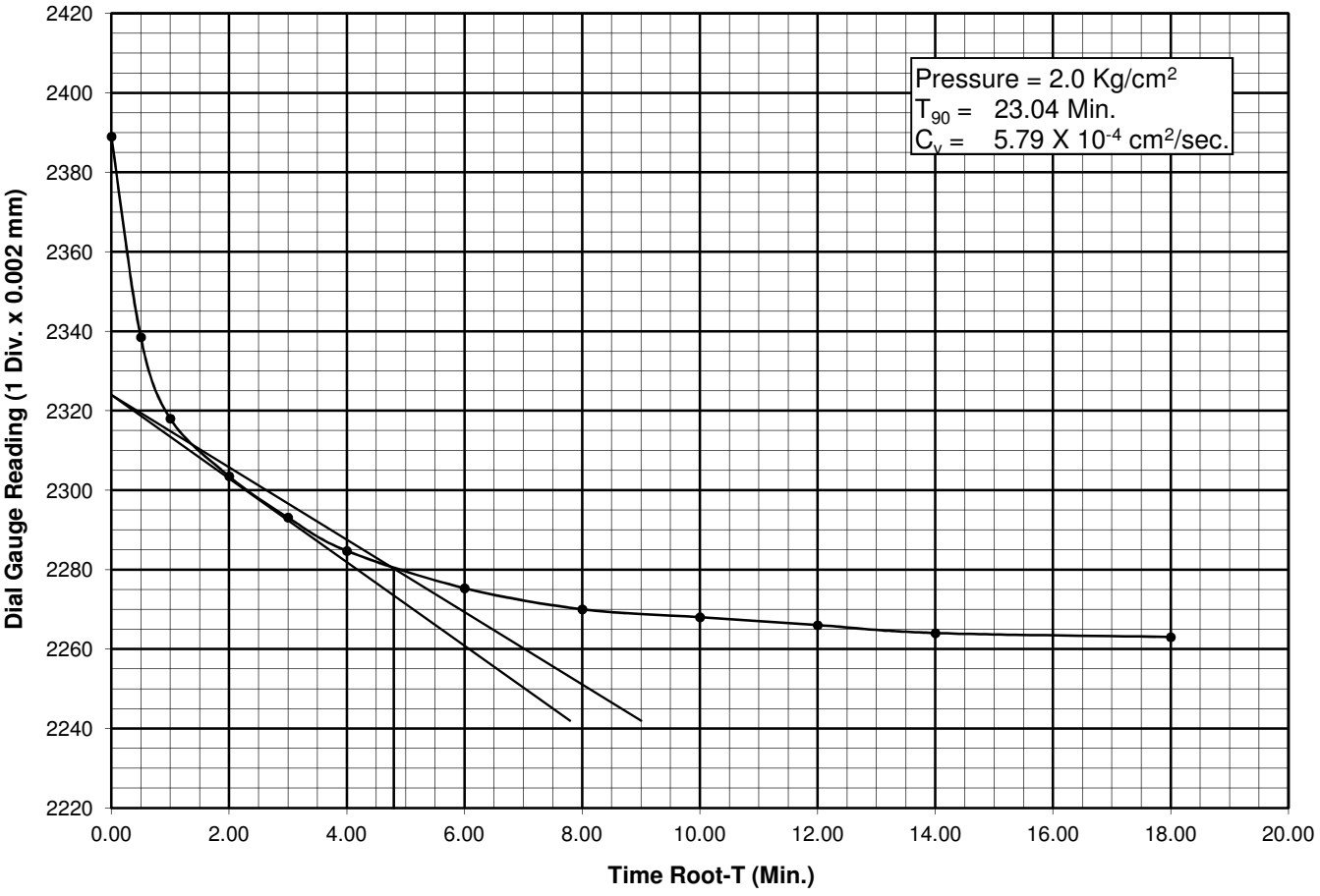
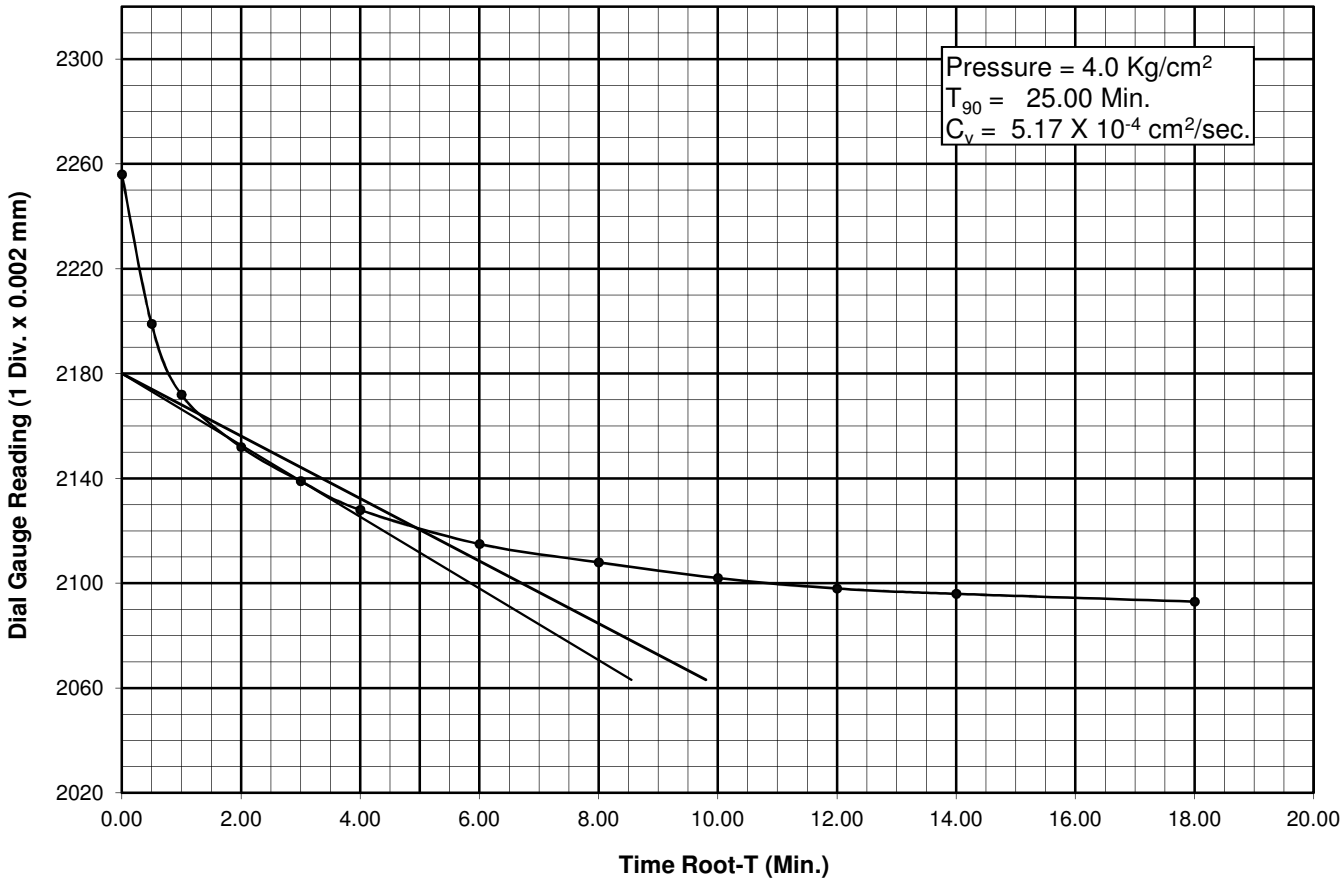


Figure No. -

CHAINAGE	=	58+497
BORE HOLE NO.	=	BH-P1
SAMPLE NO.	=	UDS-3
DEPTH	=	7.00 M



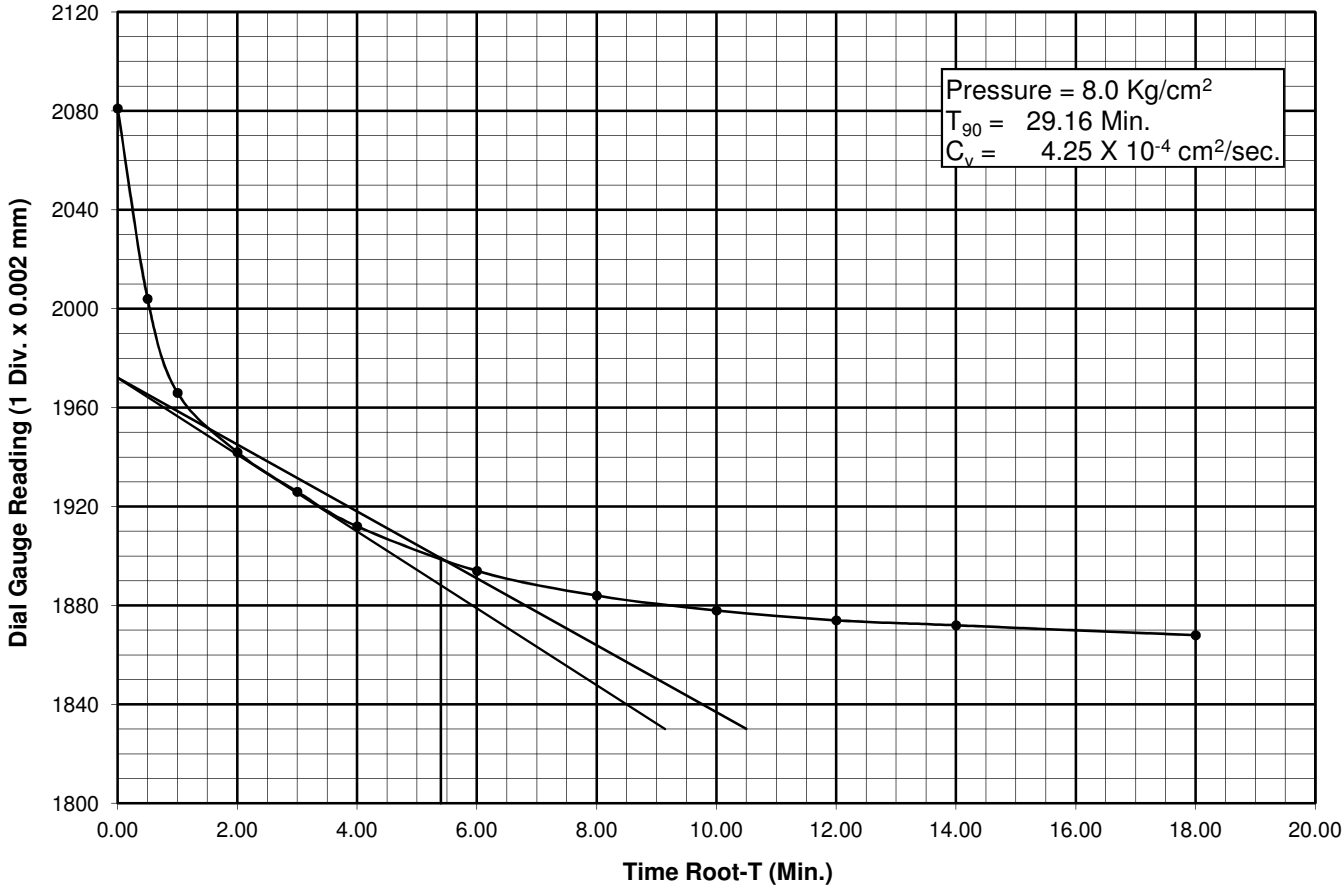
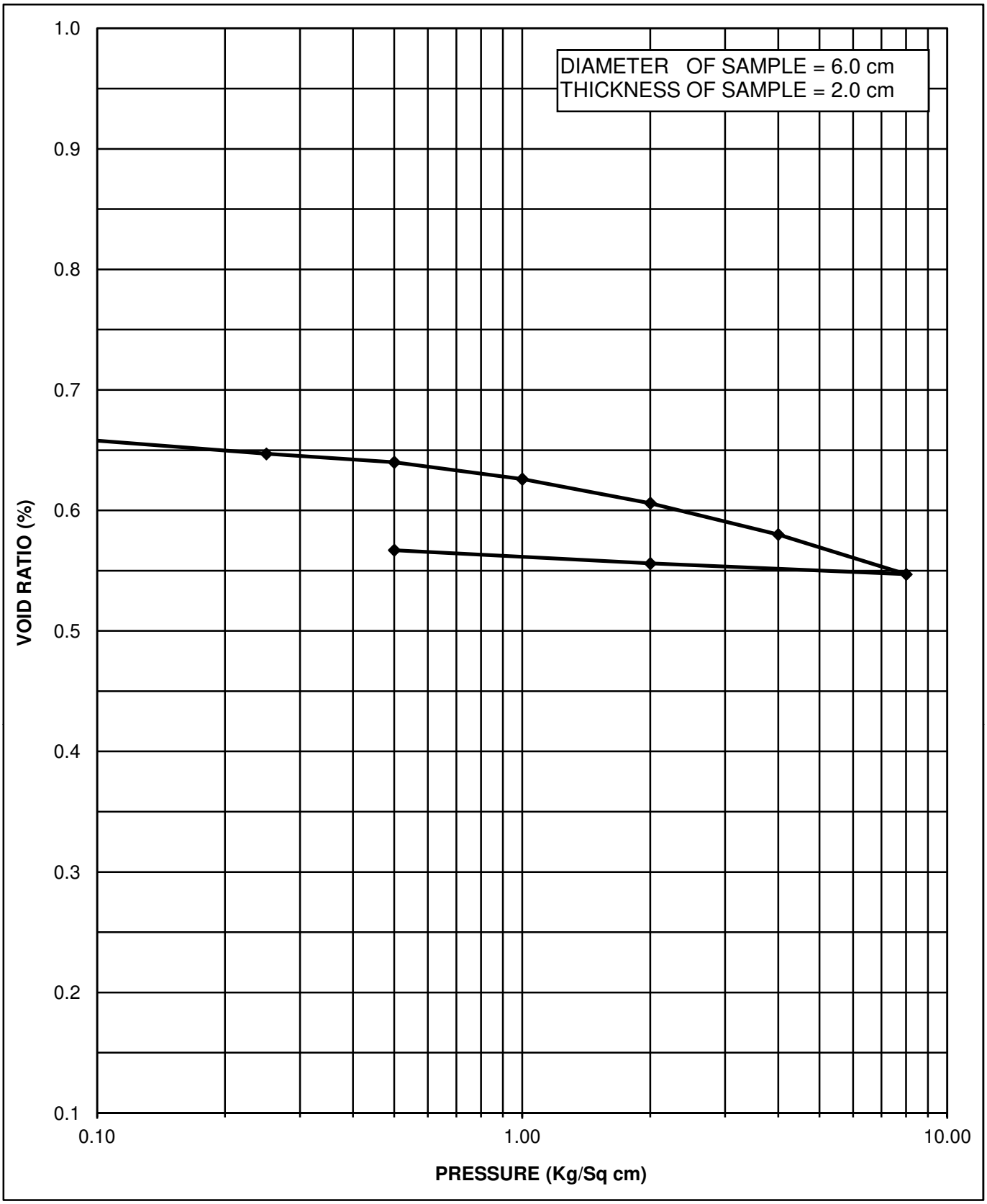


Figure No. -



CHAINAGE = 58+497

BORE HOLE NO. = BH-P6

SAMPLE NO. = UDS-4

DEPTH = 10.00 M

TYPE OF SOIL = CL

INITIAL WATER CONTENT = 17.48 %

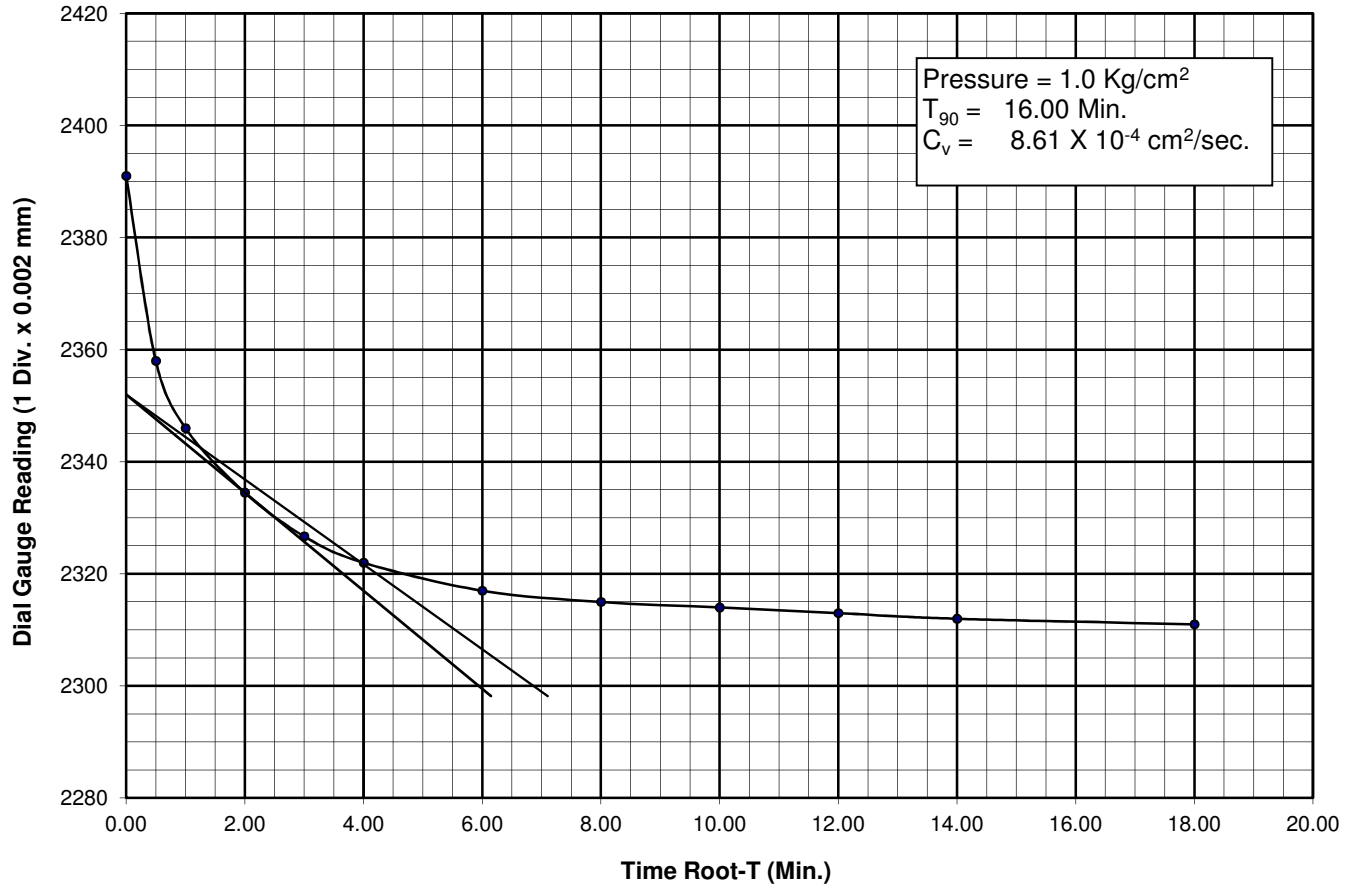
DRY DENSITY = 1.62 gm/cm^3

VOID RATIO (e_o) = 0.655

COMPRESSION INDEX (C_c) = 0.110

FIGURE NO. PRESSURE Vs VOID RATIO CURVE (e-log p)

CHAINAGE	=	58+497
BORE HOLE NO.	=	BH-P6
SAMPLE NO.	=	UDS-4
DEPTH	=	10.00 M



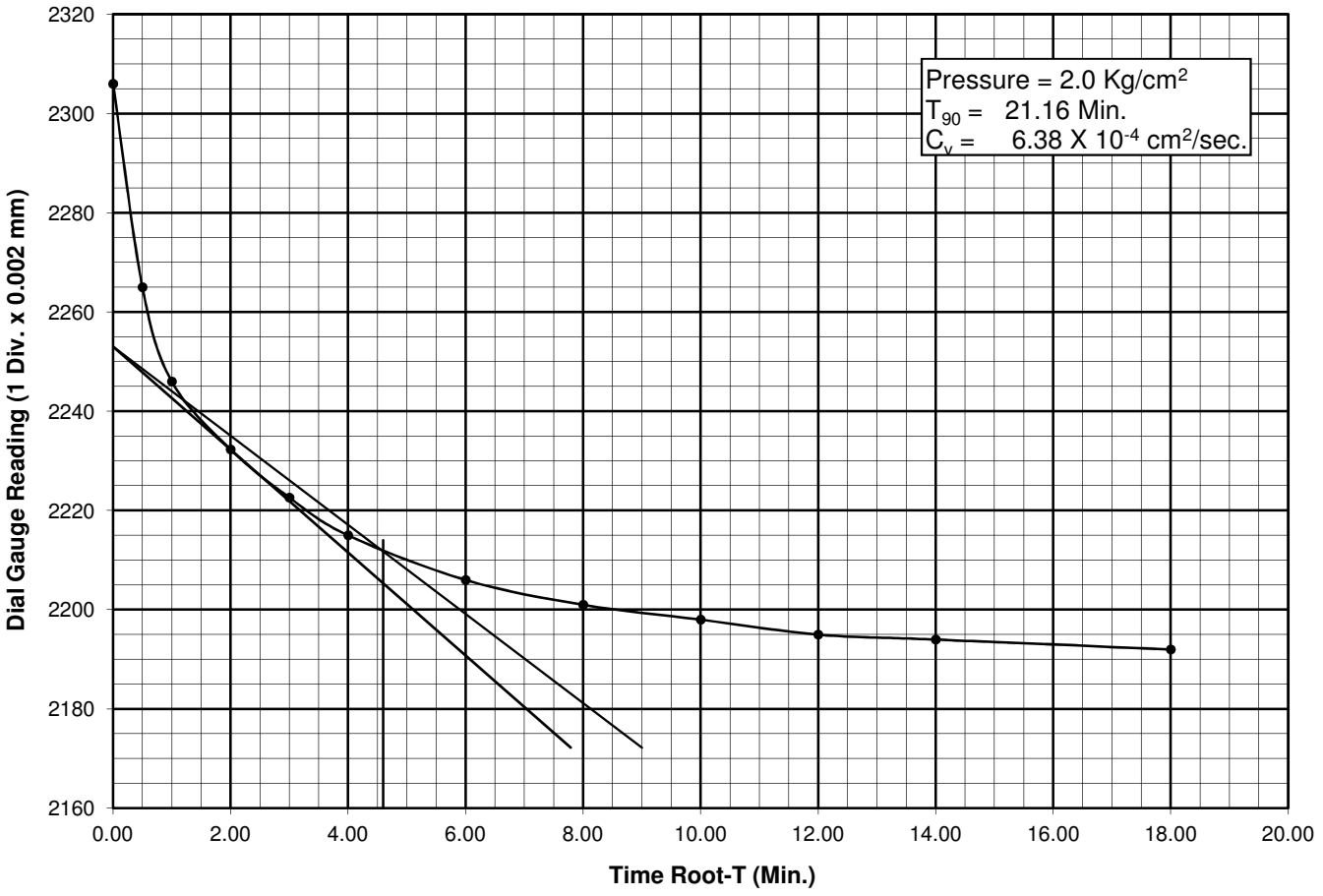
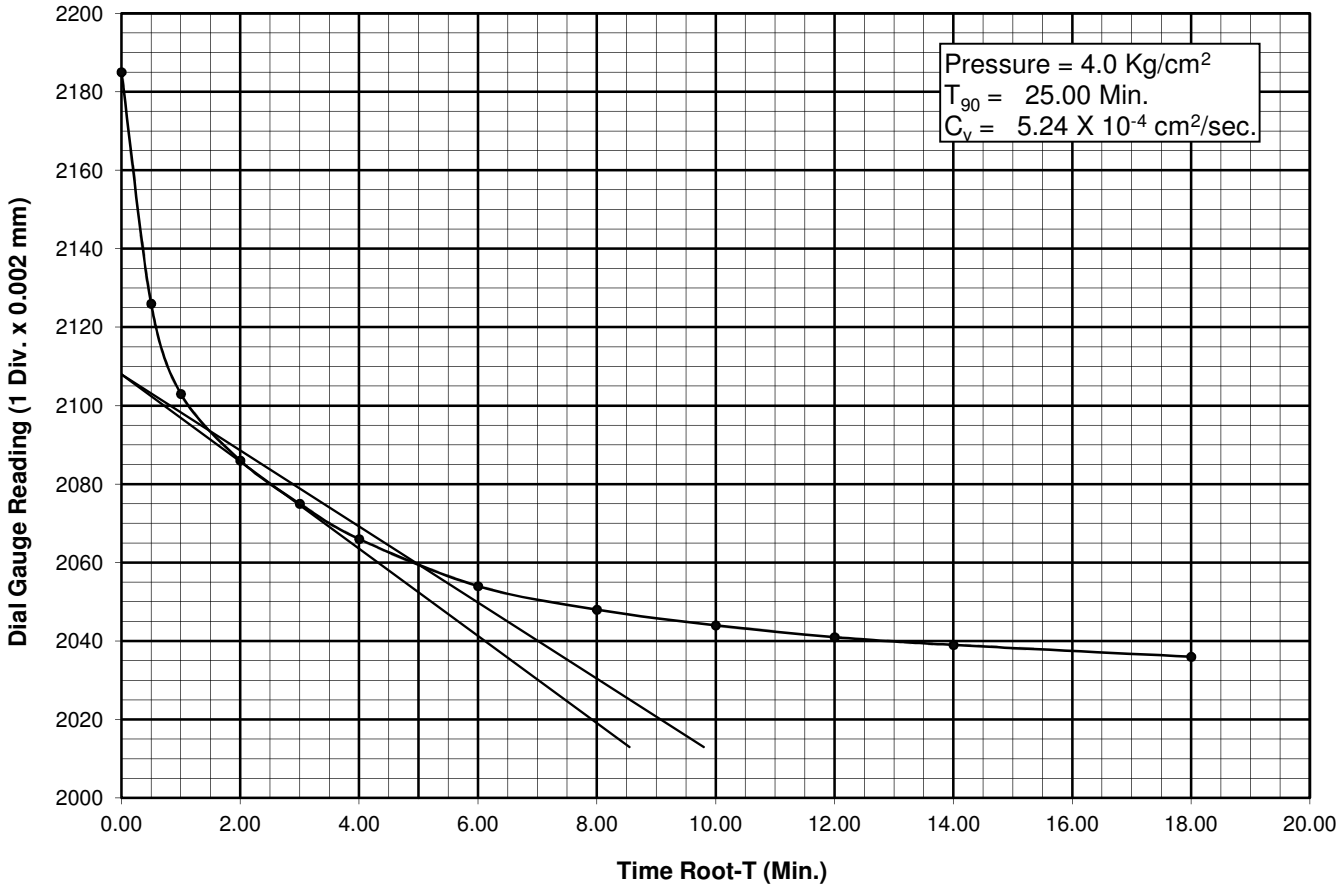


Figure No. -

CHAINAGE	=	58+497
BORE HOLE NO.	=	BH-P6
SAMPLE NO.	=	UDS-4
DEPTH	=	10.00 M



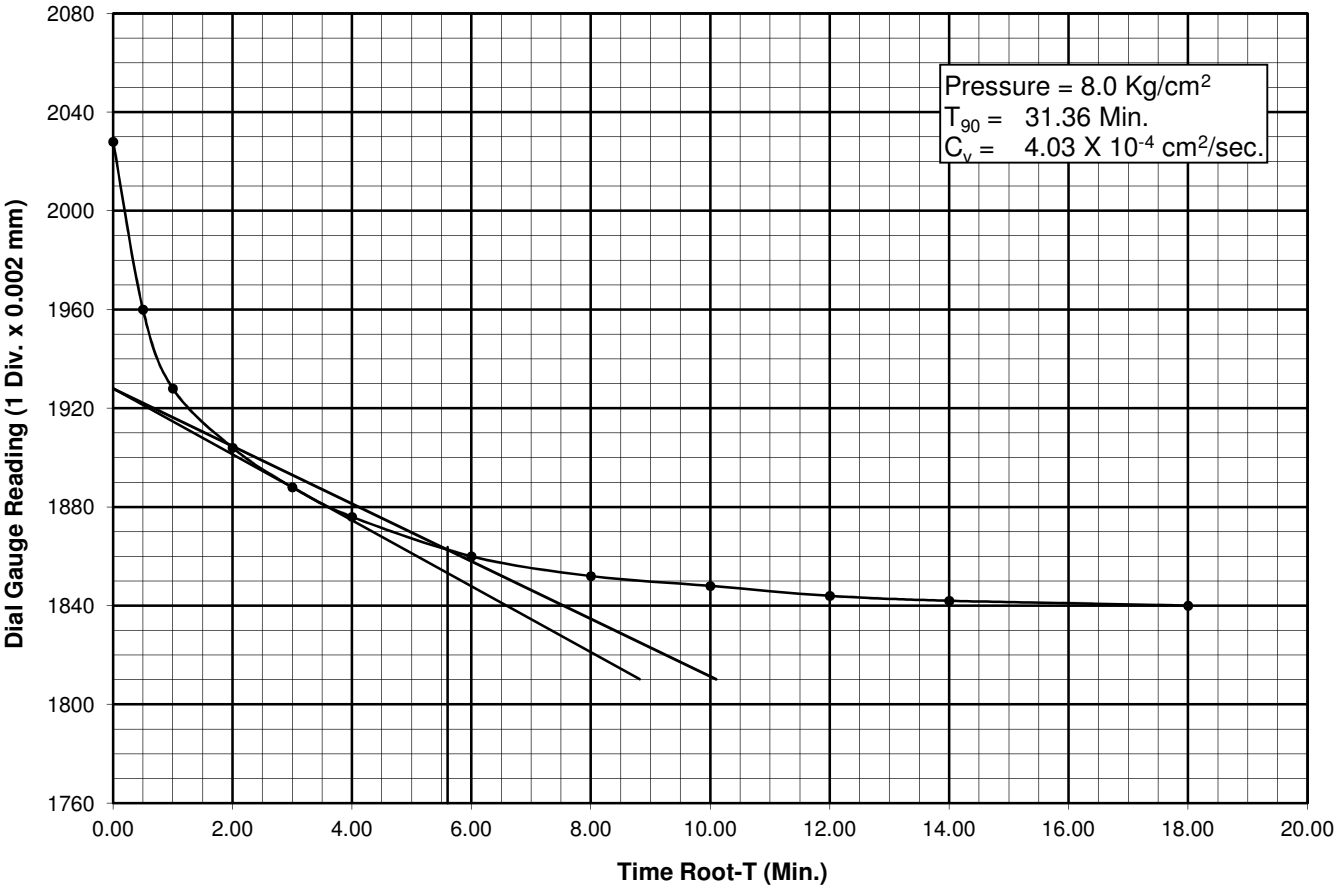


Figure No. -

APPENDIX – C
(ANALYSIS & RECOMENDATION)

Appendix No.	ITEMS
C-1	SAMPLE CALCULATIONS FOR COMPUTATION OF ALLOWABLE BEARING CAPACITY OF SUB-STRATA FOR SHALLOW FOUNDATION
C-2	SAMPLE CALCULATION FOR COMPUTATION OF SAFE LOAD CARRYING CAPACITY OF NORMAL BORED CAST-IN-SITU RCC PILE IN COMPRESSION & UPLIFT
C-3	SAMPLE CALCULATION FOR COMPUTATION OF SAFE LOAD CARRYING CAPACITY OF NORMAL BORED CAST-IN-SITU RCC PILE IN LATERAL

Calculation of SBC for shallow foundations as per IS : 6403 - 1981

INPUT DATA

CH. (KM) :- 53+107

BH NO. :- BH-CL

Type of footing

1 Continuous Strip
2 Rectangular
3 Square
4 Circular

Square **3**

Angle of internal friction (ϕ^o)	24.00
Cohesion (c in t/m^2)	2.10
Void ratio (e), $e = (G.\gamma_w/\gamma_d)-1$	0.71
Direction of load with vertical (^{o})	0.00
Density of foundation soil (t/m^3) γ_{bulk}	1.74
Depth of water table(m)	15.00
Factor of safety	2.50

S.no.	Depth (m) of footing (D_f) below EGL	Width (m)
1	1.00	6.20
2	1.50	6.20
3	2.00	6.20

SHEAR FAILURE CRITERIA

Assumptions and formula used in calculation as per IS:6403-1981 are given below -

NOTE: The type of failure used for bearing capacity analysis depends upon the value of void ratio (see IS 6403 : 1981, Page No. 9, Table No. 3).

The ultimate net bearing capacity in case of general shear failure is given by (from IS 6403 : 1981, page No. 8)

$$q_d = c\,N_c\,s_c\,d_c\,i_c + q\,(N_q-1)\,s_q\,d_q\,i_q + (1/2)\,B\,\gamma\,N_\gamma\,s_\gamma\,d_\gamma\,i_\gamma\,W'$$

The ultimate net bearing capacity in case of local shear failure is given by (from IS 6403 : 1981, page No. 8)

$$q'_d = (2/3)\,c\,N'_c\,s_c\,d_c\,i_c + q\,(N'_q-1)\,s_q\,d_q\,i_q + (1/2)\,B\,\gamma\,N'_\gamma\,s_\gamma\,d_\gamma\,i_\gamma\,W'$$

Where,

$d_c = 1+ 0.2\,(D_f/B)*SQRT(N_\phi)$

$d_q = d_\gamma = 1$ for $\phi < 10^o$

$d_q = d_\gamma = 1 + 0.1\,(D_f/B)*SQRT(N_\phi)$ for $\phi > 10^o$

(from IS 6403 : 1981, page No. 9)

$N_\phi = \tan^2(\pi/4 + \phi/2)$

ϕ' is friction angle for local shear failure = $\tan^{-1}(0.67\tan\phi)$

OUTPUT

The computer aided results for shear failure criteria are tabulated below. The results are interpolated values of bearing capacity obtained from general and local shear failure criteria.

Bearing capacity factors : (from IS 6403 : 1981, page No. 8, Table No. 1)

ϕ	24.00	ϕ'	16.61
N_c	19.32	N'_c	12.06
N_q	9.60	N'_q	4.60
N_γ	9.44	N'_γ	3.34

Shape factors : (from IS 6403 : 1981, page No. 8, Table No. 2)

S.no.	Width(m)	S_c	S_q	S_γ
1	6.20	1.30	1.20	0.80
2	6.20	1.30	1.20	0.80
3	6.20	1.30	1.20	0.80
		1.30	1.20	0.80
		1.30	1.20	0.80
		1.30	1.20	0.80

Depth factors : (from IS 6403 : 1981, page No. 9)

S.no.	Depth(m)	Width(m)	dc	d_q	d_γ
1	1.00	6.20	1.05	1.02	1.02
2	1.50	6.20	1.07	1.04	1.04
3	2.00	6.20	1.10	1.05	1.05
			#VALUE!	#VALUE!	#VALUE!
			#VALUE!	#VALUE!	#VALUE!
			#VALUE!	#VALUE!	#VALUE!

Inclination factors : (from IS 6403 : 1981, page No. 9)

$i_c = (1-\alpha/90)^2$	$i_q = (1-\alpha/90)^2$	$i_\gamma = (1-\alpha/\phi)^2$
1.00	1.00	1.00

Water table factor : (from IS 6403 : 1981, page No. 9)

S.no.	Depth(m)	Width(m)	Z_w/B	W'
1	1.00	6.20	2.26	1.00
2	1.50	6.20	2.18	1.00
3	2.00	6.20	2.10	1.00
			#VALUE!	#VALUE!
			#VALUE!	#VALUE!
			#VALUE!	#VALUE!

Safe Bearing Capacity

S.no.	Depth(m)	Width(m)	SBC in (t/m^2)		
			General shear	Local shear	Recommended
1	1.00	6.20	46.27	18.22	23.87
2	1.50	6.20	50.82	20.10	26.30
3	2.00	6.20	55.46	22.03	28.77
					#VALUE!
					#VALUE!
					#VALUE!

SETTLEMENT CALCULATION AS PER 8009 Part-1 1976																BH NO. :- BH-CL			
Layer	Depth below FGL (m)	From (m)	To (m)	Layer Thickness	Stress at Foundation level (Kg/Cm2)	Length (m)	Breadth (m)	Layer Thickness(m)	Dispersed Length (m)	Dispersed Breadth (m)	Stress Increment at top for cohesionless layer & at mid Depth for cohesive layer (kg/Cm2)	Average N-Value	Water Table Correction Factor	Settlement (mm) for 10 t/m2 (from IS:8009 (Part I), Fig. 9, Page NO. 17)	Settlement in Non-Cohesive Soil Si (mm)	Total Settlement (mm)	Depth Factor	Rigidity Factor	Corrected Total Settlement (mm)
Layer 1		1.00	5.25	4.25				4.25	6.20	6.200	1.840	21	1.00	14.90	19.33	19.33			
Layer 2		5.25	10.30	5.05				5.05	12.975	12.975	0.420	43	1.00			6.58			
	1.00				1.84	6.20	6.20										0.97	1.00	25.00
Layer 1		1.50	5.25	3.75				3.75	6.20	6.200	1.957	21	1.00	14.90	18.78	18.78			
Layer 2		5.25	10.50	5.25				5.25	12.575	12.575	0.476	43	1.00			7.75			
Layer 3		10.50	10.80	0.30				0.30	15.200	15.200	0.326	38		7.50	0.06	0.06			
	1.50				1.96	6.20	6.20										0.94	1.00	25.00
Layer 1		2.00	5.25	3.25				3.25	6.20	6.200	2.110	21	1.00	14.90	18.13	18.13			
Layer 2		5.25	10.50	5.25				5.25	12.075	12.075	0.556	43	1.00			9.06			
Layer 3		10.50	11.30	0.80				0.80	14.700	14.700	0.375	38	1.00	7.50	0.20	0.20			
	2.00				2.11	6.20	6.20										0.91	1.00	25.00

NAME OF PROJECT:- "GTI for designing of bridges and embankment for Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.

Length of Pile below cut of level = 22.00 m **Bore Hole No =** BH-A1 **Ch. (KM)** 52+518 **Dia of pile =** 1.00 m **Cut-off Level =** 2.00 m below EGL

Restricting PD to 15D **Water Table depth considered for analysis =** 18.00 m **Scour Depth =** Non-scourable **Liquefaction Depth =** Non-Liquefiable

Dia. of Pile	Cut-off Depth	Soil layers		Properties of layers/for Skin Friction							For End Bearing										
		from	to	c	Ø	k	α	γeff	ΔL	pd (s.f)	Pd (e.b)	γeff	c	Ø	Nc	Nq	Ny	As/cm	Ap	qs	Qp
(m)	(m)	(m)	(m)	kg/cm^2	deg			gm/cc	cm	kg/cm^2	kg/cm^2	gm/cc	kg/cm^2	deg				cm^2	cm^2	t	t
1.00	2.00	0.00	2.00					1.72	200	0.17											
1.00		2.00	5.50	0.19	29	1.00	1.00	1.72	350	0.64								314.29		60.14	
1.00		5.50	13.00	0.74	5	1.00	0.62	1.78	750	1.61								314.29		140.90	
1.00		13.00	15.00	1.12	4	1.00	0.40	1.85	200	2.46								314.29		38.68	
1.00		15.00	16.00	1.12	4	1.00	0.40	1.85	100	2.65								314.29		19.75	
1.00		16.00	18.00	0.21	30	1.00	1.00	1.87	200	2.65								314.29		109.40	
1.00		18.00	24.00	0.21	30	1.00	1.00	0.87	600	2.65	2.65	0.84	0.23	29	9	17.93	19.34	314.29	7857.14	328.20	395.97
																				697.07	395.97

Qu,comp.= qs + Qp Qu,uplift = Safe Frictional Resistance + Weight of Pile

Qa,comp.= (697.07 + 395.97) / 2.5 Qa,uplift = 697.07 / 3 + 43.2

Qa,comp.= 437.22 T Qa,uplift = 275.55 T

Say **Qa,comp.= 437.00 T** **Qa,uplift = 275.00 T**

*FOS for Vertical Capacity of pile in compression = 2.5

**FOS for Uplift Capacity of pile = 3.0

NAME OF PROJECT:- "GTI for designing of bridges and embankment for Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.

Length of Pile below cut of level = 24.00 m **Bore Hole No =** BH-A1 **Ch. (KM)** 52+518 **Dia of pile =** 1.00 m **Cut-off Level =** 2.00 m below EGL

Restricting PD to 15D **Water Table depth considered for analysis =** 18.00 m **Scour Depth =** Non-scourable **Liquefaction Depth =** Non-Liquefiable

Dia. of Pile	Cut-off Depth	Soil layers		Properties of layers/for Skin Friction							For End Bearing										
		from	to	c	Ø	k	α	γeff	ΔL	pd (s.f)	Pd (e.b)	γeff	c	Ø	Nc	Nq	Ny	As/cm	Ap	qs	Qp
(m)	(m)	(m)	(m)	kg/cm^2	deg			gm/cc	cm	kg/cm^2	kg/cm^2	gm/cc	kg/cm^2	deg				cm^2	cm^2	t	t
1.00	2.00	0.00	2.00					1.72	200	0.17											
1.00		2.00	5.50	0.19	29	1.00	1.00	1.72	350	0.64								314.29		60.14	
1.00		5.50	13.00	0.74	5	1.00	0.62	1.78	750	1.61								314.29		140.90	
1.00		13.00	15.00	1.12	4	1.00	0.40	1.85	200	2.46								314.29		38.68	
1.00		15.00	16.00	1.12	4	1.00	0.40	1.85	100	2.65								314.29		19.75	
1.00		16.00	18.00	0.21	30	1.00	1.00	1.87	200	2.65								314.29		109.40	
1.00		18.00	25.00	0.21	30	1.00	1.00	0.87	700	2.65								314.29		382.90	
1.00		25.00	26.00	0.23	29	1.00	1.00	0.84	100	2.65	2.65	0.84	0.23	29	9	17.93	19.34	314.29	7857.14	53.41	395.97
																				805.18	395.97

Qu,comp.= qs + Qp Qu,uplift = Safe Frictional Resistance + Weight of Pile

Qa,comp.= (805.18 + 395.97) / 2.5 Qa,uplift = 805.18 / 3 + 47.12

Qa,comp.= 480.46 T Qa,uplift = 315.52 T

Say **Qa,comp.= 480.00 T** **Qa,uplift = 315.00 T**

*FOS for Vertical Capacity of pile in compression = 2.5

**FOS for Uplift Capacity of pile = 3.0

NAME OF PROJECT:- "GTI for designing of bridges and embankment for Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.

Length of Pile below cut of level = 26.00 m **Bore Hole No =** BH-A1 **Ch. (KM)** 52+518 **Dia of pile =** 1.00 m **Cut-off Level =** 2.00 m below EGL

Restricting PD to 15D **Water Table depth considered for analysis =** 18.00 m **Scour Depth =** Non-scourable **Liquefaction Depth =** Non-Liquefiable

Dia. of Pile	Cut-off Depth	Soil layers		Properties of layers/for Skin Friction							For End Bearing										
		from	to	c	Ø	k	α	γeff	ΔL	pd (s.f)	Pd (e.b)	γeff	c	Ø	Nc	Nq	Ny	As/cm	Ap	qs	Qp
(m)	(m)	(m)	(m)	kg/cm^2	deg			gm/cc	cm	kg/cm^2	kg/cm^2	gm/cc	kg/cm^2	deg				cm^2	cm^2	t	t
1.00	2.00	0.00	2.00					1.72	200	0.17											
1.00		2.00	5.50	0.19	29	1.00	1.00	1.72	350	0.64								314.29		60.14	
1.00		5.50	13.00	0.74	5	1.00	0.62	1.78	750	1.61								314.29		140.90	
1.00		13.00	15.00	1.12	4	1.00	0.40	1.85	200	2.46								314.29		38.68	
1.00		15.00	16.00	1.12	4	1.00	0.40	1.85	100	2.65								314.29		19.75	
1.00		16.00	18.00	0.21	30	1.00	1.00	1.87	200	2.65								314.29		109.40	
1.00		18.00	25.00	0.21	30	1.00	1.00	0.87	700	2.65								314.29		382.90	
1.00		25.00	28.00	0.23	29	1.00	1.00	0.84	300	2.65	2.65	0.84	0.23	29	9	17.93	19.34	314.29	7857.14	160.23	395.97
																				912.00	395.97

Qu,comp.= qs + Qp Qu,uplift = Safe Frictional Resistance + Weight of Pile

Qa,comp.= (912 + 395.97) / 2.5 Qa,uplift = 912 / 3 + 51.05

Qa,comp.= 523.19 T Qa,uplift = 355.05 T

Say **Qa,comp.= 523.00 T** **Qa,uplift = 355.00 T**

*FOS for Vertical Capacity of pile in compression = 2.5

**FOS for Uplift Capacity of pile = 3.0

NAME OF PROJECT:- "GTI for designing of bridges and embankment for Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.

Length of Pile below cut of level = 28.00 m **Bore Hole No =** BH-A1 **Ch. (KM)** 52+518 **Dia of pile =** 1.00 m **Cut-off Level =** 2.00 m below EGL

Restricting PD to 15D **Water Table depth considered for analysis =** 18.00 m **Scour Depth =** Non-scourable **Liquefaction Depth =** Non-Liquefiable

Dia. of Pile	Cut-off Depth	Soil layers		Properties of layers/for Skin Friction							For End Bearing										
		from	to	c	Ø	k	α	γeff	ΔL	pd (s.f)	Pd (e.b)	γeff	c	Ø	Nc	Nq	Ny	As/cm	Ap	qs	Qp
(m)	(m)	(m)	(m)	kg/cm^2	deg			gm/cc	cm	kg/cm^2	kg/cm^2	gm/cc	kg/cm^2	deg				cm^2	cm^2	t	t
1.00	2.00	0.00	2.00					1.72	200	0.17											
1.00		2.00	5.50	0.19	29	1.00	1.00	1.72	350	0.64								314.29		60.14	
1.00		5.50	13.00	0.74	5	1.00	0.62	1.78	750	1.61								314.29		140.90	
1.00		13.00	15.00	1.12	4	1.00	0.40	1.85	200	2.46								314.29		38.68	
1.00		15.00	16.00	1.12	4	1.00	0.40	1.85	100	2.65								314.29		19.75	
1.00		16.00	18.00	0.21	30	1.00	1.00	1.87	200	2.65								314.29		109.40	
1.00		18.00	25.00	0.21	30	1.00	1.00	0.87	700	2.65								314.29		382.90	
1.00		25.00	30.00	0.23	29	1.00	1.00	0.84	500	2.65	2.65	0.84	0.23	29	9	17.93	19.34	314.29	7857.14	267.05	395.97
																				1018.82	395.97

Qu,comp.= qs + Qp Qu,uplift = Safe Frictional Resistance + Weight of Pile

Qa,comp.= (1018.82 + 395.97) / 2.5 Qa,uplift = 1018.82 / 3 + 54.98

Qa,comp.= 565.92 T Qa,uplift = 394.58 T

Say **Qa,comp.= 565.00 T** **Qa,uplift = 394.00 T**

*FOS for Vertical Capacity of pile in compression = 2.5

**FOS for Uplift Capacity of pile = 3.0

NAME OF PROJECT:- "GTI for designing of bridges and embankment for Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.

Length of Pile below cut of level = 22.00 m **Bore Hole No =** BH-A1 **Ch. (KM)** 52+518 **Dia of pile =** 1.20 m **Cut-off Level =** 2.00 m below EGL

Restricting PD to 15D **Water Table depth considered for analysis =** 18.00 m **Scour Depth =** Non-scourable **Liquefaction Depth =** Non-Liquefiable

Dia. of Pile	Cut-off Depth	Soil layers		Properties of layers/for Skin Friction							For End Bearing										
		from	to	c	Ø	k	α	γeff	ΔL	pd (s.f)	Pd (e.b)	γeff	c	Ø	Nc	Nq	Ny	As/cm	Ap	qs	Qp
(m)	(m)	(m)	(m)	kg/cm^2	deg			gm/cc	cm	kg/cm^2	kg/cm^2	gm/cc	kg/cm^2	deg				cm^2	cm^2	t	t
1.20	2.00	0.00	2.00					1.72	200	0.17											
1.20		2.00	5.50	0.19	29	1.00	1.00	1.72	350	0.64								377.14		72.17	
1.20		5.50	13.00	0.74	5	1.00	0.62	1.78	750	1.61								377.14		169.09	
1.20		13.00	16.00	1.12	4	1.00	0.40	1.85	300	2.56								377.14		70.35	
1.20		16.00	18.00	0.21	30	1.00	1.00	1.87	200	3.02								377.14		147.49	
1.20		18.00	24.00	0.21	30	1.00	1.00	0.87	600	3.21	3.21	0.84	0.23	29	9	17.93	19.34	377.14	11314.29	466.90	685.44
																				925.99	685.44

Qu,comp.= qs + Qp Qu,uplift = Safe Frictional Resistance + Weight of Pile

Qa,comp.= (925.99 + 685.44) / 2.5 Qa,uplift = 925.99 / 3 + 62.2

Qa,comp.= 644.57 T Qa,uplift = 370.87 T

Say **Qa,comp.= 644.00 T** **Qa,uplift = 370.00 T**

*FOS for Vertical Capacity of pile in compression = 2.5

**FOS for Uplift Capacity of pile = 3.0

NAME OF PROJECT:- "GTI for designing of bridges and embankment for Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.

Length of Pile below cut of level = 24.00 m **Bore Hole No =** BH-A1 **Ch. (KM)** 52+518 **Dia of pile =** 1.20 m **Cut-off Level =** 2.00 m below EGL

Restricting PD to 15D **Water Table depth considered for analysis =** 18.00 m **Scour Depth =** Non-scourable **Liquefaction Depth =** Non-Liquefiable

Dia. of Pile	Cut-off Depth	Soil layers		Properties of layers/for Skin Friction							For End Bearing										
		from	to	c	Ø	k	α	γeff	ΔL	pd (s.f)	Pd (e.b)	γeff	c	Ø	Nc	Nq	Ny	As/cm	Ap	qs	Qp
(m)	(m)	(m)	(m)	kg/cm^2	deg			gm/cc	cm	kg/cm^2	kg/cm^2	gm/cc	kg/cm^2	deg				cm^2	cm^2	t	t
1.20	2.00	0.00	2.00					1.72	200	0.17											
1.20		2.00	5.50	0.19	29	1.00	1.00	1.72	350	0.64								377.14		72.17	
1.20		5.50	13.00	0.74	5	1.00	0.62	1.78	750	1.61								377.14		169.09	
1.20		13.00	16.00	1.12	4	1.00	0.40	1.85	300	2.56								377.14		70.35	
1.20		16.00	18.00	0.21	30	1.00	1.00	1.87	200	3.02								377.14		147.49	
1.20		18.00	25.00	0.21	30	1.00	1.00	0.87	700	3.21								377.14		544.71	
1.20		25.00	26.00	0.23	29	1.00	1.00	0.84	100	3.21	3.21	0.84	0.23	29	9	17.93	19.34	377.14	11314.29	75.78	685.44
																				1079.59	685.44

Qu,comp.= qs + Qp Qu,uplift = Safe Frictional Resistance + Weight of Pile

Qa,comp.= (1079.59 + 685.44) / 2.5 Qa,uplift = 1079.59 / 3 + 67.86

Qa,comp.= 706.01 T Qa,uplift = 427.72 T

Say **Qa,comp.= 706.00 T** **Qa,uplift = 427.00 T**

*FOS for Vertical Capacity of pile in compression = 2.5

**FOS for Uplift Capacity of pile = 3.0

NAME OF PROJECT:- "GTI for designing of bridges and embankment for Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.

Length of Pile below cut of level = 26.00 m **Bore Hole No =** BH-A1 **Ch. (KM)** 52+518 **Dia of pile =** 1.20 m **Cut-off Level =** 2.00 m below EGL

Restricting PD to 15D **Water Table depth considered for analysis =** 18.00 m **Scour Depth =** Non-scourable **Liquefaction Depth =** Non-Liquefiable

Dia. of Pile	Cut-off Depth	Soil layers		Properties of layers/for Skin Friction							For End Bearing										
		from	to	c	Ø	k	α	γeff	ΔL	pd (s.f)	Pd (e.b)	γeff	c	Ø	Nc	Nq	Ny	As/cm	Ap	qs	Qp
(m)	(m)	(m)	(m)	kg/cm^2	deg			gm/cc	cm	kg/cm^2	kg/cm^2	gm/cc	kg/cm^2	deg				cm^2	cm^2	t	t
1.20	2.00	0.00	2.00					1.72	200	0.17											
1.20		2.00	5.50	0.19	29	1.00	1.00	1.72	350	0.64								377.14		72.17	
1.20		5.50	13.00	0.74	5	1.00	0.62	1.78	750	1.61								377.14		169.09	
1.20		13.00	16.00	1.12	4	1.00	0.40	1.85	300	2.56								377.14		70.35	
1.20		16.00	18.00	0.21	30	1.00	1.00	1.87	200	3.02								377.14		147.49	
1.20		18.00	25.00	0.21	30	1.00	1.00	0.87	700	3.21								377.14		544.71	
1.20		25.00	28.00	0.23	29	1.00	1.00	0.84	300	3.21	3.21	0.84	0.23	29	9	17.93	19.34	377.14	11314.29	227.34	685.44
																				1231.15	685.44

Qu,comp.= qs + Qp Qu,uplift = Safe Frictional Resistance + Weight of Pile

Qa,comp.= (1231.15 + 685.44) / 2.5 Qa,uplift = 1231.15 / 3 + 73.51

Qa,comp.= 766.64 T Qa,uplift = 483.90 T

Say **Qa,comp.= 766.00 T** **Qa,uplift = 483.00 T**

*FOS for Vertical Capacity of pile in compression = 2.5

**FOS for Uplift Capacity of pile = 3.0

NAME OF PROJECT:- "GTI for designing of bridges and embankment for Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.

Length of Pile below cut of level = 28.00 m **Bore Hole No =** BH-A1 **Ch. (KM)** 52+518 **Dia of pile =** 1.20 m **Cut-off Level =** 2.00 m below EGL

Restricting PD to 15D **Water Table depth considered for analysis =** 18.00 m **Scour Depth =** Non-scourable **Liquefaction Depth =** Non-Liquefiable

Dia. of Pile	Cut-off Depth	Soil layers		Properties of layers/for Skin Friction							For End Bearing										
		from	to	c	Ø	k	α	γeff	ΔL	pd (s.f)	Pd (e.b)	γeff	c	Ø	Nc	Nq	Ny	As/cm	Ap	qs	Qp
(m)	(m)	(m)	(m)	kg/cm^2	deg			gm/cc	cm	kg/cm^2	kg/cm^2	gm/cc	kg/cm^2	deg				cm^2	cm^2	t	t
1.20	2.00	0.00	2.00					1.72	200	0.17											
1.20		2.00	5.50	0.19	29	1.00	1.00	1.72	350	0.64								377.14		72.17	
1.20		5.50	13.00	0.74	5	1.00	0.62	1.78	750	1.61								377.14		169.09	
1.20		13.00	16.00	1.12	4	1.00	0.40	1.85	300	2.56								377.14		70.35	
1.20		16.00	18.00	0.21	30	1.00	1.00	1.87	200	3.02								377.14		147.49	
1.20		18.00	25.00	0.21	30	1.00	1.00	0.87	700	3.21								377.14		544.71	
1.20		25.00	30.00	0.23	29	1.00	1.00	0.84	500	3.21	3.21	0.84	0.23	29	9	17.93	19.34	377.14	11314.29	378.90	685.44
																				1382.71	685.44

Qu,comp.= qs + Qp Qu,uplift = Safe Frictional Resistance + Weight of Pile

Qa,comp.= (1382.71 + 685.44) / 2.5 Qa,uplift = 1382.71 / 3 + 79.17

Qa,comp.= 827.26 T Qa,uplift = 540.07 T

Say **Qa,comp.= 827.00 T** **Qa,uplift = 540.00 T**

*FOS for Vertical Capacity of pile in compression = 2.5

**FOS for Uplift Capacity of pile = 3.0

Lateral Load capacity of Pile

BH-A1

52+518

Type of Strata = Sandy

Le = Embedded Length of Pile in Meter = 24.000 m **Fck = 35.0 N/mm^2** **D = 100 cm**

Bed level	**0.0 m**
Pile cap bottom level	**-2.0 m**
Max. of Liquefaction & Scour Depth	**-2.0 m**

E = Young's Modulus of Pile (Kg/cm^2) = $5000\sqrt{F_{ck}}$ N/mm^2 = 295803.99 Kg/cm^2

I = Moment of Inertia (cm^2) = $\pi xD^4/64$ = 4908738.5 cm^4

K_1 = Constant for Sandy / Normally Consolidated Clay (Kg/cm^3) = **0.490**

T, Relative stiffness factor in Sand $T = \sqrt[5]{\frac{EI}{K_1}}$ = **312.1** cm

For Long Pile If $L_e > 4T$

L1 = = **0.000** cm

$\frac{L_1}{T}$ = 0.00

For Fixed Head Pile

$\frac{L_f}{T}$ = **2.219** From Fig. 4

Lf = 692.65 cm

Equivalent length of cantilever L= L1+L_F: 0.00 + 692.64846 = **692.65** cm

Y = Pile Head Deflection (Cm) = $\frac{Q(L_1 + L_F)^3}{12\ EI}$ (for fixed Head pile)

Q = Lateral Load in Kg

Lateral Load For Pile Head Deflection .5 cm Q = 26217.22 Kg

= **26.22 T**

Lateral Load capacity of Pile

BH-A1

52+518

Type of Strata = Sandy

Le = Embedded Length of Pile in Meter = 24.000 m **Fck = 35.0 N/mm^2** **D = 120 cm**

Bed level	**0.0 m**
Pile cap bottom level	**-2.0 m**
Max. of Liquefaction & Scour Depth	**-2.0 m**

E = Young's Modulus of Pile (Kg/cm^2) = $5000\sqrt{F_{ck}}$ N/mm^2 = 295803.99 Kg/cm^2

I = Moment of Inertia (cm^2) = $\pi xD^4/64$ = 10178760.2 cm^4

K_1 = Constant for Sandy / Normally Consolidated Clay (Kg/cm^3) = **0.490**

T, Relative stiffness factor in Sand $T = \sqrt[5]{\frac{EI}{K_1}}$ = **361.2** cm

For Long Pile If $L_e > 4T$

L1 = = **0.000** cm

$\frac{L_1}{T}$ = 0.00

For Fixed Head Pile

$\frac{L_f}{T}$ = **2.219** From Fig. 4

Lf = 801.42 cm

Equivalent length of cantilever $L = L1+L_F$: 0.00 + 801.41574 = **801.42** cm

Y = Pile Head Deflection (Cm) = $\frac{Q(L_1 + L_F)^3}{12\ EI}$ (for fixed Head pile)

Q = Lateral Load in Kg

Lateral Load For Pile Head Deflection .5 cm Q = 35097.53 Kg

= **35.10 T**

Geotechnical Investigation Report

Old Ch. 29+487 to Old Ch. 46+400 (New CH: 30+155 to 49+584)

SR NO. : 544_21-22

CONDUCTING GEOTECHNICAL INVESTIGATION, PREPARATION OF GEOTECHNICAL REPORT FOR DESIGNING OF BRIDGES AND FOR EMBANKMENT IN CONNECTION WITH CONSTRUCTION OF HARYANA ORBITAL RAIL CORRIDOR (HORC) PROJECT FROM PALWAL TO HARSANA KALAN INCLUDING CONNECTIVITY TO EXISTING IR NETWORK IN THE STATE OF HARYANA

CLIENT

M/S. HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LTD. (HRIDCL)

PROGRAMME

MAY - 2022

SR. No.	Report No.	Revision No.	Date
544_21-22	CEGTH/HRIDCL/SR-544/2022-23/952_(72 BHs)	03	04.10.2022
544_21-22	CEGTH/HRIDCL/SR-544/2022-23/796_(65 BHs)	02	02.09.2022
544_21-22	CEGTH/HRIDCL/SR-544/2022-23/511_(59 BHs)	01	20.06.2022
544_21-22	CEGTH/HRIDCL/SR-544/2022-23/291_(57 BHs)	00	16.05.2022

CEGTH
CEG TEST HOUSE
AND RESEARCH CENTRE PVT LTD

B-11(G), Malviya Industrial Area, Jaipur-302017
Tel. : 91-141-4046599, Fax : 91-141-2751806
E-mail : info@cegtesthouse.com., www.cegtesthouse.com

CEGTH/HRIDCL/SR-544/2022-23/952 Date:- 04.10.2022

To,

Haryana Rail Infrastructure Development Corporation Ltd. (HRIDCL)
SCO No.-17-19, 3rd & 4th Floor,
Sector - 17-A,
Chandigarh - 160017
Tele:- 0172-2715644
Email: hridc2017@gmail.com

Subject :- Geotechnical investigation work for Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan in the state of Haryana.

Dear Sir,

We are pleased to submit this report of the subject work based on 72 boreholes carried out at Old Ch. 29+487 to Old ch. 46+400 (New CH: 30+155 to 49+584) for the proposed project site.

The accompanying report presents results of various field tests and laboratory tests conducted on selected soil samples and their interpretation.

Should there be any clarifications regarding the contents please contact us at your most convenient time.

We value the opportunity to participate in this project and look forward a pleasant association on future projects.

Very truly yours,
CEG Test House & Research Centre Pvt. Ltd.

Nehal Jain
General Manager - Geotechnical
Authorized Signatory

Prepared By:-

Ankur Mudgal
Sr. Manager

SR. No.	Report Ref. No.	Revision No.	Date
544_21-22	CEGTH/HRIDCL/SR-544/2022-23/952_(72 BHs)	03	04.10.2022
544_21-22	CEGTH/HRIDCL/SR-544/2022-23/796_(65 BHs)	02	02.09.2022
544_21-22	CEGTH/HRIDCL/SR-544/2022-23/511_(59 BHs)	01	20.06.2022
544_21-22	CEGTH/HRIDCL/SR-544/2022-23/291_(57 BHs)	00	16.05.2022

CONTENTS

LIST OF FIGURES / TABLES

CHAPTER 1 GENERAL

1.0 INTRODUCTION:

The work of conducting "**Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana"** was awarded to "**CEG Test House & Research Centre Pvt. Ltd., Jaipur" by M/S.** "**Haryana Rail Infrastructure Development Corporation Ltd. (HRIDCL)"** as per work order no. HRIDC/ HORC/ GT/ CEG/ 237/ 2021/ 577-M dated 29th July 2021.

Field work including drilling of boreholes, conducting field tests such as Electrical Resistivity Test, & Plate Load Test and sample collection was carried out in the presence of representative of Client. Laboratory tests were conducted on selected soil samples to determine the design parameters, confirming to relevant IS specifications and the guidelines received from time to time from representative of Client.

This report includes the details of Methodology of Investigation, collection of samples of soil, field test results, laboratory test results, analysis of results and recommendations for proposed structure carried out at Old Ch. 29+487 to Old ch. 46+400 (New CH: 30+155 to 49+584) based on soil sample collected from the locations of 72 boreholes.

2.0 SITE LOCATION & GENERAL GEOLOGICAL HISTORY:

The details of the site & test locations for the proposed project are shown in location plan attached vide **Appendix A-1**. The site of proposed project is located from Palwal to Harsana Kalan (Sonipat) in the State of Haryana falls in seismic zone – IV (Zone factor=0.24) of India.

Soil of the Haryana Sub-Region have been classified and described under the following major soil types as shown below:-

- Typic Ustochrepts : Soil of old alluvial plains
- Typic Ustipsamments : Soil of Aravali plains
- Typic Ustifluvents : Soil of recent alluvial plains and flood plains
- Typic Torripsamments : Soil of Aeofluvial plains
- Rocky Outcrops : Aravali rocky hills

The district wise details of soil characteristics are described below:-

Panipat: The soils are well drained, Sandy loam to clay loam/silty clay loam in plains and loam to clay loam/ silty/ loose clay loam in relic channels/depressions/basins.

Sonipat: The district comprises of recent flood plains, young meander plains, old meander plains and old alluvial plains. Recent flood plains occur along the Yamuna River and clearly show fluvial features. The soils are loamy sand to sandy loam on the surface and sandy loam to clay loam in the sub surface.

Rohtak: The district mainly comprises of old alluvial plains. The soils are loamy sand to sandy loam on the surface and sandy loam to clay loam in the sub surface. Old meander plains are almost flat with loamy sand to silty clay loam soils. Oldest among all the land forms are old alluvial plains, which cover major areas in the district. These soils are sand to loamy sand/sandy loam (surface) to silt loam/silty clay loam (sub-surface).

Jhajjar: The district mainly comprises of old alluvial plains and some parts of the district also have soil belonging to Aravali plains.

Rewari: The soils of the district fall under Entisols and Inceptisols orders. The surface soil texture varies from sand to fine loamy sand.

Gurgaon: The district comprises of sand dunes, sandy plains, alluvial plains, salt affected areas,

low lands, lakes, hills and pediments. The soil varies from sand to loamy sand in sand dunes and sandy plain areas, sandy loam to clay loam / silty clay loam in alluvial plains, calcareous, loamy sand to loam in salt affected plains, silty loam to loam in low lands and calcareous, loamy sand to loam in hills.

Mewat: The soils of the area are generally sandy loam to loam. In parts of the low-lying areas, they are clayey and saline. The upper hills are mostly barren.

Faridabad and Palwal: The district comprises of recent Yamuna flood plains, low lying plains, depressions, sand dunes and hills. The texture of the soil is sand to loamy sand in recent Yamuna flood plains, sandy loam in plains, sandy loam to clay loam in alluvial plains, sandy loam to loam

(surface), clay loam/silty clay (sub-surface) in low lying plains and depressions.

3.0 SCOPE OF WORK:

The stipulated scope of work involved carrying out the following operations:-

a) Mobilisation of necessary plant equipment, men and materials for the complete Geotechnical investigation work as per specifications, drawings and instructions of the Engineer and to complete the same within the stipulated time schedule and demobilisation after completion of field work.

b) Shifting of Equipments from one structure location to another including Ereaction, installation of rigs at site and dismantling of the same after completion of field work. Shifting of setup for each borehole location and associated preparation for borehole under water

c) Making 150 mm nominal diameter boreholes at various locations in all types of soils except hard rock and large boulders using suitable approved method of boring including chiselling, cleaning, providing casing pipe as required; performing Standard Penetration Test at every 3.0m interval and at change of strata; collection of water samples and disturbed soil samples, observation such as ground water, etc., collection of undisturbed soil samples at every 3.0 m interval and at change of strata; transportation of all the collected samples to the laboratory and back filling of boreholes on completion of the same, complete as per specification and instructions of the Engineer, for depths below natural ground level.

d) Conducting Electrical resistivity tests at various locations all complete as per specification and directions of the Engineer.

e) Conducting plate load test at various locations, all complete as per specification and directions of the Engineer.

f) Drilling of Nx size boreholes (75mm dia.) in all types of hard rock, collection of core samples, maintaining continuous record of core recovery/ RQD, keeping the cores in wooden core boxes, transporting to laboratory, backfilling on completion of the same, all complete as per specification and instructions of the EIC.

g) Conducting various laboratory tests on soil samples at an approved laboratory including preparation of soil samples to determine the following properties of soil, all complete as per specification.

<u>On soil Samples</u>

- Dry density test
- Bulk Density and Moisture Content.
- Sieve Analysis
- Hydrometer Analysis
- Liquid Limit and Plastic Limit
- Specific gravity
- Shrinkage Limit

- Free Swell Index
- Direct Shear Test
- Triaxial Shear Test
- One Dimensional consolidation test
- Chemical Analysis of soil samples (pH, chloride, Sulphate)

h) Conducting laboratory tests on rock samples including preparation of the samples to determine the following properties, all complete as per specification

<u>On Rock Samples</u>

- Moisture content, porosity & Density
- Specific gravity
- Hardness
- Unconfined compression test
- Point load strength index
- Modulus of Elasticity and Poission's Ratio
- Abrasion Test

i) Conducting chemical tests on water samples to determine the Sulphate, chloride and pH value all complete as per specification.

j) Submitting draft report in soft copy including all field records and laboratory test results, graphs, etc., all complete as per specifications.

k) Submitting final report in three hard copies in after the approval of the draft report including all field records and laboratory test results, graphs, etc., all complete as per specifications.

4.0 CONDUCTING PLATE LOAD TESTS

The reaction Load is applied on the test plate by reaction truss with a weight of several tonnes. The Plate Bearing Test is normally carried out at foundation level, either on the surface or in a shallow pit. The Size of Plate is 45 cm x 45 cm size (30mm thickness) and 60 cm x 60 cm size (30mm thickness) by the hydraulic jack. The test plate was placed over a horizontal sand layer of thickness 5 mm and leveled in a manner such that the center of the plate coincides with the center of application of load. The load was applied with hydraulic jack along with a pressure gauge. Settlement of the plate was measured by using two dial gauges, fixed to reference datum bars placed on firm ground, on either side of the plate. Desired seating pressure was applied on firmly seated test plate. Settlement was recorded for each increment of load. Loading was continued till a settlement of 25 mm occurred or up to desired loading intensity as per directions.

PLATE LOAD TEST LIMITATIONS

Plate load test, though useful in obtaining the necessary information about the soil with particular reference to design of foundation has some limitations:-

(a) The tests results reflect only the character of the soil located within a depth of less than twice the width of the bearing plate. Since the foundations are generally larger than the test plates, the settlement and shear resistance will depend on the properties of much thicker stratum. Moreover this method does not give the ultimate settlements particularly in case of cohesive soils. Thus the results of the test are likely to be misleading, if the character of the soil changes at shallow depths, which is not uncommon. A satisfactory load test should, therefore, include adequate soil exploration (see IS: 1892-1979) with due attention being paid to any weaker stratum below the level of the footing.

(b) Another limitation is the concerning of the effect of size of foundation. For clayey soils the bearing capacity (from shear consideration) for a larger foundation is almost the same as that for the smaller test plate. But in dense sandy soils the bearing capacity increases with the size of the foundation. Thus tests with smaller size plate tend to give conservative values in dense sandy soils. It may, therefore, be necessary to test with plates of at least three sizes and the bearing capacity results extrapolated for the size of the actual foundation (minimum dimensions in the case of rectangular footings).

(c) It has limited depth of influence. It could only give the bearing capacity of soils with depth up to two times the diameter of plate.

(d) It may not provide information on the potential for long term consolidation of foundation soils.

(e) There is scale effect as the size of test plate is smaller than actual foundation.

(f) To gain access to test position, excavation is carried out which causes significant ground disturbance. The change in ground stress leads to the change of soil properties which the test is planned to investigate.

Hence the interpretation of the test results & recommendation has been made in view of the above limitations.

The field record of applied load and respective average settlement obtained for plate load tests is being tabulated herein below :

Plate Load Test Data PLT-01(Ch. 39+149)

Applied Load (T)	Applied Pressure (T/m^2)	Cumulative Settlement (mm)
0.000	0.00	0.00
1.020	5.04	0.49
2.039	10.07	1.09
3.059	15.11	1.70
4.078	20.14	3.53
5.098	25.18	6.80
6.118	30.21	10.54
7.137	35.25	16.03
8.157	40.28	20.75
9.176	45.32	26.01

Plate Load Test Data PLT-02(Ch. 43+100)

Applied Load (T)	Applied Pressure (T/m^2)	Cumulative Settlement (mm)
0.00	0.00	0.00
1.90	5.28	2.21
3.80	10.56	3.41
5.70	15.83	4.39
7.60	21.11	5.16
9.50	26.39	5.73
11.40	31.67	6.40
13.30	36.94	7.09

Plate Load Test Data PLT-03(Ch. 29+000)

Applied Load (T)	Applied Pressure (T/m^2)	Cumulative Settlement (mm)
0.000	0.00	0.00
1.020	5.04	0.41
2.039	10.07	0.76
3.059	15.11	1.16
4.078	20.14	1.47
5.098	25.18	1.89
6.118	30.21	2.25
7.137	35.25	2.77
8.157	40.28	3.71
9.176	45.32	4.01
10.196	50.35	4.81
11.215	55.39	5.13
12.235	60.42	5.70
13.255	65.46	6.44

FIELD INVESTIGATION IN SOIL STRATA:

The investigation was planned to obtain the subsurface stratification in the proposed project site and collect soil / rock core samples for laboratory testing to determine the engineering properties such as shear strength, along with basic engineering classification of the subsurface stratum.

For geotechnical investigation work, required equipements along with rotary drilling rigs and manpower were mobilized at site to carry out various field activities as per the scope of work. These were shifted from one test location to another location during execution of field work and were demobilized on satisfactory completion of field work.

For conducting the field investigations the following practices were followed at site:

- The locations of 72 borehole carried out at Old Ch. 29+487 to Old ch. 46+400 (New CH: 30+155 to 49+584) were marked at site at specified locations. These locations are shown in **Appendix A-1** attached subsequently.

The details of various boreholes along with their coordinates are provided herein below:

Table 1.1: Details of Borehole Locations

S. No.	Chainage Old (km)	Chainage New (km)	Structure	BH.No.	Depth of Water Table below EGL (m)	Depth of Borehole below EGL (m)	Co-ordinates (m)		(+) R.L. (m)
							E	N	
1.	29+000	-	-	BH-PLT-06	8.00	12.45	693884.000	3124860.000	265.960
2.	29+487	30+155	MJB	BH-A1	27.53	53.00	696007.240	3123405.825	263.946
3.				BH-A2	27.39	53.00	695931.872	3123393.836	266.542
4.	29+860	30+528	MNB	BH-CL	NE	10.00	695623.682	3123534.155	263.108
5.	30+176	30+829	MNB	BH-CL	NE	20.00	695330.324	3123643.872	263.553
6.	30+478	31+145	MNB	BH-CL	NE	12.00	695041.409	3123752.008	264.728
7.	30+697	31+365	MNB	BH-CL	NE	12.00	694847.555	3123845.139	264.094
8.	31+354	32+022	MNB	BH-CL	NE	15.00	694378.453	3124304.952	264.674
9.	32+160	32+767	MNB	BH-CL	NE	10.00	693822.662	3124884.260	263.186
10.	32+487	33+155	MNB	BH-CL	NE	12.00	693587.448	3125111.207	261.988
11.	30+083	33+269	MNB	BH-CL	NE	10.00	693503.406	3125192.295	263.667
12.	30+488	33+673	MJB	BH-A1	27.84	30.00	693220.478	3125465.069	262.988
13.				BH-A2	26.98	30.00	693206.085	3125478.956	262.292
14.	31+095	34+280	MNB	BH-CL	NE	10.00	692778.166	3125892.043	261.355
15.	31+714	34+899	MJB	BH-A1	36.55	40.00	692316.719	3126281.196	260.608
16.				BH-A2	36.33	40.00	692289.084	3126299.382	261.768
17.	32+191	35+371	MNB	BH-CL	NE	10.00	691893.138	3126530.493	262.443
18.	32+738	35+916	MNB	BH-CL	NE	10.00	691418.519	3126801.350	260.749

S. No.	Chainage Old (km)	Chainage New (km)	Structure	BH.No.	Depth of Water Table below EGL (m)	Depth of Borehole below EGL (m)	Co-ordinates (m)		(+) R.L. (m)
							E	N	
19.	33+713	36+984	MJB	BH-A1	28.98	30.00	690578.397	3127280.622	257.231
20.				BH-A2	29.52	30.00	690560.289	3127290.956	257.830
21.	34+019	37+318	MNB	BH-CL	NE	10.00	690307.695	312744.537	256.788
22.	34+619	37+804	MNB	BH-CL	NE	10.00	689829.431	3127806.228	256.661
23.	35+273	38+457	MJB	BH-A1	24.92	30.00	689320.433	3128197.938	257.980
24.				BH-A2	24.36	30.00	689304.586	3128210.139	215.188
25.	36+367	39+553	MNB	BH-CL	NE	10.00	688442.635	3128873.981	255.925
26.	36+816	40+003	MJB	BH-A1	23.89	30.00	688102.237	3129148.530	253.133
27.				BH-A2	23.16	30.00	688087.580	3129162.136	253.255
28.	37+174	40+358	MNB	BH-CL	NE	6.00	687850.788	3129414.081	252.485
29.	37+487	40+671	MNB	BH-CL	NE	10.00	687664.026	3129665.052	253.510
30.	38+127	41+312	MNB	BH-CL	NE	10.00	687322.404	3130206.236	254.370
31.	38+482	41+667	MNB	BH-CL	NE	6.00	687138.270	3130509.717	254.888
32.	38+701	41+926	MNB	BH-CL	NE	10.00	687027.281	3130698.508	254.062
33.	38+778	41+963	MNB	BH-CL	NE	15.00	686988.257	3130764.000	254.956
34.	39+060	42+239	MNB	BH-CL	NE	10.00	686845.338	3131007.988	256.112
35.	39+149	-	-	BH-PLT-03	NE	12.00	686653.951	3131306.518	255.863
36.	39+400	42+579	MNB	BH-CL	NE	10.00	686673.940	3131301.616	256.079
37.	40+325	43+507	MNB	BH-CL	NE	15.00	686221.079	3132119.630	257.953
38.	40+573	43+758	MNB	BH-CL	NE	10.00	686107.704	3132328.870	252.612
39.	41+056	44+246	MJB	BH-A1	NE	30.00	685995.127	3132785.751	253.199
40.				BH-A2	NE	40.00	685993.223	3132810.479	252.668
41.	41+100	44+282	MNB	BH-CL	NE	10.00	685985.307	3132839.175	252.428
42.	41+217	44+402	MNB	BH-CL	NE	10.00	685963.297	3132954.077	255.462
43.	41+235	44+421	MNB	BH-CL	NE	10.00	685959.452	3132971.662	254.441
44.	41+390	44+571	MJB	BH-A1	NE	35.00	685929.941	3133111.995	258.326
45.				BH-A2	NE	35.00	685920.014	3133135.325	258.616
46.	42+256	45+497	MJB	BH-A1	NE	35.00	685833.304	3133665.625	262.272
47.				BH-P2	NE	35.00	685843.959	3133711.521	263.721
48.				BH-P3	NE	35.00	685846.067	3133732.830	262.764
49.				BH-P4	NE	34.00	685829.930	3133756.860	262.555
50.				BH-P5	NE	40.00	685839.438	3133785.448	264.797
51.				BH-P6	NE	40.00	685841.105	3133808.838	263.810
52.				BH-P13	NE	40.00	685807.139	3133991.627	264.859
53.				BH-P14	NE	40.00	685782.242	3134066.732	263.998
54.				BH-P15	NE	40.00	685773.857	3134091.912	263.446
55.				BH-P16	NE	40.00	685765.737	3134166.127	263.316
56.				BH-A2	NE	40.00	685746.693	3134176.656	263.529
57.	43+100	46+280	MNB	BH-PLT-02	NE	12.00	685434.986	3134725.214	-

S. No.	Chainage Old (km)	Chainage New (km)	Structure	BH.No.	Depth of Water Table below EGL (m)	Depth of Borehole below EGL (m)	Co-ordinates (m)		(+) R.L. (m)
							E	N	
58.	43+452	46+636	MNB	BH-CL	NE	15.00	685239.663	3135017.235	258.485
59.	43+585	46+769	MNB	BH-CL	NE	15.00	685158.018	3135122.226	258.478
60.	43+732	46+916	MNB	BH-CL	NE	15.00	685068.353	3135238.709	257.686
61.	44+050	47+234	MNB	BH-CL	NE	15.00	684905.712	3135511.319	256.063
62.	44+116	47+301	MNB	BH-CL	NE	15.00	684877.774	3135571.113	256.889
63.	44+317	47+501	MNB	BH-CL	NE	10.00	684793.328	3135753.513	254.620
64.	44+641	47+825	MNB	BH-CL	NE	10.00	684668.530	3136052.232	256.869
65.	44+910	48+094	MNB	BH-CL	NE	10.00	684609.724	3136314.389	254.293
66.	45+048	48+232	MNB	BH-CL	NE	10.00	684590.519	3136451.182	253.929
67.	45+411	48+595	MNB	BH-CL	NE	10.00	684540.434	3136810.574	253.338
68.	45+480	48+664	MJB	BH-A1	16.00	30.00	684534.196	3136867.243	254.056
69.				BH-A2	15.75	30.00	684529.247	3136889.146	255.775
70.	45+612	48+795	MNB	BH-CL	NE	10.00	684512.699	3137009.651	254.161
71.	45+984	49+168	MNB	BH-CL	NE	15.00	684458.641	3137377.674	257.656
72.	46+400	49+584	MNB	BH-CL	NE	10.00	684341.186	3137776.436	257.489

***Not Encountered:-NE**

- In soil, boreholes of 150mm dia. were drilled as per the standard procedure laid in IS: 1892.
- Borehole was properly cleaned before taking any sample in soil.
- Casing was used as per the prevailing soil conditions, to stabilize the borehole.
- Standard Penetration Tests were conducted in bore holes at regular intervals or at every change of strata as per Technical specification.
- Undisturbed were collected wherevery feasible as per the requirements and at specified depths. The same has been discussed in detail in soil characteristics sheets attached with the report.
- The Ground Water Table was met at depths of from 15.75m to 36.55m below EGL in 12 boreholes and not encountered in the remaining boreholes. The detailed procedure adopted for conducting various field tests is given here in below:

(i) Standard Penetration Test:

The Standard Penetration Test was conducted in boreholes as per IS 2131. The test was carried out using the standard split spoon sampler to measure the number of blows 'N'.

Standard split spoon sampler was attached to an 'A' rod. It was driven from borehole bottom to a distance of 45 cm using a standard hammer of 63.5 kg falling freely from a height of 75 cm to the required depth. While driving, the number of blows required to penetrate every 15 cm are recorded. The total number of blows required for the last 30 cm is taken as 'N' value at that particular depth of the borehole. Wherever the total penetration was less than 45cm, the no. of blows & the depth penetrated is recorded in the respective borelog.

SPT 'N' values were correlated with relative density of non-cohesive stratum and with consistency of cohesive stratum as given below:-

Table 1.2: Soil compactness as per SPT N values (cl. 9.7, table 9.3 & 9.4, page 330_text book of V.N.S. Murthy)

Correlation for Clay / Plastic silt		Correlation for Sand / Non-Plastic silt	
Consistency	**SPT "N" Value**	**Compactness**	**SPT "N" Value**
Very Soft	0 - 2	Very Loose	0 - 4
Soft	2 - 4	Loose	4 - 10
Medium	4 - 8	Medium	10 - 30
Stiff	8 - 15	Dense	30 - 50
Very Stiff	15 - 30	Very Dense	> 50
Hard	> 30		

The field SPT N values obtained were further corrected as per the guidelines given in IS: 2131 as follows:

(a) For overburden: - The N value for cohesionless soil is corrected with the help of fig. 1 given in IS-2131.

(b) Due to dilatancy :- Wherever N values observed below water table in fine sand, silty sand or silt was greater than 15, then corrected N values were corrected as under:

$$N' = 15 + \tfrac{1}{2}(N-15)$$

(ii) Undisturbed Sampling (Soil) in boreholes:

Undisturbed samples were collected using MS tubes of suitable diameter and length with Area ratio as per clause 4.1.1 (c) of IS: 1892 (latest) fitted to an adopter with ball and socket arrangement. Before taking any sample, sampling tube was properly greased. Immediately after taking on undisturbed sample in a tube, the adopter head was removed along with the disturbed material. The visible ends of the sample were trimmed off any wet disturbed soil. The ends were coated alternately with four layers of just molten wax. More molten wax was added to give a total thickness of min. 25 mm. The samples were carefully labeled and transported to the laboratory for testing. Undisturbed samples wherever slipped during lifting were duly marked in the field logs as well as in the soil profile.

5.0 LABORATORY TESTS ON SOIL SAMPLES:

The following laboratory tests were conducted on selected soil samples:

Table 1.3: Description of Tests

Description of Test	Reference	Undisturbed (UDS) Soil Samples	Disturbed (DS/SPT) Soil Samples
Grain Size Analysis / Hydrometer	IS: 2720 (Part - 4)	√	-
Natural Moisture Content / Bulk / Dry density	IS : 2720 (Part – 2)	√	-
Atterberg Limits • Liquid Limit • Plastic Limit	 IS: 2720 (Part - 5) IS: 2720 (Part - 5)	 √ √	 √ √
Specific Gravity	IS : 2720 (Part – 3)	√	-
Direct Shear Test	IS : 2720 (Part – 13)	√	-
Triaxial compressive shear test	IS : 2720 (Part – 11 & 12)	√	-
Chemical Analysis of Soil Samples	IS : 2720 (Part – 26, 27)	√	-

Note:- The detailed procedure adopted for conducting various laboratory tests is described in the following paragraphs:

5.1.1 Dry density and Bulk density

For determination of bulk density and dry density, a sample of known volume 'V' was extracted from the undisturbed sampling tube and it's bulk weight 'W' was noted down.Moisture content 'Wn' was determined by oven drying method.

The bulk density and dry density were determined by following equation-

Bulk density (γ_b) = W/V

Dry density (γ_d) = γ_b/ (1+Wn)

5.1.2 Natural water content

For this test, the soil sample of known quantity (Wm) was taken in a container.The container with soil sample was placed into an oven for drying at 105-110°c temperature for 16-24 hours. After drying, the dry sample was again weighted to determine the dry weight of sample (Wd).

The natural water content was computed by the following equation-

Wn = (Wm-Wd)*100/Wd

5.1.3 Grain Size Analysis (IS: 2720- Part-4)

Wet sieve analysis:

For determination of particle sizes finer than 75 micron, wet sieve analysis test was conducted. For this test, oven dried sample of known quantity was taken in a container and soaked with dispersing

agent. The soaked soil sample was washed thoroughly over 75 micron IS sieve until the water passing sieve was substantially clean.

Fraction retained on 75 micron IS sieve was carefully collected in a container without any loss in material and placed into oven for drying.

Dry sieve analysis:

For this test, the oven dried soil sample after wet sieving was sieved through the set of IS sieves 20 mm, 10 mm, 4.75 mm, 2.0 mm, 1.0 m , 425 micron , 300 micron, 150 micron and 75micron. The amounts of soil retained on each sieve were noted down. The % retained, cumulative % retained and % passing were computed accordingly. Wherever the soil sample % passing 75 micron sieve was significant, Hydrometer method was used to find the percentage of silt and clay fraction.

Grain size analysis for the fraction passing 75 micron IS Sieve (Hydrometer method)

Calibration of Hydrometer

Hydrometer was calibrated to determine a relationship (an equation) between the effective depth H_R and corresponding hydrometer reading R_h (obtained during test).

50 to 100 gm of soil sample passing through 75 micron IS Sieve was taken. It was mixed with 100 ml of sodium hexametaphesphate solution and the mixture was warmed for about 10 minutes. It was then transferred to the cup of the mechanical mixer and the soil suspension was stirred for 15 minutes. The soil suspension was transferred into 1000 ml measuring cylinder and distilled water was added to make 1000ml solution. This solution was mixed vigorously. The measuring cylinder was then allowed to stand and the stopwatch was started. Hydrometer was immersed in the solution and reading were taken after half, one, two and four minutes. The hydrometer was then removed slowly and kept in distilled water at the same temperature as the soil suspension. Readings were taken after the periods of 8, 15 and 30 minutes, and one, two and four hours. Hydrometer was removed, rinsed and placed in the distilled water after each reading. After 4 hours reading was taken once or twice within 24 hours. Finally a reading was taken at the end of 24 hours. The temperature of the suspension was observed and recorded.

Calculations

Diameter of the particles (D):

$$D = \sqrt{\frac{30\mu}{980(G-1)}} \times \sqrt{\frac{H_R}{t}} = M\sqrt{\frac{H_R}{t}}$$

Where,

D = diameter of particle in suspension, in mm;

μ = co-efficient of viscosity of water at the temperature of the suspension at the time of taking the hydrometer reading, in poise;

G = specific gravity of the soil fraction used in the sedimentations analysis;

H_R = effective depth corresponding to R_n, in cm.

t = time elapsed between the beginning of sedimentation and taking of hydrometer reading in minutes

$M = \sqrt{\frac{30\mu}{980(G-1)}}$ = a constant factor for given values of μ and G at the temperature of the suspension.

Percentage finer than diameter D:

The percentage by mass (w) of particles smaller than corresponding equivalent particle diameters (D) was calculated from the formula:

$$w = \frac{100G_s}{W_b(G_s-1)} \times R_h$$

Where

w = percentage finer

G_s = specific gravity of soil particle

W_b = weight of soil

R_h = Hydrometer reading

5.1.4 Specific Gravity (IS: 2720-Part-3 Sec-1)

The specific gravity of soil sample was determined by density bottle method. For this test 5-10g oven dried and cooled soil sample was taken in 50ml capacity density bottle and its weight was noted down as W_2 .The soil was covered with distilled water and left for sufficient period for suitable soaking. The entrapped air was removed by vacuum. The bottle with soil was filled fully with water and its weight was noted down (W_3). The mass of empty bottle and bottle filled with distilled water were noted down as W_1 and W_4 respectively.

The Specific Gravity was determined by using following equation :

$G=W_2-W_1/[(W_2-W_1)-(W_3-W_4)]$

5.1.5 Liquid Limit (IS: 2720- Part-5)

By Cone Penetrometer Method

The 'Cone Penetrometer Apparatus' is a variant of the fall-cone and consists of a cone with a smooth polished surface and angle of 30° ± 1/2°. The weight of the cone, together with its

associated shaft is 80g ± 0.5g. A support assembly with an automatic cone release mechanism and cone height adjustment mechanism used to hold the cone vertically. The angle and weight of the cone were calibrated at regular intervals, and the sharpness of the cone tip was checked daily.

Distilled water was added and thoroughly mixed with the soil sample to produce a homogeneous paste. The paste was then placed in a cup with a diameter of at least 55mm and a depth of at least 40mm. The surface of the soil was smoothed off level and parallel to the base. The support assembly was used to position the tip of the cone so that it was just touching the top surface of the soil, and the automatic tripping mechanism was released. The cone was allowed to penetrate into the soil for a period of 5 (± 1) s, then the cone was locked off to stop further movement and the penetration was recorded. The cup was refilled and the test was repeated. The two recorded penetrations need to be within 0.5mm of each other, otherwise a third test is performed. when the three test vary by more than 1mm the test was repeated.

Further tests were conducted, at varying water contents, in order to produce a series of cone penetrations (usually 4) in the range 15mm to 25mm. The resulting cone penetrations were plotted verses the water content of the test specimens. The Liquid Limit (W_L) was read off the graph, being the water content at which the line of best fit through the test points crosses 20mm penetration.

5.1.6 Plastic Limit (IS: 2720-Part-5)

For this test, soil sample was prepared in the same way as for liquid limit test. A ball of soil sample weighed about 5 gm was formed. The ball was rolled between the fingers of one hand and the glass plate with pressure sufficient to reduce the mass into a thread of about 3 mm in 5 to 10 complete forward and back movements. When a diameter of 3 mm was reached, soil was again remolded into a ball. The process of rolling and remolding was repeated until the thread started just crumbing at a diameter of 3 mm. The crumbled thread was immediately transferred to an airtight container for determination of its moisture content by oven drying method.

This water content has been termed as plastic limit. (W_P)

5.1.7 Plasticity Index (IS: 2720-Part-5)

The plasticity index Ip was given by

$I_p = W_L - W_P$ (in percent)

5.1.8 Direct Shear Test (IS:2720-Part-13):

For this test shear box test apparatus was used. The prepared specimen from remolded/undisturbed sample was placed carefully in the box. The plain grid was kept on top of the specimen with its directions at right angles to the direction of shear. The upper porous stone was placed on the grid and loading pad on the stone. The box with specimen was gently placed in the container (water

jacket). The specimen was submerged with water. The container was mounted with the shear box and the specimen inside, on the shearing machine. The upper part of the box was so adjusted that it touchéd the proving ring. The jack was brought forward to bear up against the box container. The proving ring dial gauge was set to read zero.

The steel ball was placed in the recess of the loading pad. The loading yoke was set in contact with the steel ball on the loading pad. Vertical displacement dial gauge to read zero in contact with the top of the yoke. The normal load was applied and any change in thickness of specimen was recorded. Shear displacement dial gauge was also set to read zero. The locking screw was now removed and two parts of the shear box were separated by advancing the spacing screws.

The specimen was sheared at constant rate of strain. The readings of the proving ring dial gauge were noted down every 15 seconds for the first one-minute and then every 30 seconds thereafter. The reading of change in the thickness dial gauge and shear displacement dial gauge were also recorded at the same time interval. The test was continued until the specimen fails. The specimen was assumed to fail when the proving ring dial gauge started receding or at shear displacement of approximately 15% of the length took place.

The soil was removed from the box and test was repeated on the identical specimen under increased normal load.

The rate of strain for conducting Direct Shear Test is kept as 0.25 mm/min as per codal/literature provision based on strata.

5.1.9 Triaxial Shear Test_UUT (IS: 2720-Part-11)

For this test, Triaxial Shear Test apparatus was used. The plain disc was placed on the pedestal of the triaxial cell. The specimen was placed centrally on the disc. A correct size rubber membrane was fitted inside the stretcher with ends of membrane folded over those of the stretcher. Vacuum was applied to stretch the membrane to the inside surface of the stretcher which was carefully slipped around the specimen kept on the pedestal. The vacuum on the membrane was released. Its bottom part was rolled down into the pedestal. plain disc was placed on the top of the specimen and then loading pad was placed. The top part of membrane was rolled on to the loading pad. Then the stretcher was removed and ends were sealed with ‘O’ rings. With the properly sealed specimen placed centrally on the pedestal, the cell was assembled, keeping the loading piston initially clear of the loading pad of the specimen, the assembly was placed in the loading frame.

For unconsolidated undrained test, the bottom drainage value (BDV) and top drainage value (TDV) of cell, was closed and air release valve (ARV) was opened. The cell was filled with water through the cell water value CWV. ARV was closed when water begins to escape through it. The cell pressure was raised to the desired value and kept constant till the end of the test.

When the cell pressure was applied, the load piston rises upward, the loading machine was operated at the anticipated rate to bring the load piston slightly above the loading pad of the specimen and the load measuring dial gauge on proving ring was set to zero.

The piston was brought just in contact with loading pad by hand operation of the machine. The axial compression dial gauge was mounted and set to read zero.

The axial loading was started at 1.25 mm/min rate of strain. Simultaneous readings on the load and compression dial gauges were noted down. The test was continued until a recession of the axial load is observed or 20% of strain.

After failure, the specimen was unloaded by reversing the loading machine, cell pressure was reduced and cell water was drained out through BRV. The cell was dismantled and the specimen was taken out, rubber membrane was removed and weight of the failed sample and its water content was determined. The test was repeated on two more identical specimens with increasing cell pressure.

The rate of strain for conducting UUT is kept as 1.25 mm/min as per codal/literature provision based on strata.

5.1.10 Chemical Testing

Chemical Testing was generally performed in accordance with IS: 2720, but the different parts of method as described below:

a) Total Sulphate Content Of Soil

Samples were tested according to IS 2720 (Part 27). The dried soil was extracted with a 10% solution of hydrochloric acid. The extract was adjusted to slightly alkaline pH with ammonia, and then barium chloride solution was added to precipitate the sulphate. The barium sulphate precipitate was collected by filtration, and it was washed, dried and weighed. The mass of barium sulphate recovered was used to calculate the sulphate content of the original soil.

b) pH Value

Samples were tested according to IS: 2720 (Part 26). The soil sample (30 ± 0.1g) was extracted with 75 ml of distilled water and the pH of the resulting suspension was measured with a calibrated (by means of Standard buffer solution) pH meter.

c) Chloride Content

For the water soluble content, soil samples were extracted with a volume of water equal to twice the mass of the soil. The extract was filtered and acidified with a small amount of nitric acid. Standardized silver nitrate solution was then added to precipitate the chloride as its silver salt. The amount of precipitated silver remaining in solution was then determined by titration.

An acid-soluble version of the test was also available, with the initial extraction being with nitric acid instead of water.

CHAPTER 2 ANALYSIS OF TEST RESULTS AND INTERPRETATION

6.0 STRATIFICATION

From the study of the borehole carried out at Old Ch. 29+487 to Old ch. 46+400 (New CH: 30+155 to 49+584), it is revealed that:-

At location of O.C. 29+487 (N.C. 30+155):-

The sub strata mainly consist of sandy silt of low plasticity (ML-CL)/ silty Clay of low plasticity (CL)/Silty sand with clay (SM-SC).

At location of O.C. 29+860 (N.C. 30+528):-

The sub strata mainly consist of sandy silt of low plasticity (ML-CL)/ silty Clay of low plasticity (CL).

At location of O.C. 30+176 (N.C. 30+829):-

The sub strata mainly consist of sandy silt of low plasticity (ML-CL)/ silty Clay of low plasticity (CL).

At location of O.C. 30+478 (N.C. 31+145):-

The sub strata mainly consist of sandy silt of low plasticity (ML-CL)/ silty Clay of low plasticity (CL).

At location of O.C. 30+697 (N.C. 31+365):-

The sub strata mainly consist of silty Sand (SM).

At location of O.C. 31+354 (N.C. 32+022):-

The sub strata mainly consist of silty Clay of low plasticity (CL).

At location of O.C. 32+160 (N.C. 32+767):-

The sub strata mainly consist of Silty Clay of low plasticity (CL).

At location of O.C. 32+487 (N.C. 33+155):-

The sub strata mainly consist of sandy silt of low plasticity (ML-CL)/ silty Clay of low plasticity (CL)/Silty sand with clay (SM-SC).

At location of O.C. 30+083 (N.C. 33+269):-

The sub strata mainly consist of silty Clay of low plasticity (CL)/sandy silt of low plasticity (ML-CL).

At location of O.C. 30+488 (N.C. 33+673)

The sub strata of BHA1 mainly consist of sandy silt of low plasticity (ML-CL)/ silty Clay of low plasticity (CL)/Silty sand with clay (SM-SC).

The sub strata of BH A2 mainly consist of sandy silt of low plasticity (ML-CL)/ silty Clay of low plasticity (CL)/Silty sand with clay (SM-SC).

At location of O.C. 31+095 (N.C. 34+280)

The sub strata mainly consist of Silty Clay of low plasticity (CL)/Silty sand with clay (SM-SC).

At location of O.C. 31+714 (N.C. 34+899)

The sub strata mainly consist of Silty Clay of low plasticity (CL)/Silty sand with clay (SM-SC).

At location of O.C. 32+191 (N.C. 35+371)

The sub strata mainly consist of sandy silt of low plasticity (ML-CL)/ Silty sand (SM).

At location of O.C. 32+738 (N.C. 35+916)

The sub strata mainly consist of sandy silt of low plasticity (ML-CL)/ Silty sand (SM)/ Silty Clay of low plasticity (CL).

At location of O.C. 33+713 (N.C. 36+984)

The sub strata mainly consist of sandy silt of low plasticity (ML-CL)/ Silty sand (SM)/ Silty Clay of low plasticity (CL).

At location of O.C. 34+019 (N.C. 37+318)

The sub strata mainly consist of sandy silt of low plasticity (ML-CL)/ silty Clay of low plasticity (CL)/Silty sand with clay (SM-SC).

At location of O.C. 34+619 (N.C. 37+804)

The sub strata mainly consist of sandy silt of low plasticity (ML-CL)/ Silty sand with clay (SM-SC).

At location of O.C. 35+272 (N.C. 38+457)

The sub strata mainly consist of sandy silt of low plasticity (ML-CL)/ silty Clay of low plasticity (CL).

At location of O.C. 36+367 (N.C. 39+553)

The sub strata mainly consist of sandy silt of low plasticity (ML-CL)/ silty Clay of low plasticity (CL).

At location of O.C. 36+816 (N.C. 40+003)

The sub strata of BH A1 mainly consist of sandy silt of low plasticity (ML-CL)/ silty Clay of low plasticity (CL).

The sub strata of BH A2 mainly consist of Silty sand (SM)/sandy silt of low plasticity (ML-CL)/ silty Clay of low plasticity (CL).

At location of O.C. 37+174 (N.C. 40+358)

The sub strata of BH A2 mainly consist of Silty sand (SM)/sandy silt of low plasticity (ML-CL)

At location of O.C. 37+487 (N.C. 40+671)

The sub strata of BH A2 mainly consist of Silty sand (SM)/sandy silt of low plasticity (ML-CL)

At location of O.C. 38+127 (N.C. 41+312)

The sub strata mainly consist of sandy silt of low plasticity (ML-CL)/ silty Clay of low plasticity (CL).

At location of O.C. 38+482 (N.C. 41+667)

The sub strata mainly consist of Silty Clay of low plasticity (CL).

At location of O.C. 38+701 (N.C. 41+926)

The sub strata mainly consist of Silty Clay of low plasticity (CL).

At location of O.C. 38+778 (N.C. 41+963)

The sub strata mainly consist of sandy silt of low plasticity (ML-CL)/ silty Clay of low plasticity (CL).

At location of O.C. 39+060 (N.C. 42+239)

The sub strata mainly consist of sandy silt of low plasticity (ML-CL)/ silty Clay of low plasticity (CL)/Silty sand with clay (SM-SC).

At location of O.C. 39+400 (N.C. 42+579)

The sub strata mainly consist of sandy silt of low plasticity (ML-CL)/ Silty sand (SM).

At location of O.C. 40+325 (N.C. 43+507)

The sub strata mainly consist of sandy silt of low plasticity (ML-CL)/ silty Clay of low plasticity (CL).

At location of O.C. 40+573 (N.C. 43+758)

The sub strata mainly consist of sandy silt of low plasticity (ML-CL).

At location of O.C. 41+056 (N.C. 44+246)

The sub strata of BH-A1 mainly consist of sandy silt of low plasticity (ML-CL).

The sub strata of BH-A2 mainly consist of sandy silt of low plasticity (ML-CL)/ Silty sand with clay (SM-SC).

At location of O.C. 41+100 (N.C. 44+282)

The sub strata mainly consist of Silty Clay of low plasticity (CL)/ Silty sand with clay (SM-SC).

At location of O.C. 41+217 (N.C. 44+402)

The sub strata mainly consist of sandy silt of low plasticity (ML-CL)/ silty Clay of low plasticity (CL) and Silty sand (SM).

At location of O.C. 41+235 (N.C. 44+421)

The sub strata mainly consist of sandy silt of low plasticity (ML-CL)/ silty Clay of low plasticity (CL).

At location of O.C. 41+390 (N.C. 44+571)

The sub strata of BH-A1 mainly consist of sandy silt of low plasticity (ML-CL)/ silty Clay of low plasticity (CL).

The sub strata of BH-A2 mainly consist of sandy silt of low plasticity (ML-CL)/ silty Clay of low plasticity (CL).

At location of O.C. 42+256 (N.C. 45+497)

The sub strata of BH-A1 mainly consist of sandy silt of low plasticity (ML-CL)/ silty Clay of low plasticity (CL).

The sub strata of BH-A2 mainly consist of sandy silt of low plasticity (ML-CL).

The sub strata of BH-P2 mainly consist of sandy silt of low plasticity (ML-CL)/ Silty sand with clay (SM-SC).

The sub strata of BH-P3 mainly consist of sandy silt of low plasticity (ML-CL).

The sub strata of BH-P13 mainly consist of sandy silt of low plasticity (ML-CL)/ Silty sand with clay (SM-SC).

The sub strata of BH-P4 mainly consist of sandy silt of low plasticity (ML-CL)/ Silty sand with clay (SM-SC).

The sub strata of BH-P5 mainly consist of sandy silt of low plasticity (ML-CL).

The sub strata of BH-P6 mainly consist of sandy silt of low plasticity (ML-CL).

The sub strata of BH-P13 mainly consist of sandy silt of low plasticity (ML-CL)/ silty Clay of low plasticity (CL)/ silty Clay of low plasticity (CL).

The sub strata of BH-P14 mainly consist of sandy silt of low plasticity (ML-CL)/ silty Clay of low plasticity (CL).

At location of O.C. 43+100 (N.C. 46+280)

The sub strata mainly consist of sandy silt of low plasticity (ML-CL)/Silty sand (SM).

At location of O.C. 43+452 (N.C. 46+636)

The sub strata mainly consist of sandy silt of low plasticity (ML-CL).

At location of O.C. 43+585 (N.C. 46+769)

The sub strata mainly consist of sandy silt of low plasticity (ML-CL)/ silty Clay of low plasticity (CL).

At location of O.C. 43+732 (N.C. 46+916)

The sub strata mainly consist of sandy silt of low plasticity (ML-CL)/ silty Clay of low plasticity (CL).

At location of O.C. 44+050 (N.C. 47+234)

The sub strata mainly consist of sandy silt of low plasticity (ML-CL)/ silty Clay of low plasticity (CL).

At location of O.C. 44+116 (N.C.47+301)

The sub strata mainly consist of sandy silt of low plasticity (ML-CL)/ silty Clay of low plasticity (CL).

At location of O.C. 44+641 (N.C. 47+825)

The sub strata mainly consist of sandy silt of low plasticity (ML-CL)/ silty Clay of low plasticity (CL).

At location of O.C. 44+910 (N.C. 48+094)

The sub strata mainly consist of sandy silt of low plasticity (ML-CL)/ silty Clay of low plasticity (CL)/Silty sand with clay (SM-SC).

At location of O.C. 45+048 (N.C. 48+664)

The sub strata mainly consist of sandy silt of low plasticity (ML-CL)/ silty Clay of low plasticity (CL).

At location of Old Ch:- 45+984 New Ch:- 49+168:-

The sub strata mainly consist of sandy silt of low plasticity (ML-CL)/ silty sand (SM).

At location of CH:- 46+400 New Ch:- 49+584

The sub strata mainly consist of sandy silt of low plasticity (ML-CL)/ silty sand (SM).

At location of O.C. 45+612 (N.C. 48+795)

The sub strata mainly consist of sandy silt of low plasticity (ML-CL)/ silty Clay of low plasticity (CL).

At location of Old Ch:- 45+984 New Ch:- 49+168:-

The sub strata mainly consist of sandy silt of low plasticity (ML-CL)/ silty sand (SM).

At location of Old Ch:- 46+400 New Ch:- 49+584

The sub strata mainly consist of sandy silt of low plasticity (ML-CL)/ silty sand (SM).

6.1 GROUND WATER TABLE DEPTH

The Ground Water Table was met at depths of from 15.75m to 36.55m below EGL in 12 boreholes and not encountered in the remaining boreholes as given in Table 2.1, it may rise up during heavy rains / rainy season. Therefore, for the analysis of various foundations, the water table has been considered to rise by about 2 to 3.0m at the locations of boreholes.

6.2 RESULTS OF CHEMICAL ANALYSIS

Results of chemical analysis of soil samples (as per **Appendix – B2**) indicates that the soil sample falls under Class I for sulphates and chlorides concentration (As per IS 456-2000 and CIRIA Sp. Publication No. 31). The results are summarized here in below :-

Summary of chemical analysis of soil samples

Chemical Property	Findings (Min. to Max.)	Remarks (Required limits as per IS 456-2000)
pH	7.11 to 9.70	> 6.0
Sulphite as SO_3^{2-} (%)	0.0016 (%) to 0.0032 (%)	< 0.2% (Class I)
Chlorides as Cl^- (%)	0.0050 (%) to 0.0080 (%)	No limit specified in IS 456. However, a limit of 0.10% specified for class I in CIRIA Sp. Publication No. 31)

Note :- All the chemical contents are within permissible limit hence no special precautions are required.

6.3 COMPUTATION OF LIQUEFACTION POTENTIAL

Liquefaction is the sudden loss of shear strength of the sub soil strata due to earthquake-induced vibration under saturated conditions.

Assessment of liquefaction potential of foundation strata is made by simplified approach proposed as per IS: 1893 (Part-1)-2016, from the SPT data and peak ground acceleration likely to occur at the site. In this method, cyclic shear stress likely to be induced in the foundation strata by Design Basis Earthquake (DBE) is first evaluated.

Next threshold cyclic shear stress, which is good enough to cause liquefaction, is determined from SPT data and the empirical relations. Finally, comparison of these two stresses is used in the estimation of liquefaction susceptibility of the foundation strata.

Unsaturated soils are not subjected to liquefaction because vibratory forces from earthquakes do not cause any increase in pore water pressure in such soils.

The area of site from Palwal to Harsana Kalan (Sonipat) in the State of Haryana falls in seismic zone – IV of India as per IS: 1893. Further as per the provisions of IS: 1893 in soil deposits consisting of submerged loose sands & soils falling under classification of SP with standard penetration N value less than 15, the shaking caused by earthquake ground motion may cause liquefaction or excessive total and differential settlements.

For the analysis of liquefaction potential, following constant parameters are considered:

EQ Zone	IV
Earthquake Magnitude (Mw)	7.0
Peak Horizontal Ground Acceleration (amax /g)	0.24

The Ground Water Table was met at depths of from 15.75m to 36.55m below EGL in 12 boreholes and not encountered in the remaining boreholes. For the analysis of liquefaction potential, the water table is generally considered to rise by about 3.0m at the location of all

boreholes. Since, water table is either very deep or not encountered, the boreholes are not likely to liquefy and hence no analysis has been performed. However, a sample analysis sheet is provided for reference.

The strata in the boreholes are not likely to liquefy as mentioned above and the same is tabulated below:-

Table 2.1: Liquefaction Analysis

S. No.	Chainage Old (km)	Chainage New (km)	Structure	BH.No.	Depth of Water Table below EGL (m)	Liquefiable Depth (m)
1.	29+487	30+155	MJB	BH-A1	27.53	Non-Liquefiable
2.				BH-A2	27.39	Non-Liquefiable
3.	29+860	30+528	MNB	BH-CL	NE	Non-Liquefiable
4.	30+176	30+829	MNB	BH-CL	NE	Non-Liquefiable
5.	30+478	31+145	MNB	BH-CL	NE	Non-Liquefiable
6.	30+697	31+365	MNB	BH-CL	NE	Non-Liquefiable
7.	31+354	32+022	MNB	BH-CL	NE	Non-Liquefiable
8.	32+160	32+767	MNB	BH-CL	NE	Non-Liquefiable
9.	32+487	33+155	MNB	BH-CL	NE	Non-Liquefiable
10.	30+083	33+269	MNB	BH-CL	NE	Non-Liquefiable
11.	30+488	33+673	MJB	BH-A1	27.84	Non-Liquefiable
12.				BH-A2	26.98	Non-Liquefiable
13.	31+095	34+280	MNB	BH-CL	NE	Non-Liquefiable
14.	31+714	34+899	MJB	BH-A1	36.55	Non-Liquefiable
15.				BH-A2	36.33	Non-Liquefiable
16.	32+191	35+371	MNB	BH-CL	NE	Non-Liquefiable
17.	32+738	35+916	MNB	BH-CL	NE	Non-Liquefiable
18.	33+713	36+984	MJB	BH-A1	28.98	Non-Liquefiable
19.				BH-A2	29.52	Non-Liquefiable
20.	34+019	37+318	MNB	BH-CL	NE	Non-Liquefiable
21.	34+619	37+804	MNB	BH-CL	NE	Non-Liquefiable
22.	35+273	38+457	MJB	BH-A1	24.92	Non-Liquefiable
23.				BH-A2	24.36	Non-Liquefiable
24.	36+367	39+553	MNB	BH-CL	NE	Non-Liquefiable
25.	36+816	40+003	MJB	BH-A1	23.89	Non-Liquefiable
26.				BH-A2	23.16	Non-Liquefiable
27.	37+174	40+358	MNB	BH-CL	NE	Non-Liquefiable
28.	37+487	40+671	MNB	BH-CL	NE	Non-Liquefiable
29.	38+127	41+312	MNB	BH-CL	NE	Non-Liquefiable
30.	38+482	41+667	MNB	BH-CL	NE	Non-Liquefiable
31.	38+701	41+926	MNB	BH-CL	NE	Non-Liquefiable
32.	38+778	41+963	MNB	BH-CL	NE	Non-Liquefiable
33.	39+060	42+239	MNB	BH-CL	NE	Non-Liquefiable

S. No.	Chainage Old (km)	Chainage New (km)	Structure	BH.No.	Depth of Water Table below EGL (m)	Liquefiable Depth (m)
34.	39+400	42+579	MNB	BH-CL	NE	Non-Liquefiable
35.	40+325	43+507	MNB	BH-CL	NE	Non-Liquefiable
36.	40+573	43+758	MNB	BH-CL	NE	Non-Liquefiable
37.	41+056	44+246	MJB	BH-A1	NE	Non-Liquefiable
38.				BH-A2	NE	Non-Liquefiable
39.	41+100	44+282	MNB	BH-CL	NE	Non-Liquefiable
40.	41+217	44+402	MNB	BH-CL	NE	Non-Liquefiable
41.	41+235	44+421	MNB	BH-CL	NE	Non-Liquefiable
42.	41+390	44+571	MJB	BH-A1	NE	Non-Liquefiable
43.				BH-A2	NE	Non-Liquefiable
44.	42+256	45+497	MJB	BH-A1	NE	Non-Liquefiable
45.				BH-P2	NE	Non-Liquefiable
46.				BH-P3	NE	Non-Liquefiable
47.				BH-P4	NE	Non-Liquefiable
48.				BH-P5	NE	Non-Liquefiable
49.				BH-P6	NE	Non-Liquefiable
50.				BH-P13	NE	Non-Liquefiable
51.				BH-P14	NE	Non-Liquefiable
52.				BH-P15	NE	Non-Liquefiable
53.				BH-P16	NE	Non-Liquefiable
54.				BH-A2	NE	Non-Liquefiable
55.	43+100	46+280	MNB	BH-PLT-02	NE	Non-Liquefiable
56.	43+452	46+636	MNB	BH-CL	NE	Non-Liquefiable
57.	43+585	46+769	MNB	BH-CL	NE	Non-Liquefiable
58.	43+732	46+916	MNB	BH-CL	NE	Non-Liquefiable
59.	44+050	47+234	MNB	BH-CL	NE	Non-Liquefiable
60.	44+116	47+301	MNB	BH-CL	NE	Non-Liquefiable
61.	44+317	47+501	MNB	BH-CL	NE	Non-Liquefiable
62.	44+641	47+825	MNB	BH-CL	NE	Non-Liquefiable
63.	44+910	48+094	MNB	BH-CL	NE	Non-Liquefiable
64.	45+048	48+232	MNB	BH-CL	NE	Non-Liquefiable
65.	45+411	48+595	MNB	BH-CL	NE	Non-Liquefiable
66.	45+480	48+664	MJB	BH-A1	16.00	Non-Liquefiable
67.				BH-A2	15.75	Non-Liquefiable
68.	45+612	48+795	MNB	BH-CL	NE	Non-Liquefiable
69.	45+984	49+168	MNB	BH-CL	NE	Non-Liquefiable
70.	46+400	49+584	MNB	BH-CL	NE	Non-Liquefiable

6.4 INTERPRETATION OF LAB TEST RESULTS

Grain Size Analysis

- **Clay content:** It generally varies from 4 to 13%.
- **Silt content:** It generally varies from 21 to 65%.
- **Sand content:** It generally varies from 22 to 85%.
- **Gravel content:** It generally varies from 1 to 12%.

Atterberg's Limit

- **Liquid limit:** The test results of liquid limit of the soil samples reveal that it generally varies from 26 to 28% in ML-CL type of soil, 31 to 34% in CL type of soil.
- **Plastic Limit*:*** The plastic limit of the soil sample varies from 20 to 21% in ML-CL type of soil, 20 to 23% in CL type of soil. However ML-CL type of soil is considered as non-plastic.
- **Plasticity index*:*** The plasticity index of the soil samples generally varies from 6 to 7% in ML-CL type of soil, 09 to 11% in CL type of soil whereas ML-CL and SM/ SM-SC/ SC type of soil are non-plastic.

Natural moisture content & Bulk density

The bulk density of soil samples generally varies from 1.63gm/cc to 1.97gm/cc whereas natural moisture content varies from 10.21% to 18.26%.

Direct shear tests:

Direct shear test under drained condition have been conducted in sandy silty (ML-CL) / sandy stratum (SM/ SM-SC/ SC) type of soil.

For Sandy strata (SM/ SM-SC/ SC), the value of angle of internal friction varies from 25^o to 32^o, whereas cohesion varies from 0.00 kg/cm^2 to 0.11 kg/cm^2.

For Silty strata (ML-CL), the value of angle of internal friction varies from 22^o to 27^o, whereas cohesion varies from 0.19 kg/cm^2 to 0.22 kg/cm^2.

Triaxial shear tests:

Triaxial shear test under undrained condition have been conducted in silty clay (CL) type of soil.

For silty clay (CL) strata, the value of angle of internal friction varies from 4^o to 5^o, whereas cohesion varies from 1.42kg/cm^2 to 2.24kg/cm^2.

FROM THE STUDY OF PRESSURE-SETTLEMENT CURVE (ON ARITHMETIC SCALE) OF 03 PLATE LOAD TESTS AS PROVIDED VIDE APPENDIX A-4, IT IS REVEALED THAT

<u>For PLT-39+149:-</u>

- Ultimate bearing capacity and Safe bearing capacity of the sandy soil with respect to plate is found to be 21.98 t/m^2 and 8.79 t/m^2, respectively.

- Safe bearing capacity of soil for 2 m foundation width is found to be 31.46 t/m^2 at 25 mm settlement. As per shear failure criteria (Bowles, J.E., 1982. Foundation design and analysis), it is found to be 26.37 t/m^2.

For PLT-43+100:-

- Ultimate bearing capcity and Safe bearing capacity of the sandy soil with respect to plate is found to be 36.94 t/m2 and 14.78 t/m^2, respectively.
- Safe bearing capacity of soil for 2 m foundation width is found to be 76.60 t/m^2 at 25 mm settlement. As per shear failure criteria (Bowles, J.E., 1982. Foundation design and analysis), it is found to be 44.34 t/m^2.

For PLT-29+000:-

- Ultimate bearing capcity and Safe bearing capacity of the sandy soil with respect to plate is found to be 65.46 t/m2 and 26.18 t/m^2, respectively.
- Safe bearing capacity of sandy soil for 2 m foundation width is found to be 120.93 t/m^2 at 25 settlement. As per shear failure criteria (Bowles, J.E., 1982. Foundation design and analysis), it is found to be 78.54 t/m^2.

Note:

- The Safe bearing capacity of sandy soil as per shear failure criteria is computed by the following given relation (Bowles, J.E., 1982. Foundation design and analysis),

$$q_{Safe} = q_{safe\,(Plate)}\, X \left(\frac{B_{Foundation}}{B_{Plate}}\right)$$

- J.E., 1982 recommended that the above equation is valid when the ratio lies between 3 to 6. However for better understanding the ratio is conservatively restricted to 3. The use of this equation is not recommended unless the ratio is not much more than about 3. When the ratio is more than 6 to 15 or more the extrapolation from a plate load test is little more than a guess that could be obtained at least as reliably using an SPT or CPT corerection.

CHAPTER 3 TYPE AND DEPTH OF FOUNDATION WITH ANALYSIS

7.0 TYPE & DEPTH OF FOUNDATION:

Based on the nature & strength characteristics of the substrata and requirement of the project, the following type of foundation have been analyzed as given below:

Table 3.1 : Shallow Foundation

Type of foundation	Depth of Foundation below E.G.L. (m)	Size of Foundation (m x m)
Shallow Foundation	1.0, 1.5, 2.0	1.6 x 1.6
	1.0, 1.5, 2.0, 2.5	2.0 x 2.0 3.0 x 3.0
	1.0, 1.5, 2.0	2.2 x 2.2
	1.0, 1.5, 2.0	2.5 x 2.5
	1.0, 1.5, 2.0	2.7 x 2.7
	1.0, 1.5, 2.0	4.8 x 4.8 4.9 x 4.9
	1.0, 1.5, 2.0	6.2 x 6.2
	1.0, 1.5, 2.0 2.0, 3.0, 4.0	7.2 x 7.2 7.3 x 7.3
	1.0, 1.5, 2.0	11.5 x 11.5
	1.0, 1.5, 2.0	11.35 x 11.35

Table 3.2 : Pile Foundation

Type of foundation	Length of Pile below E.G.L. (m)	Dia. of Pile (m)
Normal Bored Cast in-situ RCC Pile	16.0, 18.0, 20.0, 22.0	1.0 & 1.2

The details of foundation analysis are given in the subsequent paragraph.

7.1 ANALYSIS OF SHALLOW FOUNDATION

7.1.1 From Shear Failure Criteria

Net Safe Bearing capacity from Shear Failure consideration has been computed in accordance with IS: 6403-1981, which is based on, modified Terzaghi's classical approach. The weighted average of shear strength parameters for various strata upto depth equal to 0.5*B*Tan (45+Ø/2) (where B = Width of the Foundation, Ø = Angle of internal friction) is used in the analysis. A factor of safety of 2.5 to estimate the net safe bearing capacity from ultimate net bearing capacity.

For soils, containing both coarse grained (gravels & sands) and fine grained (clays), c and Φ are used to determine the soil strength. In case of predominantly fine grained soils, c and Φ are

determined by the Triaxial Compression test as per IS: 2720 pt XI. For predominantly coarse grained soils, c and Φ are determined by Direct Shear test as per IS: 2720 pt XIII. These c and Φ values were used for determining the SBC of soil as per shear failure criteria.

The ultimate net bearing capacity in case of general shear failure is given by following expression,

$q_d = c\, N_c\, s_c\, d_c\, i_c + q\,(N_q-1)\, s_q\, d_q\, i_q + (1/2)\, B\, \gamma\, N_\gamma\, s_\gamma\, d_\gamma\, i_\gamma\, W'$

The ultimate net bearing capacity in case of local shear failure is given by following expression,

$q'_d = (2/3)\, c\, N'_c\, s_c\, d_c\, i_c + q\,(N'_q-1)\, s_q\, d_q\, i_q + (1/2)\, B\, \gamma\, N'_\gamma\, s_\gamma\, d_\gamma\, i_\gamma\, W'$

Where,

$d_c = 1+ 0.2\,(D_f/B)*SQRT(N_\phi)$

$d_q = d_\gamma = 1$ for $\phi < 10^o$

$d_q = d_\gamma = 1 + 0.1\,(D_f/B)*SQRT(N_\phi)$ for $\phi > 10^o$

$N_\phi = \tan^2(\pi/4 + \phi/2)$

ϕ' for local shear failure $= \tan^{-1}(0.67 \tan\phi)$

7.1.2 From Settlement Failure Criteria

Allowable Bearing Pressure from Settlement Failure consideration has been computed in accordance with IS: 8009 (Part-I). The magnitude of settlement, when foundation loads are applied, depends upon the compressibility of the underlying strata and rigidity of the substructure.

The total permissible settlement in cohesion-less soil is estimated using SPT value as per IS: 8009 (Part-I). While using this approach, the N value was corrected, wherever applicable, below the footing base to at least 1.5B below the base to account for the effects of energy ratio, adopted bearing pressure, dilation for submerged silty fine sands / fine sands as well as that due to the overburden pressure.

Further for settlement Calculation in cohesive soil the following equation has been used.

$S_t = \Delta P\, M_v\, H$

Where,

M_v = Coefficient of volume compressibility, cm^2/kg

ΔP = Pressure increment, kg/cm^2

H = Thickness of layers

Note: - Value of Coefficient of volume compressibility (Mv) has been calculated by using the following co-relation [Ref. Stroud and Butler, 1975] :-

Coefficient of Volume Compressibility derived from SPT N-Value (after Stroud and Butler, 1975)

Plasticity Index (%)	Conversion Factor (f_2)	m_v (10^{-3} kPa^{-1}) based on N-Value: $m_v = 1/(f_2N)$				
		N=10	N=20	N=30	N=40	N=50
10	800	0.12	0.06	0.04	0.03	0.02
20	525	0.19	0.09	0.06	0.05	0.04
30	475	0.21	0.10	0.07	0.05	0.04
40	450	0.22	0.11	0.07	0.06	0.04

$Mv = 1/(f_2N_{corr.})$

Where f_2 = factor based on $N_{corr.}$ Value & plasticity index of soil

$N_{corr.}$ = corrected SPT 'N' value

For analysis of shallow foundation the total permissible settlement has been considered as 25mm, & 50mm as per IS 1904.

Zone of influence below foundation has been considered up to 1.5 times the width of the foundation.

For the determination of the SBC from settlement criteria, the corrected SPT N values within the influence zone are given in the table below.

NOTE:-

- Lower of the two values obtained from settlement and shear criteria is used in arriving at allowable bearing capacity of the soil.
- Structural foundations are designed based on the minimum of Safe Bearing Capacity obtained from Shear Failure Criteria and Allowable Bearing Pressure corresponding to the permissible settlement. The permissible Settlement that can be allowed for the foundation depends on the strata at the location and type of foundation (whether Isolated or Raft).

  Settlement occurs with the application of loads on foundations. It has two components, Immediate Settlement and Long Term Settlement. The immediate settlement takes place immediately as the loading is imposed on the structure and long term settlement arises due to the consolidation of the sub-soil with time under the load. Hence, the total settlement allowed for a foundation is the sum of the immediate and consolidation settlement that is expected to occur. The cohesionless strata (predominantly sandy) is primarily subjected to immediate settlement and cohesive strata (clayey) undergoes settlement in long time with the compression of the strata due to consolidation. Settlement of the foundation is determined from the relation provided in Indian standards (IS: 8009 (part-1) &/or various literatures (Bowles, BM Das, etc.).

From the Geotechnical investigation conducted on our site along with subsequent laboratory tests on soil samples, it is observed that predominantly the strata is silty with sand (SM/SC/SM-SC/ML-CL i.e. predominantly cohesionless) with the presence of small patches of silty clay of low plasticity (CL). Since the Settlement that takes place in cohesionless strata is mostly immediate, it takes place immediately after the imposing of load, initially during construction with the application of Dead Load and further during Live Load. The live load usually is many times lesser than the dead load, and correspondingly the post construction settlement is very less for live loads. As an example, if dead load is three times that of live load, then the settlement corresponding to live load (i.e. the post construction settlement) will be one-third of the settlement due to dead load which is comparatively lesser than 25mm for permissible settlement of 50mm.

According to the IS 1904, the permissible settlement for concrete structure having raft foundation is allowed upto 75mm, and the permissible settlement is 25mm post construction as per IRS code (Code of Practice for The Design of Sub-Structures and Foundations of Bridges). As discussed above, the settlement post construction is directly proportional to the allowable settlement. Therefore, given the importance of structure to be constructed and considering mostly cohesionless strata encountered at site, it is recommended that the maximum permissible settlement shall be restricted to 50mm for the design purpose on conservative side so that the post construction settlement can be constraint to lesser than 25mm.

As per IS- 8009 part 1 clause 9.2.2.1, If the clay layer is sandwitched between cohesionless soil layers, the immediate settlement is zero. Hence, even though the immediate settlement has been calculated during analysis, however it is ignored in the calculation of total settlement.

The sample calculations for computation of allowable bearing capacity of sub-strata for shallow foundation vide **Appendix – C-1.**

7.2 ANALYSIS OF PILE FOUNDATION

(A) DEEP FOUNDATION

The safe Load Carrying Capacity of normal bored cast in-situ RCC pile is determined in compression, uplift and lateral as per IS: 2911 (Part-1/sec-2) – 2010. The axial capacity of a pile depends upon the soil skin friction along the shaft and end bearing at it's tip.

Thus Axial load = Skin Friction + End-bearing

a) For piles in granular soils (using the static formula)

$$Q_u = (0.5*D*\gamma*N_\gamma + P_D*N_q)*A_p + (\Sigma K_i*P_{Di}*\tan\delta_i)*A_{si}$$

Where,

Q_u = Ultimate load capacity of pile in KN

D = dia. of pile shaft in m

γ = effective unit weight of the soil at pile tip in kN/m^3

N_γ & N_q = bearing capacity factors depending upon the angle of internal friction Φ at pile tip (N_γ from IS 6403 for general shear failure case & N_q from Fig. 1, IS 2911)

P_D = effective overburden pressure at pile tip in kN/m^2 limited to 15-17 times diameter of pile (as per the Phi value at end bearing)

Σ = Summation for layers (1 to n) in which pile is installed and which contribute to (+ve) skin friction

K_i = coefficient of earth pressure applicable for the i^{th} layer

P_{Di} = effective overburden pressure for the i^{th} layer in kN/m^2 limited to 15-17 times diameter of pile (as per the Phi value at end bearing)

δ_i = angle of wall friction between pile and soil for i^{th} layer, and

A_{si} = surface area of pile shaft in the i^{th} layer in m^2

b) For piles in cohesive soils (using the static formula)

$$\mathbf{Q_u = cp*Nc*A_p + \Sigma\alpha_i*c_i*A_{si}}$$

Where,

Q_u = Ultimate load capacity of pile in KN

A_p = cross-sectional area of pile tip in m^2

N_c = bearing capacity factor (= 9)

Σ = Summation for layers (1 to n) in which pile is installed and which contribute to (+ve) skin friction

α_i = adhesion factor for the i^{th} layer depending on the consistency of soil

c_i = average cohesion for i^{th} layer in kN/m^2

A_{si} = surface area for pile shaft in the i^{th} layer in m^2

c) For computation of safe load carrying capacity of pile in lateral, the following equation has been used:

i. <u>Fixed Head Condition</u>

$$\mathbf{Q = (12 * E * I * Y) / (L_1 + L_f)^3}$$

ii. <u>Free Head Condition</u>

$$\mathbf{Q = (3 * E * I * Y) / (L_1 + L_f)^3}$$

Where,

Q = Lateral Load (in kg)

Y = Permissible lateral deflection taken as 5mm

E = Modulus of Elasticity of concrete

I = Moment of Inertia of the pile cross-section

L_1 = Length of pile above cut-off level

L_f = Length of fixity

The effective length of the pile has been considered below the cut-off level taken as 2.0m below the EGL. Normal Bored cast in-situ RCC piles having stem diameter equal to 100cm & 120cm and of effective length varying from 16.0m to 28.0m were selected.

For the analysis of the pile foundations the soil parameters used for computation of safe load carrying capacity of pile is tabulated below:-

Table 3.3 : Design Soil Parameter

Chainage Old (km)	Chainage New (km)	BH.No.	Layer depth below EGL (m)		Thickness of strata (m)	Strata description	SPT 'N'		Bulk Density (gm/cc)	Cohesion (C) (kg/cm2)	Angle of internal Friction (Φ) (°)
			From	To			Observed	Corrected			
29+487	30+155	BH-A1	0.00	5.50	5.50	Sandy Silt	17	21	1.79	0.19	30
			5.50	8.50	3.00	Sandy Silt	49	45	1.85	0.20	30
			8.50	11.50	3.00	Sandy Silt	57	46	1.86	0.20	30
			11.50	14.50	3.00	Sandy Silt	63	45	1.87	0.19	31
			14.50	17.50	3.00	Sandy Silt	82	53	1.89	0.23	30
			17.50	52.30	34.80	Sandy Silt	100	-	-	-	-
		BH-A2	0.00	4.00	4.00	Silty Sand	13	17	1.70	0.10	30
			4.00	7.00	3.00	Sandy Silt	52	52	1.84	0.22	29
			7.00	10.00	3.00	Sandy Silt	52	45	1.84	0.18	29
			10.00	13.00	3.00	Sandy Silt	56	42	1.85	0.18	29
			13.00	52.26	39.26	Silty Sand	100	-	-	-	-
29+860	30+528	BH-CL	0.00	4.50	4.50	Sandy Silt	12	17	1.73	0.20	28
			4.50	7.50	3.00	Silty Clay	30	31	1.86	1.02	5
			7.50	10.00	2.50	Sandy Silt	43	39	1.90	0.20	28
30+176	30+829	BH-CL	0.00	5.25	5.25	Sandy Silt	16	21	1.74	0.22	28
			5.25	8.25	3.00	Silty Clay	41	41	1.87	1.36	5
			8.25	11.25	3.00	Silty Clay	58	58	1.93	1.91	4
			11.25	14.25	3.00	Silty Clay	72	72	1.98	2.30	4
			14.25	17.25	3.00	Silty Clay	-	-	2.03	3.18	4
			17.25	19.50	2.25	Silty Clay	-	-	2.04	3.18	4
30+478	31+145	BH-CL	0.00	4.00	4.00	Silty Clay	21	21	1.76	0.72	5
			4.00	7.00	3.00	Sandy Silt	28	28	1.79	0.18	28
			7.00	10.00	3.00	Sandy Silt	23	20	1.78	0.18	28
			10.00	11.95	1.95	Sandy Silt	-	-	1.78	0.18	28
30+697	31+365	BH-CL	0.00	4.50	4.50	Sandy Silt	12	17	1.73	0.20	28
			4.50	7.50	3.00	Silty Clay	30	31	1.86	1.02	5
			7.50	10.00	2.50	Sandy Silt	43	39	1.90	0.20	28

Chainage Old (km)	Chainage New (km)	BH.No.	Layer depth below EGL (m)		Thickness of strata (m)	Strata description	SPT 'N'		Bulk Density (gm/cc)	Cohesion (C) (kg/cm2)	Angle of internal Friction (Φ) (°)
			From	To			Observed	Corrected			
31+354	32+022	BH-CL	0.00	5.50	5.50	Silty Clay	16	16	1.70	0.56	4
			5.50	8.50	3.00	Silty Clay	36	36	1.82	1.23	5
			8.50	11.50	3.00	Silty Clay	42	42	1.83	1.40	4
			11.50	15.00	3.50	Silty Clay	51	51	1.89	1.69	5
32+160	32+767	BH-CL	0.00	4.00	4.00	Silty Clay	16	16	1.70	0.56	5
			4.00	7.00	3.00	Silty Clay	22	22	1.77	0.75	4
			7.00	10.00	3.00	Silty Clay	27	27	1.81	0.92	5
32+487	33+155	BH-CL	0.00	4.50	4.50	Sandy Silt	19	27	1.80	0.23	28
			4.50	8.25	3.75	Silty Clay	43	43	1.88	1.46	4
			8.25	12.00	3.75	Silty Sand	56	45	1.88	0.11	30
30+083	33+269.72	BH-CL	0.00	1.50	1.50	Silty Clay	14	14	1.71	0.49	5
			1.50	4.50	3.00	Sandy Silt	19	25	1.78	0.18	28
			4.50	8.25	3.75	Silty Clay	26	26	1.82	0.85	6
			8.25	10.00	1.75	Silty Clay	35	35	1.87	1.16	5
30+488	33+673	BH-A1	0.00	4.00	4.00	Silty Sand	9	14	1.68	0.11	30
			4.00	8.50	4.50	Silty Clay	28	28	1.81	0.90	5
			8.50	11.50	3.00	Silty Clay	37	37	1.85	1.24	4
			11.50	16.00	4.50	Silty Clay	40	40	1.87	1.36	4
			16.00	20.50	4.50	Silty Sand	100	64	1.88	0.00	32
			20.50	26.50	6.00	Sandy Silt	83	44	1.89	0.22	27
			26.50	30.00	3.50	Silty Clay	100	100	2.03	3.11	4
		BH-A2	0.00	4.00	4.00	Silty Sand	16	21	1.72	0.09	29
			4.00	7.00	3.00	Silty Clay	24	24	1.80	0.80	5
			7.00	10.00	3.00	Silty Clay	31	31	1.84	1.06	4
			10.00	13.00	3.00	Sandy Silt	40	30	1.84	0.17	29
			13.00	16.00	3.00	Sandy Silt	54	37	1.86	0.19	30
			16.00	19.00	3.00	Silty Sand	76	47	1.84	0.00	32
			19.00	23.50	4.50	Silty Sand	100	59	1.88	0.00	33
			23.50	28.50	5.00	Silty Clay	59	59	1.95	1.98	4
			28.50	30.00	1.50	Silty Clay	100	100	2.02	3.11	4
31+095	34+280	BH-CL	0.00	3.00	3.00	Silty Clay	10	10	1.69	0.37	5
			3.00	7.50	4.50	Silty Sand	21	23	1.81	0.10	30
			7.50	10.00	2.50	Silty Clay	29	29	1.87	1.09	6
31+714	34+899	BH-A1	0.00	7.00	7.00	Sandy Silt	14	15	1.70	0.20	28
			7.00	19.00	12.00	Sandy Silt	25	18	1.73	0.21	29
			19.00	25.00	6.00	Sandy Silt	70	39	1.88	0.19	30
			25.00	37.00	12.00	Sandy Silt	91	38	1.94	0.18	30
			37.00	40.00	3.00	Sandy Silt	85	27	1.92	0.20	27

Chainage Old (km)	Chainage New (km)	BH.No.	Layer depth below EGL (m)		Thickness of strata (m)	Strata description	SPT 'N'		Bulk Density (gm/cc)	Cohesion (C) (kg/cm2)	Angle of internal Friction (Φ) (°)
			From	To			Observed	Corrected			
31+714	34+899	BH-A2	0.00	5.50	5.50	Sandy Silt	12	16	1.71	0.22	28
			5.50	11.50	6.00	Sandy Silt	23	20	1.76	0.19	28
			11.50	17.50	6.00	Sandy Silt	55	36	1.84	0.18	29
			17.50	23.50	6.00	Sandy Silt	80	47	1.89	0.22	29
			23.50	40.00	16.50	Sandy Silt	84	30	1.93	0.20	30
32+191	35+371	BH-CL	0.00	4.00	4.00	Silty Sand	20	26	1.76	0.00	29
			4.00	7.00	3.00	Sandy Silt	33	33	1.80	0.22	26
			7.00	10.00	3.00	Sandy Silt	53	45	1.85	0.20	27
32+738	35+916	BH-CL	0.00	5.50	5.50	Sandy Silt	15	20	1.71	0.19	27
			5.50	7.00	1.50	Sandy Silt	-	-	1.76	0.21	28
			7.00	10.00	3.00	Silty Clay	33	33	1.86	1.16	5
33+713	36+984	BH-A1	0.00	5.50	5.50	Sandy Silt	24	32	1.80	0.21	28
			5.50	8.50	3.00	Silty Clay	82	82	1.93	2.54	4
			8.50	11.50	3.00	Sandy Silt	36	29	1.82	0.20	29
			11.50	14.50	3.00	Sandy Silt	87	61	1.90	0.21	29
			14.50	20.50	6.00	Sandy Silt	100	59	1.94	0.19	29
			20.50	30.00	9.50	Silty Clay	100	100	2.01	3.15	4
		BH-A2	0.00	7.00	7.00	Sandy Silt	24	27	1.77	0.20	28
			7.00	10.00	3.00	Silty Clay	98	98	1.94	3.04	4
			10.00	13.00	3.00	Silty Clay	58	58	1.91	1.89	5
			13.00	20.50	7.50	Sandy Silt	100	63	1.93	0.20	30
			20.50	30.00	9.50	Silty Clay	99	99	2.01	3.16	4
34+019	37+318	BH-CL	0.00	4.00	4.00	Silty Sand	11	17	1.72	0.11	30
			4.00	10.00	6.00	Silty Clay	34	34	1.86	1.14	5
34+619	37+804	BH-CL	0.00	4.00	4.00	Sandy Silt	10	16	1.71	0.23	27
			4.00	10.00	6.00	Silty Sand	33	34	1.86	0.20	30
35+273	38+457	BH-A1	0.00	7.00	7.00	Silty Sand	10	13	1.68	0.09	28
			7.00	11.50	4.50	Silty Clay	25	25	1.81	0.85	5
			11.50	14.50	3.00	Silty Clay	27	27	1.83	0.85	5
			14.50	17.50	3.00	Silty Clay	57	57	1.92	1.84	4
			17.50	20.50	3.00	Silty Clay	65	65	1.96	2.09	4
			20.50	30.00	9.50	Silty Clay	80	80	2.01	2.57	4
		BH-A2	0.00	4.00	4.00	Sandy Silt	10	13	1.70	0.21	27
			4.00	7.00	3.00	Sandy Silt	19	19	1.76	0.20	29
			7.00	10.00	3.00	Sandy Silt	23	20	1.77	0.20	29
			10.00	16.00	6.00	Silty Clay	48	48	1.91	1.65	5
			16.00	19.00	3.00	Silty Clay	53	53	1.92	1.65	5
			19.00	30.00	11.00	Silty Clay	86	86	2.02	2.72	4

Chainage Old (km)	Chainage New (km)	BH.No.	Layer depth below EGL (m)		Thickness of strata (m)	Strata description	SPT 'N'		Bulk Density (gm/cc)	Cohesion (C) (kg/cm2)	Angle of internal Friction (Φ) (°)
			From	To			Observed	Corrected			
36+367	39+553	BH-CL	0.00	4.50	4.50	Sandy Silt	15	22	1.76	0.21	28
			4.50	8.25	3.75	Silty Clay	25	25	1.81	0.85	5
			8.25	10.00	1.75	Silty Clay	24	24	1.82	0.85	5
36+816	40+003	BH-A1	0.00	5.50	5.50	Sandy Silt	8	11	1.66	0.21	27
			5.50	11.50	6.00	Silty Clay	41	41	1.85	1.35	4
			11.50	17.50	6.00	Silty Clay	34	34	1.86	1.16	4
			17.50	23.50	6.00	Sandy Silt	89	51	1.90	0.22	30
			23.50	26.50	3.00	Silty Clay	72	72	2.01	2.24	4
			26.50	30.00	3.50	Silty Clay	36	36	2.00	1.30	5
			0.00	4.00	4.00	Silty Sand	12	15	1.70	0.10	27
		BH-A2	4.00	7.00	3.00	Silty Sand	25	25	1.78	0.12	30
			7.00	10.00	3.00	Sandy Silt	44	38	1.84	0.23	29
			10.00	13.00	3.00	Silty Clay	51	51	1.89	1.68	5
			13.00	16.00	3.00	Silty Clay	56	56	1.91	1.68	5
			16.00	19.50	3.50	Sandy Silt	64	39	1.86	0.21	30
			19.50	23.50	4.00	Sandy Silt	100	56	1.91	0.20	30
			23.50	30.00	6.50	Silty Clay	58	58	2.01	1.88	4
37+174	40+358	BH-CL	0.00	6.00	6.00	Silty Sand	13	16	1.86	0.15	20
37+487	40+671	BH-CL	0.00	3.00	3.00	Sandy Silt	10	14	1.70	0.15	24
			3.00	6.00	3.00	Silty Sand	15	16	1.76	0.00	31
			6.00	10.00	4.00	Sandy Silt	29	27	1.94	0.17	21
38+127	41+312	BH-CL	0.00	3.00	3.00	Sandy Silt	8	12	1.81	0.10	24
			3.00	8.25	5.25	Silty Clay	20	20	1.92	0.98	5
			8.25	10.00	1.75	Silty Clay	-	-	1.92	0.91	6
38+482	41+667	BH-CL	0.00	6.00	6.00	Silty Clay	13	13	1.89	1.14	6
38+701	41+926	BH-CL	0.00	4.50	4.50	Silty Clay	10	10	1.69	0.36	5
			4.50	8.25	3.75	Silty Clay	28	28	1.84	0.95	4
			8.25	10.00	1.75	Silty Clay	42	42	1.91	1.38	5
38+778	41+963	BH-CL	0.00	3.00	3.00	Sandy Silt	7	11	1.67	0.20	27
			3.00	8.25	5.25	Silty Clay	26	26	1.80	0.75	5
			8.25	11.25	3.00	Silty Clay	43	43	1.89	1.35	4
			11.25	15.00	3.75	Silty Clay	51	51	1.94	1.78	4
39+060	42+239	BH-CL	0.00	3.00	3.00	Sandy Silt	7	11	1.67	0.20	27
			3.00	5.25	2.25	Silty Sand	22	25	1.79	0.11	29
			5.25	8.25	3.00	Silty Clay	36	36	1.86	1.22	4
			8.25	10.00	1.75	Silty Clay	45	45	1.90	1.48	5
39+400	42+579	BH-CL	0.00	4.50	4.50	Silty Sand	9	13	1.67	0.00	29
			4.50	8.25	3.75	Sandy Silt	34	34	1.84	0.19	29
			8.25	10.00	1.75	Sandy Silt	43	36	1.85	0.19	29

Chainage Old (km)	Chainage New (km)	BH.No.	Layer depth below EGL (m)		Thickness of strata (m)	Strata description	SPT 'N'		Bulk Density (gm/cc)	Cohesion (C) (kg/cm2)	Angle of internal Friction (Φ) (°)
			From	To			Observed	Corrected			
40+325	43+507	BH-CL	0.00	5.25	5.25	Sandy Silt	15	18	1.75	0.23	28
			5.25	8.25	3.00	Silty Clay	52	52	1.90	1.72	5
			8.25	11.25	3.00	Silty Clay	73	73	1.96	2.36	4
			11.25	15.00	3.75	Silty Clay	71	71	1.97	2.36	4
40+573	43+758	BH-CL	0.00	5.25	5.25	Sandy Silt	22	29	1.85	0.20	30
			5.25	8.25	3.00	Sandy Silt	41	39	1.85	0.20	30
			8.25	10.00	1.75	Sandy Silt	54	44	1.85	0.20	30
41+056	44+246	BH-A1	0.00	4.00	4.00	Sandy Silt	13	17	1.72	0.20	27
			4.00	7.00	3.00	Sandy Silt	20	20	1.74	0.18	28
			7.00	13.00	6.00	Sandy Silt	31	26	1.78	0.19	28
			13.00	16.00	3.00	Sandy Silt	38	26	1.79	0.17	28
			16.00	19.00	3.00	Sandy Silt	42	26	1.81	0.17	28
			19.00	22.00	3.00	Sandy Silt	56	32	1.83	0.20	28
			22.00	31.00	9.00	Sandy Silt	100	49	1.96	0.16	28
		BH-A2	0.00	4.00	4.00	Silty Sand	11	18	1.71	0.09	30
			4.00	7.00	3.00	Silty Sand	20	23	1.73	0.09	30
			7.00	13.00	6.00	Sandy Silt	41	36	1.81	0.21	29
			13.00	17.50	4.50	Sandy Silt	69	48	1.86	0.23	29
			17.50	40.00	22.50	Sandy Silt	99	57	1.96	0.17	29
41+100	44+282	BH-CL	0.00	3.00	3.00	Silty Clay	20	20	1.90	1.58	4
			3.00	8.25	5.25	Silty Clay	36	36	1.90	1.58	4
			8.25	10.00	1.75	Silty Clay	50	50	1.90	1.58	4
41+217	44+402	BH-CL	0.00	3.00	3.00	Silty Sand	20	32	1.79	0.00	30
			3.00	8.25	5.25	Silty Sand	20	32	1.79	0.00	30
			8.25	10.00	1.75	Silty Clay	45	45	1.91	1.47	5
41+235	44+421	BH-CL	0.00	3.00	3.00	Sandy Silt	8	13	1.70	0.20	27
			3.00	8.25	5.25	Silty Clay	30	30	1.82	0.85	5
			8.25	10.00	1.75	Silty Clay	44	44	1.90	1.38	4
41+390	44+571	BH-A1	0.00	7.00	7.00	Sandy Silt	49	55	1.85	0.19	29
			7.00	10.00	3.00	Sandy Silt	71	60	1.87	0.19	29
			10.00	13.00	3.00	Sandy Silt	64	48	1.86	0.19	29
			13.00	19.00	6.00	Sandy Silt	69	44	1.86	0.21	28
			19.00	35.00	16.00	Silty Clay	100	100	1.98	3.11	5
		BH-A2	0.00	7.00	7.00	Sandy Silt	49	55	1.85	0.19	29
			7.00	10.00	3.00	Sandy Silt	71	60	1.87	0.19	29
			10.00	13.00	3.00	Sandy Silt	64	48	1.86	0.19	29
			13.00	19.00	6.00	Sandy Silt	69	44	1.86	0.21	28
			19.00	35.00	16.00	Silty Clay	100	100	1.98	3.11	5

Chainage Old (km)	Chainage New (km)	BH.No.	Layer depth below EGL (m)		Thickness of strata (m)	Strata description	SPT 'N'		Bulk Density (gm/cc)	Cohesion (C) (kg/cm2)	Angle of internal Friction (Φ) (°)
			From	To			Observed	Corrected			
42+256	45+497	BH-A1	0.00	4.00	4.00	Sandy Silt	8	13	1.68	0.24	22
			4.00	8.50	4.50	Sandy Silt	18	18	1.72	0.20	24
			8.50	11.50	3.00	Sandy Silt	22	18	1.73	0.20	24
42+256	45+497	BH-A1	11.50	14.50	3.00	Sandy Silt	25	18	1.75	0.20	24
			14.50	17.50	3.00	Sandy Silt	33	22	1.76	0.21	25
			17.50	20.50	3.00	Sandy Silt	32	19	1.78	0.21	25
			20.50	26.50	6.00	Sandy Silt	54	29	1.83	0.22	26
			26.50	32.50	6.00	Silty Clay	89	89	1.96	2.63	4
			32.50	35.00	2.50	Sandy Silt	100	46	2.00	0.19	28
		BH-P2	0.00	5.50	5.50	Silty Sand	19	25	1.75	0.08	27
			5.50	8.50	3.00	Sandy Silt	31	29	1.77	0.18	25
			8.50	11.50	3.00	Sandy Silt	36	29	1.78	0.18	25
			11.50	17.50	6.00	Sandy Silt	35	24	1.77	0.18	25
			17.50	29.50	12.00	Sandy Silt	70	36	1.84	0.20	26
			29.50	32.50	3.00	Sandy Silt	79	36	1.87	0.16	27
			32.50	35.00	2.50	Sandy Silt	95	35	1.88	0.16	27
		BH-P3	0.00	4.00	4.00	Sandy Silt	4	5	1.61	0.23	21
			4.00	7.00	3.00	Sandy Silt	30	31	1.80	0.15	26
			7.00	10.00	3.00	Sandy Silt	29	25	1.79	0.15	26
			10.00	16.00	6.00	Sandy Silt	32	24	1.80	0.15	26
			16.00	19.00	3.00	Sandy Silt	54	34	1.85	0.21	26
			19.00	25.00	6.00	Sandy Silt	58	32	1.86	0.21	26
			25.00	31.00	6.00	Sandy Silt	72	34	1.87	0.17	27
			31.00	35.50	4.50	Sandy Silt	100	46	1.93	0.18	28
		BH-P4	0.00	4.00	4.00	Silty Sand	8	13	1.67	0.08	29
			4.00	8.50	4.50	Silty Sand	14	14	1.70	0.10	29
			8.50	11.50	3.00	Silty Sand	20	16	1.73	0.12	29
			11.50	14.50	3.00	Silty Sand	23	17	1.74	0.12	29
			14.50	17.50	3.00	Silty Sand	44	29	1.81	0.09	29
			17.50	20.50	3.00	Sandy Silt	61	37	1.87	0.18	29
			20.50	25.00	4.50	Sandy Silt	66	36	1.88	0.18	29
			25.00	34.00	9.00	Sandy Silt	73	34	1.98	0.17	29
		BH-P5	0.00	4.00	4.00	Sandy Silt	12	15	1.71	0.19	24
			4.00	7.00	3.00	Sandy Silt	18	18	1.73	0.19	24
			7.00	10.00	3.00	Sandy Silt	20	17	1.74	0.19	24
			10.00	13.00	3.00	Sandy Silt	26	20	1.76	0.19	24
			13.00	19.00	6.00	Sandy Silt	32	21	1.78	0.20	25
			19.00	25.00	6.00	Sandy Silt	46	25	1.82	0.18	26

Chainage Old (km)	Chainage New (km)	BH.No.	Layer depth below EGL (m)		Thickness of strata (m)	Strata description	SPT 'N'		Bulk Density (gm/cc)	Cohesion (C) (kg/cm2)	Angle of internal Friction (Φ) (°)
			From	To			Observed	Corrected			
42+256	45+497	BH-P5	25.00	28.00	3.00	Sandy Silt	55	27	1.83	0.18	26
			28.00	34.00	6.00	Sandy Silt	81	37	1.87	0.17	27
			34.00	40.00	6.00	Sandy Silt	95	44	1.90	0.18	28
		BH-P6	0.00	8.50	8.50	Sandy Silt	33	40	1.79	0.21	26
			8.50	14.50	6.00	Sandy Silt	39	30	1.80	0.21	26
			14.50	17.50	3.00	Sandy Silt	38	25	1.81	0.21	26
			17.50	23.50	6.00	Sandy Silt	66	38	1.83	0.18	27
			23.50	26.50	3.00	Sandy Silt	70	35	1.84	0.18	27
			26.50	29.50	3.00	Sandy Silt	72	33	1.86	0.18	27
			29.50	40.00	10.50	Sandy Silt	87	40	1.88	0.16	28
		BH-P13	0.00	5.50	5.50	Silty Sand	22	28	1.76	0.10	30
			5.50	10.00	4.50	Sandy Silt	55	52	1.82	0.19	29
			10.00	13.00	3.00	Silty Sand	94	71	1.89	0.11	30
			13.00	16.00	3.00	Silty Sand	87	59	1.88	0.11	31
			16.00	19.00	3.00	Silty Sand	43	26	1.81	0.08	31
			19.00	22.00	3.00	Silty Sand	61	34	1.85	0.08	31
			22.00	25.00	3.00	Silty Sand	78	40	1.86	0.08	31
			25.00	28.00	3.00	Silty Sand	66	31	1.85	0.08	31
			28.00	31.00	3.00	Silty Sand	78	36	1.86	0.08	31
			31.00	34.00	3.00	Sandy Silt	85	39	1.88	0.16	27
			34.00	37.00	3.00	Sandy Silt	100	46	1.97	0.23	27
			37.00	40.00	3.00	Sandy Silt	100	46	1.99	0.23	27
		BH-P14	0.00	3.00	3.00	Sandy Silt	19	30	1.80	0.15	26
			3.00	8.50	5.50	Sandy Silt	39	41	1.84	0.17	27
			8.50	11.50	3.00	Sandy Silt	55	44	1.85	0.17	27
			11.50	14.50	3.00	Sandy Silt	61	43	1.87	0.17	27
			14.50	20.50	6.00	Sandy Silt	72	44	1.87	0.19	27
			20.50	26.50	6.00	Sandy Silt	84	43	1.89	0.19	27
			26.50	29.50	3.00	Silty Clay	54	54	1.92	1.76	5
			29.50	32.50	3.00	Silty Clay	54	54	1.93	1.76	5
			32.50	40.00	7.50	Silty Clay	100	46	1.99	3.13	4
		BH-P15	0.00	5.50	5.50	Silty Sand	19	24	1.75	0.09	29
			5.50	8.50	3.00	Silty Clay	40	40	1.83	1.40	3
			8.50	13.00	4.50	Sandy Silt	73	60	1.83	0.20	30
			13.00	16.00	3.00	Sandy Silt	84	57	1.86	0.23	30
			16.00	20.50	4.50	Sandy Silt	88	53	1.87	0.23	30
			20.50	25.00	4.50	Silty Clay	78	78	1.93	2.49	5
			25.00	28.00	3.00	Silty Clay	83	83	1.94	2.49	5
			28.00	40.00	12.00	Silty Clay	94	94	1.97	3.11	5

Chainage Old (km)	Chainage New (km)	BH.No.	Layer depth below EGL (m)		Thickness of strata (m)	Strata description	SPT 'N'		Bulk Density (gm/cc)	Cohesion (C) (kg/cm2)	Angle of internal Friction (Φ) (°)
			From	To			Observed	Corrected			
42+256	45+497	BH-P16	0.00	5.50	5.50	Silty Sand	22	28	1.76	0.10	27
			5.50	8.50	3.00	Silty Sand	38	35	1.80	0.08	28
			8.50	14.50	6.00	Silty Sand	50	38	1.81	0.08	28
			14.50	23.50	9.00	Silty Sand	59	35	1.83	0.08	28
			23.50	26.50	3.00	Silty Sand	77	38	1.82	0.08	28
			26.50	35.50	9.00	Silty Clay	67	67	1.89	2.04	5
			35.50	40.00	4.50	Silty Clay	96	96	1.95	2.80	4
		BH-A2	0.00	4.00	4.00	Sandy Silt	20	26	1.76	0.21	29
			4.00	7.00	3.00	Sandy Silt	34	34	1.80	0.18	30
			7.00	10.00	3.00	Sandy Silt	51	44	1.82	0.19	30
			10.00	16.00	6.00	Sandy Silt	51	37	1.83	0.19	30
			16.00	19.00	3.00	Sandy Silt	65	40	1.84	0.19	30
			19.00	31.00	12.00	Sandy Silt	63	32	1.84	0.16	30
			31.00	40.00	9.00	Sandy Silt	80	37	1.88	0.20	30
43+100	46+280	BH-PLT-02	0.00	2.25	2.25	Silty Sand	8	12	1.67	0.09	29
			2.25	4.50	2.25	Silty Sand	26	31	1.80	0.11	32
			4.50	7.50	3.00	Sandy Silt	28	29	1.83	0.18	29
			7.50	12.00	4.50	Sandy Silt	33	28	1.90	1.30	5
43+452	46+636	BH-CL	0.00	5.25	5.25	Sandy Silt	9	12	1.70	0.08	29
			5.25	11.25	6.00	Sandy Silt	63	55	1.89	0.21	30
			11.25	15.00	3.75	Sandy Silt	68	49	1.94	0.19	30
43+585	46+769	BH-CL	0.00	5.25	5.25	Sandy Silt	10	13	1.70	0.20	27
			5.25	8.25	3.00	Silty Clay	39	39	1.88	1.29	4
			8.25	11.25	3.00	Sandy Silt	54	44	1.91	0.18	29
			11.25	15.00	3.75	Sandy Silt	51	36	1.92	0.18	29
43+732	46+916	BH-CL	0.00	4.50	4.50	Sandy Silt	9	13	1.69	0.18	24
			4.50	8.25	3.75	Silty Clay	26	26	1.81	0.75	5
			8.25	11.25	3.00	Silty Clay	30	30	1.87	1.05	4
			11.25	15.00	3.75	Sandy Silt	43	32	1.89	0.19	28
44+050	47+234	BH-CL	0.00	5.25	5.25	Sandy Silt	10	13	1.69	0.21	27
			5.25	8.25	3.00	Silty Clay	30	30	1.86	1.02	5
			8.25	10.50	2.25	Silty Clay	35	35	1.89	1.19	4
			10.50	15.00	4.50	Sandy Silt	53	42	1.92	0.19	29
44+116	47+301	BH-CL	0.00	3.00	3.00	Sandy Silt	9	14	1.69	0.22	27
			3.00	8.25	5.25	Silty Clay	24	24	1.85	0.82	5
			8.25	11.25	3.00	Sandy Silt	53	44	1.92	0.22	28
			11.25	15.00	3.75	Sandy Silt	62	45	1.94	0.24	28
44+317	47+501	BH-CL	0.00	3.00	3.00	Silty Sand	7	11	1.64	0.00	30
			3.00	6.00	3.00	Sandy Silt	23	27	1.82	0.18	30
			6.00	10.00	4.00	Silty Clay	27	27	1.89	1.16	5

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			From	To			Observed	Corrected			
44+641	47+825	BH-CL	0.00	4.50	4.50	Sandy Silt	10	14	1.69	0.23	28
			4.50	10.00	5.50	Silty Clay	22	22	-	-	-
44+910	48+094	BH-CL	0.00	5.25	5.25	Silty Sand	10	13	1.69	0.11	30
			5.25	8.25	3.00	Silty Clay	23	23	1.82	0.75	4
			8.25	10.00	1.75	Sandy Silt	44	36	1.89	0.20	30
45+048	48+232	BH-CL	0.00	2.25	2.25	Sandy Silt	6	10	1.66	0.21	27
			2.25	4.50	2.25	Sandy Silt	12	15	1.71	0.20	24
			4.50	8.25	3.75	Silty Clay	27	27	1.83	0.86	6
			8.25	10.00	1.75	Silty Clay	32	32	1.86	1.04	6
45+411	48+595	BH-CL	0.00	3.00	3.00	Silty Sand	8	13	1.66	0.00	30
			3.00	7.50	4.50	Sandy Silt	22	24	1.81	0.20	28
			7.50	10.00	2.50	Silty Clay	28	28	1.88	1.06	4
45+480	48+664	BH-A1	0.00	4.00	4.00	Silty Sand	15	19	1.73	0.09	29
			4.00	7.00	3.00	Silty Sand	22	22	1.75	0.09	29
			7.00	10.00	3.00	Silty Sand	32	28	1.77	0.07	30
			10.00	13.00	3.00	Sandy Silt	47	36	1.84	0.19	30
			13.00	16.00	3.00	Sandy Silt	53	36	1.86	0.19	29
			16.00	19.00	3.00	Sandy Silt	62	28	1.89	0.20	29
			19.00	22.00	3.00	Sandy Silt	77	31	1.90	0.20	29
			22.00	30.00	7.50	Sandy Silt	100	36	1.98	0.16	30
		BH-A2	0.00	5.50	5.50	Silty Sand	19	25	1.76	0.09	29
			5.50	8.50	3.00	Silty Sand	27	25	1.77	0.09	30
			8.50	11.50	3.00	Sandy Silt	45	36	1.82	0.21	28
			11.50	14.50	3.00	Sandy Silt	43	31	1.83	0.21	28
			14.50	17.50	3.00	Sandy Silt	66	29	1.86	0.21	28
			17.50	20.50	3.00	Sandy Silt	77	32	1.90	0.18	29
			20.50	23.50	3.00	Sandy Silt	90	35	1.91	0.18	29
			23.50	30.00	6.00	Sandy Silt	100	35	1.96	0.15	29
45+612	48+795	BH-CL	0.00	3.00	3.00	Sandy Silt	7	11	1.67	0.19	27
			3.00	8.25	5.25	Silty Clay	24	24	1.82	0.82	5
			8.25	10.00	1.75	Sandy Silt	38	31	1.86	0.21	29
45+984	49+168	BH-CL	0.00	3.00	3.00	Silty Sand	6	9	1.63	0.00	30
			3.00	15.00	12.00	Sandy Silt	41	35	1.84	0.20	30
46+400	49+584	BH-CL	0.00	3.00	3.00	Silty Sand	14	22	1.73	0.00	31
			3.00	15.00	12.00	Sandy Silt	38	36	1.85	0.21	29

Design parameter have been obtain from the laboratory test results however various depth where the shear parameter seems on the lower side with respect to SPT 'N' values those shear parameter have been judicially improved based on the SPT 'N' for the analysis purpose.

The sample calculation for computation of safe load carrying capacity of normal bored cast-in-situ RCC pile in compression & uplift are attached vide **Appendix C-2.**

The sample calculation for computation of safe load carrying capacity of normal bored cast-in-situ RCC pile in lateral are attached vide **Appendix C-3.**

CHAPTER 4 FOUNDATION RECOMMENDATIONS

8.0 FOUNDATION RECOMMENDATIONS

- Based on the nature & strength characteristics of the substrata and requirement of the project, shallow foundation and normal bored cast in-situ RCC pile foundation have been analyzed.
- Based on the method of analysis & design parameters given under Para 7.1 above, the recommended net allowable bearing capacity values are given in Table 4.1 to 4.4.

Table 4.1: Recommended Net Allowable Bearing Capacity for shallow foundation for allowable settlement 25mm

Chainage Old (km)	Chainage New (km)	BH. No.	Foundation Size (m x m)	Depth of foundation below EGL (m)	Net Safe Bearing Capacity from Shear Failure (t/m^2)	Net Allowable Bearing Pressure from settlement failure (t/m^2)	Recommended Net Allowable Bearing Capacity (t/m^2)
29+000	-	BH-PLT-06	2.0 x 2.0	1.0	20.6	41.4	20.6
			2.0 x 2.0	1.5	24.5	45.2	24.5
			2.0 x 2.0	2.0	28.7	47.7	28.7
			2.0 x 2.0	2.5	33.0	51.3	33.0
			3.0 X 3.0	1.0	21.6	34.0	21.6
			3.0 X 3.0	1.5	25.0	36.3	25.0
			3.0 X 3.0	2.0	28.6	38.5	28.6
			3.0 X 3.0	2.5	31.9	40.6	31.9
29+000	-	PLT-06	2.0 x 2.0	2.5	78.5	120.9	78.5
29+487	30+155	BH-A1	7.2 X 7.2	2.0	46.1	27.1	27.1
			7.2 X 7.2	3.0	54.2	32.6	32.6
			7.2 X 7.2	4.0	62.5	40.0	40.0
		BH-A2	7.2 X 7.2	2.0	32.0	28.2	28.2
			7.2 X 7.2	3.0	38.6	37.1	37.1
			7.2 X 7.2	4.0	45.4	50.9	45.4
29+860	30+528	BH-CL	7.2 X 7.2	2.0	33.8	14.1	14.1
			7.2 X 7.2	3.0	39.8	15.2	15.2
			7.2 X 7.2	4.0	46.1	16.0	16.0
30+176	30+829	BH-CL	12 X 12	1.0	36.4	6.9	6.9
			12 X 12	1.5	39.0	6.9	6.9
			12 X 12	2.0	41.7	7.0	7.0
30+478	31+145	BH-CL	7.2 X 7.2	1.0	17.7	9.9	9.9
			7.2 X 7.2	1.5	18.1	12.0	12.0
			7.2 X 7.2	2.0	18.5	14.9	14.9
30+697	31+365	BH-CL	7.2 X 7.2	2.0	31.9	22.1	22.1
			7.2 X 7.2	3.0	39.6	23.3	23.3
			7.2 X 7.2	4.0	47.7	24.6	24.6

Chainage Old (km)	Chainage New (km)	BH. No.	Foundation Size (m x m)	Depth of foundation below EGL (m)	Net Safe Bearing Capacity from Shear Failure (t/m^2)	Net Allowable Bearing Pressure from settlement failure (t/m^2)	Recommended Net Allowable Bearing Capacity (t/m^2)
31+354	32+022	BH-CL	7.2 X 7.2	1.0	12.3	7.1	7.1
			7.2 X 7.2	1.5	12.5	7.2	7.2
			7.2 X 7.2	2.0	12.8	7.4	7.4
32+160	32+767	BH-CL	7.2 X 7.2	1.0	17.8	6.5	6.5
			7.2 X 7.2	1.5	18.2	6.7	6.7
			7.2 X 7.2	2.0	18.5	6.8	6.8
32+487	33+155	BH-CL	7.2 X 7.2	1.0	47.6	25.6	25.6
			7.2 X 7.2	1.5	52.1	26.9	26.9
			7.2 X 7.2	2.0	56.7	28.3	28.3
30+083	33+269	BH-CL	2.5 X 2.5	1.0	30.0	27.0	27.0
			2.5 X 2.5	1.5	35.1	29.2	29.2
			2.5 X 2.5	2.0	40.5	31.9	31.9
30+488	33+673	BH-A1	7.2 X 7.2	2.0	29.9	14.8	14.8
			7.2 X 7.2	3.0	36.1	17.7	17.7
			7.2 X 7.2	4.0	42.5	21.7	21.7
		BH-A2	7.2 X 7.2	2.0	37.7	17.6	17.6
			7.2 X 7.2	3.0	45.5	18.9	18.9
			7.2 X 7.2	4.0	53.5	19.7	19.7
31+095	34+280	BH-CL	4.8 X 4.8	1.0	13.0	8.9	8.9
			4.8 X 4.8	1.5	14.4	11.7	11.7
			4.8 X 4.8	2.0	15.8	14.0	14.0
31+714	34+899	BH-A1	7.2 X 7.2	2.0	32.5	14.1	14.1
			7.2 X 7.2	3.0	38.4	14.9	14.9
			7.2 X 7.2	4.0	44.4	15.7	15.7
		BH-A2	7.2 X 7.2	2.0	38.4	15.1	15.1
			7.2 X 7.2	3.0	45.1	16.3	16.3
			7.2 X 7.2	4.0	52.2	17.9	17.9
32+191	35+371	BH-CL	4.8 X 4.8	1.0	24.7	31.9	24.7
			4.8 X 4.8	1.5	29.5	33.1	29.5
			4.8 X 4.8	2.0	34.4	34.5	34.4
32+738	35+916	BH-CL	4.8 X 4.8	1.0	21.5	16.1	16.1
			4.8 X 4.8	1.5	24.2	16.8	16.8
			4.8 X 4.8	2.0	27.0	17.6	17.6
33+713	36+984	BH-A1	7.2 X 7.2	2.0	84.9	36.8	36.8
			7.2 X 7.2	3.0	89.0	42.3	42.3
			7.2 X 7.2	4.0	93.2	48.6	48.6
		BH-A2	7.2 X 7.2	2.0	91.5	27.1	27.1
			7.2 X 7.2	3.0	94.7	30.4	30.4
			7.2 X 7.2	4.0	98.0	34.7	34.7

Chainage Old (km)	Chainage New (km)	BH. No.	Foundation Size (m x m)	Depth of foundation below EGL (m)	Net Safe Bearing Capacity from Shear Failure (t/m^2)	Net Allowable Bearing Pressure from settlement failure (t/m^2)	Recommended Net Allowable Bearing Capacity (t/m^2)
34+019	37+318	BH-CL	2.5 X 2.5	1.0	24.1	44.3	24.1
			2.5 X 2.5	1.5	29.2	47.9	29.2
			2.5 X 2.5	2.0	34.5	50.1	34.5
34+619	37+804	BH-CL	4.8 X 4.8	1.0	22.0	17.0	17.0
			4.8 X 4.8	1.5	24.5	19.1	19.1
			4.8 X 4.8	2.0	27.2	21.7	21.7
35+273	38+457	BH-A1	7.2 X 7.2	2.0	23.9	13.1	13.1
			7.2 X 7.2	3.0	29.0	14.0	14.0
			7.2 X 7.2	4.0	34.2	15.1	15.1
		BH-A2	7.2 X 7.2	2.0	28.3	14.0	14.0
			7.2 X 7.2	3.0	33.3	15.1	15.1
			7.2 X 7.2	4.0	38.4	16.6	16.6
36+367	39+553	BH-CL	4.8 X 4.8	1.0	32.4	18.0	18.0
			4.8 X 4.8	1.5	36.4	19.0	19.0
			4.8 X 4.8	2.0	40.4	20.1	20.1
36+816	40+003	BH-A1	4.8 X 4.8	2.0	25.7	9.8	9.8
			4.8 X 4.8	3.0	31.0	12.6	12.6
			4.8 X 4.8	4.0	36.5	17.6	17.6
		BH-A2	4.8 X 4.8	2.0	21.2	25.8	21.2
			4.8 X 4.8	3.0	26.5	27.7	26.5
			4.8 X 4.8	4.0	32.1	29.2	29.2
37+174	40+358	BH-CL	2.2 X 2.2	1.0	14.3	14.9	14.3
			2.2 X 2.2	1.5	18.8	16.2	16.2
			2.2 X 2.2	2.0	23.7	17.3	17.3
37+487	40+671	BH-CL	4.8 X 4.8	1.0	15.3	16.5	15.3
			4.8 X 4.8	1.5	17.3	17.2	17.2
			4.8 X 4.8	2.0	19.3	17.1	17.1
38+127	41+312	BH-CL	4.8 X 4.8	1.0	17.2	8.5	8.5
			4.8 X 4.8	1.5	19.7	8.9	8.9
			4.8 X 4.8	2.0	22.3	9.3	9.3
38+482	41+667	BH-CL	2.2 X 2.2	1.0	13.9	16.6	13.9
			2.2 X 2.2	1.5	14.7	18.0	14.7
			2.2 X 2.2	2.0	15.5	19.3	15.5
38+701	41+926	BH-CL	2.7 X 2.7	1.0	24.4	16.7	16.7
			2.7 X 2.7	1.5	25.4	18.0	18.0
			2.7 X 2.7	2.0	26.4	19.2	19.2
38+778	41+963	BH-CL	11.35 X 11.35	1.0	29.6	9.2	9.2
			11.35 X 11.35	1.5	31.9	9.4	9.4
			11.35 X 11.35	2.0	34.2	9.7	9.7

Chainage Old (km)	Chainage New (km)	BH. No.	Foundation Size (m x m)	Depth of foundation below EGL (m)	Net Safe Bearing Capacity from Shear Failure (t/m^2)	Net Allowable Bearing Pressure from settlement failure (t/m^2)	Recommended Net Allowable Bearing Capacity (t/m^2)
39+060	42+239	BH-CL	2.7 X 2.7	1.0	18.2	11.0	11.0
			2.7 X 2.7	1.5	21.1	13.8	13.8
			2.7 X 2.7	2.0	24.0	18.0	18.0
39+149	-	BH-PLT-03	2.0 x 2.0	1.0	10.9	19.6	10.9
			2.0 x 2.0	1.5	13.4	21.4	13.4
			2.0 x 2.0	2.0	16.0	22.6	16.0
			2.0 x 2.0	2.5	18.8	24.3	18.8
			3.0 X 3.0	1.0	17.2	11.7	17.2
			3.0 X 3.0	1.5	18.4	13.9	18.4
			3.0 X 3.0	2.0	19.5	16.3	19.5
			3.0 X 3.0	2.5	20.5	18.7	20.5
39+149	-	PLT-03	2.0 x 2.0	2.5	26.3	31.4	26.3
39+400	42+579	BH-CL	7.3 X 7.3	1.0	16.5	14.0	14.0
			7.3 X 7.3	1.5	19.1	15.5	15.5
			7.3 X 7.3	2.0	21.8	17.3	17.3
40+325	43+507	BH-CL	11.35 X 11.35	1.0	39.7	17.4	17.4
			11.35 X 11.35	1.5	42.6	18.1	18.1
			11.35 X 11.35	2.0	45.6	18.8	18.8
40+573	43+758	BH-CL	4.8 X 4.8	1.0	43.8	28.5	28.5
			4.8 X 4.8	1.5	49.2	31.0	31.0
			4.8 X 4.8	2.0	54.7	34.1	34.1
41+056	44+246	BH-A1	7.2 X 7.2	2.0	37.2	23.4	23.4
			7.2 X 7.2	3.0	43.9	24.7	24.7
			7.2 X 7.2	4.0	50.9	26.1	26.1
		BH-A2	7.2 X 7.2	2.0	48.3	35.9	35.9
			7.2 X 7.2	3.0	57.6	37.9	37.9
			7.2 X 7.2	4.0	67.4	40.0	40.0
41+100	44+282	BH-CL	4.9 X 4.9	1.0	42.6	29.6	29.6
			4.9 X 4.9	1.5	48.8	31.6	31.6
			4.9 X 4.9	2.0	55.1	33.9	33.9
41+217	44+402	BH-CL	4.9 X 4.9	1.0	46.0	29.5	29.5
			4.9 X 4.9	1.5	54.3	31.0	31.0
			4.9 X 4.9	2.0	62.9	32.7	32.7
41+235	44+421	BH-CL	4.9 X 4.9	1.0	20.5	13.9	13.9
			4.9 X 4.9	1.5	23.0	16.3	16.3
			4.9 X 4.9	2.0	25.5	19.7	19.7
41+390	44+571	BH-A1	7.2 X 7.2	2.0	62.0	49.0	49.0
			7.2 X 7.2	3.0	72.8	51.6	51.6
			7.2 X 7.2	4.0	83.9	54.5	54.5

Chainage Old (km)	Chainage New (km)	BH. No.	Foundation Size (m x m)	Depth of foundation below EGL (m)	Net Safe Bearing Capacity from Shear Failure (t/m^2)	Net Allowable Bearing Pressure from settlement failure (t/m^2)	Recommended Net Allowable Bearing Capacity (t/m^2)
41+390	44+571	BH-A2	7.2 X 7.2	2.0	28.9	24.5	24.5
			7.2 X 7.2	3.0	33.9	28.7	28.7
			7.2 X 7.2	4.0	39.1	34.6	34.6
42+256	45+497	BH-A1	7.2 X 7.2	2.0	20.4	16.8	16.8
			7.2 X 7.2	3.0	23.6	17.7	17.7
			7.2 X 7.2	4.0	26.9	18.7	18.7
		BH-P2	7.2 X 7.2	2.0	52.0	28.1	28.1
			7.2 X 7.2	3.0	62.6	29.6	29.6
			7.2 X 7.2	4.0	73.6	31.2	31.2
		BH-P3	7.2 X 7.2	2.0	32.9	4.6	4.6
			7.2 X 7.2	3.0	39.2	8.0	8.0
			7.2 X 7.2	4.0	45.8	30.0	30.0
		BH-P4	7.2 X 7.2	2.0	25.5	12.2	12.2
			7.2 X 7.2	3.0	31.0	12.9	12.9
			7.2 X 7.2	4.0	36.7	13.6	13.6
		BH-P5	7.2 X 7.2	2.0	37.9	15.0	15.0
			7.2 X 7.2	3.0	44.7	15.9	15.9
			7.2 X 7.2	4.0	51.8	17.0	17.0
		BH-P6	7.2 X 7.2	2.0	64.4	30.6	30.6
			7.2 X 7.2	3.0	75.4	32.3	32.3
			7.2 X 7.2	4.0	86.8	34.1	34.1
		BH-P13	7.2 X 7.2	2.0	56.2	37.4	37.4
			7.2 X 7.2	3.0	67.3	44.5	44.5
			7.2 X 7.2	4.0	78.9	53.2	53.2
		BH-P14	7.2 X 7.2	2.0	63.2	41.0	41.0
			7.2 X 7.2	3.0	74.9	43.7	43.7
			7.2 X 7.2	4.0	87.1	46.1	46.1
		BH-P15	7.2 X 7.2	2.0	49.4	32.9	32.9
			7.2 X 7.2	3.0	59.4	39.7	39.7
			7.2 X 7.2	4.0	69.8	48.6	48.6
		BH-P16	7.2 X 7.2	2.0	54.1	31.7	31.7
			7.2 X 7.2	3.0	64.8	33.4	33.4
			7.2 X 7.2	4.0	76.0	35.3	35.3
		BH-A2	7.2 X 7.2	2.0	70.4	19.4	19.4
			7.2 X 7.2	3.0	82.9	20.4	20.4
			7.2 X 7.2	4.0	95.9	21.6	21.6
43+100	46+280	PLT-02	2.0 X 2.0	2.5	44.3	76.6	44.3
43+100	46+280	BH-PLT-02	2.0 X 2.0	1.0	13.7	15.5	13.7
				1.5	17.0	21.8	17.0
				2.0	20.5	34.4	20.5
				2.5	24.1	48.5	24.1

Chainage Old (km)	Chainage New (km)	BH. No.	Foundation Size (m x m)	Depth of foundation below EGL (m)	Net Safe Bearing Capacity from Shear Failure (t/m^2)	Net Allowable Bearing Pressure from settlement failure (t/m^2)	Recommended Net Allowable Bearing Capacity (t/m^2)
43+100	46+280	BH-PLT-02	3.0 X 3.0	1.0	14.9	15.9	14.9
				1.5	17.8	21.8	17.8
				2.0	20.9	32.1	20.9
				2.5	24.2	82.8	24.2
43+452	46+636	BH-CL	7.3 X 7.3	1.0	18.9	12.0	12.0
			7.3 X 7.3	1.5	21.3	13.2	13.2
			7.3 X 7.3	2.0	23.8	14.8	14.8
43+585	46+769	BH-CL	7.3 X 7.3	1.0	23.2	11.8	11.8
			7.3 X 7.3	1.5	25.5	12.7	12.7
			7.3 X 7.3	2.0	27.9	14.0	14.0
43+732	46+916	BH-CL	6.2 X 6.2	1.0	20.9	10.5	10.5
			6.2 X 6.2	1.5	23.3	11.3	11.3
			6.2 X 6.2	2.0	25.7	12.3	12.3
44+050	47+234	BH-CL	6.2 X 6.2	1.0	22.4	11.0	11.0
			6.2 X 6.2	1.5	24.8	11.9	11.9
			6.2 X 6.2	2.0	27.2	13.1	13.1
44+116	47+301	BH-CL	11.5 X 11.5	1.0	29.1	11.0	11.0
			11.5 X 11.5	1.5	31.4	11.2	11.2
			11.5 X 11.5	2.0	33.6	11.4	11.4
44+317	47+501	BH-CL	4.9 X 4.9	1.0	26.7	12.4	12.4
			4.9 X 4.9	1.5	30.0	14.6	14.6
			4.9 X 4.9	2.0	33.3	17.7	17.7
44+641	47+825	BH-CL	4.8 X 4.8	1.0	21.9	11.2	11.2
			4.8 X 4.8	1.5	24.4	12.3	12.3
			4.8 X 4.8	2.0	27.1	13.7	13.7
44+910	48+094	BH-CL	4.8 X 4.8	1.0	17.1	9.5	9.5
			4.8 X 4.8	1.5	19.6	10.4	10.4
			4.8 X 4.8	2.0	22.3	11.5	11.5
45+048	48+232	BH-CL	4.9 X 4.9	1.0	16.6	8.8	8.8
			4.9 X 4.9	1.5	18.5	9.8	9.8
			4.9 X 4.9	2.0	20.5	11.1	11.1
45+411	48+595	BH-CL	2.2 X 2.2	1.0	14.3	13.3	13.3
			2.2 X 2.2	1.5	17.3	16.3	16.3
			2.2 X 2.2	2.0	20.4	20.6	20.4
45+480	48+664	BH-A1	7.2 X 7.2	2.0	41.2	26.4	26.4
			7.2 X 7.2	3.0	49.6	27.8	27.8
			7.2 X 7.2	4.0	58.3	29.4	29.4
		BH-A2	7.2 X 7.2	2.0	53.4	26.9	26.9
			7.2 X 7.2	3.0	64.1	28.4	28.4
			7.2 X 7.2	4.0	75.3	30.0	30.0

Chainage Old (km)	Chainage New (km)	BH. No.	Foundation Size (m x m)	Depth of foundation below EGL (m)	Net Safe Bearing Capacity from Shear Failure (t/m^2)	Net Allowable Bearing Pressure from settlement failure (t/m^2)	Recommended Net Allowable Bearing Capacity (t/m^2)
45+612	48+795	BH-CL	4.9 X 4.9	1.0	19.8	10.8	10.8
			4.9 X 4.9	1.5	22.2	12.6	12.6
			4.9 X 4.9	2.0	24.7	15.0	15.0
45+984	49+168	BH-CL	11.5 x 11.5	1.0	22.6	25.4	22.6
			11.5 x 11.5	1.5	24.7	25.7	24.7
			11.5 x 11.5	2.0	26.8	26.0	26.0
46+400	49+584	BH-CL	1.6 x 1.6	1.0	12.6	25.6	12.6
			1.6 x 1.6	1.5	17.3	30.5	17.3
			1.6 x 1.6	2.0	22.4	38.7	22.4

* The maximum value of recommended net allowable bearing capacity shall be restricted to 30 t/m^2.

Table 4.2: Recommended Net Allowable Bearing Capacity for shallow foundation for allowable settlement 50mm

Chainage Old (km)	Chainage New (km)	BH. No.	Foundation Size (m x m)	Depth of foundation below EGL (m)	Net Safe Bearing Capacity from Shear Failure (t/m^2)	Net Allowable Bearing Pressure from settlement failure (t/m^2)	Recommended Net Allowable Bearing Capacity (t/m^2)
29+000	-	BH-PLT-06	2.0 x 2.0	1.0	20.6	82.9	20.6
			2.0 x 2.0	1.5	24.5	90.3	24.5
			2.0 x 2.0	2.0	28.7	95.4	28.7
			2.0 x 2.0	2.5	33.0	102.6	33.0
			3.0 X 3.0	1.0	21.6	67.9	21.6
			3.0 X 3.0	1.5	25.0	72.6	25.0
			3.0 X 3.0	2.0	28.6	77.1	28.6
			3.0 X 3.0	2.5	31.9	81.2	31.9
29+487	30+155	BH-A1	7.2 X 7.2	2.0	46.1	54.2	46.1
			7.2 X 7.2	3.0	54.2	65.2	54.2
			7.2 X 7.2	4.0	62.5	80.0	62.5
		BH-A2	7.2 X 7.2	2.0	32.0	56.4	32.0
			7.2 X 7.2	3.0	38.6	74.2	38.6
			7.2 X 7.2	4.0	45.4	101.7	45.4
29+860	30+528	BH-CL	7.2 X 7.2	2.0	33.8	28.3	28.3
			7.2 X 7.2	3.0	39.8	30.4	30.4
			7.2 X 7.2	4.0	46.1	31.9	31.9

Chainage Old (km)	Chainage New (km)	BH. No.	Foundation Size (m x m)	Depth of foundation below EGL (m)	Net Safe Bearing Capacity from Shear Failure (t/m^2)	Net Allowable Bearing Pressure from settlement failure (t/m^2)	Recommended Net Allowable Bearing Capacity (t/m^2)
30+176	30+829	BH-CL	12 X 12	1.0	36.4	13.7	13.7
			12 X 12	1.5	39.0	13.9	13.9
			12 X 12	2.0	41.7	14.0	14.0
30+478	31+145	BH-CL	7.2 X 7.2	1.0	17.7	19.8	17.7
			7.2 X 7.2	1.5	18.1	23.9	18.1
			7.2 X 7.2	2.0	18.5	29.8	18.5
30+697	31+365	BH-CL	7.2 X 7.2	2.0	31.9	44.2	31.9
			7.2 X 7.2	3.0	39.6	46.6	39.6
			7.2 X 7.2	4.0	47.7	49.2	47.7
31+354	32+022	BH-CL	7.2 X 7.2	1.0	12.3	14.2	12.3
			7.2 X 7.2	1.5	12.5	14.5	12.5
			7.2 X 7.2	2.0	12.8	14.9	12.8
32+160	32+767	BH-CL	7.2 X 7.2	1.0	17.8	13.1	13.1
			7.2 X 7.2	1.5	18.2	13.3	13.3
			7.2 X 7.2	2.0	18.5	13.7	13.7
32+487	33+155	BH-CL	7.2 X 7.2	1.0	47.6	51.2	47.6
			7.2 X 7.2	1.5	52.1	53.7	52.1
			7.2 X 7.2	2.0	56.7	56.6	56.6
30+083	33+269	BH-CL	2.5 X 2.5	1.0	30.0	54.0	30.0
			2.5 X 2.5	1.5	35.1	58.4	35.1
			2.5 X 2.5	2.0	40.5	63.8	40.5
30+488	33+673	BH-A1	7.2 X 7.2	2.0	29.9	29.7	29.7
			7.2 X 7.2	3.0	36.1	35.4	35.4
			7.2 X 7.2	4.0	42.5	43.4	42.5
		BH-A2	7.2 X 7.2	2.0	37.7	35.1	35.1
			7.2 X 7.2	3.0	45.5	37.7	37.7
			7.2 X 7.2	4.0	53.5	39.5	39.5
31+095	34+280	BH-CL	4.8 X 4.8	1.0	13.0	17.9	13.0
			4.8 X 4.8	1.5	14.4	23.4	14.4
			4.8 X 4.8	2.0	15.8	28.1	15.8
31+714	34+899	BH-A1	7.2 X 7.2	2.0	32.5	28.2	28.2
			7.2 X 7.2	3.0	38.4	29.7	29.7
			7.2 X 7.2	4.0	44.4	31.4	31.4
		BH-A2	7.2 X 7.2	2.0	38.4	30.3	30.3
			7.2 X 7.2	3.0	45.1	32.6	32.6
			7.2 X 7.2	4.0	52.2	35.7	35.7
32+191	35+371	BH-CL	4.8 X 4.8	1.0	24.7	63.8	24.7
			4.8 X 4.8	1.5	29.5	66.2	29.5
			4.8 X 4.8	2.0	34.4	68.9	34.4

Chainage Old (km)	Chainage New (km)	BH. No.	Foundation Size (m x m)	Depth of foundation below EGL (m)	Net Safe Bearing Capacity from Shear Failure (t/m^2)	Net Allowable Bearing Pressure from settlement failure (t/m^2)	Recommended Net Allowable Bearing Capacity (t/m^2)
32+738	35+916	BH-CL	4.8 X 4.8	1.0	21.5	32.2	21.5
			4.8 X 4.8	1.5	24.2	33.5	24.2
			4.8 X 4.8	2.0	27.0	35.2	27.0
33+713	36+984	BH-A1	7.2 X 7.2	2.0	84.9	73.5	73.5
			7.2 X 7.2	3.0	89.0	84.5	84.5
			7.2 X 7.2	4.0	93.2	97.2	93.2
		BH-A2	7.2 X 7.2	2.0	91.5	54.2	54.2
			7.2 X 7.2	3.0	94.7	60.8	60.8
			7.2 X 7.2	4.0	98.0	69.4	69.4
34+019	37+318	BH-CL	2.5 X 2.5	1.0	24.1	88.7	24.1
			2.5 X 2.5	1.5	29.2	95.8	29.2
			2.5 X 2.5	2.0	34.5	100.2	34.5
34+619	37+804	BH-CL	4.8 X 4.8	1.0	22.0	34.0	22.0
			4.8 X 4.8	1.5	24.5	38.2	24.5
			4.8 X 4.8	2.0	27.2	43.3	27.2
35+273	38+457	BH-A1	7.2 X 7.2	2.0	23.9	26.1	23.9
			7.2 X 7.2	3.0	29.0	27.9	27.9
			7.2 X 7.2	4.0	34.2	30.2	30.2
		BH-A2	7.2 X 7.2	2.0	28.3	28.0	28.0
			7.2 X 7.2	3.0	33.3	30.2	30.2
			7.2 X 7.2	4.0	38.4	33.1	33.1
36+367	39+553	BH-CL	4.8 X 4.8	1.0	32.4	36.1	32.4
			4.8 X 4.8	1.5	36.4	38.0	36.4
			4.8 X 4.8	2.0	40.4	40.2	40.2
36+816	40+003	BH-A1	4.8 X 4.8	2.0	25.7	19.7	19.7
			4.8 X 4.8	3.0	31.0	25.3	25.3
			4.8 X 4.8	4.0	36.5	35.2	35.2
		BH-A2	4.8 X 4.8	2.0	21.2	51.5	21.2
			4.8 X 4.8	3.0	26.5	55.4	26.5
			4.8 X 4.8	4.0	32.1	58.5	32.1
37+174	40+358	BH-CL	2.2 X 2.2	1.0	14.3	29.7	14.3
			2.2 X 2.2	1.5	18.8	32.4	18.8
			2.2 X 2.2	2.0	23.7	34.6	23.7
37+487	40+671	BH-CL	4.8 X 4.8	1.0	15.3	33.0	15.3
			4.8 X 4.8	1.5	17.3	34.3	17.3
			4.8 X 4.8	2.0	19.3	34.1	19.3

Chainage Old (km)	Chainage New (km)	BH. No.	Foundation Size (m x m)	Depth of foundation below EGL (m)	Net Safe Bearing Capacity from Shear Failure (t/m^2)	Net Allowable Bearing Pressure from settlement failure (t/m^2)	Recommended Net Allowable Bearing Capacity (t/m^2)
38+127	41+312	BH-CL	4.8 X 4.8	1.0	17.2	17.0	17.0
			4.8 X 4.8	1.5	19.7	17.8	17.8
			4.8 X 4.8	2.0	22.3	18.7	18.7
38+482	41+667	BH-CL	2.2 X 2.2	1.0	13.9	33.1	13.9
			2.2 X 2.2	1.5	14.7	36.0	14.7
			2.2 X 2.2	2.0	15.5	38.5	15.5
38+701	41+926	BH-CL	2.7 X 2.7	1.0	24.4	33.5	24.4
			2.7 X 2.7	1.5	25.4	36.0	25.4
			2.7 X 2.7	2.0	26.4	38.4	26.4
38+778	41+963	BH-CL	11.35 X 11.35	1.0	29.6	18.3	18.3
			11.35 X 11.35	1.5	31.9	18.9	18.9
			11.35 X 11.35	2.0	34.2	19.4	19.4
39+060	42+239	BH-CL	2.7 X 2.7	1.0	18.2	22.1	18.2
			2.7 X 2.7	1.5	21.1	27.5	21.1
			2.7 X 2.7	2.0	24.0	36.0	24.0
39+149	-	BH-PLT-03	2.0 x 2.0	1.0	10.9	39.2	10.9
			2.0 x 2.0	1.5	13.4	42.8	13.4
			2.0 x 2.0	2.0	16.0	45.2	16.0
			2.0 x 2.0	2.5	18.8	24.3	18.8
			3.0 X 3.0	1.0	11.7	34.4	11.7
			3.0 X 3.0	1.5	13.9	36.8	13.9
			3.0 X 3.0	2.0	16.3	39.0	16.3
			3.0 X 3.0	2.5	18.7	41.1	18.7
39+400	42+579	BH-CL	7.3 X 7.3	1.0	16.5	28.1	16.5
			7.3 X 7.3	1.5	19.1	30.9	19.1
			7.3 X 7.3	2.0	21.8	34.5	21.8
40+325	43+507	BH-CL	11.35 X 11.35	1.0	39.7	34.8	34.8
			11.35 X 11.35	1.5	42.6	36.1	36.1
			11.35 X 11.35	2.0	45.6	37.6	37.6
40+573	43+758	BH-CL	4.8 X 4.8	1.0	43.8	57.0	43.8
			4.8 X 4.8	1.5	49.2	62.0	49.2
			4.8 X 4.8	2.0	54.7	68.2	54.7
41+056	44+246	BH-A1	7.2 X 7.2	2.0	37.2	46.9	37.2
			7.2 X 7.2	3.0	43.9	49.4	43.9
			7.2 X 7.2	4.0	50.9	52.2	50.9
		BH-A2	7.2 X 7.2	2.0	48.3	71.8	48.3
			7.2 X 7.2	3.0	57.6	75.7	57.6
			7.2 X 7.2	4.0	67.4	80.0	67.4

Chainage Old (km)	Chainage New (km)	BH. No.	Foundation Size (m x m)	Depth of foundation below EGL (m)	Net Safe Bearing Capacity from Shear Failure (t/m^2)	Net Allowable Bearing Pressure from settlement failure (t/m^2)	Recommended Net Allowable Bearing Capacity (t/m^2)
41+100	44+282	BH-CL	4.9 X 4.9	1.0	42.6	59.1	42.6
			4.9 X 4.9	1.5	48.8	63.2	48.8
			4.9 X 4.9	2.0	55.1	67.8	55.1
41+217	44+402	BH-CL	4.9 X 4.9	1.0	46.0	59.0	46.0
			4.9 X 4.9	1.5	54.3	61.9	54.3
			4.9 X 4.9	2.0	62.9	65.5	62.9
41+235	44+421	BH-CL	4.9 X 4.9	1.0	20.5	27.7	20.5
			4.9 X 4.9	1.5	23.0	32.5	23.0
			4.9 X 4.9	1.5	25.5	39.4	25.5
41+390	44+571	BH-A1	7.2 X 7.2	2.0	62.0	98.0	62.0
			7.2 X 7.2	3.0	72.8	103.3	72.8
			7.2 X 7.2	4.0	83.9	109.1	83.9
		BH-A2	7.2 X 7.2	2.0	28.9	49.0	28.9
			7.2 X 7.2	3.0	33.9	57.4	33.9
			7.2 X 7.2	4.0	39.1	69.2	39.1
42+256	45+497	BH-A1	7.2 X 7.2	2.0	20.4	33.7	20.4
			7.2 X 7.2	3.0	23.6	35.5	23.6
			7.2 X 7.2	4.0	26.9	37.5	26.9
		BH-P2	7.2 X 7.2	2.0	52.0	56.1	52.0
			7.2 X 7.2	3.0	62.6	59.2	59.2
			7.2 X 7.2	4.0	73.6	62.5	62.5
		BH-P3	7.2 X 7.2	2.0	32.9	9.1	9.1
			7.2 X 7.2	3.0	39.2	15.9	15.9
			7.2 X 7.2	4.0	45.8	60.0	45.8
		BH-P4	7.2 X 7.2	2.0	25.5	24.5	24.5
			7.2 X 7.2	3.0	31.0	25.8	25.8
			7.2 X 7.2	4.0	36.7	27.2	27.2
		BH-P5	7.2 X 7.2	2.0	37.9	30.1	30.1
			7.2 X 7.2	3.0	44.7	31.7	31.7
			7.2 X 7.2	4.0	51.8	33.9	33.9
		BH-P6	7.2 X 7.2	2.0	64.4	61.2	61.2
			7.2 X 7.2	3.0	75.4	64.5	64.5
			7.2 X 7.2	4.0	86.8	68.2	68.2
		BH-P13	7.2 X 7.2	2.0	56.2	74.8	56.2
			7.2 X 7.2	3.0	67.3	89.0	67.3
			7.2 X 7.2	4.0	78.9	106.4	78.9

Chainage Old (km)	Chainage New (km)	BH. No.	Foundation Size (m x m)	Depth of foundation below EGL (m)	Net Safe Bearing Capacity from Shear Failure (t/m^2)	Net Allowable Bearing Pressure from settlement failure (t/m^2)	Recommended Net Allowable Bearing Capacity (t/m^2)
42+256	45+497	BH-P14	7.2 X 7.2	2.0	63.2	82.0	63.2
			7.2 X 7.2	3.0	74.9	87.4	74.9
			7.2 X 7.2	4.0	87.1	92.3	87.1
		BH-P15	7.2 X 7.2	2.0	49.4	65.8	49.4
			7.2 X 7.2	3.0	59.4	79.4	59.4
			7.2 X 7.2	4.0	69.8	97.2	69.8
		BH-P16	7.2 X 7.2	2.0	54.1	63.4	54.1
			7.2 X 7.2	3.0	64.8	66.8	64.8
			7.2 X 7.2	4.0	76.0	70.6	70.6
		BH-A2	7.2 X 7.2	2.0	70.4	38.8	38.8
			7.2 X 7.2	3.0	82.9	40.9	40.9
			7.2 X 7.2	4.0	95.9	43.2	43.2
43+100	46+280	BH-PLT-02	2.0 x 2.0	1.0	13.7	31.0	13.7
			2.0 x 2.0	1.5	17.0	43.7	17.0
			2.0 x 2.0	2.0	20.5	68.8	20.5
			2.0 x 2.0	2.5	24.1	96.9	24.1
			3.0 X 3.0	1.0	14.9	31.8	14.9
			3.0 X 3.0	1.5	17.8	43.7	17.8
			3.0 X 3.0	2.0	20.9	64.2	20.9
			3.0 X 3.0	2.5	24.2	82.8	24.2
43+452	46+636	BH-CL	7.3 X 7.3	1.0	18.9	23.9	18.9
			7.3 X 7.3	1.5	21.3	26.4	21.3
			7.3 X 7.3	2.0	23.8	29.5	23.8
43+585	46+769	BH-CL	7.3 X 7.3	1.0	23.2	23.5	23.2
			7.3 X 7.3	1.5	25.5	25.5	25.5
			7.3 X 7.3	2.0	27.9	28.0	27.9
43+732	46+916	BH-CL	6.2 X 6.2	1.0	20.9	21.0	20.9
			6.2 X 6.2	1.5	23.3	22.6	22.6
			6.2 X 6.2	2.0	25.7	24.6	24.6
44+050	47+234	BH-CL	6.2 X 6.2	1.0	22.4	22.0	22.0
			6.2 X 6.2	1.5	24.8	23.8	23.8
			6.2 X 6.2	2.0	27.2	26.2	26.2
44+116	47+301	BH-CL	11.5 X 11.5	1.0	29.1	21.9	21.9
			11.5 X 11.5	1.5	31.4	22.4	22.4
			11.5 X 11.5	2.0	33.6	22.8	22.8
44+317	47+501	BH-CL	4.9 X 4.9	1.0	26.7	24.8	24.8
			4.9 X 4.9	1.5	30.0	29.3	29.3
			4.9 X 4.9	2.0	33.3	35.4	33.3

Chainage Old (km)	Chainage New (km)	BH. No.	Foundation Size (m x m)	Depth of foundation below EGL (m)	Net Safe Bearing Capacity from Shear Failure (t/m^2)	Net Allowable Bearing Pressure from settlement failure (t/m^2)	Recommended Net Allowable Bearing Capacity (t/m^2)
44+641	47+825	BH-CL	4.8 X 4.8	1.0	21.9	22.4	21.9
			4.8 X 4.8	1.5	24.4	24.6	24.4
			4.8 X 4.8	2.0	27.1	27.4	27.1
44+910	48+094	BH-CL	4.8 X 4.8	1.0	17.1	19.1	17.1
			4.8 X 4.8	1.5	19.6	20.8	19.6
			4.8 X 4.8	2.0	22.3	23.0	22.3
45+048	48+232	BH-CL	4.9 X 4.9	1.0	16.6	17.7	16.6
			4.9 X 4.9	1.5	18.5	19.6	18.5
			4.9 X 4.9	2.0	20.5	22.2	20.5
45+411	48+595	BH-CL	2.2 X 2.2	1.0	14.3	26.5	14.3
			2.2 X 2.2	1.5	17.3	32.6	17.3
			2.2 X 2.2	2.0	20.4	41.1	20.4
45+480	48+664	BH-A1	7.2 X 7.2	2.0	41.2	52.8	41.2
			7.2 X 7.2	3.0	49.6	55.7	49.6
			7.2 X 7.2	4.0	58.3	58.8	58.3
		BH-A2	7.2 X 7.2	2.0	53.4	53.9	53.4
			7.2 X 7.2	3.0	64.1	56.8	56.8
			7.2 X 7.2	4.0	75.3	60.0	60.0
45+612	48+795	BH-CL	4.9 X 4.9	1.0	19.8	21.5	19.8
			4.9 X 4.9	1.5	22.2	25.1	22.2
			4.9 X 4.9	2.0	24.7	30.0	24.7
45+984	49+168	BH-CL	11.5 x 11.5	1.0	22.6	50.8	22.6
			11.5 x 11.5	1.5	24.7	51.4	24.7
			11.5 x 11.5	2.0	26.8	52.0	26.8
46+400	49+584	BH-CL	1.6 x 1.6	1.0	12.6	51.3	12.6
			1.6 x 1.6	1.5	17.3	61.1	17.3
			1.6 x 1.6	2.0	22.4	77.4	22.4

Table 4.3: Recommended Net Allowable Bearing Capacity for shallow foundation for allowable settlement 25mm (Replaced or Compacted Soil)

Sr. No.	Chainage Old (km)	Chainage New (km)	BH. No.	Depth of foundation below EGL (m)	Foundation Size (m x m)	Net Safe Bearing Capacity from Shear Failure (t/m^2)	Net Allowable Bearing Pressure from 50 mm settlement failure (t/m^2)	*Recommended Net Allowable Bearing Capacity (t/m^2)
1.	30+176	30+829	BH-CL	1.0	12 X 12	44.5	19.9	19.9
				1.5		47.8	20.1	20.1
				2.0		51.2	20.6	20.6
2.	31+354	32+022	BH-CL	1.0	7.2 X 7.2	37.8	16.6	16.6
				1.5		38.7	17.0	17.0
				2.0		39.7	17.4	17.4
3.	32+160	37+767	BH-CL	1.0	7.2 X 7.2	18.0	13.1	13.1
				1.5		18.4	14.6	14.6
				2.0		18.9	15.0	15.0
4.	31+095	34+280	BH-CL	1.0	4.8 X 4.8	29.8	25.5	25.5
				1.5		30.8	26.7	26.7
				2.0		32.6	26.2	26.2
5.	37+487	40+671	BH-CL	1.0	4.8 X 4.8	33.2	22.9	22.9
				1.5		38.6	23.7	23.7
				2.0		44.0	24.4	24.4
6.	45+048	48+232	BH-CL	1.0	4.9 X 4.9	31.0	27.5	27.5
				1.5		32.8	25.9	25.9
				2.0		34.6	28.9	28.9
7.	38+482	41+667	BH-CL	1.0	2.2 X 2.2	34.2	28.8	28.8
				1.5		41.9	31.4	31.4
				2.0		50.0	33.5	33.5

Table 4.4: Recommended Net Allowable Bearing Capacity for shallow foundation for allowable settlement 50mm (Replaced or Compacted Soil)

Sr. No.	Chainage Old (km)	Chainage New (km)	BH. No.	Depth of foundation below EGL (m)	Foundation Size (m x m)	Net Safe Bearing Capacity from Shear Failure (t/m^2)	Net Allowable Bearing Pressure from 50 mm settlement failure (t/m^2)	*Recommended Net Allowable Bearing Capacity (t/m^2)
1.	30+176	30+829	BH-CL	1.0	12 X 12	44.5	39.8	39.8
				1.5		47.8	40.7	40.7
				2.0		51.2	41.7	41.7

Sr. No.	Chainage Old (km)	Chainage New (km)	BH. No.	Depth of foundation below EGL (m)	Foundation Size (m x m)	Net Safe Bearing Capacity from Shear Failure (t/m^2)	Net Allowable Bearing Pressure from 50 mm settlement failure (t/m^2)	*Recommended Net Allowable Bearing Capacity (t/m^2)
2.	31+354	32+022	BH-CL	1.0	7.2 X 7.2	37.8	33.3	33.3
				1.5		38.7	34.0	34.0
				2.0		39.7	34.8	34.8
3.	32+160	37+767	BH-CL	1.0	7.2 X 7.2	18.0	26.3	18.0
				1.5		18.4	29.2	18.4
				2.0		18.9	30.0	18.9
4.	31+095	34+280	BH-CL	1.0	4.8 X 4.8	29.8	50.9	29.8
				1.5		30.8	53.4	30.8
				2.0		32.4	54.4	32.4
5.	37+487	40+671	BH-CL	1.0	4.8 X 4.8	33.2	45.7	33.2
				1.5		38.6	47.5	38.6
				2.0		44.0	47.5	44.0
6.	45+048	48+232	BH-CL	1.0	4.9 X 4.9	31.0	55.0	31.0
				1.5		32.8	51.8	32.8
				2.0		34.6	57.9	34.6
7.	38+482	41+667	BH-CL	1.0	2.2 X 2.2	34.2	57.6	34.2
				1.5		41.9	62.7	41.9
				2.0		50.0	67.0	50.0

Note:-

From table no. 4.1, PLT and boreholes have been conducted on Chainage 39+149, 43+100 and Dhulawat section. Least value of SBC obtained from PLT and Soil exploration data has been recommended.

- The maximum value of recommended net allowable bearing capacity shall be restricted to 30 t/m^2.
- **Table 4.1&4.2 Show that the SBC at location Ch (Old) 30+176, Ch (Old) 31+354, Ch (Old) 32+160, Ch(Old) 31+095, Ch (Old) 37+487, Ch (Old) 45+048, & Ch (Old) 38+482 are poor. Therefore before laying the open foundation at 1.0, 1.5 m & 2.0m depth, it is recommended to replace or Compact the existing the soil up for 1.5m depth with properly compacted granular material below the foundation level.**
- As per the Morth guidelines the gradation of fill soil shall be as per following limits. The effective angle of friction not less than 30º. The gradation of fill soil shall be as per following limits.

Sieve Size	Percentage Passing
75 mm	100%
425 micron	0-60%
75 micron	less than 15 %
PI	≤6

1. The density of backfill soil should be more than 95% of proctor density. The replaced /compacted soil should be lay down layer wise for each 300mm.
2. The design parameters considered for replaced/compacted Soil for calculating the SBC from shear criteria are as follows;

C=0, Phi = 32 degree, Sp. Gravity= 2.63 Moisture content= 8%, Bulk density =1.84 g/cc N = 25.

- Based on the method of analysis given under Para 7.2 above, The values of Safe Load Carrying Capacity of piles in compression, uplift and lateral under static conditions have been tabulated below:-

Table 4.5: Safe Load Carrying Capacity of normal bored cast in-situ RCC Pile in Soil

Chainage Old (km)	Chainage New (km)	BH. No.	Diameter of Pile (m)	Length of piles below cut-off (m)	Cut-off level below EGL (m)	Safe load carrying capacity of single pile (T)		
						In compression	In uplift	In Lateral
								Fixed Head
29+487	30+155	BH-A1	1.0	20.0	2.0	532.0	322.0	74.0
				22.0		578.0	364.0	
				24.0		624.0	406.0	
				26.0		666.0	448.0	
				28.0		711.0	490.0	
				30.0		757.0	532.0	
			1.2	20.0	2.0	772.0	420.0	120.0
				22.0		832.0	478.0	
				24.0		897.0	538.0	
				26.0		955.0	598.0	
				28.0		1020.0	657.0	
				30.0		1085.0	717.0	
		BH-A2	1.0	22.0	2.0	520.0	340.0	67.0
				24.0		562.0	379.0	
				26.0		601.0	418.0	
				28.0		644.0	458.0	
				30.0		686.0	497.0	
				32.0		728.0	536.0	
			1.2	22.0	2.0	564.0	447.0	108.0
				24.0		804.0	503.0	
				26.0		859.0	559.0	
				28.0		919.0	614.0	
				30.0		979.0	670.0	
				32.0		1039.0	726.0	
30+488	33+673	BH-A1	1.0	16.0	2.0	264.0	148.0	18.8
				18.0		307.0	187.0	
				20.0		347.0	225.0	
				22.0		387.0	263.0	
			1.2	16.0	2.0	389.0	191.0	22.6
				18.0		451.0	248.0	
				20.0		509.0	302.0	
				22.0		566.0	355.0	

Chainage Old (km)	Chainage New (km)	BH. No.	Diameter of Pile (m)	Length of piles below cut-off (m)	Cut-off level below EGL (m)	Safe load carrying capacity of single pile (T)		
						In compression	In uplift	In Lateral
								Fixed Head
30+488	33+673	BH-A2	1.0	16.0	2.0	274.0	203.0	19.2
				18.0		317.0	243.0	
				20.0		361.0	283.0	
				22.0		399.0	319.0	
			1.2	16.0	2.0	356.0	257.0	23.1
				18.0		419.0	315.0	
				20.0		483.0	374.0	
				22.0		537.0	424.0	
31+714	34+899	BH-A1	1.0	22.0	2.0	438.0	282.0	22.9
				24.0		475.0	317.0	
				26.0		536.0	352.0	
				28.0		570.0	387.0	
			1.2	22.0	2.0	639.0	377.0	30.6
				24.0		692.0	426.0	
				26.0		787.0	477.0	
				28.0		835.0	528.0	
		BH-A2	1.0	22.0	2.0	428.0	288.0	23.6
				24.0		466.0	324.0	
				26.0		504.0	360.0	
				28.0		539.0	395.0	
			1.2	22.0	2.0	621.0	386.0	31.5
				24.0		676.0	438.0	
				26.0		732.0	490.0	
				28.0		782.0	541.0	
33+713	36+984	BH-A1	1.0	16.0	2.0	335.0	226.0	30.5
				18.0		379.0	266.0	
				20.0		409.0	295.0	
				22.0		434.0	320.0	
			1.2	16.0	2.0	438.0	285.0	40.8
				18.0		500.0	342.0	
				20.0		539.0	380.0	
				22.0		571.0	412.0	
		BH-A2	1.0	16.0	2.0	311.0	205.0	29.3
				18.0		356.0	247.0	
				20.0		387.0	276.0	
				22.0		412.0	302.0	

Chainage Old (km)	Chainage New (km)	BH. No.	Diameter of Pile (m)	Length of piles below cut-off (m)	Cut-off level below EGL (m)	Safe load carrying capacity of single pile (T)		
						In compression	In uplift	In Lateral
								Fixed Head
33+713	36+984	BH-A2	1.2	16.0	2.0	409.0	260.0	39.2
				18.0		474.0	320.0	
				20.0		514.0	359.0	
				22.0		545.0	391.0	
35+273	38+457	BH-A1	1.0	16.0	2.0	181.0	129.0	22.9
				18.0		207.0	148.0	
				20.0		228.0	170.0	
				22.0		262.0	191.0	
			1.2	16.0	2.0	238.0	163.0	30.6
				18.0		271.0	188.0	
				20.0		297.0	216.0	
				22.0		344.0	244.0	
		BH-A2	1.0	16.0	2.0	203.0	151.0	22.9
				18.0		223.0	171.0	
				20.0		275.0	194.0	
				22.0		297.0	216.0	
			1.2	16.0	2.0	264.0	189.0	30.6
				18.0		289.0	216.0	
				20.0		358.0	245.0	
				22.0		387.0	274.0	
36+816	40+003	BH-A1	1.0	16.0	2.0	173.0	134.0	22.2
				18.0		218.0	175.0	
				20.0		262.0	216.0	
				22.0		300.0	252.0	
			1.2	16.0	2.0	227.0	171.0	29.7
				18.0		290.0	229.0	
				20.0		353.0	287.0	
				22.0		406.0	337.0	
		BH-A2	1.0	16.0	2.0	233.0	171.0	22.2
				18.0		278.0	212.0	
				20.0		322.0	253.0	
				22.0		360.0	289.0	
			1.2	16.0	2.0	306.0	219.0	29.7
				18.0		370.0	277.0	
				20.0		433.0	335.0	
				22.0		485.0	385.0	
41+056	44+246	BH-A1	1.0	16.0	2.0	342.0	188.0	24.9
				18.0		379.0	223.0	
				20.0		416.0	257.0	
				22.0		479.0	293.0	

Chainage Old (km)	Chainage New (km)	BH. No.	Diameter of Pile (m)	Length of piles below cut-off (m)	Cut-off level below EGL (m)	Safe load carrying capacity of single pile (T)		
						In compression	In uplift	In Lateral
								Fixed Head
41+056	44+246	BH-A1	1.2	16.0	2.0	500.0	239.0	33.3
				18.0		553.0	289.0	
				20.0		607.0	339.0	
				22.0		662.0	391.0	
		BH-A2	1.0	22.0	2.0	421.0	281.0	26.9
				24.0		456.0	315.0	
				26.0		492.0	349.0	
				28.0		528.0	382.0	
			1.2	22.0	2.0	612.0	376.0	36.0
				24.0		664.0	425.0	
				26.0		716.0	474.0	
				28.0		768.0	523.0	
41+390	44+571	BH-A1	1.0	20.0	2.0	259.0	244.0	44.1
				22.0		266.0	253.0	
				24.0		272.0	262.0	
				26.0		278.0	271.0	
			1.2	20.0	2.0	333.0	314.0	59.1
				22.0		342.0	327.0	
				24.0		351.0	340.0	
				26.0		360.0	353.0	
		BH-A2	1.0	22.0	2.0	283.0	209.0	42.2
				24.0		327.0	235.0	
				26.0		353.0	261.0	
				28.0		380.0	287.0	
			1.2	22.0	2.0	368.0	265.0	56.5
				24.0		427.0	299.0	
				26.0		460.0	332.0	
				28.0		493.0	365.0	
42+256	45+497	BH-A1	1.0	20.0	2.0	262.0	248.0	23.6
				22.0		300.0	283.0	
				24.0		337.0	318.0	
				26.0		350.0	333.0	
			1.2	20.0	2.0	345.0	327.0	31.5
				22.0		399.0	378.0	
				24.0		453.0	429.0	
				26.0		472.0	450.0	
		BH-P2	1.0	20.0	2.0	413.0	255.0	28.1
				22.0		450.0	289.0	
				24.0		487.0	324.0	
				26.0		524.0	359.0	

Chainage Old (km)	Chainage New (km)	BH. No.	Diameter of Pile (m)	Length of piles below cut-off (m)	Cut-off level below EGL (m)	Safe load carrying capacity of single pile (T)		
						In compression	In uplift	In Lateral
								Fixed Head
42+256	45+497	BH-P2	1.2	20.0	2.0	603.0	335.0	37.6
				22.0		656.0	385.0	
				24.0		710.0	436.0	
				26.0		763.0	486.0	
		BH-P3	1.0	20.0	2.0	411.0	254.0	26.9
				22.0		447.0	288.0	
				24.0		484.0	323.0	
				26.0		520.0	357.0	
			1.2	20.0	2.0	601.0	335.0	36.0
				22.0		654.0	385.0	
				24.0		707.0	435.0	
				26.0		760.0	485.0	
		BH-P4	1.0	20.0	2.0	476.0	295.0	20.7
				22.0		513.0	330.0	
				24.0		551.0	365.0	
				26.0		588.0	400.0	
			1.2	20.0	2.0	703.0	395.0	27.7
				22.0		757.0	446.0	
				24.0		812.0	496.0	
				26.0		866.0	547.0	
		BH-P5	1.0	22.0	2.0	398.0	266.0	23.6
				24.0		433.0	298.0	
				26.0		468.0	331.0	
				28.0		503.0	364.0	
			1.2	22.0	2.0	580.0	355.0	31.5
				24.0		630.0	403.0	
				26.0		680.0	450.0	
				28.0		730.0	498.0	
		BH-P6	1.0	22.0	2.0	432.0	290.0	31.1
				24.0		468.0	323.0	
				26.0		505.0	358.0	
				28.0		564.0	394.0	
			1.2	22.0	2.0	623.0	385.0	41.6
				24.0		675.0	434.0	
				26.0		728.0	484.0	
				28.0		820.0	535.0	

Chainage Old (km)	Chainage New (km)	BH. No.	Diameter of Pile (m)	Length of piles below cut-off (m)	Cut-off level below EGL (m)	Safe load carrying capacity of single pile (T)		
						In compression	In uplift	In Lateral
								Fixed Head
42+256	45+497	BH-P13	1.0	22.0	2.0	443.0	298.0	29.9
				24.0		480.0	332.0	
				26.0		516.0	366.0	
				28.0		553.0	401.0	
			1.2	22.0	2.0	641.0	396.0	40.0
				24.0		694.0	446.0	
				26.0		746.0	496.0	
				28.0		799.0	546.0	
		BH-P14	1.0	22.0	2.0	340.0	315.0	31.1
				24.0		380.0	352.0	
				26.0		394.0	368.0	
				28.0		400.0	377.0	
			1.2	22.0	2.0	452.0	419.0	41.6
				24.0		509.0	472.0	
				26.0		530.0	496.0	
				28.0		539.0	509.0	
		BH-P15	1.0	22.0	2.0	403.0	309.0	27.5
				24.0		425.0	331.0	
				26.0		447.0	354.0	
				28.0		491.0	379.0	
			1.2	22.0	2.0	530.0	399.0	36.8
				24.0		558.0	428.0	
				26.0		586.0	458.0	
				28.0		619.0	491.0	
		BH-P16	1.0	22.0	2.0	400.0	317.0	28.1
				24.0		441.0	355.0	
				26.0		465.0	379.0	
				28.0		484.0	399.0	
			1.2	22.0	2.0	538.0	422.0	37.6
				24.0		596.0	476.0	
				26.0		629.0	509.0	
				28.0		654.0	535.0	
		BH-A2	1.0	22.0	2.0	463.0	298.0	33.3
				24.0		501.0	333.0	
				26.0		539.0	368.0	
				28.0		576.0	404.0	
			1.2	22.0	2.0	674.0	396.0	44.6
				24.0		729.0	447.0	
				26.0		783.0	498.0	
				28.0		837.0	549.0	

Chainage Old (km)	Chainage New (km)	BH. No.	Diameter of Pile (m)	Length of piles below cut-off (m)	Cut-off level below EGL (m)	Safe load carrying capacity of single pile (T)		
						In compression	In uplift	In Lateral Fixed Head
45+480	48+664	BH-A1	1.0	16.0	2.0	382.0	214.0	26.2
				18.0		422.0	251.0	
				20.0		461.0	288.0	
				22.0		568.0	326.0	
			1.2	16.0	2.0	526.0	268.0	35.1
				18.0		579.0	316.0	
				20.0		631.0	365.0	
				22.0		685.0	416.0	
		BH-A2	1.0	16.0	2.0	390.0	220.0	27.5
				18.0		429.0	256.0	
				20.0		468.0	293.0	
				22.0		467.0	330.0	
			1.2	16.0	2.0	535.0	274.0	36.8
				18.0		587.0	323.0	
				20.0		638.0	371.0	
				22.0		625.0	420.0	

Notes : -

1. Permissible lateral deflection has been taken as 5mm.
2. The self weight of the pile has been taken into account while computing the Safe Load Carrying Capacity of Pile in uplift only and not considered for vertical load capacity in compression.
3. The safe load carrying capacity of piles have been worked out on the basis of IS: 2911 (Part-1/sec-2) – 2010 as per provisions / assumptions provided therein & are only an assessment based on characteristics of the sub-strata obtained at the locations of the above BHs. The safe load carrying capacities as tabulated above will further depend substantially on the piling technique adopted and equipment used for making the piles in the field. However, for the final designs & constructions, the safe/allowable load carrying capacities of these piles should be taken by conducting actual initial load tests on these piles by casting them in the respective areas.
4. While erecting normal bored cast in-situ pile, utmost care should be taken while flushing/cleaning the bottom of pile particularly prior to start of pouring of concrete so as o rest

the pile in virgin soil only for obtaining full point bearing as while computing safe load carrying capacity of pile no bottom softening during erection of pile has been considered.

5. Further the pile should have necessary structural strength to transmit / sustain the design load.

Notes: **-**

All The above recommendations are based on the field and laboratory tests conducted on selected soil/ rock core samples and our experience in this regard. If the actual substrata conditions during excavation for the foundation differ from the observations reported here, the design experts/consultants should be referred for suggestion, further investigations.

REFERENCES

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19. IS: 2720 (Part 3/See 1)–(1980) Methods of test for soils, determination of specific gravity of soil. New Delhi, India.
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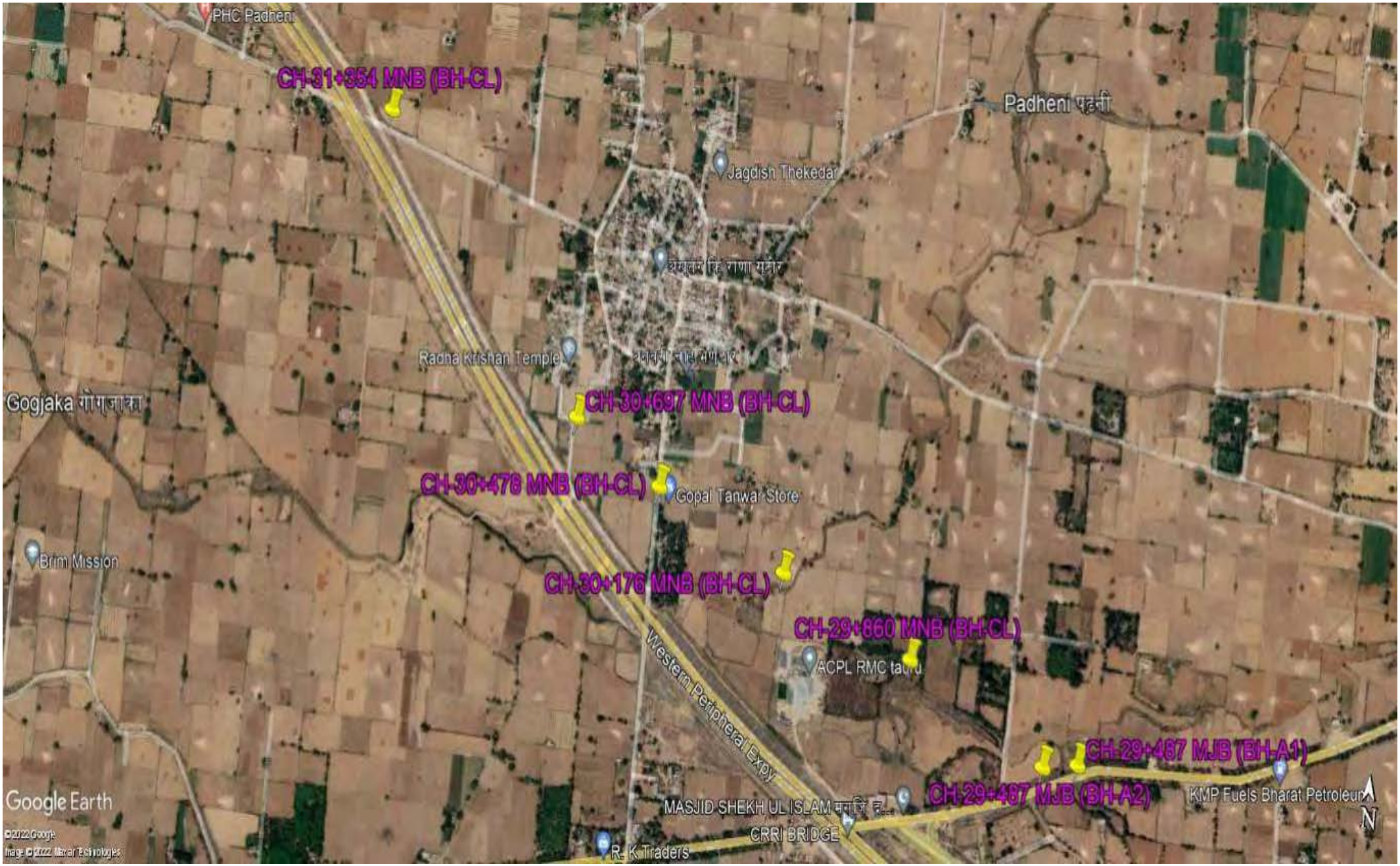
Abbreviations

BH	Borehole
ERT	Electrical Resistivity Test
EGL	Existing Ground Level
GWT	Ground Water Table
IS	Indian Standards
SPT	Standard Penetration Test
DS	Disturbed Soil
R.L.	Reduced Level
m	Metre
sp. gr.	Specific Gravity
%	Percentage
mg /l	Milligram per litre
mg /kg	Milligram per kilogram

APPENDIX – A (FIELD DATA RESULTS)

Appendix No.	ITEMS
A-1	LOCATION PLAN
A-2	FIELD BORE HOLE LOGS
A-3	SUB SOIL PROFILE DIAGRAM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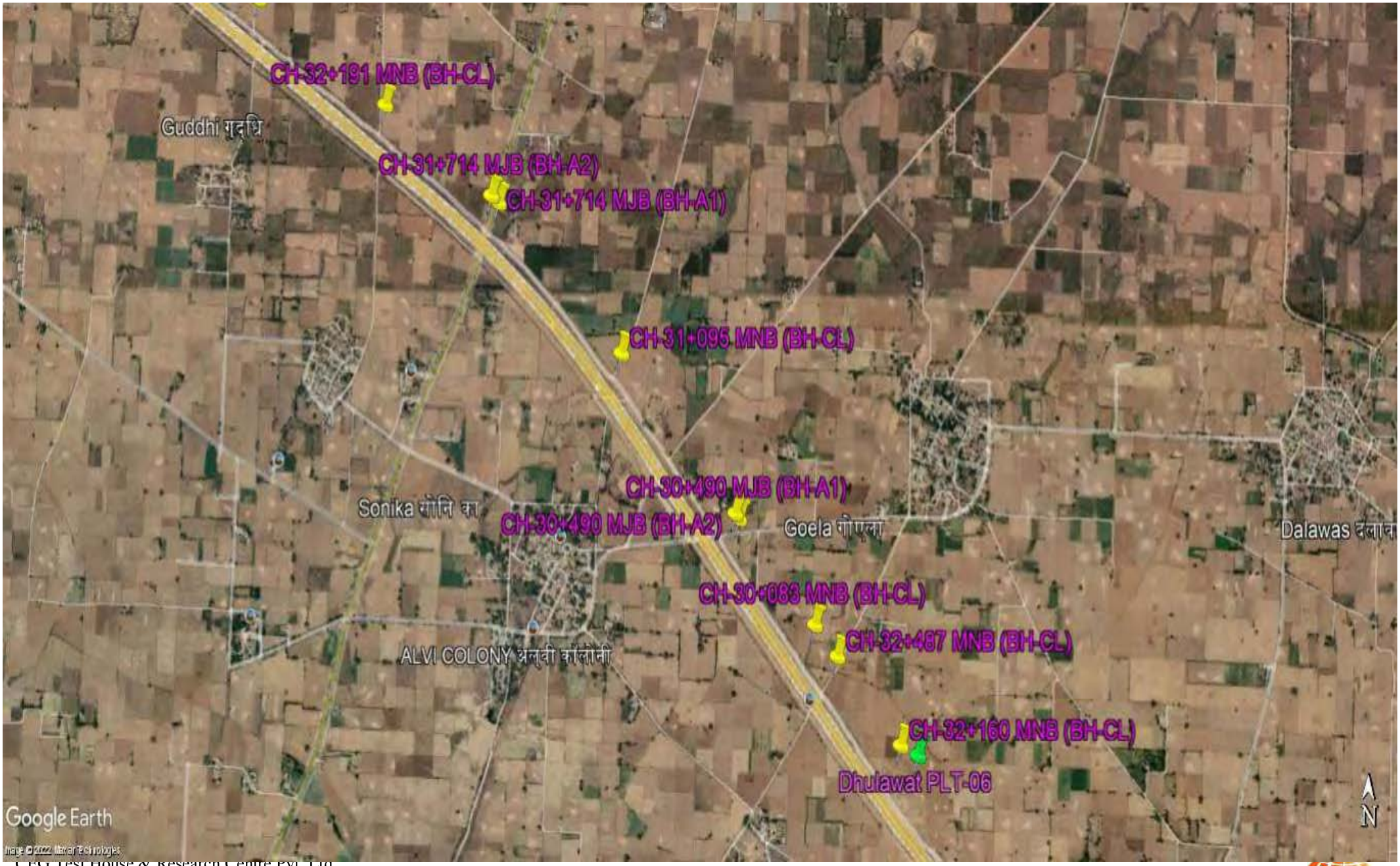
Padheni पढ़नी
Jagdish Thekedar
Radha Krishan Temple
CH-30+697 MNB (BH-CL)
Gogjaka गोगजाका
CH-30+478 MNB (BH-CL)
Gopal Tanwar Store
Brim Mission
CH-30+176 MNB (BH-CL)
CH-29+860 MNB (BH-CL)
ACPL RMC
Western Peripheral Expy
CH-29+467 MJB (BH-A1)
CH-29+487 MJB (BH-A2)
KMP Fuels Bharat Petroleum
MASJID SHEKH UL ISLAM
CRRI BRIDGE
R. K Traders
Google Earth
N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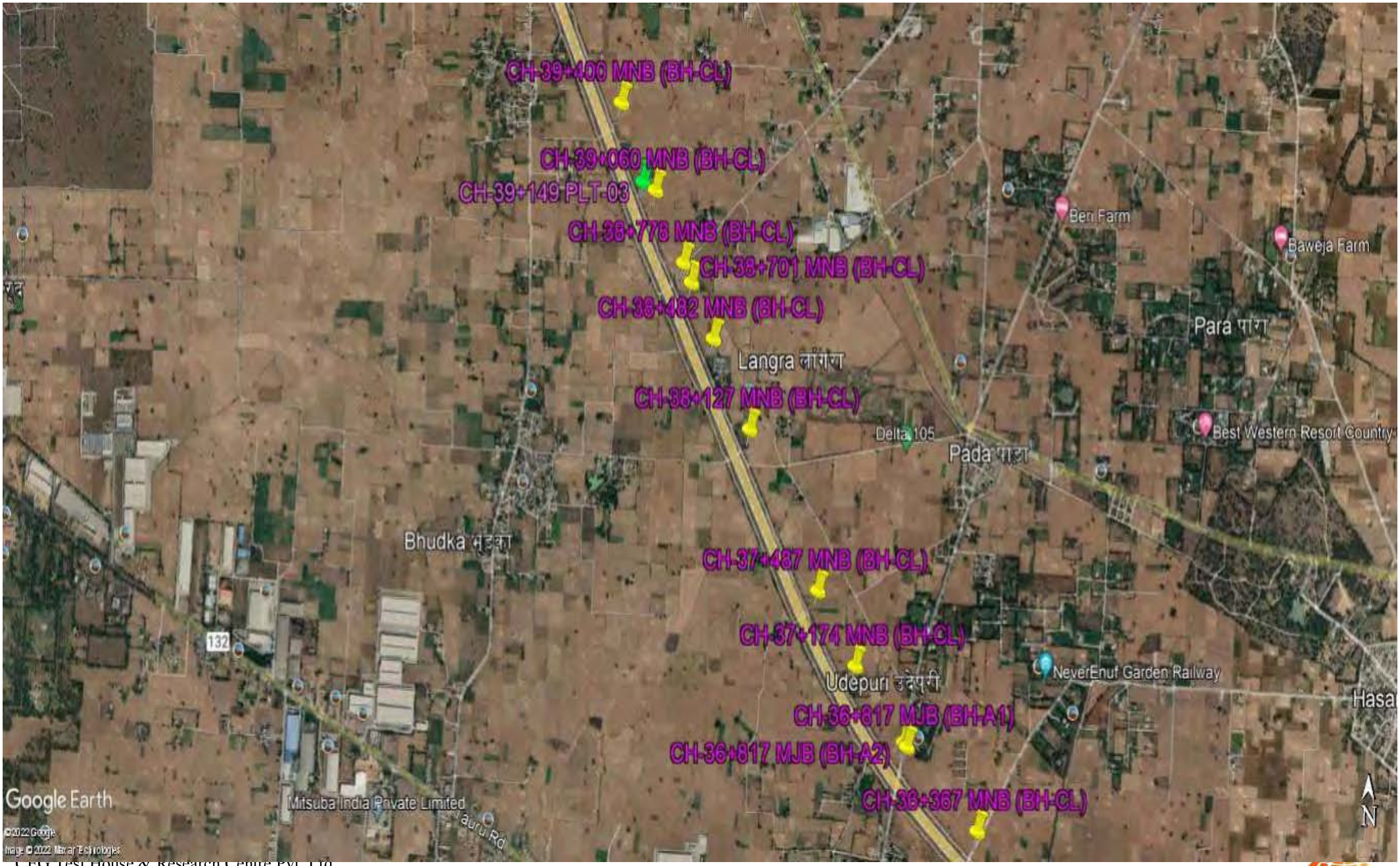
Guddhi गुढ्धि
CH-31+714 MJB (BH-A2)
CH-31+714 MJB (BH-A1)
CH-31+095 MNB (BH-CL)
CH-30+490 MJB (BH-A1)
Sonika सोनि का
CH-30+490 MJB (BH-A2)
Goela गोएला
Dalawas दलावा
CH-30+083 MNB (BH-CL)
CH-32+487 MNB (BH-CL)
ALVI COLONY अलवी कालोनी
CH-32+160 MNB (BH-CL)
Dhulawat PLT-06
Google Earth
N


CH-35+273 MJB (BH-A1)
CH-35+273 MJB (BH-A2)
CH-34+619 MNB (BH-CL)
CH-34+019 MNB (BH-CL)
CH-33+713 MJB (BH-A1)
CH-33+713 MJB (BH-A2)
CH-32+736 MNB (BH-CL)
Google Earth
N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CH-39+060 MNB (BH-CL)
CH-39+149 PLT-03
CH-38+778 MNB (BH-CL)
CH-38+701 MNB (BH-CL)
CH-38+482 MNB (BH-CL)
Langra लांगरा
CH-38+127 MNB (BH-CL)
Delta 105
Pada पाडा
Para पारा
Beri Farm
Baweja Farm
Best Western Resort Country
Bhudka भुडका
CH-37+487 MNB (BH-CL)
CH-37+174 MNB (BH-CL)
Udepuri उदेपुरी
NeverEnuf Garden Railway
CH-36+817 MJB (BH-A1)
CH-36+817 MJB (BH-A2)
CH-36+367 MNB (BH-CL)
132
Mitsuba India Private Limited
Google Earth
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N


Somdev Trading
CH-41+390 MJB (BH-A1)
CH-41+390 MJB (BH-A2)
Radha Krishan Mandir
KMP Toll Plaza Panchgaon
CH-41+235 MNB (BH-CL)
The Royal pg
CH-41+217 MNB (BH-CL)
CH-41+056 MJB (BH-A2)
CH-41+100 MNB (BH-CL)
CH-41+056 MJB (BH-A1)
Chandla Dungerwas चांदला डूंगरवास
CH-40+573 MNB (BH-CL)
CH-40+325 MNB (BH-CL)
Google Earth
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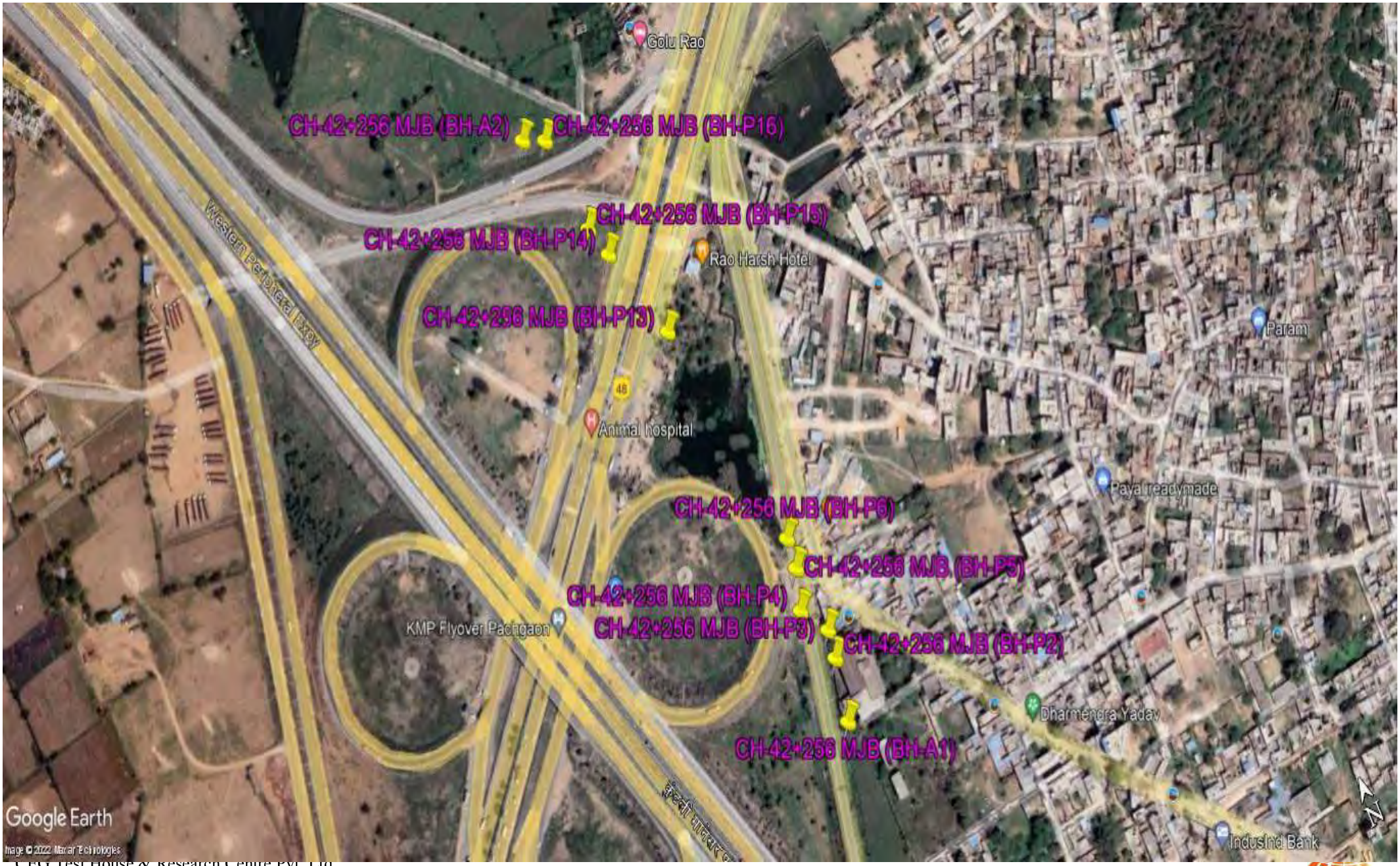
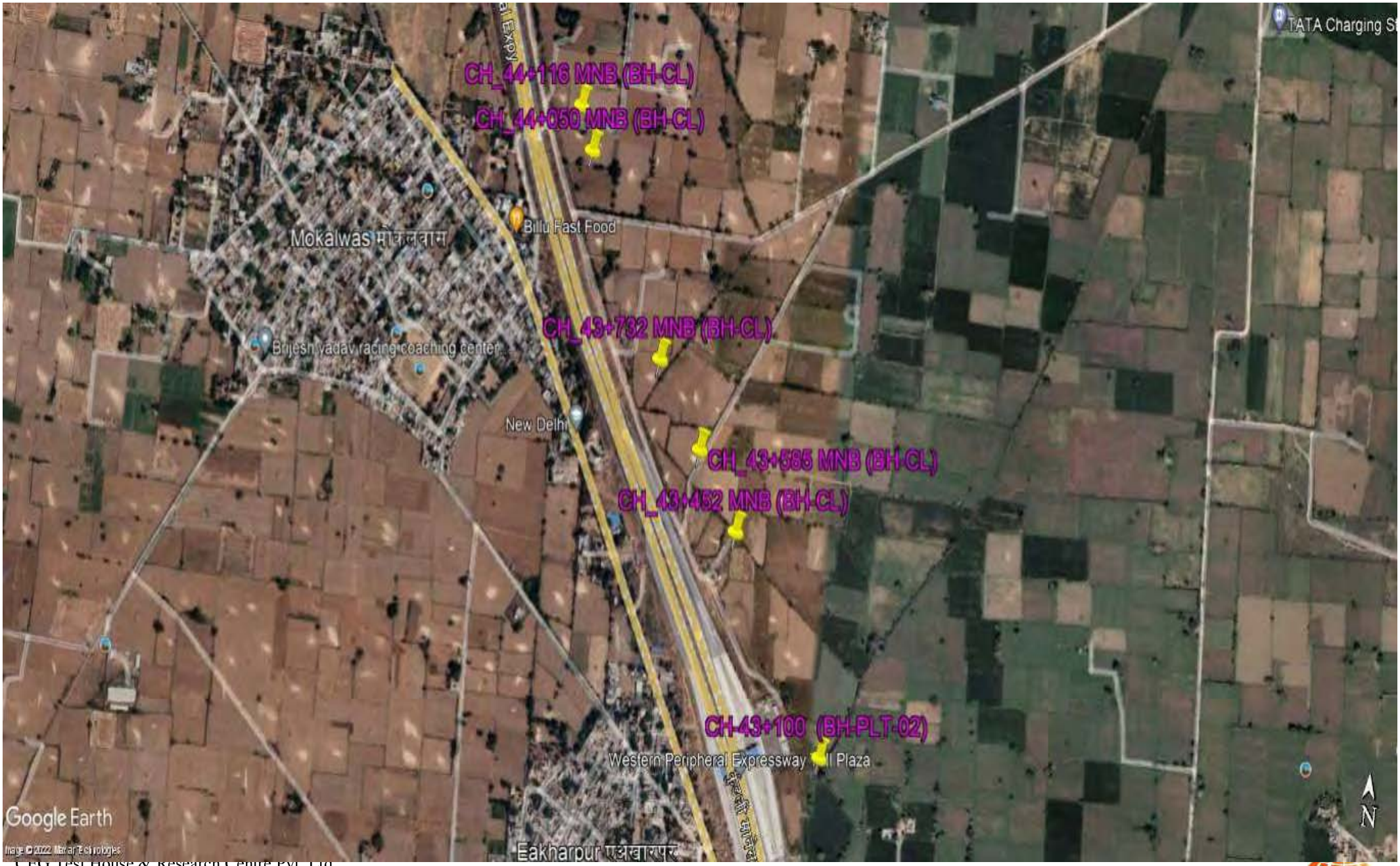

Golu Rao
CH-42+256 MJB (BH-A2)
CH-42+256 MJB (BH-P16)
CH-42+256 MJB (BH-P15)
CH-42+256 MJB (BH-P14)
Rao Harsh Hotel
CH-42+256 MJB (BH-P13)
Western Peripheral Expy
48
Animal Hospital
Param
Paya readymade
CH-42+256 MJB (BH-P6)
CH-42+256 MJB (BH-P5)
CH-42+256 MJB (BH-P4)
CH-42+256 MJB (BH-P3)
CH-42+256 MJB (BH-P2)
KMP Flyover Pachgaon
Dharmendra Yadav
CH-42+256 MJB (BH-A1)
IndusInd Bank
Google Earth
Image © 2022 Maxar Technologies
N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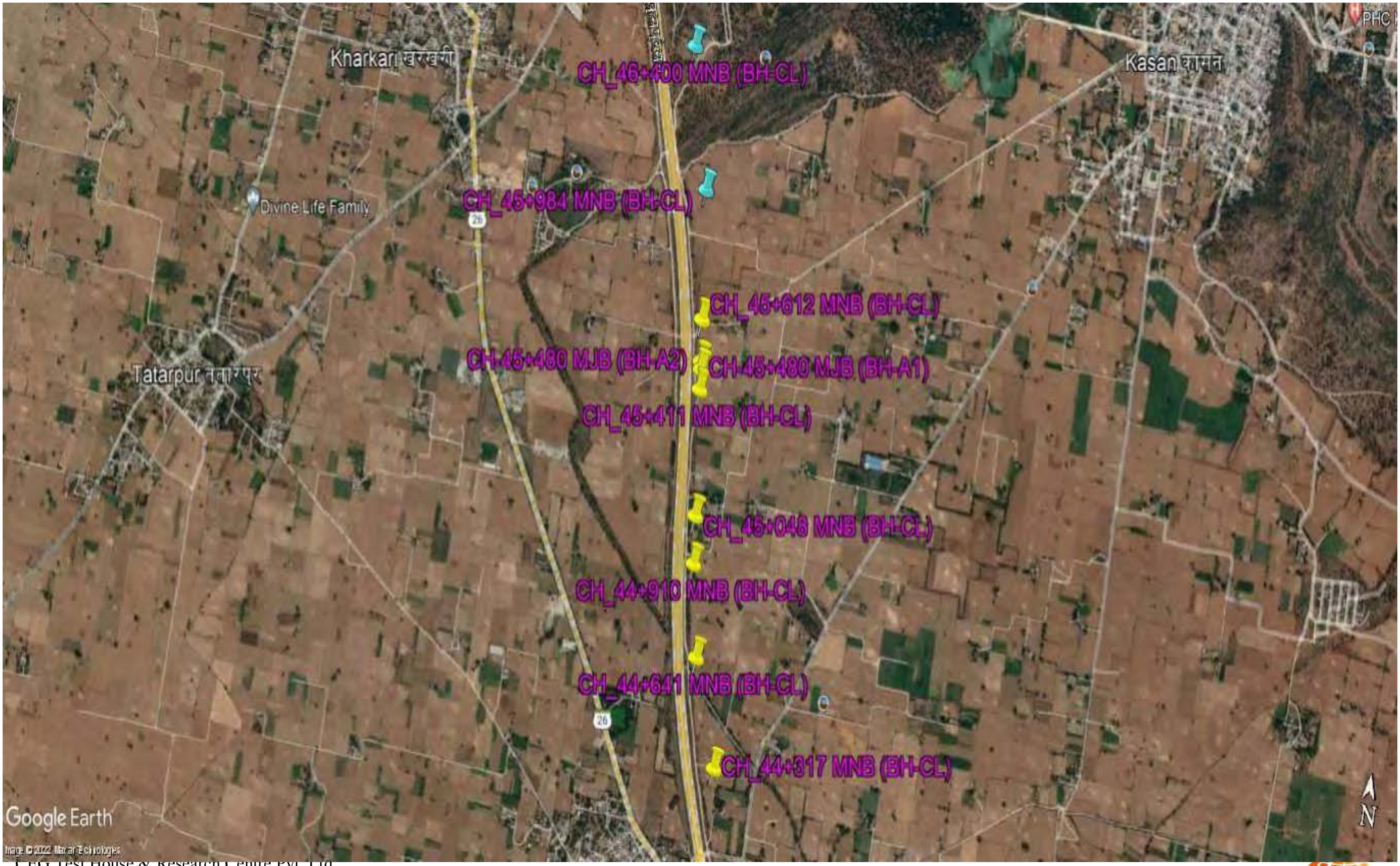
CH_44+050 MNB (BH-CL)
Billu Fast Food
Mokalwas मोकलवास
CH_43+732 MNB (BH-CL)
Brijesh yadav racing coaching center
New Delhi
CH_43+585 MNB (BH-CL)
CH_43+452 MNB (BH-CL)
CH-43+100 (BH-PLT-02)
Western Peripheral Expressway
Eakharpur एखारपुर
Google Earth
N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CH_46+400 MNB (BH-CL)
Kasan कसन
Divine Life Family
CH_45+984 MNB (BH-CL)
CH_45+612 MNB (BH-CL)
CH-45+480 MJB (BH-A2)
CH-45+480 MJB (BH-A1)
Tatarpur तातारपुर
CH_45+411 MNB (BH-CL)
CH_45+048 MNB (BH-CL)
CH_44+910 MNB (BH-CL)
CH_44+641 MNB (BH-CL)
CH_44+317 MNB (BH-CL)
Google Earth
N

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*Dhulawat	*Northing :*3124860 m	*Easting :*693884 m
Reduced Level (m):(+)265.96	*BH. No. :*BH-PLT-06	*BH Termination Depth (m):*12.45
Proposed / Existing Structure :-	*Water Table (m):*8.00	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*19-12-2021	*Date of Completion :*19-12-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification
0.0		DS						
0.5								
	0.75	UDS-1						
1.0							Yellowish brown, Loose, Sandy silt	ML-CL
1.5	1.5	SPT-1	1	2	3	5		
2.0								
	2.25	SPT-2	6	9	13	22		
2.5								
3.0	3	SPT-3	9	14	16	30		
3.5								
	3.75	SPT-4	14	17	20	37		
4.0								
4.5	4.5	UDS-2						
5.0								
5.5								
6.0	6	SPT-5	20	23	26	49	Yellowish brown, Medium dense to Very dense, Sandy silt	ML-CL
6.5								
7.0								
7.5	7.5	UDS-3						
8.0								
8.5								
9.0	9	SPT-6	24	26	28	26		
9.5								
10.0								

Graphic Log: 8.00m

(Depth v/s SPT N Value): 0 10 20 30 40 50 60 70 80 90 100

Special Observations

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*Dhulawat	*Northing :*3124860 m	*Easting :*693884 m
Reduced Level (m):(+)265.96	*BH. No. :*BH-PLT-06	*BH Termination Depth (m):*12.45
Proposed / Existing Structure :-	*Water Table (m):*8.00	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*19-12-2021	*Date of Completion :*19-12-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0											
10.5	10.5	UDS-4					Yellowish brown, Medium dense to Very dense, Sandy silt	ML-CL			
11.0											
11.5											
12.0	12	SPT-7	26	30	33	63					
	12.45										

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*29+487 km	*Northing :*3123405.825 m	*Easting :*696007.24 m
Reduced Level (m):(+)263.946	*BH. No. :*BH-A1	*BH Termination Depth (m):*53
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*27.53	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*03-10-2021	*Date of Completion :*05-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	SPT-1	3	4	5	9	Brown, Loose, Sandy silt of low plasticity	ML-CL			
1.5											
2.0											
2.5	2.5	UDS-1									
3.0											
3.5											
4.0	4	SPT-2	7	12	13	25	Brown, Medium dense, Sandy silt of low plasticity	ML-CL			
4.5											
5.0											
5.5	5.5	UDS-2									
6.0											
6.5											
7.0	7	SPT-3	14	22	27	49	Brown, Dense to very dense, Sandy silt of low plasticity with gravel	ML-CL			
7.5											
8.0											
8.5	8.5	UDS-3									
9.0											
9.5											
10.0	10	SPT-4	18	25	32	57					

(Depth v/s SPT N Value) axis: 0 10 20 30 40 50 60 70 80 90 100

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*29+487 km	*Northing :*3123405.825 m	*Easting :*696007.24 m
Reduced Level (m):(+)263.946	*BH. No. :*BH-A1	*BH Termination Depth (m):*53
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*27.53	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*03-10-2021	*Date of Completion :*05-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0											
10.5											
11.0											
11.5	11.5	UDS-4									
12.0											
12.5											
13.0	13	SPT-5	21	27	36	63					
13.5											
14.0											
14.5	14.5	UDS-5									
15.0							Brown, Dense to very dense, Sandy silt of low plasticity with gravel	ML-CL			
15.5											
16.0	16	SPT-6	22	39	43	82					
16.5											
17.0											
17.5	17.5	UDS-6									
18.0											
18.5											
19.0	19	SPT-7	35	75	25 (8cm)	>100					
19.5											
20.0											

(Depth v/s SPT N Value) axis: 0 10 20 30 40 50 60 70 80 90 100

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*29+487 km	*Northing :*3123405.825 m	*Easting :*696007.24 m
Reduced Level (m):(+)263.946	*BH. No. :*BH-A1	*BH Termination Depth (m):*53
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*27.53	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*03-10-2021	*Date of Completion :*05-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
20.0											
20.5	20.5	UDS*									
21.0											
21.5											
22.0	22	SPT-8	34	65	35 (7cm)	>100					
22.5											
23.0											
23.5	23.5	SPT-9	45	60	40 (7cm)	>100	Brown, Dense to very dense, Sandy silt of low plasticity with gravel	ML-CL			
24.0											
24.5											
25.0	25	SPT-10	50	100 (15cm)	-	>100					
25.5											
26.0											
26.5	26.5	UDS*									
27.0											
27.5									27.53m		
28.0	28	SPT-11	37	46	54 (7cm)	>100	Brown, Hard, Silty clay of low plasticity with gravel	CL			
28.5											
29.0											
29.5	29.5	UDS*									
30.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*29+487 km	*Northing :*3123405.825 m	*Easting :*696007.24 m
Reduced Level (m):(+)263.946	*BH. No. :*BH-A1	*BH Termination Depth (m):*53
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*27.53	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*03-10-2021	*Date of Completion :*05-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
30.0											
30.5											
31.0	31	SPT-12	38	51	49 (6cm)	>100					
31.5											
32.0											
32.5	32.5	UDS*									
33.0											
33.5											
34.0	34	SPT-13	100 (8cm)	-	-	>100					
34.5											
35.0							Brown, Hard, Silty clay of low plasticity with gravel	CL			
35.5	35.5	SPT-14	37	50	50 (11cm)	>100					
36.0											
36.5											
37.0	37	SPT-15	33	47	53 (6cm)	>100					
37.5											
38.0											
38.5	38.5	UDS*									
39.0											
39.5											
40.0	40	SPT-16	36	70	30 (9cm)	>100					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*29+487 km	*Northing :*3123405.825 m	*Easting :*696007.24 m
Reduced Level (m):(+)263.946	*BH. No. :*BH-A1	*BH Termination Depth (m):*53
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*27.53	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*03-10-2021	*Date of Completion :*05-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value) 0 10 20 30 40 50 60 70 80 90 100	Special Observations
40.0											
40.5											
41.0											
41.5	41.5	UDS*									
42.0											
42.5											
43.0	43	SPT-17	44	57	43 (5cm)	>100					
43.5	43.5	UDS*									
44.0											
44.5											
45.0							Brown, Hard, Silty clay of low plasticity with gravel	CL			
45.5											
46.0	46	SPT-18	30	47	53 (6cm)	>100					
46.5											
47.0											
47.5	47.5	UDS*									
48.0											
48.5											
49.0	49	SPT-19	31	57	43 (5cm)	>100					
49.5											
50.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*29+487 km	*Northing :*3123405.825 m	*Easting :*696007.24 m
Reduced Level (m):(+)263.946	*BH. No. :*BH-A1	*BH Termination Depth (m):*53
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*27.53	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*03-10-2021	*Date of Completion :*05-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
50.0											
50.5	50.5	SPT-20	38	70	30 (9cm)	>100					
51.0											
51.5							Brown, Hard, Silty clay of low plasticity with gravel	CL			
52.0	52	SPT-21	47	100 (15cm)	-	>100					
	52.3	-									
52.5											
53.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*29+487 km	*Northing :*3123393.836 m	*Easting :*695931.872 m
Reduced Level (m):(+)266.542	*BH. No. :*BH-A2	*BH Termination Depth (m):*53
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*27.39	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*03-10-2021	*Date of Completion :*06-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS-1									
0.5											
1.0	1	UDS-1									
1.5											
2.0							Brown, Medium dense, Silty sand with clay	SM-SC			
2.5	2.5	SPT-1	3	5	8	13					
3.0											
3.5											
4.0	4	UDS-2									
4.5											
5.0											
5.5	5.5	SPT-2	10	18	34	52					
6.0											
6.5											
7.0	7	UDS-3					Brown, Very dense, Sandy silt of low plasticity with gravel	ML-CL			
7.5											
8.0											
8.5	8.5	SPT-3	15	22	30	52					
9.0											
9.5											
10.0	10	UDS-4									

(Depth v/s SPT N Value) axis: 0 10 20 30 40 50 60 70 80 90 100

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*29+487 km	*Northing :*3123393.836 m	*Easting :*695931.872 m
Reduced Level (m):(+)266.542	*BH. No. :*BH-A2	*BH Termination Depth (m):*53
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*27.39	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*03-10-2021	*Date of Completion :*06-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0											
10.5											
11.0											
11.5	11.5	SPT-4	17	25	31	56	Brown, Very dense, Sandy silt of low plasticity with gravel	ML-CL			
12.0											
12.5											
13.0	13	UDS-5									
13.5											
14.0											
14.5	14.5	SPT-5	20	28	72	>100					
15.0											
15.5											
16.0	16	SPT-6	40	100 (15cm)	-	>100					
16.5							Brown, Very dense, Silty sand with clay & gravel	SM-SC			
17.0											
17.5	17.5	SPT-7	32	45	55 (6cm)	>100					
18.0											
18.5											
19.0	19	SPT-8	50	100 (10cm)	-	>100					
19.5											
20.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*29+487 km	*Northing :*3123393.836 m	*Easting :*695931.872 m
Reduced Level (m):(+)266.542	*BH. No. :*BH-A2	*BH Termination Depth (m):*53
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*27.39	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*03-10-2021	*Date of Completion :*06-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
20.0											
20.5	20.5	SPT-9	37	100 (15cm)	-	>100	Brown, Very dense, Silty sand with clay & gravel	SM-SC			
21.0											
21.5											
22.0	22	SPT-10	40	100 (12cm)	-	>100					
22.5											
23.0											
23.5	23.5	SPT-11	45	100 (10cm)	-	>100					
24.0											
24.5											
25.0	25	SPT-12	55	100 (5cm)	-	>100					
25.5											
26.0							Brown, Very dense, Sandy silt of low plasticity with gravel	ML-CL			
26.5	26.5	SPT-13	48	100 (5cm)	-	>100					
27.0											
27.5									▼27.39m		
28.0	28	SPT-14	45	100 (7cm)	-	>100					
28.5											
29.0											
29.5	29.5	SPT-15	52	100 (11cm)	-	>100					
30.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*29+487 km	*Northing :*3123393.836 m	*Easting :*695931.872 m
Reduced Level (m):(+)266.542	*BH. No. :*BH-A2	*BH Termination Depth (m):*53
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*27.39	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*03-10-2021	*Date of Completion :*06-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
30.0											
30.5							Brown, Very dense, Sandy silt of low plasticity with gravel	ML-CL			
31.0	31	SPT-16	52	100 (12cm)	-	>100					
31.5											
32.0											
32.5	32.5	SPT-17	35	55	45 (13cm)	>100					
33.0											
33.5											
34.0	34	SPT-18	40	61	39 (8cm)	>100					
34.5											
35.0											
35.5	35.5	SPT-19	45	65	35 (10cm)	>100	Brown, Hard, Silty clay of low plasticity with gravel	CL			
36.0											
36.5											
37.0	37	SPT-20	100 (10cm)	-	-	>100					
37.5											
38.0											
38.5	38.5	SPT-21	100 (12cm)	-	-	>100					
39.0											
39.5											
40.0	40	SPT-22	100 (15cm)	-	-	>100					

(Depth v/s SPT N Value) axis: 0 10 20 30 40 50 60 70 80 90 100

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*29+487 km	*Northing :*3123393.836 m	*Easting :*695931.872 m
Reduced Level (m):(+)266.542	*BH. No. :*BH-A2	*BH Termination Depth (m):*53
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*27.39	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*03-10-2021	*Date of Completion :*06-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
40.0										0 10 20 30 40 50 60 70 80 90 100	
40.5											
41.0							Brown, Hard, Silty clay of low plasticity with gravel	CL			
41.5	41.5	SPT-23	45	100 (8cm)	-	>100					
42.0											
42.5											
43.0	43	SPT-24	52	100 (5cm)	-	>100					
43.5											
44.0											
44.5	44.5	SPT-25	39	65	35 (5cm)	>100	Brown, Very dense, Sandy silt of low plasticity with gravel	ML-CL			
45.0											
45.5											
46.0	46	SPT-26	45	60	40 (9cm)	>100					
46.5											
47.0											
47.5	47.5	SPT-27	38	65	35 (7cm)	>100					
48.0	48	SPT-28	45	70	30 (9cm)	>100					
48.5							Brown, Hard, Silty clay of low plasticity with gravel	CL			
49.0											
49.5											
50.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*29+487 km	*Northing :*3123393.836 m	*Easting :*695931.872 m
Reduced Level (m):(+)266.542	*BH. No. :*BH-A2	*BH Termination Depth (m):*53
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*27.39	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*03-10-2021	*Date of Completion :*06-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
50.0											
50.5	50.5	SPT-29	44	66	34 (12cm)	>100					
51.0											
51.5							Brown, Hard, Silty clay of low plasticity with gravel	CL			
52.0	52	SPT-30	47	100 (11cm)	-	>100					
	52.26	DS-2									
52.5											
53.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*29+860 km	*Northing :*3123534.155 m	*Easting :*695623.682 m
Reduced Level (m):(+)263.108	*BH. No. :*BH-CL	*BH Termination Depth (m):*10
*Proposed / Existing Structure :*Minor Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*20-11-2021	*Date of Completion :*20-11-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5	0.5	SPT-1	2	4	5	9					
1.0											
1.5	1.5	SPT-2	4	5	7	12					
2.0											
2.5	2.25	UDS-1					Brown, Loose to medium dense, Sandy silt of low plasticity	ML-CL			
3.0	3	SPT-3	5	6	8	14					
3.5											
4.0											
4.5	4.5	SPT-4	8	12	14	26					
5.0											
5.5	5.25	UDS-2									
6.0	6	SPT-5	10	16	17	33	Brown, Very stiff to hard, Silty clay of low plasticity	CL			
6.5											
7.0											
7.5	7.5	SPT-6	12	18	25	43					
8.0											
8.5	8.25	UDS-3									
9.0	9	SPT-7	14	22	38	60	Brown, Dense to very dense, Sandy silt of low plasticity	ML-CL			
9.5											
10.0	10	SPT-8	13	20	35	55					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*30+176 km	*Northing :*3123643.872 m	*Easting :*695330.324 m
Reduced Level (m):(+)263.553	*BH. No. :*BH-CL	*BH Termination Depth (m):*20
*Proposed / Existing Structure :*Minor Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*21-11-2021	*Date of Completion :*21-11-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5	0.5	SPT-1	3	4	6	10					
1.0											
1.5	1.5	SPT-2	5	6	7	13					
2.0											
2.5	2.25	UDS-1					Brown, Medium dense, Sandy silt of low plasticity	ML-CL			
3.0	3	SPT-3	6	7	9	16					
3.5											
4.0											
4.5	4.5	SPT-4	9	11	15	26					
5.0											
5.5	5.25	UDS-2									
6.0	6	SPT-5	11	18	20	38					
6.5											
7.0											
7.5	7.5	SPT-6	13	17	26	43	Brown, Hard, Silty clay of low plasticity with gravel	CL			
8.0											
8.5	8.25	UDS-3									
9.0	9	SPT-7	3	23	34	57					
9.5											
10.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*30+176 km	*Northing :*3123643.872 m	*Easting :*695330.324 m
Reduced Level (m):(+)263.553	*BH. No. :*BH-CL	*BH Termination Depth (m):*20
*Proposed / Existing Structure :*Minor Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*21-11-2021	*Date of Completion :*21-11-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0											
10.5	10.5	SPT-8	15	20	39	59					
11.0											
	11.25	UDS-4									
11.5											
12.0	12	SPT-9	12	25	42	67					
12.5											
13.0											
13.5	13.5	SPT-10	16	29	48	77					
14.0											
	14.25	UDS-5									
14.5											
15.0	15	SPT-11	27	42	58 (12cm)	>100	Brown, Hard, Silty clay of low plasticity with gravel	CL			
15.5											
16.0											
16.5	16.5	SPT-12	32	47	53 (10cm)	>100					
17.0											
	17.25	UDS*									
17.5											
18.0	18	SPT-13	35	45	55 (15cm)	>100					
18.5											
19.0											
19.5	19.5	SPT-14	38	52	48 (7cm)	>100					
20.0	20										

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*30+478 km	*Northing :*3123752.008 m	*Easting :*695041.409 m
Reduced Level (m):(+)264.728	*BH. No. :*BH-CL	*BH Termination Depth (m):*12
*Proposed / Existing Structure :*Minor Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*16-10-2021	*Date of Completion :*16-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	UDS-1									
1.5											
2.0							Brown, Very stiff, Silty clay of low plasticity with gravel	CL			
2.5	2.5	SPT-1	7	9	12	21					
3.0											
3.5											
4.0	4	UDS-2									
4.5											
5.0											
5.5	5.5	SPT-2	10	13	15	28					
6.0											
6.5											
7.0	7	UDS-3					Brown, Medium dense, Sandy silt of low plasticity with gravel	ML-CL			
7.5											
8.0											
8.5	8.5	SPT-3	8	10	13	23					
9.0											
9.5											
10.0	10	UDS-4									

(Depth v/s SPT N Value) axis: 0 10 20 30 40 50 60 70 80 90 100

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*30+478 km	*Northing :*3123752.008 m	*Easting :*695041.409 m
Reduced Level (m):(+)264.728	*BH. No. :*BH-CL	*BH Termination Depth (m):*12
*Proposed / Existing Structure :*Minor Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*16-10-2021	*Date of Completion :*16-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0										0 10 20 30 40 50 60 70 80 90 100	
10.5											
11.0							Brown, Medium dense, Sandy silt of low plasticity with gravel	ML-CL			
11.5	11.5	SPT-4	11	12	16	28					
12.0	11.95	-									
	12										

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*30+697 km	*Northing :*3123845.139 m	*Easting :*694847.555 m
Reduced Level (m):(+)264.094	*BH. No. :*BH-CL	*BH Termination Depth (m):*12
*Proposed / Existing Structure :*Minor Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*16-10-2021	*Date of Completion :*16-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	SPT-1	8	3	7	10					
1.5											
2.0							Brown, Loose, Silty sand	SM			
2.5	2.5	UDS-1									
3.0											
3.5											
4.0	4	SPT-2	6	6	10	16					
4.5											
5.0											
5.5	5.5	UDS-2									
6.0											
6.5							Brown, Medium dense, Silty sand	SM			
7.0	7	SPT-3	10	13	16	29					
7.5											
8.0											
8.5	8.5	UDS-3									
9.0											
9.5							Brown, Dense, Silty sand	SM			
10.0	10	SPT-4	15	19	22	41					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*30+697 km	*Northing :*3123845.139 m	*Easting :*694847.555 m
Reduced Level (m):(+)264.094	*BH. No. :*BH-CL	*BH Termination Depth (m):*12
*Proposed / Existing Structure :*Minor Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*16-10-2021	*Date of Completion :*16-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0										0 10 20 30 40 50 60 70 80 90 100	
10.5											
11.0							Brown, Dense, Silty sand	SM			
11.5	11.5	UDS-4									
12.0	11.95	-									
	12										

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*31+354 km	*Northing :*3124304.952 m	*Easting :*694378.453 m
Reduced Level (m):(+)264.674	*BH. No. :*BH-CL	*BH Termination Depth (m):*15
*Proposed / Existing Structure :*Minor Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*17-10-2021	*Date of Completion :*17-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	SPT-1	3	4	6	10					
1.5											
2.0											
2.5	2.5	UDS-1					Brown, Stiff to very stiff, Silty clay of low plasticity	CL			
3.0											
3.5											
4.0	4	SPT-2	6	9	12	21					
4.5											
5.0											
5.5	5.5	UDS-2									
6.0											
6.5											
7.0	7	SPT-3	12	15	21	36					
7.5											
8.0							Brown, Hard, Silty clay of low plasticity with gravel	CL			
8.5	8.5	UDS-3									
9.0											
9.5											
10.0	10	SPT-4	10	18	24	42					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*31+354 km	*Northing :*3124304.952 m	*Easting :*694378.453 m
Reduced Level (m):(+)264.674	*BH. No. :*BH-CL	*BH Termination Depth (m):*15
*Proposed / Existing Structure :*Minor Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*17-10-2021	*Date of Completion :*17-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0										0 10 20 30 40 50 60 70 80 90 100	
10.5											
11.0											
11.5	11.5	UDS-4									
12.0											
12.5							Brown, Hard, Silty clay of low plasticity with gravel	CL			
13.0	13	SPT-5	17	21	30	51					
13.5											
14.0											
14.5	14.5	UDS-5									
15.0	15	-									

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*32+160 km	*Northing :*3124884.26 m	*Easting :*693822.662 m
Reduced Level (m):(+)263.186	*BH. No. :*BH-CL	*BH Termination Depth (m):*10
*Proposed / Existing Structure :*Minor Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*17-10-2021	*Date of Completion :*17-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	UDS-1									
1.5											
2.0											
2.5	2.5	SPT-1	4	6	10	16					
3.0											
3.5											
4.0	4	UDS-2									
4.5											
5.0							Brown, Very stiff, Silty clay of low plasticity	CL			
5.5	5.5	SPT-2	7	10	12	22					
6.0											
6.5											
7.0	7	UDS-3									
7.5											
8.0											
8.5	8.5	SPT-3	8	12	15	27					
9.0											
9.5											
10.0	10	UDS-4									

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*32+487 km	*Northing :*3125111.207 m	*Easting :*69358.448 m
Reduced Level (m):(+)261.988	*BH. No. :*BH-CL	*BH Termination Depth (m):*12
*Proposed / Existing Structure :*Minor Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*16-11-2021	*Date of Completion :*16-11-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5	0.5	SPT-1	4	5	7	12					
1.0											
1.5	1.5	SPT-2	6	8	12	20					
2.0											
2.5	2.25	UDS-1					Brown, Medium dense, Sandy silt of low plasticity	ML-CL			
3.0	3	SPT-3	8	10	15	25					
3.5											
4.0											
4.5	4.5	SPT-4	10	16	25	41					
5.0											
5.5	5.25	UDS-2									
6.0	6	SPT-5	13	15	27	42	Brown, Hard, Silty clay of low plasticity	CL			
6.5											
7.0											
7.5	7.5	SPT-6	12	17	30	47					
8.0											
8.5	8.25	UDS-3									
9.0	9	SPT-7	14	20	34	54	Brown, Very dense, Silty sand with clay	SM-SC			
9.5											
10.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*32+487 km	*Northing :*3125111.207 m	*Easting :*69358.448 m
Reduced Level (m):(+)261.988	*BH. No. :*BH-CL	*BH Termination Depth (m):*12
*Proposed / Existing Structure :*Minor Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*16-11-2021	*Date of Completion :*16-11-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0											
10.5	10.5	SPT-8	19	23	34	57	Brown, Very dense, Silty sand with clay	SM-SC			
11.0											
	11.25	UDS-4									
11.5											
12.0	12	SPT-9	20	26	37	63					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*30+083 km	*Northing :*3125192.295 m	*Easting :*693503.406 m
Reduced Level (m):(+)263.667	*BH. No. :*BH-CL	*BH Termination Depth (m):*10
*Proposed / Existing Structure :*Minor Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not-used
*Date of Start :*16-11-2021	*Date of Completion :*16-11-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5	0.5	SPT-1	4	6	8	14	Brown, Very stiff, Silty clay of low plasticity	CL			
1.0											
1.5	1.5	SPT-2	6	7	11	18					
2.0											
2.5	2.25	UDS-1									
3.0	3	SPT-3	6	8	12	20	Brown, Medium dense, Sandy silt of low plasticity	ML-CL			
3.5											
4.0											
4.5	4.5	SPT-4	7	8	14	22					
5.0											
5.5	5.25	UDS-2									
6.0	6	SPT-5	8	10	18	28					
6.5											
7.0											
7.5	7.5	SPT-6	8	11	17	28	Brown, Very stiff to hard, Silty clay of low plasticity	CL			
8.0											
8.5	8.25	UDS-3									
9.0	9	SPT-7	9	14	18	32					
9.5											
10.0	10	SPT-8	12	16	22	38					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*30+488 km	*Northing :*3125465.069 m	*Easting :*693220.478 m
Reduced Level (m):(+)262.988	*BH. No. :*BH-A1	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*27.84	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not-used
*Date of Start :*28-09-2021	*Date of Completion :*29-09-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	SPT-1	3	4	5	9					
1.5											
2.0							Brown, Loose, Silty sand with clay	SM-SC			
2.5	2.5	UDS-1									
3.0											
3.5											
4.0	4	SPT-2	6	9	13	22					
4.5											
5.0											
5.5	5.5	UDS-2									
6.0											
6.5											
7.0	7	SPT-3	9	13	20	33	Brown, Very stiff to hard, Silty clay of low plasticity with gravel	CL			
7.5											
8.0											
8.5	8.5	UDS-3									
9.0											
9.5											
10.0	10	SPT-4	11	15	22	37					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*30+488 km	*Northing :*3125465.069 m	*Easting :*693220.478 m
Reduced Level (m):(+)262.988	*BH. No. :*BH-A1	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*27.84	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not-used
*Date of Start :*28-09-2021	*Date of Completion :*29-09-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0										0 10 20 30 40 50 60 70 80 90 100	
10.5											
11.0											
11.5	11.5	UDS-4									
12.0											
12.5											
13.0	13	SPT-5	10	16	24	40	Brown, Very stiff to hard, Silty clay of low plasticity with gravel	CL			
13.5											
14.0											
14.5	14.5	UDS-5									
15.0											
15.5											
16.0	16	SPT-6	26	42	58 (15cm)	>100					
16.5											
17.0											
17.5	17.5	SPT-7	28	65	35 (5cm)	>100					
18.0							Brown, Very dense, Silty sand with gravel	SM			
18.5											
19.0	19	SPT-8	50	100 (12cm)	-	>100					
19.5											
20.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*30+488 km	*Northing :*3125465.069 m	*Easting :*693220.478 m
Reduced Level (m):(+)262.988	*BH. No. :*BH-A1	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*27.84	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not-used
*Date of Start :*28-09-2021	*Date of Completion :*29-09-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value) 0 10 20 30 40 50 60 70 80 90 100	Special Observations
20.0							Brown, Very dense, Silty sand with gravel	SM			
20.5	20.5	SPT-9	24	38	51	89					
21.0											
21.5											
22.0	22	SPT-10	27	45	54	99					
22.5											
23.0											
23.5	23.5	UDS-6					Brown, Very dense, Sandy silt of low plasticity with gravel	ML-CL			
24.0											
24.5											
25.0	25	SPT-11	22	27	33	60					
25.5											
26.0											
26.5	26.5	UDS-7									
27.0											
27.5											
28.0	28	SPT-12	40	100 (15cm)	-	>100	Brown, Hard, Silty clay of low plasticity with gravel	CL	27.84m		
28.5											
29.0											
29.5	29.5	SPT-13	45	100 (13cm)	-	>100					
30.0	30	DS-2									

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*30+488 km	*Northing :*3125478.956 m	*Easting :*693206.085 m
Reduced Level (m):(+)262.292	*BH. No. :*BH-A2	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*26.98	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not-used
*Date of Start :*28-09-2021	*Date of Completion :*29-09-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	UDS-1									
1.5											
2.0							Brown, Medium dense, Silty sand with clay	SM-SC			
2.5	2.5	SPT-1	4	7	9	16					
3.0											
3.5											
4.0	4	UDS-2									
4.5											
5.0											
5.5	5.5	SPT-2	9	11	13	24					
6.0											
6.5											
7.0	7	UDS-3					Brown, Very stiff to hard, Silty clay of low plasticity	CL			
7.5											
8.0											
8.5	8.5	SPT-3	11	14	17	31					
9.0											
9.5											
10.0	10	UDS-4									

(Depth v/s SPT N Value) axis: 0 10 20 30 40 50 60 70 80 90 100

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*30+488 km	*Northing :*3125478.956 m	*Easting :*693206.085 m
Reduced Level (m):(+)262.292	*BH. No. :*BH-A2	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*26.98	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not-used
*Date of Start :*28-09-2021	*Date of Completion :*29-09-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value) 0 10 20 30 40 50 60 70 80 90 100	Special Observations
10.0											
10.5											
11.0											
11.5	11.5	SPT-4	14	18	22	40					
12.0											
12.5											
13.0	13	UDS-5					Brown, Dense to very dense, Sandy silt of low plasticity with gravel	ML-CL			
13.5											
14.0											
14.5	14.5	SPT-5	17	25	29	54					
15.0											
15.5											
16.0	16	UDS-6									
16.5											
17.0											
17.5	17.5	SPT-6	23	33	43	76					
18.0							Brown, Very dense, Silty sand with gravel	SM			
18.5											
19.0	19	UDS-7									
19.5											
20.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*30+488 km	*Northing :*3125478.956 m	*Easting :*693206.085 m
Reduced Level (m):(+)262.292	*BH. No. :*BH-A2	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*26.98	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not-used
*Date of Start :*28-09-2021	*Date of Completion :*29-09-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
20.0											
20.5	20.5	SPT-7	40	55	45 (6cm)	>100	Brown, Very dense, Silty sand with gravel	SM			
21.0											
21.5											
22.0	22	SPT-8	43	62	38 (4cm)	>100					
22.5											
23.0											
23.5	23.5	SPT-9	17	25	31	56					
24.0							Brown, Hard, Silty clay of low plasticity with gravel	CL			
24.5											
25.0	25	UDS-8									
25.5											
26.0											
26.5	26.5	SPT-10	20	27	35	62					
27.0									26.98m		
27.5											
28.0	28	UDS*									
28.5	28.5	SPT-11	70	100 (5cm)	-	>100					
29.0											
29.5	29.5	SPT-12				>100					
30.0	30	DS-2									

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*31+095 km	*Northing :*3125892.043 m	*Easting :*692778.166 m
Reduced Level (m):(+)261.355	*BH. No. :*BH-CL	*BH Termination Depth (m):*10
*Proposed / Existing Structure :*Minor Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not-used
*Date of Start :*16-11-2021	*Date of Completion :*16-11-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5	0.5	SPT-1	3	4	4	8					
1.0											
1.5	1.5	SPT-2	5	5	7	12	Brown, Stiff, Silty clay of low plasticity	CL			
2.0											
	2.25	UDS-1									
2.5											
3.0	3	SPT-3	6	8	10	18					
3.5											
4.0											
4.5	4.5	SPT-4	7	8	12	20					
5.0											
	5.25	UDS-2					Brown, Medium dense, Silty sand with clay	SM-SC			
5.5											
6.0	6	SPT-5	8	10	14	24					
6.5											
7.0											
7.5	7.5	SPT-6	8	12	17	29					
8.0											
	8.25	UDS-3									
8.5											
9.0	9	SPT-7	9	14	19	33	Brown, Very stiff to hard, Silty clay of low plasticity	CL			
9.5											
10.0	10	SPT-8	9	15	21	36					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*31+714 km	*Northing :*3126281.196 m	*Easting :*692316.719 m
Reduced Level (m):(+)260.608	*BH. No. :*BH-A1	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*36.55	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not-used
*Date of Start :*28-09-2021	*Date of Completion :*29-09-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	UDS-1									
1.5											
2.0											
2.5	2.5	SPT-1	4	5	6	11					
3.0											
3.5											
4.0	4	UDS-2									
4.5											
5.0							Brown, Medium dense, Sandy silt of low plasticity	ML-CL			
5.5	5.5	SPT-2	5	7	9	16					
6.0											
6.5											
7.0	7	UDS-3									
7.5											
8.0											
8.5	8.5	SPT-3	8	11	16	27					
9.0											
9.5											
10.0	10	UDS-4									

(Depth v/s SPT N Value) axis: 0 10 20 30 40 50 60 70 80 90 100

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*31+714 km	*Northing :*3126281.196 m	*Easting :*692316.719 m
Reduced Level (m):(+)260.608	*BH. No. :*BH-A1	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*36.55	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not-used
*Date of Start :*28-09-2021	*Date of Completion :*29-09-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value) 0 10 20 30 40 50 60 70 80 90 100	Special Observations
10.0											
10.5											
11.0											
11.5	11.5	SPT-4	6	9	12	21					
12.0											
12.5											
13.0	13	UDS-5									
13.5											
14.0											
14.5	14.5	SPT-5	7	10	14	24	Brown, Medium dense, Sandy silt of low plasticity	ML-CL			
15.0											
15.5											
16.0	16	UDS-6									
16.5											
17.0											
17.5	17.5	SPT-6	8	11	15	26					
18.0											
18.5											
19.0	19	UDS-7									
19.5							Brown, Very dense, Sandy silt of low plasticity with gravel	ML-CL			
20.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*31+714 km	*Northing :*3126281.196 m	*Easting :*692316.719 m
Reduced Level (m):(+)260.608	*BH. No. :*BH-A1	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*36.55	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not-used
*Date of Start :*28-09-2021	*Date of Completion :*29-09-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value) 0 10 20 30 40 50 60 70 80 90 100	Special Observations
20.0											
20.5	20.5	SPT-7	15	35	45	80					
21.0											
21.5											
22.0	22	UDS-8									
22.5											
23.0											
23.5	23.5	SPT-8	16	22	38	60					
24.0											
24.5											
25.0	25	UDS-9					Brown, Very dense, Sandy silt of low plasticity with gravel	ML-CL			
25.5											
26.0											
26.5	26.5	SPT-9	30	53	47 (12cm)	>100					
27.0											
27.5											
28.0	28	UDS-10									
28.5											
29.0											
29.5	29.5	SPT-10	31	57	43 (9cm)	>100					
30.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*31+714 km	*Northing :*3126281.196 m	*Easting :*692316.719 m
Reduced Level (m):(+)260.608	*BH. No. :*BH-A1	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*36.55	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not-used
*Date of Start :*28-09-2021	*Date of Completion :*29-09-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
30.0											
30.5											
31.0	31	SPT-11	33	56	44 (8cm)	>100					
31.5											
32.0											
32.5	32.5	SPT-12	36	62	38 (5cm)	>100					
33.0											
33.5											
34.0	34	SPT-13	34	100 (14cm)	-	>100					
34.5											
35.0							Brown, Very dense, Sandy silt of low plasticity with gravel	ML-CL			
35.5	35.5	SPT-14	32	40	42	82					
36.0											
36.5									36.55m		
37.0	37	UDS-11									
37.5											
38.0											
38.5	38.5	SPT-15	24	35	46	81					
39.0											
39.5											
40.0	40	SPT-16	26	38	50	88					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*31+714 km	*Northing :*3126299.382 m	*Easting :*692289.084 m
Reduced Level (m):(+)261.768	*BH. No. :*BH-A2	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*36.33	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not-used
*Date of Start :*28-09-2021	*Date of Completion :*29-09-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	SPT-1	3	4	4	8					
1.5											
2.0											
2.5	2.5	UDS-1									
3.0											
3.5											
4.0	4	SPT-2	5	7	9	16					
4.5											
5.0							Brown, Loose to medium dense, Sandy silt of low plasticity	ML-CL			
5.5	5.5	UDS-2									
6.0											
6.5											
7.0	7	SPT-3	6	8	13	21					
7.5											
8.0											
8.5	8.5	UDS-3									
9.0											
9.5											
10.0	10	SPT-4	8	11	14	25					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*31+714 km	*Northing :*3126299.382 m	*Easting :*692289.084 m
Reduced Level (m):(+)261.768	*BH. No. :*BH-A2	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*36.33	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not-used
*Date of Start :*28-09-2021	*Date of Completion :*29-09-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value) 0 10 20 30 40 50 60 70 80 90 100	Special Observations
10.0											
10.5							Brown, Loose to medium dense, Sandy silt of low plasticity	ML-CL			
11.0											
11.5	11.5	UDS-4									
12.0											
12.5											
13.0	13	SPT-5	24	42	58 (8cm)	>100					
13.5											
14.0											
14.5	14.5	UDS-5									
15.0											
15.5											
16.0	16	SPT-6	12	20	35	55	Brown, Very dense, Sandy silt of low plasticity with gravel	ML-CL			
16.5											
17.0											
17.5	17.5	UDS-6									
18.0											
18.5											
19.0	19	SPT-7	14	30	50	80					
19.5											
20.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*31+714 km	*Northing :*3126299.382 m	*Easting :*692289.084 m
Reduced Level (m):(+)261.768	*BH. No. :*BH-A2	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*36.33	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not-used
*Date of Start :*28-09-2021	*Date of Completion :*29-09-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value) 0 10 20 30 40 50 60 70 80 90 100	Special Observations
20.0											
20.5	20.5	UDS-7									
21.0											
21.5											
22.0	22	SPT-8	38	64	36 (6cm)	>100					
22.5											
23.0											
23.5	23.5	UDS-8									
24.0											
24.5											
25.0	25	SPT-9	32	53	47 (12cm)	>100	Brown, Very dense, Sandy silt of low plasticity with gravel	ML-CL			
25.5											
26.0											
26.5	26.5	UDS-9									
27.0											
27.5											
28.0	28	SPT-10	26	36	39	75					
28.5											
29.0											
29.5	29.5	UDS-10									
30.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*31+714 km	*Northing :*3126299.382 m	*Easting :*692289.084 m
Reduced Level (m):(+)261.768	*BH. No. :*BH-A2	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*36.33	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not-used
*Date of Start :*28-09-2021	*Date of Completion :*29-09-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
30.0											
30.5											
31.0	31	SPT-11	29	56	44 (7cm)	>100					
31.5											
32.0											
32.5	32.5	SPT-12	30	61	39 (5cm)	>100					
33.0											
33.5											
34.0	34	SPT-13	34	100 (12cm)	-	>100					
34.5											
35.0							Brown, Very dense, Sandy silt of low plasticity with gravel	ML-CL			
35.5	35.5	SPT-14	33	70	30 (5cm)	>100					
36.0											
36.5									▼36.33m		
37.0	37	SPT-15	25	33	44	77					
37.5											
38.0											
38.5	38.5	UDS-11									
39.0											
39.5											
40.0	40	SPT-16	28	40	50	90					

(Depth v/s SPT N Value) axis: 0 10 20 30 40 50 60 70 80 90 100

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*32+191 km	*Northing :*3126530.493 m	*Easting :*691893.138 m
Reduced Level (m):(+)262.443	*BH. No. :*BH-CL	*BH Termination Depth (m):*10
*Proposed / Existing Structure :*Minor Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*30-09-2021	*Date of Completion :*30-09-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	UDS-1									
1.5											
2.0							Brown, Medium dense, Silty sand	SM			
2.5	2.5	SPT-1	7	9	11	20					
3.0											
3.5											
4.0	4	UDS-2									
4.5											
5.0											
5.5	5.5	SPT-2	12	15	18	33					
6.0											
6.5											
7.0	7	UDS-3					Brown, Medium dense to dense, Sandy silt of low plasticity with gravel	ML-CL			
7.5											
8.0											
8.5	8.5	SPT-3	20	24	29	53					
9.0											
9.5											
10.0	10	UDS-4									

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*32+738 km	*Northing :*3126801.35 m	*Easting :*691418.519 m
Reduced Level (m):(+)260.749	*BH. No. :*BH-CL	*BH Termination Depth (m):*10
*Proposed / Existing Structure :*Minor Bridge	*Water Table (m):*Not encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*29-09-2021	*Date of Completion :*29-09-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	SPT-1	3	4	6	10					
1.5											
2.0											
2.5	2.5	UDS-1									
3.0											
3.5							Brown, Medium dense, Sandy silt of low plasticity	ML-CL			
4.0	4	SPT-2	6	9	11	20					
4.5											
5.0											
5.5	5.5	UDS-2									
6.0											
6.5											
7.0	7	SPT-3	11	15	18	33					
7.5											
8.0											
8.5	8.5	UDS-3					Brown, Hard, Silty clay of low plasticity with gravel	CL			
9.0											
9.5											
10.0	10	SPT-4	20	25	29	54					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*33+713 km	*Northing :*3127280.622 m	*Easting :*690578.397 m
Reduced Level (m):(+)257.231	*BH. No. :*33+713_A1	*BH Termination Depth (m):*30
Proposed / Existing Structure :-	*Water Table (m):*28.98	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*28-09-2021	*Date of Completion :*29-09-2021	

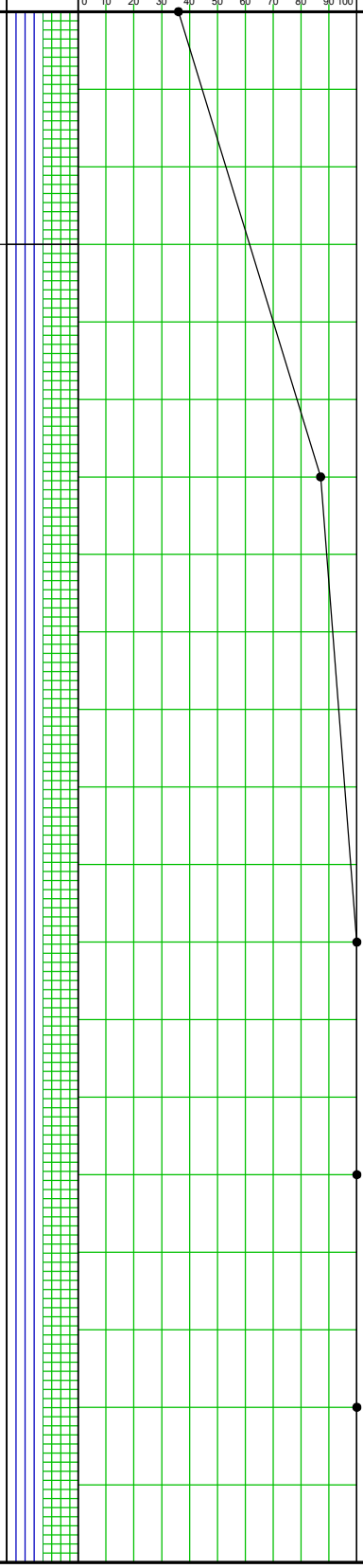
Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	SPT-1	7	9	13	22					
1.5											
2.0											
2.5	2.5	UDS-1					Brown, Medium dense, Sandy silt of low plasticity	ML-CL			
3.0											
3.5											
4.0	4	SPT-2	8	11	15	26					
4.5											
5.0											
5.5	5.5	UDS-2									
6.0											
6.5											
7.0	7	SPT-3	14	33	49	82	Brown, Hard, Silty clay of low plasticity with gravel	CL			
7.5											
8.0											
8.5	8.5	UDS-3									
9.0											
9.5							Brown, Dense, Sandy silt of low plasticity with gravel	ML-CL			
10.0	10	SPT-4	11	15	21	36					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*33+713 km	*Northing :*3127280.622 m	*Easting :*690578.397 m
Reduced Level (m):(+)257.231	*BH. No. :*33+713_A1	*BH Termination Depth (m):*30
Proposed / Existing Structure :-	*Water Table (m):*28.98	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*28-09-2021	*Date of Completion :*29-09-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0											
10.5							Brown, Dense, Sandy silt of low plasticity with gravel	ML-CL			
11.0											
11.5	11.5	UDS-4									
12.0											
12.5											
13.0	13	SPT-5	18	42	45	87					
13.5											
14.0											
14.5	14.5	UDS-5									
15.0											
15.5											
16.0	16	SPT-6	30	79	21 (3cm)	>100	Brown, Very dense, Sandy silt of low plasticity with gravel	ML-CL			
16.5											
17.0											
17.5	17.5	SPT-7	32	100 (11cm)	-	>100					
18.0											
18.5											
19.0	19	SPT-8	45	100 (11cm)	-	>100					
19.5											
20.0											



UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*33+713 km	*Northing :*3127280.622 m	*Easting :*690578.397 m
Reduced Level (m):(+)257.231	*BH. No. :*33+713_A1	*BH Termination Depth (m):*30
Proposed / Existing Structure :-	*Water Table (m):*28.98	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*28-09-2021	*Date of Completion :*29-09-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
20.0							Brown, Very dense, Sandy silt of low plasticity with gravel	ML-CL			
20.5	20.5	SPT-9	40	64	36 (8cm)	>100					
21.0											
21.5											
22.0	22	SPT-10	45	70	30 (7cm)	>100					
22.5											
23.0											
23.5	23.5	SPT-11	30	40	60 (5cm)	>100					
24.0											
24.5											
25.0	25	SPT-12	47	100 (8cm)	-	>100	Brown, Hard, Silty clay of low plasticity with gravel	CL			
25.5											
26.0											
26.5	26.5	SPT-13	26	43	57 (13cm)	>100					
27.0											
27.5											
28.0	28	SPT-14	30	100 (12cm)	-	>100					
28.5											
29.0									28.98m		
29.5	29.5	SPT-15	30	40	50	90					
30.0	30	DS-2									

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*33+713 km	*Northing :*3127290.956 m	*Easting :*690560.289 m
Reduced Level (m):(+)257.830	*BH. No. :*33+713_A2	*BH Termination Depth (m):*30
Proposed / Existing Structure :-	*Water Table (m):*29.52	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*28-09-2021	*Date of Completion :*29-09-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	UDS-1									
1.5											
2.0											
2.5	2.5	SPT-1	7	11	11	22					
3.0											
3.5							Brown, Medium dense, Sandy silt of low plasticity	ML-CL			
4.0	4	UDS-2									
4.5											
5.0											
5.5	5.5	SPT-2	8	12	14	26					
6.0											
6.5											
7.0	7	UDS-3									
7.5											
8.0											
8.5	8.5	SPT-3	20	40	58	98	Brown, Hard, Silty clay of low plasticity with gravel	CL			
9.0											
9.5											
10.0	10	UDS-4									

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*33+713 km	*Northing :*3127290.956 m	*Easting :*690560.289 m
Reduced Level (m):(+)257.830	*BH. No. :*33+713_A2	*BH Termination Depth (m):*30
Proposed / Existing Structure :-	*Water Table (m):*29.52	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*28-09-2021	*Date of Completion :*29-09-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0											
10.5											
11.0											
11.5	11.5	SPT-4	16	25	33	58	Brown, Hard, Silty clay of low plasticity with gravel	CL			
12.0											
12.5											
13.0	13	UDS-5									
13.5											
14.0											
14.5	14.5	SPT-5	29	45	55 (8cm)	>100					
15.0											
15.5											
16.0	16	SPT-6	26	48	52 (12cm)	>100					
16.5							Brown, Very dense, Sandy silt of low plasticity with gravel	ML-CL			
17.0											
17.5	17.5	SPT-7	38	73	27 (5cm)	>100					
18.0											
18.5											
19.0	19	SPT-8	29	100 (12cm)	-	>100					
19.5											
20.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*33+713 km	*Northing :*3127290.956 m	*Easting :*690560.289 m
Reduced Level (m):(+)257.830	*BH. No. :*33+713_A2	*BH Termination Depth (m):*30
Proposed / Existing Structure :-	*Water Table (m):*29.52	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*28-09-2021	*Date of Completion :*29-09-2021	

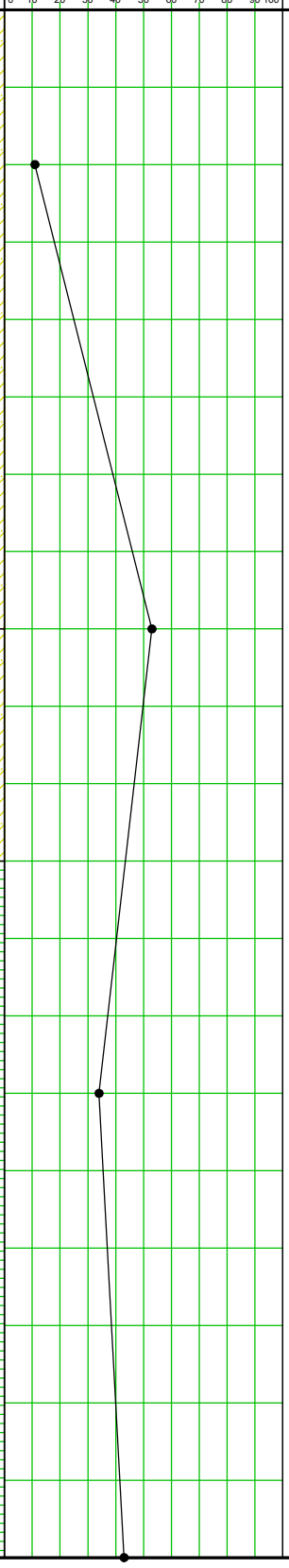
Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
20.0							Brown, Very dense, Sandy silt of low plasticity with gravel	ML-CL			
20.5	20.5	SPT-9	45	80 (3cm)	-	>100					
21.0											
21.5											
22.0	22	SPT-10	24	34	64	98					
22.5											
23.0											
23.5	23.5	SPT-11	26	43	57 (12cm)	>100					
24.0											
24.5											
25.0	25	SPT-12	36	44	56 (13cm)	>100	Brown, Hard, Silty clay of low plasticity with gravel	CL			
25.5											
26.0											
26.5	26.5	SPT-13	35	45	55 (9cm)	>100					
27.0											
27.5											
28.0	28	SPT-14	32	60	40 (10cm)	>100					
28.5											
29.0											
29.5	29.5	SPT-15	34	70	30 (9cm)	>100			29.52m		
30.0	30	DS-2									

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*34+019 km	*Northing :*312744.537 m	*Easting :*690307.695 m
Reduced Level (m):(+)256.788	*BH. No. :*34+019_C-L	*BH Termination Depth (m):*10
Proposed / Existing Structure :-	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*01-10-2021	*Date of Completion :*01-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	SPT-1	4	5	6	11					
1.5											
2.0							Brown, Medium dense, Silty sand with clay	SM-SC			
2.5	2.5	UDS-1									
3.0											
3.5											
4.0	4	SPT-2	12	18	35	53					
4.5											
5.0							Brown, Very dense, Silty sand with clay	SM-SC			
5.5	5.5	UDS-2									
6.0											
6.5											
7.0	7	SPT-3	10	14	20	34					
7.5											
8.0							Brown, Hard, Silty clay of low plasticity with gravel	CL			
8.5	8.5	UDS-3									
9.0											
9.5											
10.0	10	SPT-4	15	18	25	43					



UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*34+019 km	*Northing :*312744.537 m	*Easting :*690307.695 m
Reduced Level (m):(+)256.788	*BH. No. :*34+019_C-L	*BH Termination Depth (m):*10
Proposed / Existing Structure :-	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*01-10-2021	*Date of Completion :*01-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value) 0 10 20 30 40 50 60 70 80 90 100	Special Observations
							Brown, Dense, Sandy silt of low plasticity with gravel	ML-CL			

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*34+619 km	*Northing :*3127806.228 m	*Easting :*689829.431 m
Reduced Level (m):(+)256.661	*BH. No. :*34+619_C-L	*BH Termination Depth (m):*10
Proposed / Existing Structure :-	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*29-09-2021	*Date of Completion :*29-09-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	SPT-1	4	4	6	10					
1.5											
2.0							Brown, Medium dense, Sandy silt of low plasticity	ML-CL			
2.5	2.5	UDS-1									
3.0											
3.5											
4.0	4	SPT-2	8	14	17	31					
4.5											
5.0											
5.5	5.5	UDS-2									
6.0											
6.5							Brown, Dense, Silty sand with clay	SM-SC			
7.0	7	SPT-3	10	15	20	35					
7.5											
8.0											
8.5	8.5	UDS-3									
9.0											
9.5							Brown, Very dense, Sandy silt of low plasticity	ML-CL			
10.0	10	SPT-4	15	18	32	50					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*35+273 km	*Northing :*3128197.938 m	*Easting :*689320.433 m
Reduced Level (m):(+)257.980	*BH. No. :*35+272_A1	*BH Termination Depth (m):*30
Proposed / Existing Structure :-	*Water Table (m):*24.92	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*27-09-2021	*Date of Completion :*30-09-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	SPT-1	3	4	5	9					
1.5											
2.0											
2.5	2.5	UDS-1									
3.0											
3.5							Brown, Loose, Silty sand with clay	SM-SC			
4.0	4	SPT-2	4	5	5	10					
4.5											
5.0											
5.5	5.5	UDS-2									
6.0											
6.5											
7.0	7	SPT-3	7	13	16	29					
7.5											
8.0											
8.5	8.5	UDS-3					Brown, Very stiff, Silty clay of low plasticity	CL			
9.0											
9.5											
10.0	10	SPT-4	8	10	11	21					

(Depth v/s SPT N Value) axis: 0 10 20 30 40 50 60 70 80 90 100

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*35+273 km	*Northing :*3128197.938 m	*Easting :*689320.433 m
Reduced Level (m):(+)257.980	*BH. No. :*35+272_A1	*BH Termination Depth (m):*30
Proposed / Existing Structure :-	*Water Table (m):*24.92	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*27-09-2021	*Date of Completion :*30-09-2021	

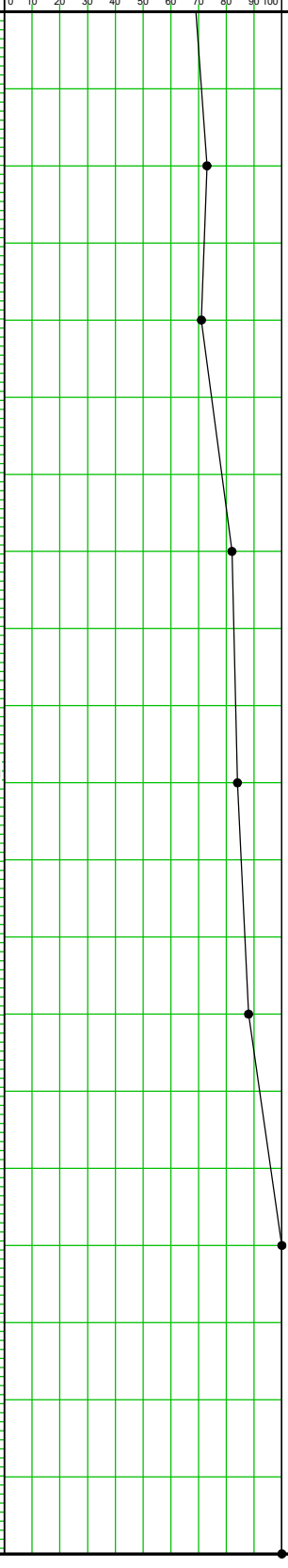
Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0											
10.5											
11.0											
11.5	11.5	UDS-4									
12.0											
12.5							Brown, Very stiff, Silty clay of low plasticity	CL			
13.0	13	SPT-5	6	9	18	27					
13.5											
14.0											
14.5	14.5	UDS-5									
15.0	15	SPT-6	18	24	30	54					
15.5											
16.0	16	SPT-7	15	25	34	59					
16.5											
17.0											
17.5	17.5	UDS-6					Brown, Hard, Silty clay of low plasticity with gravel	CL			
18.0											
18.5											
19.0	19	SPT-8	22	27	38	65					
19.5											
20.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*35+273 km	*Northing :*3128197.938 m	*Easting :*689320.433 m
Reduced Level (m):(+)257.980	*BH. No. :*35+272_A1	*BH Termination Depth (m):*30
Proposed / Existing Structure :-	*Water Table (m):*24.92	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*27-09-2021	*Date of Completion :*30-09-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
20.0											
20.5	20.5	UDS-7									
21.0	21	SPT-9	29	32	41	73					
21.5											
22.0	22	SPT-10	19	31	40	71					
22.5											
23.0											
23.5	23.5	SPT-11	25	37	45	82					
24.0											
24.5											
25.0	25	SPT-12	30	38	46	84	Brown, Hard, Silty clay of low plasticity with gravel	CL	▼24.92m		
25.5											
26.0											
26.5	26.5	SPT-13	35	42	46	88					
27.0											
27.5											
28.0	28	SPT-14	40	48	52 (12cm)	>100					
28.5											
29.0											
29.5											
30.0	30	SPT-15	46	53	47 (11cm)	>100					



UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*35+273 km	*Northing :*3128210.139 m	*Easting :*689304.586 m
Reduced Level (m):(+)257.188	*BH. No. :*35+272_A2	*BH Termination Depth (m):*30
Proposed / Existing Structure :-	*Water Table (m):*24.36	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*27-09-2021	*Date of Completion :*28-09-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	UDS-1									
1.5											
2.0											
2.5	2.5	SPT-1	3	4	6	10					
3.0											
3.5											
4.0	4	UDS-2									
4.5											
5.0							Brown, Medium dense, Sandy silt of low plasticity	ML-CL			
5.5	5.5	SPT-2	6	7	12	19					
6.0											
6.5											
7.0	7	UDS-3									
7.5											
8.0											
8.5	8.5	SPT-3	5	11	12	23					
9.0											
9.5											
10.0	10	UDS-4									

(Depth v/s SPT N Value) axis: 0 10 20 30 40 50 60 70 80 90 100

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*35+273 km	*Northing :*3128210.139 m	*Easting :*689304.586 m
Reduced Level (m):(+)257.188	*BH. No. :*35+272_A2	*BH Termination Depth (m):*30
Proposed / Existing Structure :-	*Water Table (m):*24.36	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*27-09-2021	*Date of Completion :*28-09-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0											
10.5											
11.0											
11.5	11.5	SPT-4	16	24	25	49					
12.0											
12.5											
13.0	13	UDS-5									
13.5											
14.0											
14.5	14.5	SPT-5	15	21	25	46	Brown, Hard, Silty clay of low plasticity with gravel	CL			
15.0											
15.5											
16.0	16	UDS-6									
16.5											
17.0											
17.5	17.5	SPT-6	17	25	28	53					
18.0											
18.5											
19.0	19	UDS-7									
19.5							Brown, Hard, Silty clay of low plasticity with gravel	CL			
20.0											

(Depth v/s SPT N Value) axis: 0 10 20 30 40 50 60 70 80 90 100

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*35+273 km	*Northing :*3128210.139 m	*Easting :*689304.586 m
Reduced Level (m):(+)257.188	*BH. No. :*35+272_A2	*BH Termination Depth (m):*30
Proposed / Existing Structure :-	*Water Table (m):*24.36	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*27-09-2021	*Date of Completion :*28-09-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
20.0											
20.5	20.5	SPT-7	25	32	48	80					
21.0											
21.5											
22.0	22	SPT-8	24	37	47	84					
22.5											
23.0											
23.5	23.5	SPT-9	27	38	52	90					
24.0											
24.5									24.36m		
25.0	25	SPT-10	30	36	47	83	Brown, Hard, Silty clay of low plasticity with gravel	CL			
25.5											
26.0											
26.5	26.5	SPT-11	42	45	50	95					
27.0											
27.5											
28.0	28	SPT-12	46	55	45 (10cm)	>100					
28.5											
29.0											
29.5	29.5	SPT-13	52	100 (10cm)	-	>100					
30.0	30	DS-2									

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*36+367 km	*Northing :*3128873.981 m	*Easting :*688442.635 m
Reduced Level (m):(+)255.925	*BH. No. :*BH-CL	*BH Termination Depth (m):*10
*Proposed / Existing Structure :*Minor Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not-used
*Date of Start :*17-11-2021	*Date of Completion :*17-11-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5	0.5	SPT-1	4	6	7	13					
1.0											
1.5	1.5	SPT-2	5	6	9	15					
2.0											
2.5	2.25	UDS-1					Brown, Medium dense, Sandy silt of low plasticity	ML-CL			
3.0	3	SPT-3	6	7	10	17					
3.5											
4.0											
4.5	4.5	SPT-4	7	9	12	21					
5.0											
5.5	5.25	UDS-2									
6.0	6	SPT-5	8	12	15	27					
6.5											
7.0											
7.5	7.5	SPT-6	8	10	17	27	Brown, Very stiff, Silty clay of low plasticity	CL			
8.0											
8.5	8.25	UDS-3									
9.0	9	SPT-7	8	10	12	22					
9.5											
10.0	10	SPT-8	10	11	15	26					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*36+816 km	*Northing :*3129148.53 m	*Easting :*688102.237 m
Reduced Level (m):(+)253.133	*BH. No. :*36+817_A1	*BH Termination Depth (m):*30
Proposed / Existing Structure :-	*Water Table (m):*23.89	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*27-09-2021	*Date of Completion :*28-09-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	SPT-1	2	2	3	5					
1.5											
2.0											
2.5	2.5	UDS-1					Brown, Loose to medium dense, Sandy silt of low plasticity	ML-CL			
3.0											
3.5											
4.0	4	SPT-2	3	3	8	11					
4.5											
5.0											
5.5	5.5	UDS-2									
6.0											
6.5											
7.0	7	SPT-3	8	16	22	38	Brown, Hard, Silty clay of low plasticity with gravel	CL			
7.5											
8.0											
8.5	8.5	UDS-3									
9.0											
9.5											
10.0	10	SPT-4	10	21	23	44					

(Depth v/s SPT N Value) axis: 0 10 20 30 40 50 60 70 80 90 100

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*36+816 km	*Northing :*3129148.53 m	*Easting :*688102.237 m
Reduced Level (m):(+)253.133	*BH. No. :*36+817_A1	*BH Termination Depth (m):*30
Proposed / Existing Structure :-	*Water Table (m):*23.89	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*27-09-2021	*Date of Completion :*28-09-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0										0 10 20 30 40 50 60 70 80 90 100	
10.5											
11.0											
11.5	11.5	UDS-4									
12.0											
12.5											
13.0	13	SPT-5	10	15	17	32					
13.5											
14.0							Brown, Hard, Silty clay of low plasticity with gravel	CL			
14.5	14.5	UDS-5									
15.0											
15.5											
16.0	16	SPT-6	12	14	22	36					
16.5											
17.0											
17.5	17.5	UDS-6									
18.0											
18.5											
19.0	19	SPT-7	20	36	44	80	Brown, Very dense, Sandy silt of low plasticity with	ML-CL			
19.5											
20.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*36+816 km	*Northing :*3129148.53 m	*Easting :*688102.237 m
Reduced Level (m):(+)253.133	*BH. No. :*36+817_A1	*BH Termination Depth (m):*30
Proposed / Existing Structure :-	*Water Table (m):*23.89	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*27-09-2021	*Date of Completion :*28-09-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
20.0											
20.5	20.5	UDS*									
21.0	21	SPT-8	25	45	53	98					
21.5											
22.0	22	SPT-9	34	57	43 (10cm)	>100	Brown, Very dense, Sandy silt of low plasticity with	ML-CL			
22.5											
23.0											
23.5	23.5	SPT-10	18	27	42	69					
24.0									23.89m		
24.5											
25.0	25	SPT-11	21	29	45	74					
25.5											
26.0											
26.5	26.5	UDS-7					Brown, Hard, Silty clay of low plasticity with gravel	CL			
27.0											
27.5											
28.0	28	SPT-12	12	15	21	36					
28.5											
29.0											
29.5	29.5	UDS*									
30.0	30	SPT-13	10	18	24	42					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*36+816 km	*Northing :*3129162.136 m	*Easting :*688087.58 m
Reduced Level (m):(+)253.255	*BH. No. :*36+817_A2	*BH Termination Depth (m):*30
Proposed / Existing Structure :-	*Water Table (m):*23.16	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*27-09-2021	*Date of Completion :*28-09-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	UDS-1									
1.5											
2.0											
2.5	2.5	SPT-1	3	5	7	12					
3.0											
3.5							Brown, Medium dense, Silty sand with clay	SM-SC			
4.0	4	UDS-2									
4.5											
5.0											
5.5	5.5	SPT-2	5	10	15	25					
6.0											
6.5											
7.0	7	UDS-3									
7.5											
8.0											
8.5	8.5	SPT-3	16	20	24	44	Brown, Dense, Sandy silt of low plasticity with gravel	ML-CL			
9.0											
9.5											
10.0	10	UDS-4									

(Depth v/s SPT N Value) axis: 0 10 20 30 40 50 60 70 80 90 100

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*36+816 km	*Northing :*3129162.136 m	*Easting :*688087.58 m
Reduced Level (m):(+)253.255	*BH. No. :*36+817_A2	*BH Termination Depth (m):*30
Proposed / Existing Structure :-	*Water Table (m):*23.16	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*27-09-2021	*Date of Completion :*28-09-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0											
10.5											
11.0											
11.5	11.5	SPT-4	20	23	28	51					
12.0											
12.5											
13.0	13	UDS-5					Brown, Hard, Silty clay of low plasticity with gravel	CL			
13.5											
14.0											
14.5	14.5	SPT-5	22	26	30	56					
15.0											
15.5											
16.0	16	UDS-6									
16.5											
17.0											
17.5	17.5	SPT-6	25	31	33	64					
18.0							Brown, Very dense, Sandy silt of low plasticity with	ML-CL			
18.5											
19.0	19	UDS*									
19.5	19.5	SPT-7	32	52	48 (6cm)	>100					
20.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*36+816 km	*Northing :*3129162.136 m	*Easting :*688087.58 m
Reduced Level (m):(+)253.255	*BH. No. :*36+817_A2	*BH Termination Depth (m):*30
Proposed / Existing Structure :-	*Water Table (m):*23.16	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*27-09-2021	*Date of Completion :*28-09-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
20.0											
20.5	20.5	SPT-8	38	58	42 (10cm)	>100					
21.0											
21.5											
22.0	22	SPT-9	44	64	36 (11cm)	>100	Brown, Very dense, Sandy silt of low plasticity with	ML-CL			
22.5											
23.0									23.16m		
23.5	23.5	SPT-10	20	31	36	67					
24.0											
24.5											
25.0	25	UDS*									
25.5	25.5	SPT-11	18	24	29	53					
26.0											
26.5	26.5	SPT-12	21	27	31	58	Brown, Hard, Silty clay of low plasticity with gravel	CL			
27.0											
27.5											
28.0	28	SPT-13	19	25	28	53					
28.5											
29.0											
29.5	29.5	SPT-14	17	21	25	46					
30.0	30	DS-2									

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*37+174 km	*Northing :*3129414.081 m	*Easting :*687850.788 m
Reduced Level (m):(+)252.485	*BH. No. :*BH-CL	*BH Termination Depth (m):*6
*Proposed / Existing Structure :*Minor Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*08-07-2022	*Date of Completion :*08-07-2022	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0											
1.5	1.5	SPT-1	4	5	6	11					
2.0											
	2.25	UDS-1									
2.5							Reddish Brown,Medium dense,Silty Sand	SM			
3.0	3	SPT-2	4	5	7	12					
3.5											
4.0											
4.5	4.5	SPT-3	5	7	9	16					
5.0											
	5.25	UDS-2									
5.5							Brown, Medium dense, Sandy silt of low plasticity	ML-CL			
6.0	6	SPT-4	6	6	8	14					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*37+487 km	*Northing :*3129665.052 m	*Easting :*687664.026 m
Reduced Level (m):(+)253.510	*BH. No. :*BH-CL	*BH Termination Depth (m):*10
*Proposed / Existing Structure :*Minor Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*151 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*07-07-2022	*Date of Completion :*07-07-2022	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
1.5	1.5	SPT-1	3	4	6	10	Brown, Medium dense, Sandy silt of low plasticity	ML-CL			
	2.25	UDS-1									
3.0	3	SPT-2	5	6	6	12					
4.5	4.5	SPT-3	6	8	9	17	Reddish Brown,Medium dense,Silty Sand	SM			
	5.25	UDS-2									
6.0	6	SPT-4	9	13	18	31					
7.5	7.5	SPT-5	7	12	14	26	Brown, Dense, Sandy silt of low plasticity	ML-CL			
	8.25	UDS-3									
9.0	9	SPT-6	9	14	21	35					
10.0	10	SPT-7	7	12	14	26	Brown, Dense, Silty Clay of low plasticity	CL			

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*38+127 km	*Northing :*3130206.236 m	*Easting :*687322.404 m
Reduced Level (m):(+)254.370	*BH. No. :*BH-CL	*BH Termination Depth (m):*10
*Proposed / Existing Structure :*Minor Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*152 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*06-07-2022	*Date of Completion :*07-07-2022	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0											
1.5	1.5	SPT-1	2	3	5	8	Brown, Medium dense, Sandy silt of low plasticity	ML-CL			
2.0											
	2.25	UDS-1									
2.5											
3.0	3	SPT-2	4	5	6	11					
3.5											
4.0											
4.5	4.5	SPT-3	5	6	7	13					
5.0											
	5.25	UDS-2									
5.5											
6.0	6	SPT-4	8	12	14	26					
6.5							Brown, Dense, Silty Clay of low plasticity	CL			
7.0											
7.5	7.5	SPT-5	10	14	16	30					
8.0											
	8.25	UDS-3									
8.5											
9.0	9	SPT-6	7	11	13	24					
9.5											
10.0	10	SPT-7	9	12	14	26					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*38+482 km	*Northing :*3130509.717 m	*Easting :*687138.27 m
Reduced Level (m):(+)254.888	*BH. No. :*BH-CL	*BH Termination Depth (m):*6
*Proposed / Existing Structure :*Minor Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*153 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*08-07-2022	*Date of Completion :*08-07-2022	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0											
1.5	1.5	SPT-1	3	4	5	9					
2.0											
	2.25	UDS-1									
2.5											
3.0	3	SPT-2	4	6	7	13	Reddish Brown,Medium Dense,Silty Clay of low plasticity	CL			
3.5											
4.0											
4.5	4.5	SPT-3	6	8	8	16					
5.0											
	5.25	UDS-2									
5.5											
6.0	6	SPT-4	8	13	17	30					

(Depth v/s SPT N Value) axis: 0 10 20 30 40 50 60 70 80 90 100

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*38+701 km	*Northing :*3130698.508 m	*Easting :*687027.281 m
Reduced Level (m):(+)254.062	*BH. No. :*BH-CL	*BH Termination Depth (m):*10
*Proposed / Existing Structure :*Minor Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*30-01-2022	*Date of Completion :*30-01-2022	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5	0.5	SPT-1	2	2	4	6					
1.0											
1.5	1.5	SPT-2	3	4	6	10					
2.0											
2.5	2.25	UDS*					Brown, Medium stiff to stiff, Silty clay of low plasticity	CL			
3.0	3	SPT-3	7	7	8	15					
3.5											
4.0											
4.5	4.5	SPT-4	10	11	13	24					
5.0											
5.5	5.25	UDS-1									
6.0	6	SPT-5	9	13	18	31					
6.5											
7.0											
7.5	7.5	SPT-6	12	14	16	30	Brown, Very stiff to hard, Silty clay of low plasticity with gravel	CL			
8.0											
8.5	8.25	UDS-2									
9.0	9	SPT-7	13	17	22	39					
9.5											
10.0	10	SPT-8	15	21	24	45					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*38+778 km	*Northing :*3130764 m	*Easting :*686988.257 m
Reduced Level (m):(+)254.956	*BH. No. :*BH-CL	*BH Termination Depth (m):*15
*Proposed / Existing Structure :*Minor Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*30-01-2022	*Date of Completion :*30-01-2022	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5	0.5	SPT-1	2	2	3	5					
1.0											
1.5	1.5	SPT-2	4	4	5	9	Brown, Loose, Sandy silt of low plasticity	ML-CL			
2.0											
	2.25	UDS*									
2.5											
3.0	3	SPT-3	5	6	8	14					
3.5											
4.0											
4.5	4.5	SPT-4	7	9	11	20					
5.0											
	5.25	UDS-1									
5.5											
6.0	6	SPT-5	10	14	18	32					
6.5							Brown, Very stiff to hard, Silty clay of low plasticity with gravel	CL			
7.0											
7.5	7.5	SPT-6	13	17	21	38					
8.0											
	8.25	UDS-2									
8.5											
9.0	9	SPT-7	15	19	22	41					
9.5											
10.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*38+778 km	*Northing :*3130764 m	*Easting :*686988.257 m
Reduced Level (m):(+)254.956	*BH. No. :*BH-CL	*BH Termination Depth (m):*15
*Proposed / Existing Structure :*Minor Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*30-01-2022	*Date of Completion :*30-01-2022	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0											
10.5	10.5	SPT-8	18	21	24	45					
11.0											
	11.25	UDS-3									
11.5											
12.0	12	SPT-9	17	19	29	48					
12.5							Brown, Very stiff to hard, Silty clay of low plasticity with gravel	CL			
13.0											
13.5	13.5	SPT-10	19	23	31	54					
14.0											
	14.25	UDS*									
14.5											
15.0	15	SPT-11	25	22	38	60					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*39+060 km	*Northing :*3131007.988 m	*Easting :*686845.338 m
Reduced Level (m):(+)256.112	*BH. No. :*BH-CL	*BH Termination Depth (m):*10
*Proposed / Existing Structure :*Minor Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*29-01-2022	*Date of Completion :*29-01-2022	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5	0.5	SPT-1	2	2	3	5					
1.0											
1.5	1.5	SPT-2	3	4	4	8	Brown, Loose, Sandy silt of low plasticity	ML-CL			
2.0											
	2.25	UDS*									
2.5											
3.0	3	SPT-3	7	9	11	20					
3.5											
4.0							Brown, Medium dense, Silty sand with clay	SM-SC			
4.5	4.5	SPT-4	8	10	13	23					
5.0											
	5.25	UDS-1									
5.5											
6.0	6	SPT-5	10	15	19	34					
6.5											
7.0											
7.5	7.5	SPT-6	12	17	21	38	Brown, Hard, Silty clay of low plasticity with gravel	CL			
8.0											
	8.25	UDS-2									
8.5											
9.0	9	SPT-7	15	19	23	42					
9.5											
10.0	10	SPT-8	17	22	26	48					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*39+149 km	*Northing :*3131306.518 m	*Easting :*686653.951 m
Reduced Level (m):(+)255.863	*BH. No. :*BH-PLT-03	*BH Termination Depth (m):*12
Proposed / Existing Structure :-	*Water Table (m):*Not encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*21-10-2021	*Date of Completion :*21-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
	0.75	UDS-1									
1.0											
1.5	1.5	SPT-1	2	3	3	3	Brown, Loose, Silty sand with clay	SM-SC			
2.0											
	2.25	SPT-2	2	3	4	4					
2.5											
3.0	3	SPT-3	5	7	9	9					
3.5											
	3.75	SPT-4	5	7	9	9					
4.0											
4.5	4.5	UDS-2									
5.0											
5.5											
6.0	6	SPT-5	10	12	18	18					
6.5							Brown, Medium dense, Sandy silt of low plasticity	ML-CL			
7.0											
7.5	7.5	UDS-3									
8.0											
8.5											
9.0	9	SPT-6	9	11	15	15					
9.5											
10.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*39+149 km	*Northing :*3131306.518 m	*Easting :*686653.951 m
Reduced Level (m):(+)255.863	*BH. No. :*BH-PLT-03	*BH Termination Depth (m):*12
Proposed / Existing Structure :-	*Water Table (m):*Not encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*21-10-2021	*Date of Completion :*21-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0										0 10 20 30 40 50 60 70 80 90 100	
10.5	10.5	UDS-4					Brown, Medium dense, Sandy silt of low plasticity	ML-CL			
11.0											
11.5											
12.0	12	SPT-7	10	12	16	16					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*39+400 km	*Northing :*3131301.616 m	*Easting :*686673.94 m
Reduced Level (m):(+)256.079	*BH. No. :*39+400_CL	*BH Termination Depth (m):*10
Proposed / Existing Structure :-	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*20-11-2021	*Date of Completion :*20-11-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5	0.5	SPT-1	2	3	3	6					
1.0											
1.5	1.5	SPT-2	2	3	4	7					
2.0											
2.5	2.25	UDS-1					Brown, Loose to medium dense, Silty sand	SM			
3.0	3	SPT-3	5	7	8	15					
3.5											
4.0											
4.5	4.5	SPT-4	8	14	16	30					
5.0											
5.5	5.25	UDS-2									
6.0	6	SPT-5	11	15	18	33					
6.5											
7.0											
7.5	7.5	SPT-6	10	18	20	38	Brown, Dense, Sandy silt of low plasticity	ML-CL			
8.0											
8.5	8.25	UDS-3									
9.0	9	SPT-7	10	19	22	41					
9.5											
10.0	10	SPT-8	13	21	23	44					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*40+325 km	*Northing :*3132119.63 m	*Easting :*686221.079 m
Reduced Level (m):(+)257.953	*BH. No. :*BH-CL	*BH Termination Depth (m):*15
*Proposed / Existing Structure :*Minor Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not-used
*Date of Start :*29-01-2022	*Date of Completion :*29-01-2022	

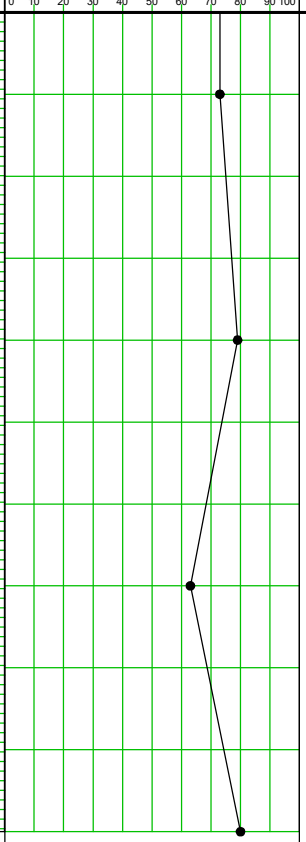
Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5	0.5	SPT-1				6					
1.0											
1.5	1.5	SPT-2				7					
2.0											
	2.25	UDS*				UDS*					
2.5							Brown, Loose to medium dense, Sandy silt of low plasticity	ML-CL			
3.0	3	SPT-3				19					
3.5											
4.0											
4.5	4.5	SPT-4				26					
5.0											
	5.25	UDS-1				UDS					
5.5											
6.0	6	SPT-5				55					
6.5											
7.0											
7.5	7.5	SPT-6				49	Brown, Hard, Silty clay of low plasticity with gravel	CL			
8.0											
	8.25	UDS-2				UDS					
8.5											
9.0	9	SPT-7				73					
9.5											
10.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*40+325 km	*Northing :*3132119.63 m	*Easting :*686221.079 m
Reduced Level (m):(+)257.953	*BH. No. :*BH-CL	*BH Termination Depth (m):*15
*Proposed / Existing Structure :*Minor Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not-used
*Date of Start :*29-01-2022	*Date of Completion :*29-01-2022	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0											
10.5	10.5	SPT-8				73					
11.0											
	11.25	UDS-3				UDS					
11.5											
12.0	12	SPT-9				79					
12.5							Brown, Hard, Silty clay of low plasticity with gravel	CL			
13.0											
13.5	13.5	SPT-10				63					
14.0											
	14.25	UDS*				UDS*					
14.5											
15.0	15	SPT-11				80					



UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*40+573 km	*Northing :*3132328.87 m	*Easting :*686107.704 m
Reduced Level (m):(+)252.612	*BH. No. :*40+573_CL	*BH Termination Depth (m):*10
Proposed / Existing Structure :-	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*19-11-2021	*Date of Completion :*19-11-2021	

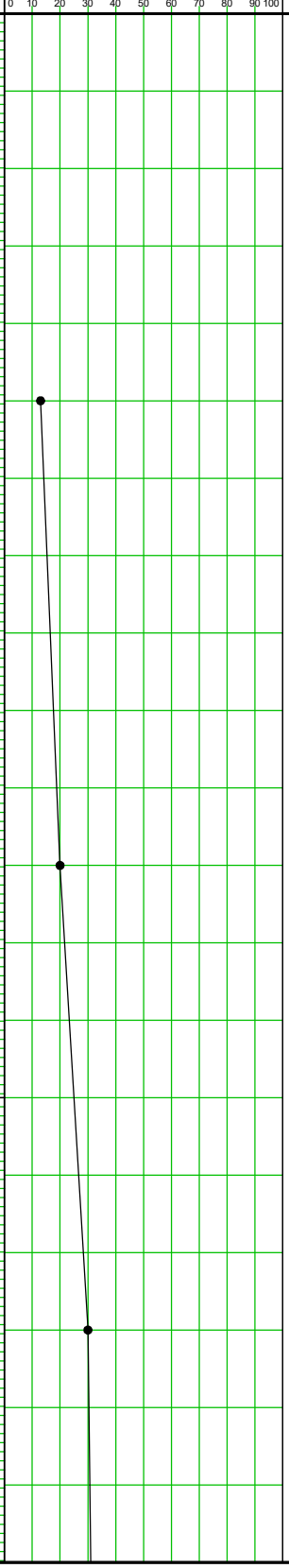
Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5	0.5	SPT-1	4	8	9	17					
1.0											
1.5	1.5	SPT-2	5	9	9	18					
2.0											
2.5	2.25	UDS-1					Brown, Medium dense to very dense, Sandy silt of low plasticity	ML-CL			
3.0	3	SPT-3	9	11	13	24					
3.5											
4.0											
4.5	4.5	SPT-4	11	13	14	27					
5.0											
5.5	5.25	UDS-2									
6.0	6	SPT-5	14	18	21	39	Brown, Medium dense to very dense, Sandy silt of low plasticity	SM-SC			
6.5											
7.0											
7.5	7.5	SPT-6	13	20	23	43					
8.0											
8.5	8.25	UDS-3									
9.0	9	SPT-7	15	24	26	50	Brown, Medium dense to very dense, Sandy silt of low plasticity	ML-CL			
9.5											
10.0	10	SPT-8	17	26	31	57					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*41+056 km	*Northing :*3132785.751 m	*Easting :*685995.127 m
Reduced Level (m):(+)253.199	*BH. No. :*BH-A1	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*18-08-2021	*Date of Completion :*19-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	UDS-1									
1.5											
2.0											
2.5	2.5	SPT-1	3	5	8	13					
3.0											
3.5							Brown, Medium dense, Sandy silt of low plasticity	ML-CL			
4.0	4	UDS-2									
4.5											
5.0											
5.5	5.5	SPT-2	5	8	12	20					
6.0											
6.5											
7.0	7	UDS-3									
7.5											
8.0											
8.5	8.5	SPT-3	8	13	17	30	Brown, Dense to very dense, Sandy silt of low plasticity with gravel	ML-CL			
9.0											
9.5											
10.0	10	UDS-4									

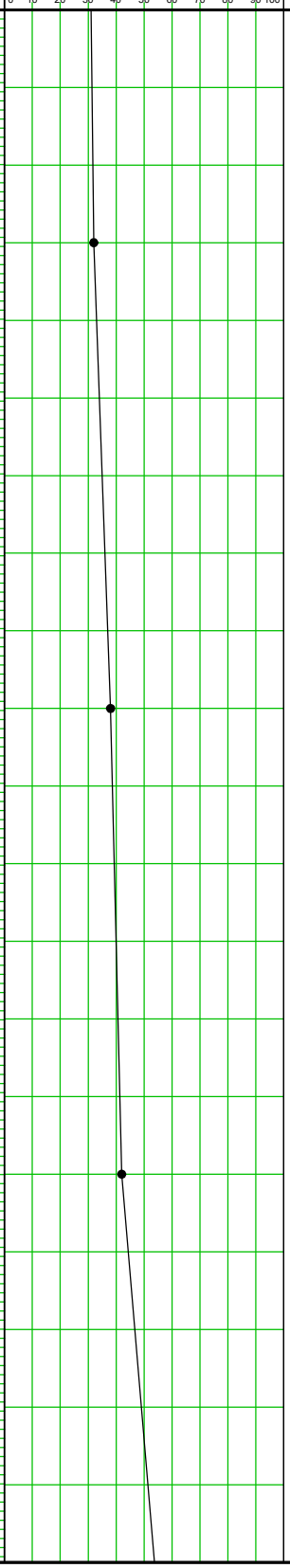


UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*41+056 km	*Northing :*3132785.751 m	*Easting :*685995.127 m
Reduced Level (m):(+)253.199	*BH. No. :*BH-A1	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*18-08-2021	*Date of Completion :*19-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0											
10.5											
11.0											
11.5	11.5	SPT-4	7	14	18	32					
12.0											
12.5											
13.0	13	UDS-5									
13.5											
14.0											
14.5	14.5	SPT-5	10	16	22	38					
15.0							Brown, Dense to very dense, Sandy silt of low plasticity with gravel	ML-CL			
15.5											
16.0	16	UDS-6									
16.5											
17.0											
17.5	17.5	SPT-6	10	18	24	42					
18.0											
18.5											
19.0	19	UDS-7									
19.5											
20.0											



UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*41+056 km	*Northing :*3132785.751 m	*Easting :*685995.127 m
Reduced Level (m):(+)253.199	*BH. No. :*BH-A1	*BH Termination Depth (m):*30
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*18-08-2021	*Date of Completion :*19-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
20.0											
20.5	20.5	SPT-7	14	22	34	56	Brown, Dense to very dense, Sandy silt of low plasticity with gravel	ML-CL			
21.0											
21.5											
22.0	22	UDS-8									
22.5											
23.0											
23.5	23.5	SPT-8	20	39	61 (3cm)	>100					
24.0											
24.5											
25.0	25	UDS*					Brown, Very dense, Sandy silt of low plasticity with gravel	ML-CL			
25.5											
26.0											
26.5	26.5	SPT-9	30	48	54 (7cm)	>100					
27.0											
27.5											
28.0	28	UDS*									
28.5											
29.0							Brown, Very dense, Sandy silt of low plasticity with gravel	ML-CL			
29.5	29.5	SPT-10	32	89	11 (7cm)	>100					
30.0	30	SPT-11	42	100 (11cm)	-	>100					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*41+056 km	*Northing :*3132810.479 m	*Easting :*685993.223 m
Reduced Level (m):(+)252.668	*BH. No. :*BH-A2	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*12-08-2021	*Date of Completion :*14-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	SPT-1	2	4	7	11					
1.5											
2.0											
2.5	2.5	UDS-1									
3.0											
3.5							Brown, Medium dense, Silty sand with clay	SM-SC			
4.0	4	SPT-2	7	9	11	20					
4.5											
5.0											
5.5	5.5	UDS-2									
6.0											
6.5											
7.0	7	SPT-3	12	17	21	38					
7.5											
8.0											
8.5	8.5	UDS-3					Brown, Dense to very dense, Sandy silt of low plasticity with gravel	ML-CL			
9.0											
9.5											
10.0	10	SPT-4	15	19	24	43					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*41+056 km	*Northing :*3132810.479 m	*Easting :*685993.223 m
Reduced Level (m):(+)252.668	*BH. No. :*BH-A2	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*12-08-2021	*Date of Completion :*14-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0											
10.5											
11.0											
11.5	11.5	UDS-4									
12.0											
12.5											
13.0	13	SPT-5	20	30	37	67					
13.5											
14.0											
14.5	14.5	UDS-5									
15.0							Brown, Dense to very dense, Sandy silt of low plasticity with gravel	ML-CL			
15.5											
16.0	16	SPT-6	25	34	37	71					
16.5											
17.0											
17.5	17.5	UDS-6									
18.0											
18.5											
19.0	19	SPT-7	29	39	57	96					
19.5											
20.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*41+056 km	*Northing :*3132810.479 m	*Easting :*685993.223 m
Reduced Level (m):(+)252.668	*BH. No. :*BH-A2	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*12-08-2021	*Date of Completion :*14-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
20.0											
20.5	20.5	UDS-7									
21.0											
21.5											
22.0	22	SPT-8	36	45	65 (4cm)	>100					
22.5											
23.0											
23.5	23.5	SPT-9	39	57	50 (5cm)	>100					
24.0											
24.5											
25.0	25	SPT-10	45	67	40 (4cm)	>100	Brown, Dense to very dense, Sandy silt of low plasticity with gravel	ML-CL			
25.5											
26.0											
26.5	26.5	SPT-11	53	100 (5cm)	-	>100					
27.0											
27.5											
28.0	28	SPT-12	57	100 (12cm)	-	>100					
28.5											
29.0											
29.5	29.5	SPT-13	43	59	41 (8cm)	>100					
30.0											

(Depth v/s SPT N Value) axis: 0 10 20 30 40 50 60 70 80 90 100

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*41+056 km	*Northing :*3132810.479 m	*Easting :*685993.223 m
Reduced Level (m):(+)252.668	*BH. No. :*BH-A2	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*12-08-2021	*Date of Completion :*14-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
30.0										0 10 20 30 40 50 60 70 80 90 100	
30.5											
31.0	31	SPT-14	51	62	38 (12cm)	>100					
31.5											
32.0											
32.5	32.5	SPT-15	45	56	44 (7cm)	>100					
33.0											
33.5											
34.0	34	SPT-16	50	100 (3cm)	-	>100					
34.5											
35.0							Brown, Dense to very dense, Sandy silt of low plasticity with gravel	ML-CL			
35.5	35.5	SPT-17	57	100 (4cm)	-	>100					
36.0											
36.5											
37.0	37	SPT-18	47	100 (8cm)	-	>100					
37.5											
38.0											
38.5	38.5	SPT-19	54	100 (10cm)	-	>100					
39.0											
39.5											
40.0	40	SPT-20	60	100 (10cm)	-	>100					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*41+100 km	*Northing :*3132839.175 m	*Easting :*685985.307 m
Reduced Level (m):(+)252.428	*BH. No. :BH-*CL	*BH Termination Depth (m):*10
*Proposed / Existing Structure :*Minor Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*18-11-2021	*Date of Completion :*18-11-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5	0.5	SPT-1	5	6	11	17					
1.0											
1.5	1.5	SPT-2	4	9	13	22	Brown, Medium dense, Silty sand with clay	SM-SC			
2.0											
	2.25	UDS-1									
2.5											
3.0	3	SPT-3	8	12	15	27					
3.5											
4.0											
4.5	4.5	SPT-4	9	14	19	33					
5.0											
	5.25	UDS-2									
5.5											
6.0	6	SPT-5	12	17	22	39					
6.5							Brown, Very stiff to hard, Silty clay of low plasticity with gravel	CL			
7.0											
7.5	7.5	SPT-6	13	21	23	44					
8.0											
	8.25	UDS-3									
8.5											
9.0	9	SPT-7	11	22	24	46					
9.5											
10.0	10	SPT-8	12	26	28	54					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*41+217 km	*Northing :*3132954.077 m	*Easting :*685963.297 m
Reduced Level (m):(+)255.462	*BH. No. :BH-*CL	*BH Termination Depth (m):*10
Proposed / Existing Structure :-	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*18-11-2021	*Date of Completion :*18-11-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5	0.5	SPT-1	3	8	9	17					
1.0											
1.5	1.5	SPT-2	4	8	15	23	Brown, Medium dense, Silty sand	SM			
2.0											
	2.25	UDS-1									
2.5											
3.0	3	SPT-3	9	16	19	35					
3.5											
4.0							Brown,Medium dense to dense, Sandy Silt of low plasticity	ML-CL			
4.5	4.5	SPT-4	11	17	11	28					
5.0											
	5.25	UDS-2									
5.5											
6.0	6	SPT-5	13	20	21	41					
6.5											
7.0											
7.5	7.5	SPT-6	15	22	26	48	Brown, Hard, Silty clay of low plasticity	CL			
8.0											
	8.25	UDS-3									
8.5											
9.0	9	SPT-7	13	20	21	41					
9.5											
10.0	10	SPT-8	15	22	26	48					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*41+235 km	*Northing :*3132971.662 m	*Easting :*685959.452 m
Reduced Level (m):(+)254.441	*BH. No. :*BH-CL	*BH Termination Depth (m):*10
*Proposed / Existing Structure :*Minor Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*28-01-2022	*Date of Completion :*28-01-2022	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5	0.5	SPT-1	2	3	4	7					
1.0											
1.5	1.5	SPT-2	3	3	5	8	Brown, Loose, Sandy silt of low plasticity	ML-CL			
2.0											
	2.25	UDS*									
2.5											
3.0	3	SPT-3	8	9	11	20					
3.5											
4.0											
4.5	4.5	SPT-4	7	12	14	26					
5.0											
	5.25	UDS-1									
5.5											
6.0	6	SPT-5	9	14	21	35					
6.5							Brown, Very stiff to hard, Silty clay of low plasticity with gravel	CL			
7.0											
7.5	7.5	SPT-6	11	16	23	39					
8.0											
	8.25	UDS-2									
8.5											
9.0	9	SPT-7	10	19	21	40					
9.5											
10.0	10	SPT-8	12	22	26	48					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*41+390 km	*Northing :*3133111.995 m	*Easting :*685929.941 m
Reduced Level (m):(+)258.326	*BH. No. :*BH-A1	*BH Termination Depth (m):*35
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*13-08-2021	*Date of Completion :*16-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	UDS-1									
1.5											
2.0											
2.5	2.5	SPT-1	14	22	26	48					
3.0											
3.5											
4.0	4	UDS-2									
4.5											
5.0							Brown, Very dense, Sandy silt of low plasticity	ML-CL			
5.5	5.5	SPT-2	16	21	29	50					
6.0											
6.5											
7.0	7	UDS-3									
7.5											
8.0											
8.5	8.5	SPT-3	22	29	42	71					
9.0											
9.5											
10.0	10	UDS-4									

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*41+390 km	*Northing :*3133111.995 m	*Easting :*685929.941 m
Reduced Level (m):(+)258.326	*BH. No. :*BH-A1	*BH Termination Depth (m):*35
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*13-08-2021	*Date of Completion :*16-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0											
10.5											
11.0											
11.5	11.5	SPT-4	24	29	35	64					
12.0											
12.5											
13.0	13	UDS-5									
13.5											
14.0											
14.5	14.5	SPT-5	24	29	35	64	Brown, Very dense, Sandy silt of low plasticity	ML-CL			
15.0											
15.5											
16.0	16	UDS-6									
16.5											
17.0											
17.5	17.5	SPT-6	27	34	39	73					
18.0											
18.5											
19.0	19	UDS-7									
19.5							Brown, Hard, Silty clay of low plasticity	CL			
20.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*41+390 km	*Northing :*3133111.995 m	*Easting :*685929.941 m
Reduced Level (m):(+)258.326	*BH. No. :*BH-A1	*BH Termination Depth (m):*35
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*13-08-2021	*Date of Completion :*16-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
20.0										0 10 20 30 40 50 60 70 80 90 100	
	20.2	SPT-7	31	45	57	>100					
20.5											
21.0											
21.5											
22.0	22	SPT-8	32	42	55	97					
22.5											
23.0											
23.5	23.5	SPT-9	100 (3cm)	-	-	>100					
24.0							Brown, Hard, Silty clay of low plasticity	CL			
24.5											
25.0	25	SPT-10	37	95	5 (12cm)	>100					
25.5											
26.0											
26.5	26.5	SPT-11	41	54	46 (3cm)	>100					
27.0											
27.5											
28.0	28	SPT-12	47	59	41 (8cm)	>100					
28.5											
29.0							Brown, Hard, Silty clay of low plasticity	CL			
29.5	29.5	SPT-13	51	61	39 (3cm)	>100					
30.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*41+390 km	*Northing :*3133111.995 m	*Easting :*685929.941 m
Reduced Level (m):(+)258.326	*BH. No. :*BH-A1	*BH Termination Depth (m):*35
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*13-08-2021	*Date of Completion :*16-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
30.0											
30.5											
31.0	31	SPT-14	54	67	33 (7cm)	>100					
31.5											
32.0											
32.5	32.5	SPT-15	41	54	46 (7cm)	>100	Brown, Hard, Silty clay of low plasticity	CL			
33.0											
33.5											
34.0	34	SPT-16	45	57	43 (5cm)	>100					
34.5											
35.0	35	SPT-17	49	58	42 (5cm)	>100					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*41+390 km	*Northing :*3133135.325 m	*Easting :*685920.014 m
Reduced Level (m):(+)258.616	*BH. No. :*BH-A2	*BH Termination Depth (m):*35
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*12-08-2021	*Date of Completion :*14-08-2021	

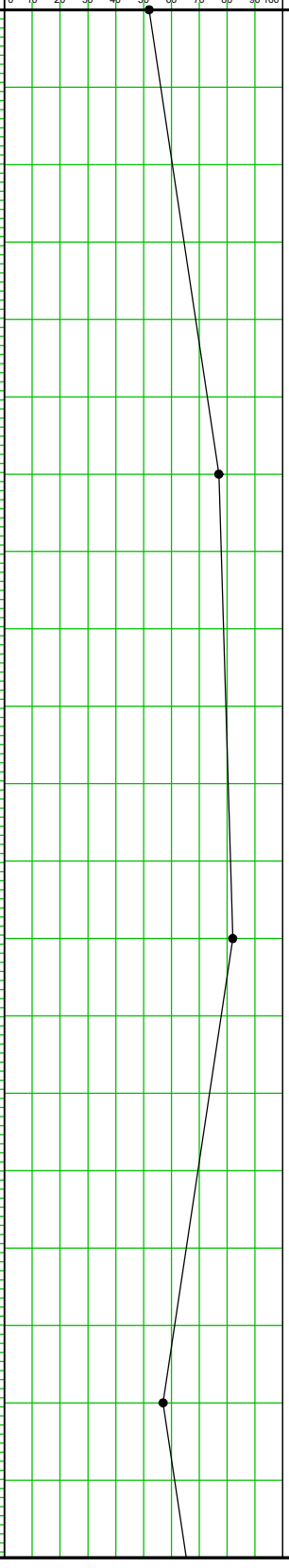
Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	SPT-1	5	6	9	15					
1.5											
2.0											
2.5	2.5	UDS-1					Brown, Medium dense, Sandy silt of low plasticity	ML-CL			
3.0											
3.5											
4.0	4	SPT-2	4	7	11	18					
4.5											
5.0											
5.5	5.5	UDS-2									
6.0											
6.5											
7.0	7	SPT-3	15	22	25	47					
7.5											
8.0							Brown, Hard, Silty clay of low plasticity	CL			
8.5	8.5	UDS-3									
9.0											
9.5											
10.0	10	SPT-4	15	23	29	52					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*41+390 km	*Northing :*3133135.325 m	*Easting :*685920.014 m
Reduced Level (m):(+)258.616	*BH. No. :*BH-A2	*BH Termination Depth (m):*35
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*12-08-2021	*Date of Completion :*14-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0											
10.5											
11.0											
11.5	11.5	UDS-4									
12.0											
12.5											
13.0	13	SPT-5	16	32	45	77					
13.5											
14.0											
14.5	14.5	UDS-5									
15.0							Brown, Hard, Silty clay of low plasticity	CL			
15.5											
16.0	16	SPT-6	15	35	47	82					
16.5											
17.0											
17.5	17.5	UDS-6									
18.0											
18.5											
19.0	19	SPT-7	19	25	32	57					
19.5											
20.0											



UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*41+390 km	*Northing :*3133135.325 m	*Easting :*685920.014 m
Reduced Level (m):(+)258.616	*BH. No. :*BH-A2	*BH Termination Depth (m):*35
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*12-08-2021	*Date of Completion :*14-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
20.0											
20.5	20.5	UDS-7									
21.0											
21.5											
22.0	22	SPT-8	22	35	47	82					
22.5											
23.0											
23.5	23.5	UDS-8									
24.0							Brown, Hard, Silty clay of low plasticity	CL			
24.5											
25.0	25	SPT-9	26	46	68	>100					
25.5											
26.0											
26.5	26.5	SPT-10	28	49	51 (3cm)	>100					
27.0											
27.5											
28.0	28	SPT-11	31	55	45 (7cm)	>100					
28.5											
29.0							Brown, Hard, Silty clay of low plasticity	CL			
29.5	29.5	SPT-12	36	62	38 (12cm)	>100					
30.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*41+390 km	*Northing :*3133135.325 m	*Easting :*685920.014 m
Reduced Level (m):(+)258.616	*BH. No. :*BH-A2	*BH Termination Depth (m):*35
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*12-08-2021	*Date of Completion :*14-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
30.0											
30.5											
31.0	31	SPT-13	25	51	49 (4cm)	>100					
31.5											
32.0											
32.5	32.5	SPT-14	55	65	35 (13cm)	>100	Brown, Hard, Silty clay of low plasticity	CL			
33.0											
33.5											
34.0	34	SPT-15	45	70	30 (5cm)	>100					
34.5											
35.0	35	SPT-16	47	59	41 (5cm)	>100					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*42+256 km	*Northing :*3133665.625 m	*Easting :*685833.304 m
Reduced Level (m):(+)262.272	*BH. No. :*BH-A1	*BH Termination Depth (m):*35
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*10-08-2021	*Date of Completion :*12-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	SPT-1	3	3	5	8					
1.5											
2.0							Brown, Loose, Sandy silt of low plasticity	ML-CL			
2.5	2.5	UDS-1									
3.0											
3.5											
4.0	4	SPT-2	5	7	9	16					
4.5											
5.0											
5.5	5.5	UDS-2									
6.0											
6.5											
7.0	7	SPT-3	5	8	11	19	Brown, Medium dense to dense, Sandy silt of low plasticity	ML-CL			
7.5											
8.0											
8.5	8.5	UDS-3									
9.0											
9.5											
10.0	10	SPT-4	7	10	12	22					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*42+256 km	*Northing :*3133665.625 m	*Easting :*685833.304 m
Reduced Level (m):(+)262.272	*BH. No. :*BH-A1	*BH Termination Depth (m):*35
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*10-08-2021	*Date of Completion :*12-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0										0 10 20 30 40 50 60 70 80 90 100	
10.5											
11.0											
11.5	11.5	UDS-4									
12.0											
12.5											
13.0	13	SPT-5	9	11	14	25					
13.5											
14.0											
14.5	14.5	UDS-5									
15.0							Brown, Medium dense to dense, Sandy silt of low plasticity	ML-CL			
15.5											
16.0	16	SPT-6	13	15	18	33					
16.5											
17.0											
17.5	17.5	UDS-6									
18.0											
18.5											
19.0	19	SPT-7	10	15	17	32					
19.5											
20.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*42+256 km	*Northing :*3133665.625 m	*Easting :*685833.304 m
Reduced Level (m):(+)262.272	*BH. No. :*BH-A1	*BH Termination Depth (m):*35
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*10-08-2021	*Date of Completion :*12-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
20.0											
20.5	20.5	UDS-7					Brown, Medium dense to dense, Sandy silt of low plasticity	ML-CL			
21.0											
21.5											
22.0	22	SPT-8	17	24	28	52					
22.5											
23.0											
23.5	23.5	UDS-8					Brown, Very dense, Sandy silt of low plasticity	ML-CL			
24.0											
24.5											
25.0	25	SPT-9	16	26	30	56					
25.5											
26.0											
26.5	26.5	UDS-9									
27.0											
27.5											
28.0	28	SPT-10	21	39	43	82	Brown, Hard, Silty clay of low plasticity	CL			
28.5											
29.0											
29.5	29.5	SPT-11	19	41	49	90					
30.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*42+256 km	*Northing :*3133665.625 m	*Easting :*685833.304 m
Reduced Level (m):(+)262.272	*BH. No. :*BH-A1	*BH Termination Depth (m):*35
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*10-08-2021	*Date of Completion :*12-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
30.0											
30.5											
31.0	31	SPT-12	22	45	51	96	Brown, Hard, Silty clay of low plasticity	CL			
31.5											
32.0											
32.5	32.5	SPT-13	24	49	52 (14cm)	>100					
33.0											
33.5											
34.0	34	SPT-14	28	51	49 (13cm)	>100	Brown, Very dense, Sandy silt of low plasticity	ML-CL			
34.5											
35.0	35	SPT-15	100 (15cm)	-	-	>100					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*42+256 km	*Northing :*3133711.521 m	*Easting :*685843.959 m
Reduced Level (m):(+)263.721	*BH. No. :*BH-P2	*BH Termination Depth (m):*35
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*13-08-2021	*Date of Completion :*16-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	SPT-1	4	7	9	16					
1.5											
2.0											
2.5	2.5	UDS-1					Brown, Medium dense, Silty sand with clay	SM-SC			
3.0											
3.5											
4.0	4	SPT-2	7	10	12	22					
4.5											
5.0											
5.5	5.5	UDS-2									
6.0											
6.5											
7.0	7	SPT-3	8	14	17	31					
7.5											
8.0							Brown, Dense, Sandy silt of low plasticity	ML-CL			
8.5	8.5	UDS-3									
9.0											
9.5											
10.0	10	SPT-4	10	16	20	36					

(Depth v/s SPT N Value) axis: 0 10 20 30 40 50 60 70 80 90 100

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*42+256 km	*Northing :*3133711.521 m	*Easting :*685843.959 m
Reduced Level (m):(+)263.721	*BH. No. :*BH-P2	*BH Termination Depth (m):*35
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*13-08-2021	*Date of Completion :*16-08-2021	

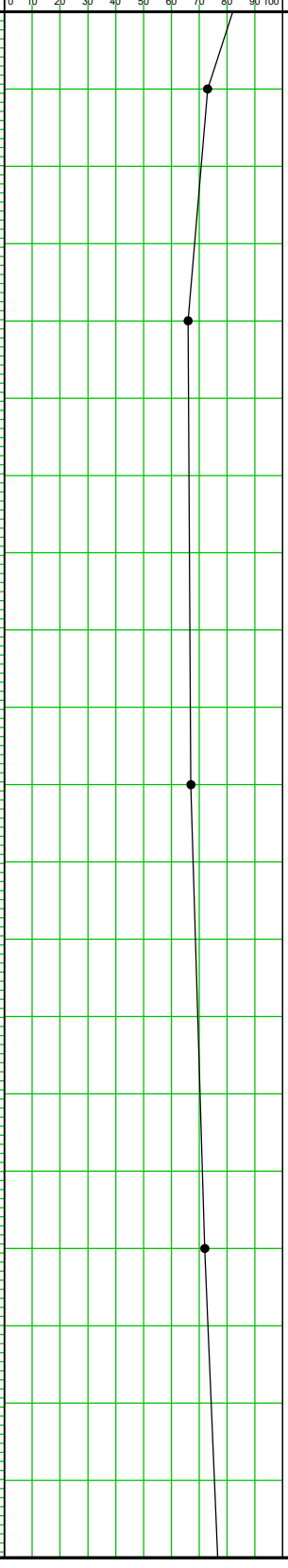
Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0										0 10 20 30 40 50 60 70 80 90 100	
10.5											
11.0											
11.5	11.5	UDS-4									
12.0											
12.5											
13.0	13	SPT-5	10	12	18	30					
13.5											
14.0							Brown, Dense, Sandy silt of low plasticity	ML-CL			
14.5	14.5	UDS-5									
15.0											
15.5											
16.0	16	SPT-6	14	17	22	39					
16.5											
17.0											
17.5	17.5	UDS-6									
18.0											
18.5											
19.0	19	SPT-7	19	72	21 (3cm)	>100	Brown, Very dense, Sandy silt of low plasticity	ML-CL			
19.5											
20.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*42+256 km	*Northing :*3133711.521 m	*Easting :*685843.959 m
Reduced Level (m):(+)263.721	*BH. No. :*BH-P2	*BH Termination Depth (m):*35
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*13-08-2021	*Date of Completion :*16-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
20.0											
20.5	20.5	SPT-8	16	34	39	73					
21.0											
21.5											
22.0	22	SPT-9	15	32	34	66					
22.5											
23.0											
23.5	23.5	UDS-7									
24.0											
24.5											
25.0	25	SPT-10	17	30	37	67	Brown, Very dense, Sandy silt of low plasticity	ML-CL			
25.5											
26.0											
26.5	26.5	UDS-8									
27.0											
27.5											
28.0	28	SPT-11	15	32	40	72					
28.5											
29.0											
29.5	29.5	UDS-9									
30.0											



UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*42+256 km	*Northing :*3133711.521 m	*Easting :*685843.959 m
Reduced Level (m):(+)263.721	*BH. No. :*BH-P2	*BH Termination Depth (m):*35
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*13-08-2021	*Date of Completion :*16-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
30.0										0 10 20 30 40 50 60 70 80 90 100	
30.5											
31.0	31	SPT-12	18	35	44	79					
31.5											
32.0											
32.5	32.5	UDS-10					Brown, Very dense, Sandy silt of low plasticity	ML-CL			
33.0											
33.5											
34.0	34	SPT-13	21	43	47	90					
34.5											
35.0	35	SPT-14	52	100 (12cm)	-	>100					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*42+256 km	*Northing :*3133732.83 m	*Easting :*685846.067 m
Reduced Level (m):(+)262.764	*BH. No. :*BH-P3	*BH Termination Depth (m):*35
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*17-08-2021	*Date of Completion :*18-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	UDS-1									
1.5											
2.0							Brown, Very loose, Sandy silt of low plasticity	ML-CL			
2.5	2.5	SPT-1	2	2	2	4					
3.0											
3.5											
4.0	4	UDS-2									
4.5											
5.0											
5.5	5.5	SPT-2	11	13	17	30					
6.0											
6.5											
7.0	7	UDS-3					Brown, Dense, Sandy silt of low plasticity	ML-CL			
7.5											
8.0											
8.5	8.5	SPT-3	10	13	16	29					
9.0											
9.5											
10.0	10	UDS-4									

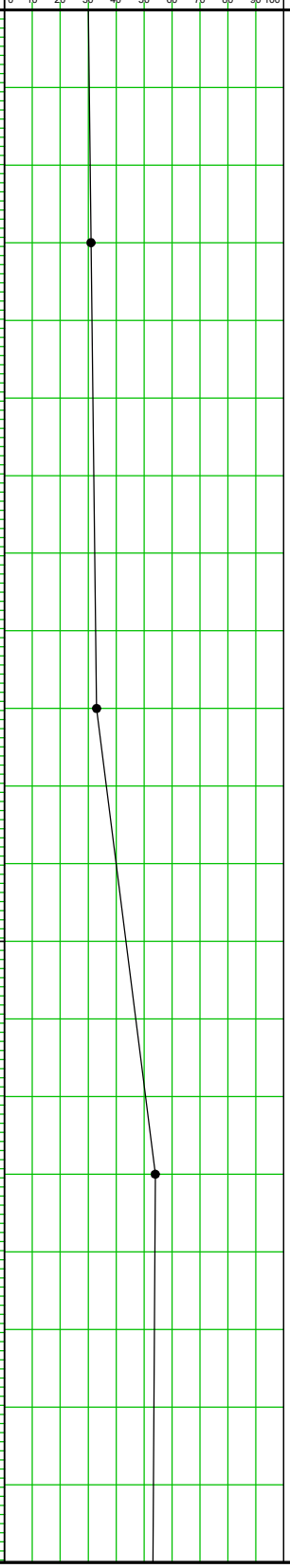
(Depth v/s SPT N Value) axis: 0 10 20 30 40 50 60 70 80 90 100

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*42+256 km	*Northing :*3133732.83 m	*Easting :*685846.067 m
Reduced Level (m):(+)262.764	*BH. No. :*BH-P3	*BH Termination Depth (m):*35
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*17-08-2021	*Date of Completion :*18-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0											
10.5											
11.0											
11.5	11.5	SPT-4	11	14	17	31					
12.0											
12.5											
13.0	13	UDS-5					Brown, Dense, Sandy silt of low plasticity	ML-CL			
13.5											
14.0											
14.5	14.5	SPT-5	12	15	18	33					
15.0											
15.5											
16.0	16	UDS-6									
16.5											
17.0											
17.5	17.5	SPT-6	13	25	29	54					
18.0							Brown, Very dense, Sandy silt of low plasticity	ML-CL			
18.5											
19.0	19	UDS-7									
19.5											
20.0											



UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*42+256 km	*Northing :*3133732.83 m	*Easting :*685846.067 m
Reduced Level (m):(+)262.764	*BH. No. :*BH-P3	*BH Termination Depth (m):*35
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*17-08-2021	*Date of Completion :*18-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
20.0											
20.5	20.5	SPT-7	17	22	51	53					
21.0											
21.5											
22.0	22	UDS-8									
22.5											
23.0											
23.5	23.5	SPT-8	22	27	36	63					
24.0											
24.5											
25.0	25	UDS-9					Brown, Very dense, Sandy silt of low plasticity	ML-CL			
25.5											
26.0											
26.5	26.5	SPT-9	24	29	38	67					
27.0											
27.5											
28.0	28	UDS-10									
28.5											
29.0											
29.5	29.5	SPT-10	25	30	46	76					
30.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*42+256 km	*Northing :*3133732.83 m	*Easting :*685846.067 m
Reduced Level (m):(+)262.764	*BH. No. :*BH-P3	*BH Termination Depth (m):*35
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*17-08-2021	*Date of Completion :*18-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
30.0										0 10 20 30 40 50 60 70 80 90 100	
30.5											
31.0	31	UDS-11									
31.5											
32.0											
32.5	32.5	SPT-11	28	52	48 (12cm)	>100	Brown, Very dense, Sandy silt of low plasticity	ML-CL			
33.0											
33.5											
34.0	34	SPT-12	30	75	25 (4cm)	>100					
34.5											
35.0	35	SPT-13	45	86	14 (2cm)	>100					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*42+256 km	*Northing :*3133756.86 m	*Easting :*685829.93 m
Reduced Level (m):(+)262.555	*BH. No. :*BH-P4	*BH Termination Depth (m):*34
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*09-08-2021	*Date of Completion :*12-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	SPT-1	3	4	4	8					
1.5											
2.0							Brown, Loose, Silty sand with clay	SM-SC			
2.5	2.5	UDS-1									
3.0											
3.5											
4.0	4	SPT-2	3	5	7	12					
4.5											
5.0											
5.5	5.5	UDS-2									
6.0											
6.5											
7.0	7	SPT-3	4	6	9	15	Brown, Medium dense, Silty sand with clay	SM-SC			
7.5											
8.0											
8.5	8.5	UDS-3									
9.0											
9.5											
10.0	10	SPT-4	4	9	11	20					

(Depth v/s SPT N Value) axis: 0 10 20 30 40 50 60 70 80 90 100

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*42+256 km	*Northing :*3133756.86 m	*Easting :*685829.93 m
Reduced Level (m):(+)262.555	*BH. No. :*BH-P4	*BH Termination Depth (m):*34
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*09-08-2021	*Date of Completion :*12-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0										0 10 20 30 40 50 60 70 80 90 100	
10.5											
11.0											
11.5	11.5	UDS-4									
12.0											
12.5							Brown, Medium dense, Silty sand with clay	SM-SC			
13.0	13	SPT-5	7	10	13	23					
13.5											
14.0											
14.5	14.5	UDS-5									
15.0											
15.5											
16.0	16	SPT-6	16	21	23	44	Brown, Dense, Silty sand with clay	SM-SC			
16.5											
17.0											
17.5	17.5	UDS-6									
18.0											
18.5											
19.0	19	SPT-7	14	25	36	61	Brown, Very dense, Sandy silt of low plasticity	ML-CL			
19.5											
20.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*42+256 km	*Northing :*3133756.86 m	*Easting :*685829.93 m
Reduced Level (m):(+)262.555	*BH. No. :*BH-P4	*BH Termination Depth (m):*34
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*09-08-2021	*Date of Completion :*12-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
20.0											
20.5	20.5	UDS-7									
21.0											
21.5											
22.0	22	SPT-8	21	28	41	69					
22.5											
23.0											
23.5	23.5	SPT-9	21	26	37	63					
24.0											
24.5											
25.0	25	UDS-8					Brown, Very dense, Sandy silt of low plasticity	ML-CL			
25.5											
26.0											
26.5	26.5	SPT-10	24	56	45 (9cm)	>100					
27.0											
27.5											
28.0	28	SPT-11	21	26	47	73					
28.5											
29.0											
29.5	29.5	SPT-12	36	59	42 (11cm)	>100					
30.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*42+256 km	*Northing :*3133756.86 m	*Easting :*685829.93 m
Reduced Level (m):(+)262.555	*BH. No. :*BH-P4	*BH Termination Depth (m):*34
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*09-08-2021	*Date of Completion :*12-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
30.0											
30.5											
31.0	31	SPT-13	33	54	47 (13cm)	>100					
31.5											
32.0							Brown, Very dense, Sandy silt of low plasticity	ML-CL			
32.5	32.5	SPT-14	43	68	33 (5cm)	>100					
33.0											
33.5											
34.0	34	SPT-15	60	78	23 (4cm)	>100					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*42+256 km	*Northing :*3133785.448 m	*Easting :*685839.438 m
Reduced Level (m):(+)264.797	*BH. No. :*BH-P5	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*14-08-2021	*Date of Completion :*17-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	UDS-1									
1.5											
2.0											
2.5	2.5	SPT-1	5	5	7	12					
3.0											
3.5											
4.0	4	UDS-2									
4.5											
5.0							Brown, Medium dense, Sandy silt of low plasticity	ML-CL			
5.5	5.5	SPT-2	6	8	10	18					
6.0											
6.5											
7.0	7	UDS-3									
7.5											
8.0											
8.5	8.5	SPT-3	7	9	11	20					
9.0											
9.5											
10.0	10	UDS-4									

(Depth v/s SPT N Value) axis: 0 10 20 30 40 50 60 70 80 90 100

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*42+256 km	*Northing :*3133785.448 m	*Easting :*685839.438 m
Reduced Level (m):(+)264.797	*BH. No. :*BH-P5	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*14-08-2021	*Date of Completion :*17-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0										0 10 20 30 40 50 60 70 80 90 100	
10.5											
11.0											
11.5	11.5	SPT-4	9	11	15	26	Brown, Medium dense, Sandy silt of low plasticity	ML-CL			
12.0											
12.5											
13.0	13	UDS-5									
13.5											
14.0											
14.5	14.5	SPT-5	10	13	17	30					
15.0											
15.5											
16.0	16	UDS-6									
16.5							Brown, Dense, Sandy silt of low plasticity	ML-CL			
17.0											
17.5	17.5	SPT-6	11	14	19	33					
18.0											
18.5											
19.0	19	UDS-7									
19.5											
20.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*42+256 km	*Northing :*3133785.448 m	*Easting :*685839.438 m
Reduced Level (m):(+)264.797	*BH. No. :*BH-P5	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*14-08-2021	*Date of Completion :*17-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
20.0											
20.5	20.5	SPT-7	13	17	26	43					
21.0											
21.5											
22.0	22	UDS-8									
22.5											
23.0											
23.5	23.5	SPT-8	14	19	29	48					
24.0							Brown, Dense, Sandy silt of low plasticity	ML-CL			
24.5											
25.0	25	UDS-9									
25.5											
26.0											
26.5	26.5	SPT-9	17	24	31	55					
27.0											
27.5											
28.0	28	UDS-10									
28.5											
29.0							Brown, Very dense, Sandy silt of low plasticity	ML-CL			
29.5	29.5	SPT-10	21	33	44	77					
30.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*42+256 km	*Northing :*3133785.448 m	*Easting :*685839.438 m
Reduced Level (m):(+)264.797	*BH. No. :*BH-P5	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*14-08-2021	*Date of Completion :*17-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
30.0											
30.5											
31.0	31	UDS-11									
31.5											
32.0											
32.5	32.5	SPT-11	22	35	50	85					
33.0											
33.5											
34.0	34	UDS-12									
34.5											
35.0							Brown, Very dense, Sandy silt of low plasticity	ML-CL			
35.5	35.5	SPT-12	24	39	56	95					
36.0											
36.5											
37.0	37	SPT-13	28	58	42 (12cm)	>100					
37.5											
38.0											
38.5	38.5	SPT-14	34	76	25 (6cm)	>100					
39.0											
39.5											
40.0	40	SPT-15	41	100 (14cm)	-	>100					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*42+256 km	*Northing :*3133808.838 m	*Easting :*685841.105 m
Reduced Level (m):(+)263.810	*BH. No. :*BH-P6	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*17-08-2021	*Date of Completion :*19-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	SPT-1	11	20	15	35					
1.5											
2.0											
2.5	2.5	UDS-1									
3.0											
3.5											
4.0	4	SPT-2	10	13	17	30					
4.5											
5.0							Brown, Dense, Sandy silt of low plasticity	ML-CL			
5.5	5.5	UDS-2									
6.0											
6.5											
7.0	7	SPT-3	12	15	20	35					
7.5											
8.0											
8.5	8.5	UDS-3									
9.0											
9.5											
10.0	10	SPT-4	10	16	22	38					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*42+256 km	*Northing :*3133808.838 m	*Easting :*685841.105 m
Reduced Level (m):(+)263.810	*BH. No. :*BH-P6	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*17-08-2021	*Date of Completion :*19-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0											
10.5											
11.0											
11.5	11.5	UDS-4									
12.0											
12.5											
13.0	13	SPT-5	12	18	21	39					
13.5							Brown, Dense, Sandy silt of low plasticity	ML-CL			
14.0											
14.5	14.5	UDS-5									
15.0											
15.5											
16.0	16	SPT-6	8	16	22	38					
16.5											
17.0											
17.5	17.5	UDS-6									
18.0											
18.5							Brown, Very dense, Sandy silt of low plasticity	ML-CL			
19.0	19	SPT-7	19	27	35	62					
19.5											
20.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*42+256 km	*Northing :*3133808.838 m	*Easting :*685841.105 m
Reduced Level (m):(+)263.810	*BH. No. :*BH-P6	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*17-08-2021	*Date of Completion :*19-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
20.0										0 10 20 30 40 50 60 70 80 90 100	
20.5	20.5	UDS-7									
21.0											
21.5											
22.0	22	SPT-8	22	31	39	70					
22.5											
23.0											
23.5	23.5	UDS-8									
24.0											
24.5											
25.0	25	SPT-9	18	29	41	70	Brown, Very dense, Sandy silt of low plasticity	ML-CL			
25.5											
26.0											
26.5	26.5	UDS-9									
27.0											
27.5											
28.0	28	SPT-10	19	28	44	72					
28.5											
29.0											
29.5	29.5	UDS-10									
30.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*42+256 km	*Northing :*3133808.838 m	*Easting :*685841.105 m
Reduced Level (m):(+)263.810	*BH. No. :*BH-P6	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*17-08-2021	*Date of Completion :*19-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
30.0										0 10 20 30 40 50 60 70 80 90 100	
30.5											
31.0	31	SPT-11	22	39	48	87					
31.5											
32.0											
32.5	32.5	SPT-12	23	40	60 (5cm)	>100					
33.0											
33.5											
34.0	34	SPT-13	25	58	42 (4cm)	>100					
34.5											
35.0							Brown, Very dense, Sandy silt of low plasticity	ML-CL			
35.5	35.5	SPT-14	28	62	38 (3cm)	>100					
36.0											
36.5											
37.0	37	SPT-15	31	43	59 (11cm)	>100					
37.5											
38.0											
38.5	38.5	SPT-16	34	60	40 (10cm)	>100					
39.0											
39.5											
40.0	40	SPT-17	55	95	5 (12cm)	>100					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*42+256 km	*Northing :*3133991.627 m	*Easting :*685807.139 m
Reduced Level (m):(+)264.859	*BH. No. :*BH-P13	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*11-08-2021	*Date of Completion :*12-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	UDS-1									
1.5											
2.0											
2.5	2.5	SPT-1	6	9	13	22	Brown, Medium dense, Silty sand with clay	SM-SC			
3.0											
3.5											
4.0	4	UDS-2									
4.5											
5.0											
5.5	5.5	SPT-2	8	22	42	64					
6.0											
6.5											
7.0	7	UDS-3									
7.5											
8.0							Brown, Very dense, Sandy silt of low plasticity	ML-CL			
8.5	8.5	SPT-3	17	19	26	45					
9.0											
9.5											
10.0	10	UDS-4									

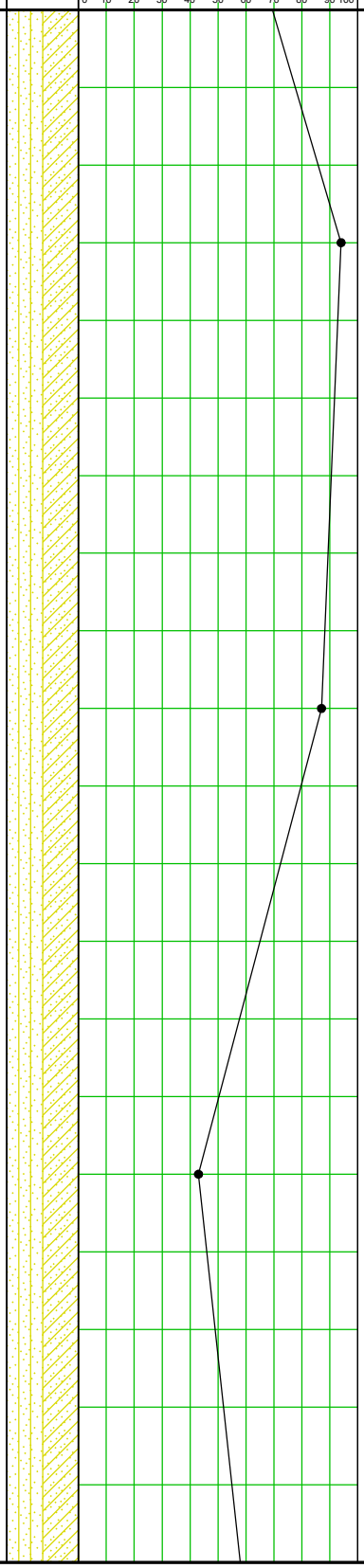
(Depth v/s SPT N Value) axis: 0 10 20 30 40 50 60 70 80 90 100

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*42+256 km	*Northing :*3133991.627 m	*Easting :*685807.139 m
Reduced Level (m):(+)264.859	*BH. No. :*BH-P13	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*11-08-2021	*Date of Completion :*12-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0											
10.5											
11.0											
11.5	11.5	SPT-4	18	38	56	94					
12.0											
12.5											
13.0	13	UDS-5									
13.5											
14.0											
14.5	14.5	SPT-5	15	36	51	87					
15.0							Brown, Very dense, Silty sand with clay	SM-SC			
15.5											
16.0	16	UDS-6									
16.5											
17.0											
17.5	17.5	SPT-6	10	16	27	43					
18.0											
18.5											
19.0	19	UDS-7									
19.5											
20.0											

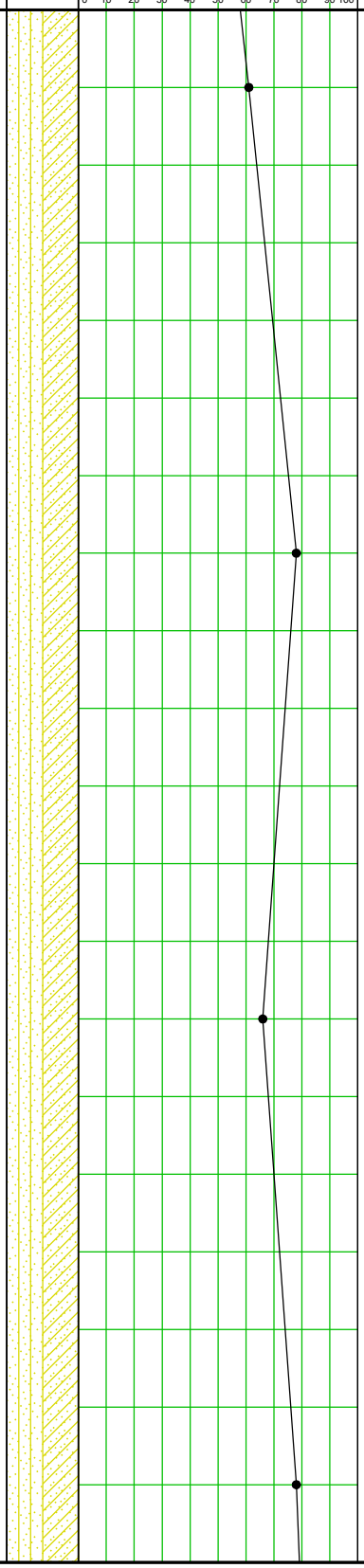


UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*42+256 km	*Northing :*3133991.627 m	*Easting :*685807.139 m
Reduced Level (m):(+)264.859	*BH. No. :*BH-P13	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*11-08-2021	*Date of Completion :*12-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
20.0											
20.5	20.5	SPT-7	12	28	33	61					
21.0											
21.5											
22.0	22	UDS-8									
22.5											
23.0											
23.5	23.5	SPT-8	24	36	42	78					
24.0											
24.5											
25.0	25	UDS-9					Brown, Very dense, Silty sand with clay	SM-SC			
25.5											
26.0											
26.5	26.5	SPT-9	17	29	37	66					
27.0											
27.5											
28.0	28	UDS-10									
28.5											
29.0											
29.5	29.5	SPT-10	22	33	45	78					
30.0											



UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*42+256 km	*Northing :*3133991.627 m	*Easting :*685807.139 m
Reduced Level (m):(+)264.859	*BH. No. :*BH-P13	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*11-08-2021	*Date of Completion :*12-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
30.0											
30.5							Brown, Very dense, Silty sand with clay	SM-SC			
31.0	31	UDS-11									
31.5											
32.0											
32.5	32.5	SPT-11	24	37	48	85					
33.0											
33.5											
34.0	34	UDS-12									
34.5											
35.0											
35.5	35.5	SPT-12	22	100 (11cm)	-	>100	Brown, Very dense, Sandy silt of low plasticity	ML-CL			
36.0											
36.5											
37.0	37	UDS-13									
37.5											
38.0											
38.5	38.5	SPT-13	36	55	46 (7cm)	>100					
39.0											
39.5											
40.0	40	UDS*									

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*42+256 km	*Northing :*3134066.732 m	*Easting :*685782.242 m
Reduced Level (m):(+)263.998	*BH. No. :*BH-P14	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*07-08-2021	*Date of Completion :*10-08-2021	

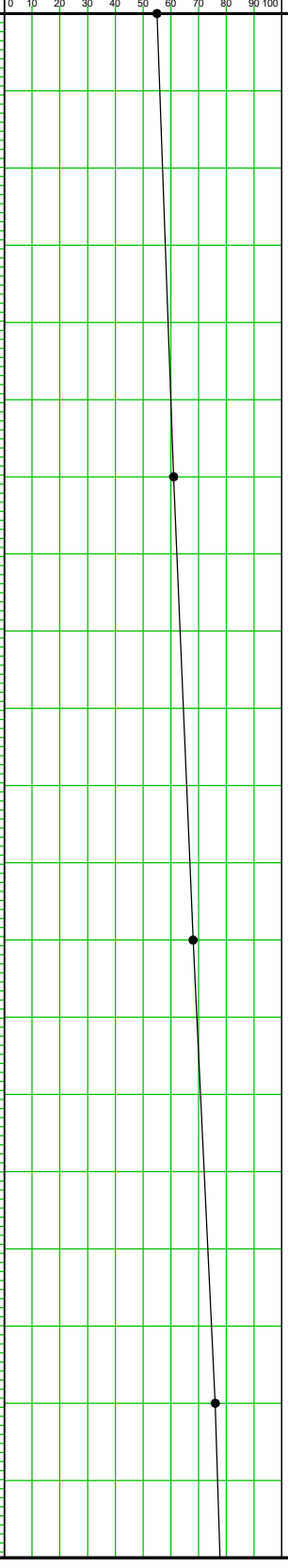
Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	SPT-1	5	8	11	19					
1.5							Brown, Medium dense, Sandy silt of low plasticity	ML-CL			
2.0											
2.5	2.5	UDS-1									
3.0	3	SPT-2	10	15	16	31					
3.5											
4.0	4	SPT-3	12	18	21	39					
4.5											
5.0											
5.5	5.5	UDS-2									
6.0											
6.5							Brown, Dense to very dense, Sandy silt of low plasticity	ML-CL			
7.0	7	SPT-4	16	22	26	48					
7.5											
8.0											
8.5	8.5	UDS-3									
9.0											
9.5											
10.0	10	SPT-5	18	24	31	55					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*42+256 km	*Northing :*3134066.732 m	*Easting :*685782.242 m
Reduced Level (m):(+)263.998	*BH. No. :*BH-P14	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*07-08-2021	*Date of Completion :*10-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0											
10.5											
11.0											
11.5	11.5	UDS-4									
12.0											
12.5											
13.0	13	SPT-6	15	27	34	61					
13.5											
14.0											
14.5	14.5	UDS-5									
15.0							Brown, Dense to very dense, Sandy silt of low plasticity	ML-CL			
15.5											
16.0	16	SPT-7	19	30	38	68					
16.5											
17.0											
17.5	17.5	UDS*									
18.0											
18.5											
19.0	19	SPT-8	23	34	42	76					
19.5											
20.0											



UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*42+256 km	*Northing :*3134066.732 m	*Easting :*685782.242 m
Reduced Level (m):(+)263.998	*BH. No. :*BH-P14	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*07-08-2021	*Date of Completion :*10-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
20.0											
20.5	20.5	UDS-6									
21.0											
21.5											
22.0	22	SPT-9	20	36	45	81					
22.5											
23.0							Brown, Dense to very dense, Sandy silt of low plasticity	ML-CL			
23.5	23.5	UDS-7									
24.0											
24.5											
25.0	25	SPT-10	24	38	48	86					
25.5											
26.0											
26.5	26.5	UDS-8									
27.0											
27.5											
28.0	28	SPT-11	21	27	27	54	Brown, Hard, Silty clay of low plasticity	CL			
28.5											
29.0											
29.5	29.5	UDS-9									
30.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*42+256 km	*Northing :*3134066.732 m	*Easting :*685782.242 m
Reduced Level (m):(+)263.998	*BH. No. :*BH-P14	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*07-08-2021	*Date of Completion :*10-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
30.0											
30.5											
31.0	31	SPT-12	19	25	29	54					
31.5											
32.0											
32.5	32.5	UDS-10									
33.0											
33.5											
34.0	34	SPT-13	53	65	35 (4cm)	>100					
34.5											
35.0							Brown, Hard, Silty clay of low plasticity	CL			
35.5	35.5	UDS*									
36.0											
36.5											
37.0	37	SPT-14	36	52	48 (4cm)	>100					
37.5											
38.0											
38.5	38.5	UDS*									
39.0											
39.5											
40.0	40	SPT-15	38	67	33 (10cm)	>100					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*42+256 km	*Northing :*3134091.912 m	*Easting :*685773.857 m
Reduced Level (m):(+)263.446	*BH. No. :*BH-P15	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*11-08-2021	*Date of Completion :*13-08-2021	

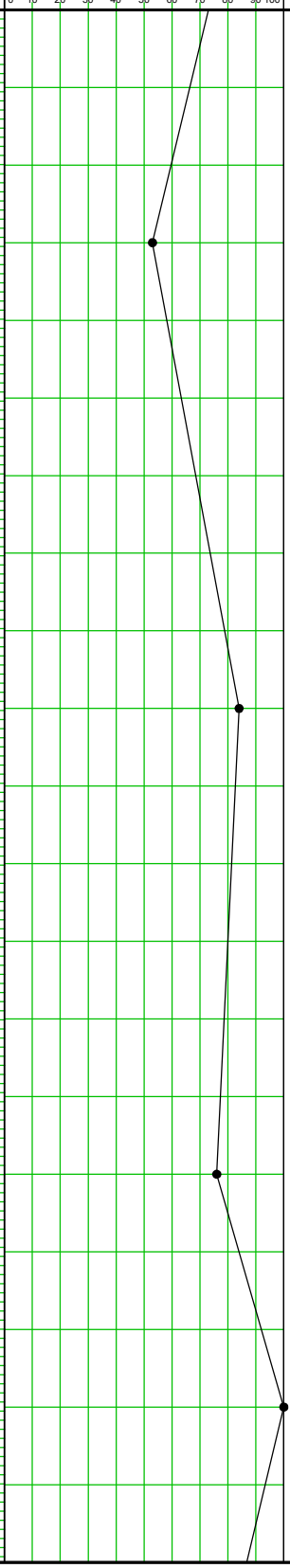
Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	UDS-1									
1.5											
2.0											
2.5	2.5	SPT-1	7	8	11	19	Brown, Medium dense, Silty sand with clay	SM-SC			
3.0											
3.5											
4.0	4	UDS-2									
4.5											
5.0											
5.5	5.5	SPT-2	12	16	24	40					
6.0											
6.5											
7.0	7	UDS-3					Brown, Hard, Silty clay of medium plasticity	CI			
7.5											
8.0											
8.5	8.5	SPT-3	24	38	55	93					
9.0											
9.5							Brown, Very dense, Sandy silt of low plasticity	ML-CL			
10.0	10	UDS-4									

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*42+256 km	*Northing :*3134091.912 m	*Easting :*685773.857 m
Reduced Level (m):(+)263.446	*BH. No. :*BH-P15	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*11-08-2021	*Date of Completion :*13-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0											
10.5											
11.0											
11.5	11.5	SPT-4	17	24	29	53					
12.0											
12.5											
13.0	13	UDS-5									
13.5											
14.0											
14.5	14.5	SPT-5	26	38	46	84					
15.0							Brown, Very dense, Sandy silt of low plasticity	ML-CL			
15.5											
16.0	16	UDS-6									
16.5											
17.0											
17.5	17.5	SPT-6	25	35	41	76					
18.0											
18.5											
19.0	19	SPT-7	24	48	52	>100					
19.5											
20.0											



UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*42+256 km	*Northing :*3134091.912 m	*Easting :*685773.857 m
Reduced Level (m):(+)263.446	*BH. No. :*BH-P15	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*11-08-2021	*Date of Completion :*13-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
20.0											
20.5	20.5	SPT-8	24	38	42	80	Brown, Very dense, Sandy silt of low plasticity	ML-CL			
21.0											
21.5											
22.0	22	UDS-7									
22.5											
23.0											
23.5	23.5	SPT-9	22	32	43	75					
24.0											
24.5											
25.0	25	UDS-8					Brown, Hard, Silty clay of low plasticity	CL			
25.5											
26.0											
26.5	26.5	SPT-10	22	36	47	83					
27.0											
27.5											
28.0	28	UDS-9									
28.5											
29.0											
29.5	29.5	SPT-11	37	48	53 (13cm)	>100					
30.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*42+256 km	*Northing :*3134091.912 m	*Easting :*685773.857 m
Reduced Level (m):(+)263.446	*BH. No. :*BH-P15	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*11-08-2021	*Date of Completion :*13-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
30.0										0 10 20 30 40 50 60 70 80 90 100	
30.5											
31.0	31	SPT-12	42	48	53 (12cm)	>100					
31.5											
32.0											
32.5	32.5	SPT-13	28	41	53	94					
33.0											
33.5											
34.0	34	SPT-14	30	58	43 (10cm)	>100					
34.5											
35.0							Brown, Hard, Silty clay of low plasticity	CL			
35.5	35.5	SPT-15	33	40	55	95					
36.0											
36.5											
37.0	37	SPT-16	33	39	53	92					
37.5											
38.0											
38.5	38.5	SPT-17	41	85	16 (4cm)	>100					
39.0											
39.5											
40.0	40	SPT-18	38	80	21 (6cm)	>100					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*42+256 km	*Northing :*3134166.127 m	*Easting :*685765.737 m
Reduced Level (m):(+)263.316	*BH. No. :*BH-P16	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*11-08-2021	*Date of Completion :*13-08-2021	

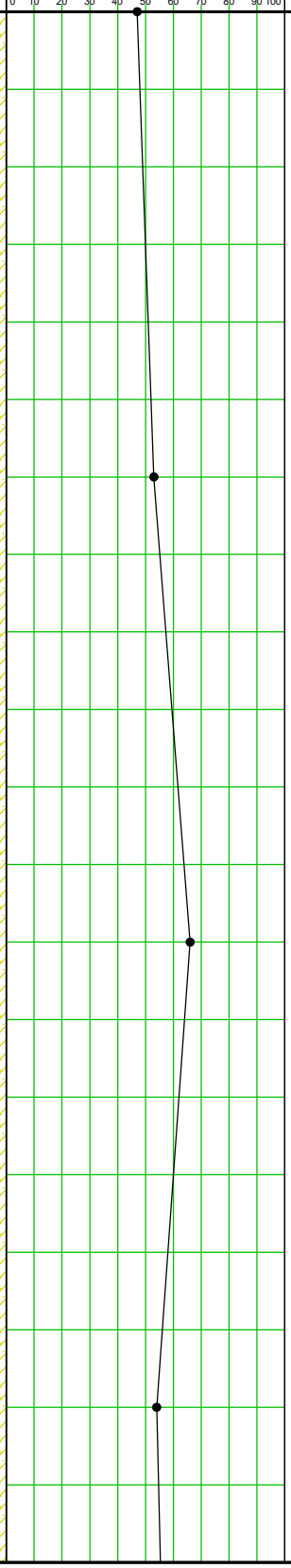
Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	SPT-1	4	7	9	16					
1.5											
2.0											
2.5	2.5	UDS-1									
3.0											
3.5											
4.0	4	SPT-2	9	12	15	27					
4.5											
5.0							Brown, Medium dense to very dense, Silty sand with clay	SM-SC			
5.5	5.5	UDS-2									
6.0											
6.5											
7.0	7	SPT-3	11	17	21	38					
7.5											
8.0											
8.5	8.5	UDS-3									
9.0											
9.5											
10.0	10	SPT-4	15	21	26	47					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*42+256 km	*Northing :*3134166.127 m	*Easting :*685765.737 m
Reduced Level (m):(+)263.316	*BH. No. :*BH-P16	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*11-08-2021	*Date of Completion :*13-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0											
10.5											
11.0											
11.5	11.5	UDS-4									
12.0											
12.5											
13.0	13	SPT-5	16	25	28	53					
13.5											
14.0											
14.5	14.5	UDS-5									
15.0							Brown, Medium dense to very dense, Silty sand with clay	SM-SC			
15.5											
16.0	16	SPT-6	20	29	37	66					
16.5											
17.0											
17.5	17.5	UDS*									
18.0											
18.5											
19.0	19	SPT-7	19	24	30	54					
19.5											
20.0											



UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*42+256 km	*Northing :*3134166.127 m	*Easting :*685765.737 m
Reduced Level (m):(+)263.316	*BH. No. :*BH-P16	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*11-08-2021	*Date of Completion :*13-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
20.0											
20.5	20.5	UDS*									
21.0											
21.5											
22.0	22	SPT-8	18	27	31	58					
22.5											
23.0							Brown, Medium dense to very dense, Silty sand with clay	SM-SC			
23.5	23.5	UDS-6									
24.0											
24.5											
25.0	25	SPT-9	21	34	43	77					
25.5											
26.0											
26.5	26.5	UDS-7									
27.0											
27.5											
28.0	28	SPT-10	20	26	31	57					
28.5							Brown, Hard, Silty clay of low plasticity	CL			
29.0											
29.5	29.5	UDS*									
30.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*42+256 km	*Northing :*3134166.127 m	*Easting :*685765.737 m
Reduced Level (m):(+)263.316	*BH. No. :*BH-P16	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*11-08-2021	*Date of Completion :*13-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
30.0											
30.5											
31.0	31	SPT-11	25	32	44	76					
31.5											
32.0											
32.5	32.5	UDS*									
33.0											
33.5											
34.0	34	SPT-12	58	72	28 (12cm)	>100					
34.5											
35.0							Brown, Hard, Silty clay of low plasticity	CL			
35.5	35.5	SPT-13	34	42	55	97					
36.0											
36.5											
37.0	37	SPT-14	31	48	47	95					
37.5											
38.0											
38.5	38.5	SPT-15	35	41	45	86					
39.0											
39.5											
40.0	40	SPT-16	48	75	26 (12cm)	>100					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*42+256 km	*Northing :*3134176.656 m	*Easting :*685746.693 m
Reduced Level (m):(+)263.529	*BH. No. :*BH-A2	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*14-08-2021	*Date of Completion :*16-08-2021	

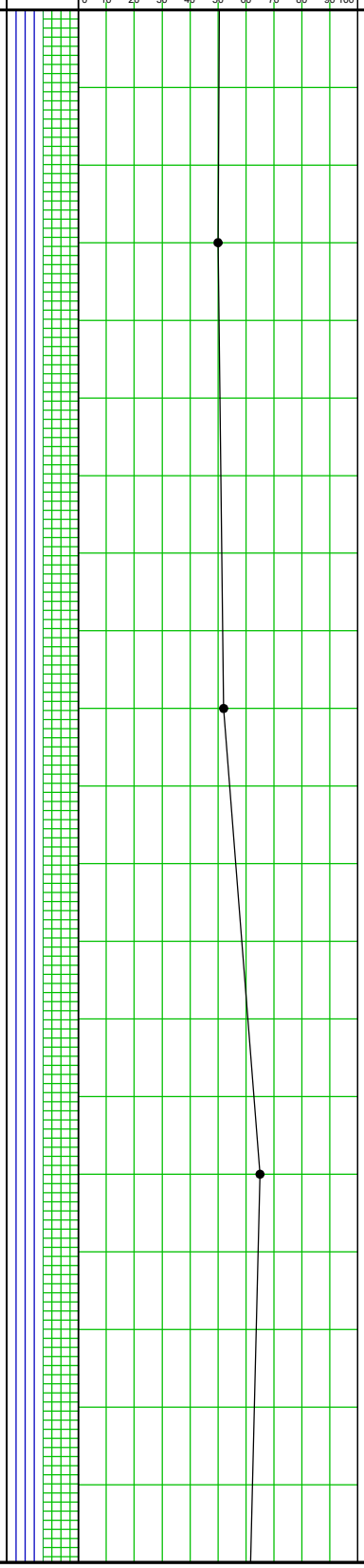
Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	UDS-1									
1.5											
2.0											
2.5	2.5	SPT-1	6	8	12	20					
3.0											
3.5							Brown, Medium dense to dense, Sandy silt of low plasticity	ML-CL			
4.0	4	UDS-2									
4.5											
5.0											
5.5	5.5	SPT-2	12	17	17	34					
6.0											
6.5											
7.0	7	UDS-3									
7.5											
8.0											
8.5	8.5	SPT-3	14	24	27	51	Brown, very dense, Sandy silt of low plasticity	ML-CL			
9.0											
9.5											
10.0	10	UDS-4									

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*42+256 km	*Northing :*3134176.656 m	*Easting :*685746.693 m
Reduced Level (m):(+)263.529	*BH. No. :*BH-A2	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*14-08-2021	*Date of Completion :*16-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0											
10.5											
11.0											
11.5	11.5	SPT-4	16	22	28	50					
12.0											
12.5											
13.0	13	UDS-5									
13.5											
14.0											
14.5	14.5	SPT-5	14	21	31	52					
15.0							Brown, very dense, Sandy silt of low plasticity	ML-CL			
15.5											
16.0	16	UDS-6									
16.5											
17.0											
17.5	17.5	SPT-6	21	27	38	65					
18.0											
18.5											
19.0	19	UDS-7									
19.5											
20.0											



UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*42+256 km	*Northing :*3134176.656 m	*Easting :*685746.693 m
Reduced Level (m):(+)263.529	*BH. No. :*BH-A2	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*14-08-2021	*Date of Completion :*16-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
20.0											
20.5	20.5	SPT-7	17	29	32	61					
21.0											
21.5											
22.0	22	UDS-8									
22.5											
23.0											
23.5	23.5	SPT-8	19	27	35	62					
24.0											
24.5											
25.0	25	UDS-9					Brown, very dense, Sandy silt of low plasticity	ML-CL			
25.5											
26.0											
26.5	26.5	SPT-9	24	31	39	70					
27.0											
27.5											
28.0	28	UDS-10									
28.5											
29.0											
29.5	29.5	SPT-10	23	24	34	58					
30.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*42+256 km	*Northing :*3134176.656 m	*Easting :*685746.693 m
Reduced Level (m):(+)263.529	*BH. No. :*BH-A2	*BH Termination Depth (m):*40
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*14-08-2021	*Date of Completion :*16-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
30.0										0 10 20 30 40 50 60 70 80 90 100	
30.5											
31.0	31	UDS-11									
31.5											
32.0											
32.5	32.5	SPT-11	21	32	48	80					
33.0											
33.5											
34.0	34	UDS-12									
34.5											
35.0							Brown, very dense, Sandy silt of low plasticity	ML-CL			
35.5	35.5	SPT-12	25	57	43 (7cm)	>100					
36.0											
36.5											
37.0	37	SPT-13	48	52	49 (8cm)	>100					
37.5											
38.0											
38.5	38.5	SPT-14	70	100 (10cm)	-	>100					
39.0											
39.5											
40.0	40	SPT-15	53	100 (11cm)	-	>100					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*43+100 km	*Northing :*3134725.214 m	*Easting :*685434.986 m
Reduced Level (m):(+)-	*BH. No. :*BH-PLT-02	*BH Termination Depth (m):*12
Proposed / Existing Structure :	*Water Table (m):*Not encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not-used
*Date of Start :*21-10-2021	*Date of Completion :*21-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
	0.75	UDS-1									
1.0							Brown, Loose, Silty sand with clay	SM-SC			
1.5	1.5	SPT-1	2	3	5	8					
2.0											
	2.25	SPT-2	5	6	10	16					
2.5											
3.0	3	SPT-3	10	13	20	33					
3.5							Brown, Medium dense to dense, Silty sand with clay	SM-SC			
	3.75	SPT-4	9	13	16	29					
4.0											
4.5	4.5	UDS-2									
5.0	5	SPT-5	9	15	17	32					
5.5											
6.0	6	SPT-6	8	11	13	24					
6.5											
7.0											
7.5	7.5	UDS-3					Brown, Medium dense to dense, Sandy silt of low plasticity	ML-CL			
8.0											
8.5											
9.0	9	SPT-7	12	15	18	33					
9.5											
10.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*43+100 km	*Northing :*3134725.214 m	*Easting :*685434.986 m
Reduced Level (m):(+)-	*BH. No. :*BH-PLT-02	*BH Termination Depth (m):*12
Proposed / Existing Structure :	*Water Table (m):*Not encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not-used
*Date of Start :*21-10-2021	*Date of Completion :*21-10-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0										0 10 20 30 40 50 60 70 80 90 100	
10.5	10.5	UDS-4					Brown, Medium dense to dense, Sandy silt of low plasticity	ML-CL			
11.0							Brown, Hard, Silty clay of low plasticity with gravel	CL			
11.5											
12.0	12	SPT-8	13	18	20	38					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*43+452 km	*Northing :*3135017.235 m	*Easting :*685239.663 m
Reduced Level (m):(+)258.485	*BH. No. :*BH-CL	*BH Termination Depth (m):*15
*Proposed / Existing Structure :*Minor Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*27-01-2022	*Date of Completion :*27-01-2022	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5	0.5	SPT-1	2	3	3	6					
1.0											
1.5	1.5	SPT-2	3	3	4	7					
2.0											
2.5	2.25	UDS-1					Brown, Loose to medium dense, Sandy silt of low plasticity	ML-CL			
3.0	3	SPT-3	3	5	6	11					
3.5											
4.0											
4.5	4.5	SPT-4	4	6	7	13					
5.0											
5.5	5.25	UDS-2									
6.0	6	SPT-5	15	26	29	55					
6.5											
7.0											
7.5	7.5	SPT-6	14	21	32	53	Brown, Very dense, Sandy silt of low plasticity with gravel	ML-CL			
8.0											
8.5	8.25	UDS*									
9.0	9	SPT-7	21	29	40	69					
9.5											
10.0	10	SPT-8	23	31	42	73					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*43+452 km	*Northing :*3135017.235 m	*Easting :*685239.663 m
Reduced Level (m):(+)258.485	*BH. No. :*BH-CL	*BH Termination Depth (m):*15
*Proposed / Existing Structure :*Minor Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*27-01-2022	*Date of Completion :*27-01-2022	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0											
10.5											
11.0											
	11.25	UDS-3									
11.5											
12.0	12	SPT-9	19	29	36	65					
12.5							Brown, Very dense, Sandy silt of low plasticity with gravel	ML-CL			
13.0											
13.5	13.5	SPT-10	24	32	39	71					
14.0											
	14.25	UDS*									
14.5											
15.0	15	SPT-11	19	24	36	60					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*43+585 km	*Northing :*3135122.226 m	*Easting :*685158.018 m
Reduced Level (m):(+)258.478	*BH. No. :*BH-CL	*BH Termination Depth (m):*15
*Proposed / Existing Structure :*Minor Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*25-01-2022	*Date of Completion :*25-01-2022	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5	0.5	SPT-1	2	2	3	5					
1.0											
1.5	1.5	SPT-2	3	4	4	8					
2.0											
	2.25	UDS-1									
2.5							Brown, Loose to medium dense, Sandy silt of low plasticity	ML-CL			
3.0	3	SPT-3	4	5	6	11					
3.5											
4.0											
4.5	4.5	SPT-4	5	7	8	15					
5.0											
	5.25	UDS-2									
5.5											
6.0	6	SPT-5	11	17	19	36					
6.5							Brown, Very stiff to hard, Silty clay of low plasticity	CL			
7.0											
7.5	7.5	SPT-6	12	19	23	42					
8.0											
	8.25	UDS-3									
8.5											
9.0	9	SPT-7	21	24	27	51	Brown, Dense to very dense, Sandy silt of low plasticity	ML-CL			
9.5											
10.0											

(Depth v/s SPT N Value) axis: 0 10 20 30 40 50 60 70 80 90 100

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*43+585 km	*Northing :*3135122.226 m	*Easting :*685158.018 m
Reduced Level (m):(+)258.478	*BH. No. :*BH-CL	*BH Termination Depth (m):*15
*Proposed / Existing Structure :*Minor Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*25-01-2022	*Date of Completion :*25-01-2022	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0											
10.5	10.5	SPT-8	22	26	31	57					
11.0											
	11.25	UDS-4									
11.5											
12.0	12	SPT-9	19	22	24	46					
12.5							Brown, Dense to very dense, Sandy silt of low plasticity	ML-CL			
13.0											
13.5	13.5	SPT-10	22	26	29	55					
14.0											
	14.25	UDS*									
14.5											
15.0	15	SPT-11	24	32	39	71					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*43+732 km	*Northing :*3135218.709 m	*Easting :*685068.353 m
Reduced Level (m):(+)257.686	*BH. No. :*BH-CL	*BH Termination Depth (m):*15
*Proposed / Existing Structure :*Minor Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*24-01-2022	*Date of Completion :*24-01-2022	

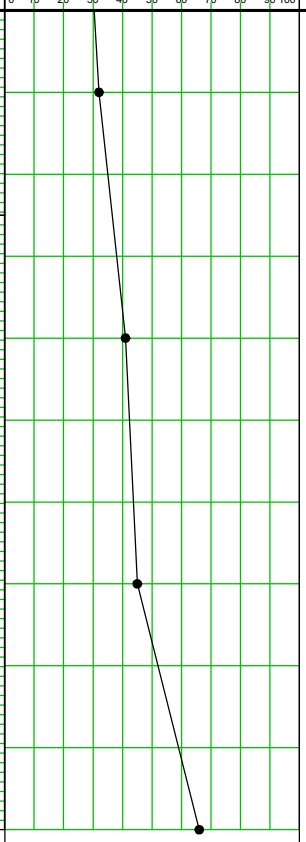
Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5	0.5	SPT-1	2	3	4	7					
1.0											
1.5	1.5	SPT-2	3	3	5	8					
2.0											
2.5	2.25	UDS-1					Brown, Loose to medium dense, Sandy silt of low plasticity	ML-CL			
3.0	3	SPT-3	4	5	7	12					
3.5											
4.0											
4.5	4.5	SPT-4	6	9	10	19					
5.0											
5.5	5.25	UDS-2									
6.0	6	SPT-5	10	11	13	24					
6.5											
7.0											
7.5	7.5	SPT-6	12	15	19	34	Brown, Very stiff to hard, Silty clay of low plasticity	CL			
8.0											
8.5	8.25	UDS-3									
9.0	9	SPT-7	8	12	15	27					
9.5											
10.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*43+732 km	*Northing :*3135218.709 m	*Easting :*685068.353 m
Reduced Level (m):(+)257.686	*BH. No. :*BH-CL	*BH Termination Depth (m):*15
*Proposed / Existing Structure :*Minor Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*24-01-2022	*Date of Completion :*24-01-2022	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0											
10.5	10.5	SPT-8	11	14	18	32	Brown, Very stiff to hard, Silty clay of low plasticity	CL			
11.0											
	11.25	UDS-4									
11.5											
12.0	12	SPT-9	15	19	22	41					
12.5											
13.0							Brown, Dense to very dense, Sandy silt of low plasticity	ML-CL			
13.5	13.5	SPT-10	18	21	24	45					
14.0											
	14.25	UDS*									
14.5											
15.0	15	SPT-11	26	30	36	66					



UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*44+050 km	*Northing :*3135511.319 m	*Easting :*684905.712 m
Reduced Level (m):(+)256.063	*BH. No. :*BH-CL	*BH Termination Depth (m):*15
*Proposed / Existing Structure :*Minor Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*23-01-2022	*Date of Completion :*23-01-2022	

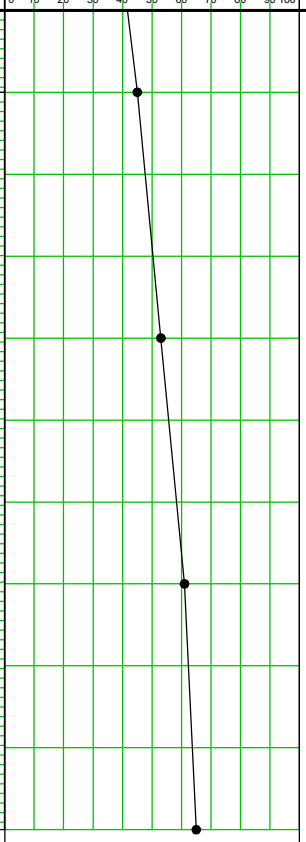
Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5	0.5	SPT-1	2	2	3	5					
1.0											
1.5	1.5	SPT-2	3	3	5	8					
2.0											
	2.25	UDS*									
2.5							Brown, Loose to medium dense, Sandy silt of low plasticity	ML-CL			
3.0	3	SPT-3	4	5	6	11					
3.5											
4.0											
4.5	4.5	SPT-4	5	7	8	15					
5.0											
	5.25	UDS-1									
5.5											
6.0	6	SPT-5	9	14	16	30					
6.5											
7.0											
7.5	7.5	SPT-6	11	13	17	30	Brown, Hard, Silty clay of low plasticity	CL			
8.0											
	8.25	UDS-2									
8.5											
9.0	9	SPT-7	14	16	19	35					
9.5											
10.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*44+050 km	*Northing :*3135511.319 m	*Easting :*684905.712 m
Reduced Level (m):(+)256.063	*BH. No. :*BH-CL	*BH Termination Depth (m):*15
*Proposed / Existing Structure :*Minor Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*23-01-2022	*Date of Completion :*23-01-2022	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0							Brown, Hard, Silty clay of low plasticity	CL			
10.5	10.5	SPT-8	17	20	25	45					
11.0											
	11.25	UDS-3									
11.5											
12.0	12	SPT-9	21	26	27	53					
12.5											
							Brown, Very dense, Sandy silt of low plasticity with grvael	ML-CL			
13.0											
13.5	13.5	SPT-10	23	29	32	61					
14.0											
	14.25	UDS*									
14.5											
15.0	15	SPT-11	24	31	34	65					



UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*44+116 km	*Northing :*3135571.113 m	*Easting :*684877.774 m
Reduced Level (m):(+)256.889	*BH. No. :*BH-CL	*BH Termination Depth (m):*15
*Proposed / Existing Structure :*Minor Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*21-01-2022	*Date of Completion :*21-01-2022	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5	0.5	SPT-1	2	3	4	7					
1.0											
1.5	1.5	SPT-2	2	4	6	10	Brown, Loose, Sandy silt of low plasticity	ML-CL			
2.0											
	2.25	UDS*									
2.5											
3.0	3	SPT-3	5	7	9	16					
3.5											
4.0											
4.5	4.5	SPT-4	6	11	14	25					
5.0											
	5.25	UDS-1									
5.5							Brown, Very stiff, Silty clay of low plasticity	CL			
6.0	6	SPT-5	9	14	17	31					
6.5											
7.0											
7.5	7.5	SPT-6	7	11	14	25					
8.0											
	8.25	UDS-2									
8.5											
9.0	9	SPT-7	19	24	27	51	Brown, Very dense, Sandy silt of low plasticity	ML-CL			
9.5											
10.0	10	SPT-8	23	26	29	55					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*44+116 km	*Northing :*3135571.113 m	*Easting :*684877.774 m
Reduced Level (m):(+)256.889	*BH. No. :*BH-CL	*BH Termination Depth (m):*15
*Proposed / Existing Structure :*Minor Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*21-01-2022	*Date of Completion :*21-01-2022	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0											
10.5											
11.0											
	11.25	UDS-3									
11.5											
12.0	12	SPT-9	22	28	31	59					
12.5							Brown, Very dense, Sandy silt of low plasticity	ML-CL			
13.0											
13.5	13.5	SPT-10	24	30	34	64					
14.0											
	14.25	UDS*									
14.5											
15.0	15	SPT-11	26	33	40	73					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*44+317 km	*Northing :*3135753.513 m	*Easting :*684793.328 m
Reduced Level (m):(+)254.620	*BH. No. :*BH-CL	*BH Termination Depth (m):*10
*Proposed / Existing Structure :*Minor Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not-used
*Date of Start :*20-01-2022	*Date of Completion :*20-01-2022	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5	0.5	SPT-1	2	2	3	5					
1.0											
1.5	1.5	SPT-2	2	3	5	8	Brown, Loose, Silty sand	SM			
2.0											
	2.25	UDS*									
2.5											
3.0	3	SPT-3	4	6	11	17					
3.5											
4.0											
4.5	4.5	SPT-4	7	12	17	29					
5.0											
	5.25	UDS-1					Brown, Medium dense, Sandy silt of low plasticity	ML-CL			
5.5											
6.0	6	SPT-5	5	10	13	23					
6.5											
7.0											
7.5	7.5	SPT-6	7	12	19	31					
8.0											
	8.25	UDS-2									
8.5											
9.0	9	SPT-7	9	17	22	39	Brown, Very stiff to hard, Silty clay of low plasticity	CL			
9.5											
10.0	10	SPT-8	11	15	29	44					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*44+641 km	*Northing :*3136052.232 m	*Easting :*684668.53 m
Reduced Level (m):(+)256.869	*BH. No. :*BH-CL	*BH Termination Depth (m):*10
*Proposed / Existing Structure :*Minor Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*19-01-2022	*Date of Completion :*19-01-2022	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5	0.5	SPT-1	2	2	4	6					
1.0											
1.5	1.5	SPT-2	3	4	7	11					
2.0											
2.5	2.25	UDS*					Brown, Loose to medium dense, Sandy silt of low plasticity	ML-CL			
3.0	3	SPT-3	4	5	7	12					
3.5											
4.0											
4.5	4.5	SPT-4	6	9	11	20					
5.0											
5.5	5.25	UDS-1									
6.0	6	SPT-5	7	8	12	20	Brown, Very stiff, Silty clay of low plasticity	CL			
6.5											
7.0											
7.5	7.5	SPT-6	5	11	14	25					
8.0											
8.5	8.25	UDS*									
9.0	9	SPT-7	17	21	24	45	Brown, Dense to very dense, Sandy silt of low plasticity	ML-CL			
9.5											
10.0	10	SPT-8	15	24	28	52					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*44+910 km	*Northing :*3136314.389 m	*Easting :*684609.724 m
Reduced Level (m):(+)254.293	*BH. No. :*BH-CL	*BH Termination Depth (m):*10
*Proposed / Existing Structure :*Minor Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*18-01-2022	*Date of Completion :*18-01-2022	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5	0.5	SPT-1	3	3	4	7					
1.0											
1.5	1.5	SPT-2	2	3	4	7					
2.0											
	2.25	UDS*									
2.5							Brown, Loose to medium dense, Silty sand with clay	SM-SC			
3.0	3	SPT-3	4	5	7	12					
3.5											
4.0											
4.5	4.5	SPT-4	6	5	9	14					
5.0											
	5.25	UDS-1									
5.5											
6.0	6	SPT-5	8	9	11	20					
6.5											
7.0							Brown, Very stiff, Silty clay of low plasticity	CL			
7.5	7.5	SPT-6	10	12	14	26					
8.0											
	8.25	UDS-2									
8.5											
9.0	9	SPT-7	17	19	22	41	Brown, Dense, Sandy silt of low plasticity	ML-CL			
9.5											
10.0	10	SPT-8	18	21	25	46					

(Depth v/s SPT N Value) axis: 0 10 20 30 40 50 60 70 80 90 100

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*45+048 km	*Northing :*3136451.182 m	*Easting :*684590.519 m
Reduced Level (m):(+)253.929	*BH. No. :*45+048_CL	*BH Termination Depth (m):*10
Proposed / Existing Structure :-	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*15-11-2021	*Date of Completion :*15-11-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5	0.5	SPT-1	1	2	3	5					
1.0											
1.5	1.5	SPT-2	2	3	4	7					
2.0											
2.5	2.25	UDS-1					Brown, Loose to medium dense, Sandy silt of low plasticity	ML-CL			
3.0	3	SPT-3	5	5	7	12					
3.5											
4.0											
4.5	4.5	SPT-4	8	9	11	20					
5.0											
5.5	5.25	UDS-2									
6.0	6	SPT-5	7	12	14	26					
6.5											
7.0											
7.5	7.5	SPT-6	9	15	20	35	Brown, Very stiff to hard, Silty clay of low plasticity with gravel	CL			
8.0											
8.5	8.25	UDS-3									
9.0	9	SPT-7	10	12	17	29					
9.5											
10.0	10	SPT-8	12	15	19	34					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*45+411 km	*Northing :*3136810.574 m	*Easting :*684540.434 m
Reduced Level (m):(+)253.338	*BH. No. :*BH-CL	*BH Termination Depth (m):*10
*Proposed / Existing Structure :*Minor Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not-used
*Date of Start :*17-01-2022	*Date of Completion :*17-01-2022	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5	0.5	SPT-1	2	3	4	7					
1.0											
1.5	1.5	SPT-2	3	4	4	8	Brown, Loose, Silty sand	SM			
2.0											
	2.25	UDS*									
2.5											
3.0	3	SPT-3	6	7	9	16					
3.5											
4.0											
4.5	4.5	SPT-4	7	11	14	25					
5.0											
	5.25	UDS-1					Brown, Medium dense, Sandy silt of low plasticity	ML-CL			
5.5											
6.0	6	SPT-5	10	11	13	24					
6.5											
7.0											
7.5	7.5	SPT-6	9	12	16	28					
8.0											
	8.25	UDS-2									
8.5											
9.0	9	SPT-7	11	15	17	32	Brown, Very stiff to hard, Silty clay of low plasticity	CL			
9.5											
10.0	10	SPT-8	13	15	19	34					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*45+480 km	*Northing :*3136867.243 m	*Easting :*684534.196 m
Reduced Level (m):(+)254.056	*BH. No. :*BH-A1	*BH Termination Depth (m):*29.5
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*16.00	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*17-08-2021	*Date of Completion :*18-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	UDS-1									
1.5											
2.0											
2.5	2.5	SPT-1	4	6	9	15					
3.0											
3.5											
4.0	4	UDS-2									
4.5											
5.0							Brown, Medium dense to dense, Silty sand with clay	SM-SC			
5.5	5.5	SPT-2	7	10	12	22					
6.0											
6.5											
7.0	7	UDS-3									
7.5											
8.0											
8.5	8.5	SPT-3	11	14	18	32					
9.0											
9.5											
10.0	10	UDS-4									

(Depth v/s SPT N Value) axis: 0 10 20 30 40 50 60 70 80 90 100

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*45+480 km	*Northing :*3136867.243 m	*Easting :*684534.196 m
Reduced Level (m):(+)254.056	*BH. No. :*BH-A1	*BH Termination Depth (m):*29.5
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*16.00	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*17-08-2021	*Date of Completion :*18-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0										0 10 20 30 40 50 60 70 80 90 100	
10.5											
11.0											
11.5	11.5	SPT-4	13	22	25	47					
12.0											
12.5											
13.0	13	UDS-5									
13.5											
14.0											
14.5	14.5	SPT-5	17	24	29	53					
15.0							Brown, Dense to very dense, Sandy silt of low plasticity	ML-CL			
15.5											
16.0	16	UDS-6							16.00m		
16.5											
17.0											
17.5	17.5	SPT-6	19	27	35	62					
18.0											
18.5											
19.0	19	UDS-7									
19.5											
20.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*45+480 km	*Northing :*3136867.243 m	*Easting :*684534.196 m
Reduced Level (m):(+)254.056	*BH. No. :*BH-A1	*BH Termination Depth (m):*29.5
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*16.00	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*17-08-2021	*Date of Completion :*18-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
20.0											
20.5	20.5	SPT-7	22	35	42	77					
21.0											
21.5											
22.0	22	UDS-8									
22.5											
23.0											
23.5	23.5	SPT-8	25	45	60	>100					
24.0											
24.5											
25.0	25	SPT-9	28	47	62	>100	Brown, Dense to very dense, Sandy silt of low plasticity	ML-CL			
25.5											
26.0											
26.5	26.5	SPT-10	27	42	66	>100					
27.0											
27.5											
28.0	28	SPT-11	29	44	67	>100					
28.5											
29.0											
29.5	29.5	SPT-12	31	58	79	>100					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*45+480 km	*Northing :*3136889.146 m	*Easting :*684529.247 m
Reduced Level (m):(+)255.775	*BH. No. :*BH-A2	*BH Termination Depth (m):*29.5
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*15.75	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*17-08-2021	*Date of Completion :*18-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	SPT-1	4	7	9	16					
1.5											
2.0											
2.5	2.5	UDS-1									
3.0											
3.5											
4.0	4	SPT-2	7	7	14	21	Brown, Medium dense, Silty sand with clay	SM-SC			
4.5											
5.0											
5.5	5.5	UDS-2									
6.0											
6.5											
7.0	7	SPT-3	9	11	16	27					
7.5											
8.0											
8.5	8.5	UDS-3									
9.0							Brown, Dense to very dense, Sandy silt of low plasticity	ML-CL			
9.5											
10.0	10	SPT-4	14	19	26	45					

(Depth v/s SPT N Value) axis: 0 10 20 30 40 50 60 70 80 90 100

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*45+480 km	*Northing :*3136889.146 m	*Easting :*684529.247 m
Reduced Level (m):(+)255.775	*BH. No. :*BH-A2	*BH Termination Depth (m):*29.5
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*15.75	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*17-08-2021	*Date of Completion :*18-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0											
10.5											
11.0											
11.5	11.5	UDS-4									
12.0											
12.5											
13.0	13	SPT-5	10	15	28	43					
13.5											
14.0											
14.5	14.5	UDS-5									
15.0							Brown, Dense to very dense, Sandy silt of low plasticity	ML-CL			
15.5									15.75m		
16.0	16	SPT-6	15	25	41	66					
16.5											
17.0											
17.5	17.5	UDS-6									
18.0											
18.5											
19.0	19	SPT-7	18	29	48	77					
19.5											
20.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*45+480 km	*Northing :*3136889.146 m	*Easting :*684529.247 m
Reduced Level (m):(+)255.775	*BH. No. :*BH-A2	*BH Termination Depth (m):*29.5
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*15.75	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*17-08-2021	*Date of Completion :*18-08-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
20.0											
20.5	20.5	UDS-7									
21.0											
21.5											
22.0	22	SPT-8	24	38	52	90					
22.5											
23.0											
23.5	23.5	UDS-8									
24.0											
24.5											
25.0	25	SPT-9	27	49	57	>100	Brown, Dense to very dense, Sandy silt of low plasticity	ML-CL			
25.5											
26.0											
26.5	26.5	SPT-10	30	55	61	>100					
27.0											
27.5											
28.0	28	SPT-11	24	53	47	>100					
28.5											
29.0											
29.5	29.5	SPT-12	29	55	45	>100					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*45+612 km	*Northing :*3137009.651 m	*Easting :*684512.699 m
Reduced Level (m):(+)254.161	*BH. No. :*BH-CL	*BH Termination Depth (m):*10
*Proposed / Existing Structure :*Minor Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*14-11-2021	*Date of Completion :*15-11-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5	0.5	SPT-1	2	2	3	5					
1.0											
1.5	1.5	SPT-2	3	4	5	9	Brown, Loose, Sandy silt of low plasticity	ML-CL			
2.0											
	2.25	UDS-1									
2.5											
3.0	3	SPT-3	5	7	8	15					
3.5											
4.0											
4.5	4.5	SPT-4	7	10	12	22					
5.0											
	5.25	UDS-2									
5.5							Brown, Very stiff to hard, Silty clay of low plasticity	CL			
6.0	6	SPT-5	10	13	15	28					
6.5											
7.0											
7.5	7.5	SPT-6	12	15	17	32					
8.0											
	8.25	UDS-3									
8.5											
9.0	9	SPT-7	13	16	18	34	Brown, Dense, Sandy silt of low plasticity	ML-CL			
9.5											
10.0	10	SPT-8	15	20	21	41					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*45+984 km	*Northing :*3137377.674 m	*Easting :*684458.641 m
Reduced Level (m):(+)257.656	*BH. No. :*BH-CL	*BH Termination Depth (m):*15
Proposed / Existing Structure :-	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*16-01-2022	*Date of Completion :*16-01-2022	

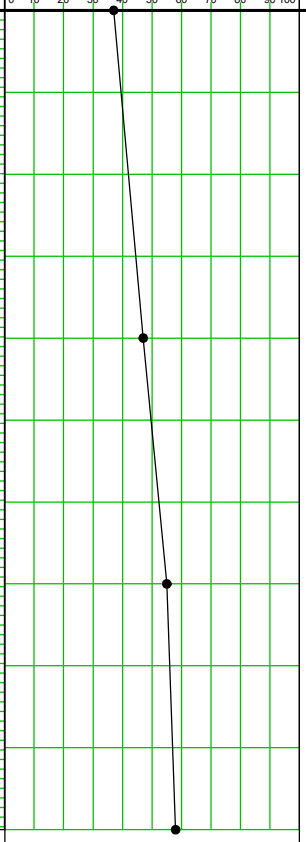
Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5	0.5	SPT-1	2	2	3	5					
1.0											
1.5	1.5	SPT-2	2	3	3	6	Brown, Loose, Silty sand	SM			
2.0											
	2.25	UDS*									
2.5											
3.0	3	SPT-3	5	10	13	23					
3.5											
4.0											
4.5	4.5	SPT-4	7	11	15	26					
5.0											
	5.25	UDS-1									
5.5											
6.0	6	SPT-5	15	20	24	44					
6.5							Brown, Medium dense to very dense, Sandy silt of low plasticity	ML-CL			
7.0											
7.5	7.5	SPT-6	16	21	26	47					
8.0											
	8.25	UDS-2									
8.5											
9.0	9	SPT-7	13	15	16	31					
9.5											
10.0	10	SPT-8	15	17	20	37					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*45+984 km	*Northing :*3137377.674 m	*Easting :*684458.641 m
Reduced Level (m):(+)257.656	*BH. No. :*BH-CL	*BH Termination Depth (m):*15
Proposed / Existing Structure :-	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*16-01-2022	*Date of Completion :*16-01-2022	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0											
10.5											
11.0											
	11.25	UDS-3									
11.5											
12.0	12	SPT-9	11	19	28	47					
12.5							Brown, Medium dense to very dense, Sandy silt of low plasticity	ML-CL			
13.0											
13.5	13.5	SPT-10	15	26	29	55					
14.0											
	14.25	UDS*									
14.5											
15.0	15	SPT-11	16	23	35	58					



UDS*-UDS not recovered

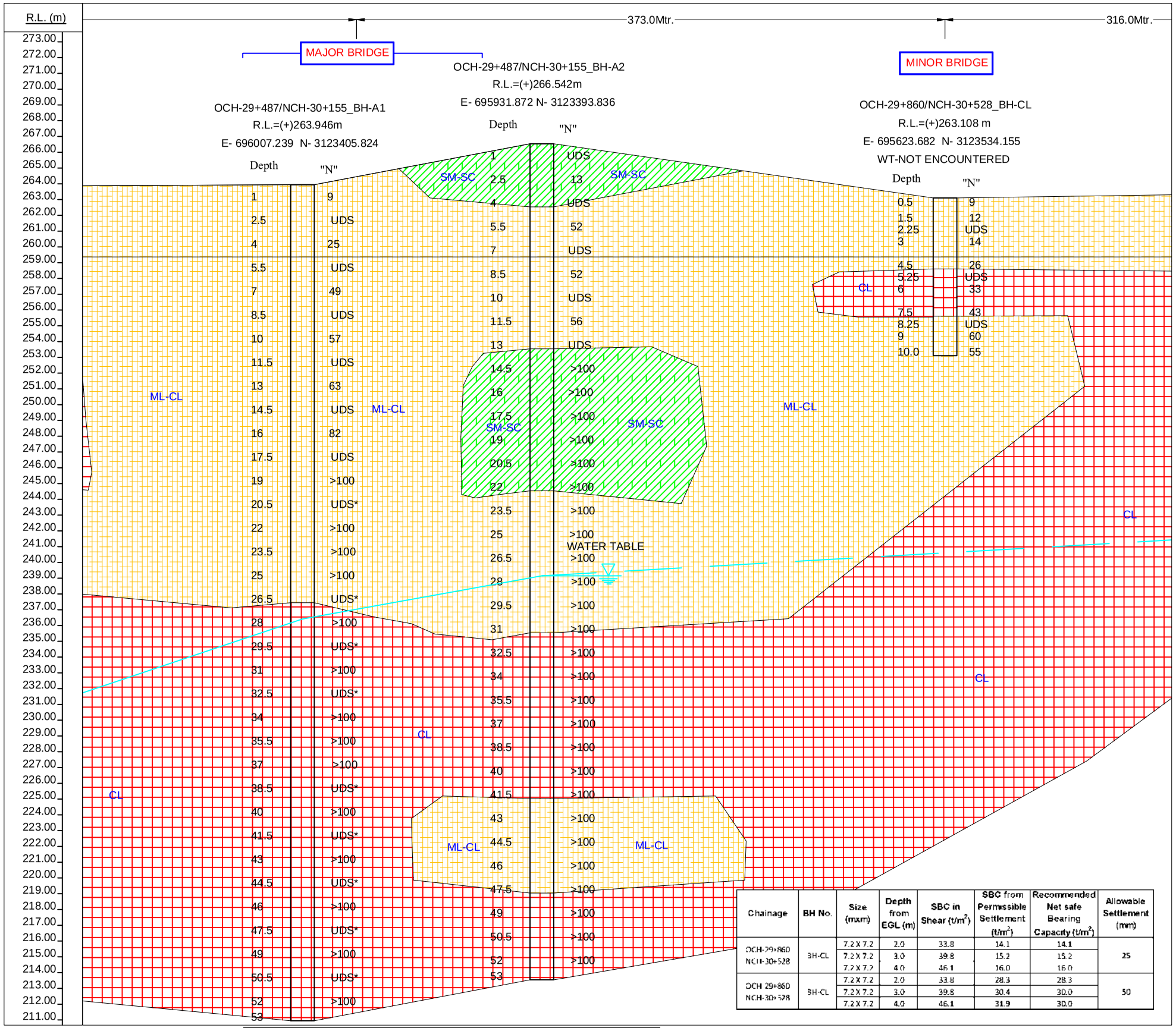
FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*46+400 km	*Northing :*3137776.436 m	*Easting :*684341.186 m
Reduced Level (m):(+)257.489	*BH. No. :*BH-CL	*BH Termination Depth (m):*10
Proposed / Existing Structure :-	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*14-11-2021	*Date of Completion :*14-11-2021	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS	3	4	6	10	Brown, Medium dense, Silty sand	SM			
0.5	0.5	SPT-1	5	7	11	17					
1.0											
1.5	1.5	SPT-2									
2.0											
	2.25	UDS-1	12	15	18	33					
2.5											
3.0	3	SPT-3	9	13	16	29					
3.5							Brown, Dense, Sandy silt of low plasticity	ML-CL			
4.0											
4.5	4.5	SPT-4									
5.0											
	5.25	UDS-2	12	16	19	35					
5.5											
6.0	6	SPT-5	13	18	21	39					
6.5											
7.0											
7.5	7.5	SPT-6									
8.0											
	8.25	UDS-3	15	19	24	43					
8.5											
9.0	9	SPT-7	20	21	26	47					
9.5											
10.0	10	SPT-8				47					

UDS*-UDS not recovered

CONDUCTING GEOTECHNICAL INVESTIGATION, PREPARATION OF GEOTECHNICAL REPORT FOR DESIGNING OF BRIDGES AND FOR EMBANKMENT IN CONNECTION WITH CONSTRUCTION OF HARYANA ORBITAL RAIL CORRIDOR (HORC) PROJECT FROM PALWAL TO HARSANA KALAN INCLUDING CONNECTIVITY TO EXISTING IR NETWORK IN THE STATE OF HARYANA.



Chainage	BH No.	Size (mxm)	Depth from EGL (m)	SBC in Shear (t/m²)	SBC from Permissible Settlement (t/m²)	Recommended Net safe Bearing Capacity (t/m²)	Allowable Settlement (mm)
OCH-29+487 NCH-30+155	BH A1	7.2 X 7.2	2.0	46.1	27.1	27.1	25
		7.2 X 7.2	3.0	54.2	32.6	30.0	
		7.2 X 7.2	4.0	62.5	40.0	30.0	
OCH-29+487 NCH-30+155	BH-A1	7.2 X 7.2	2.0	46.1	54.2	30.0	50
		7.2 X 7.2	3.0	54.2	65.2	30.0	
		7.2 X 7.2	4.0	62.5	80.0	30.0	
OCH-29+487 NCH-30+155	BH A2	7.2 X 7.2	2.0	32.0	28.2	28.2	25
		7.2 X 7.2	3.0	38.6	37.1	30.0	
		7.2 X 7.2	4.0	45.4	50.9	30.0	
OCH-29+487 NCH-30+155	BH-A2	7.2 X 7.2	2.0	32.0	56.4	30.0	50
		7.2 X 7.2	3.0	38.6	74.2	30.0	
		7.2 X 7.2	4.0	45.4	101.7	30.0	

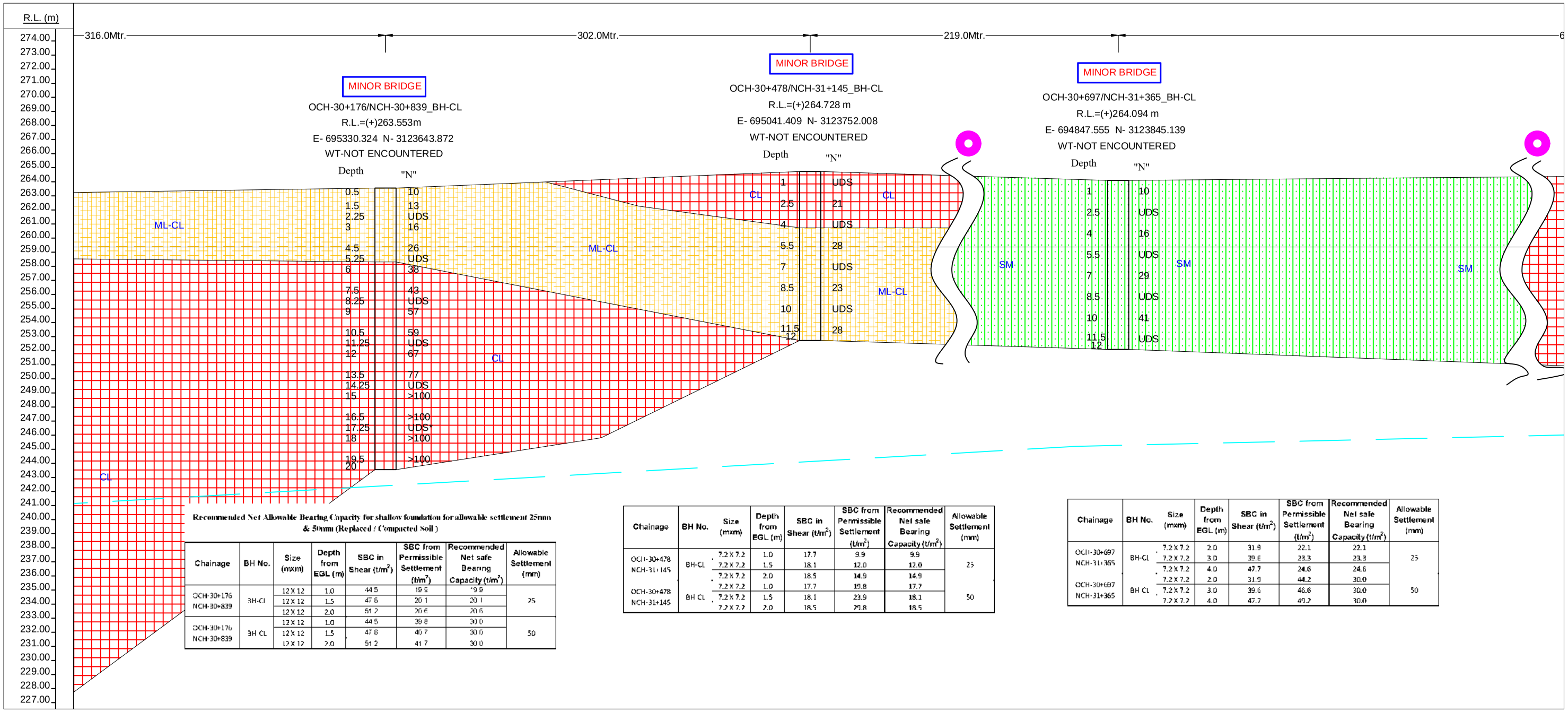
Chainage	BH No.	Size (mxm)	Depth from EGL (m)	SBC in Shear (t/m²)	SBC from Permissible Settlement (t/m²)	Recommended Net safe Bearing Capacity (t/m²)	Allowable Settlement (mm)
OCH-29+860 NCH-30+528	BH-CL	7.2 X 7.2	2.0	33.8	14.1	14.1	25
		7.2 X 7.2	3.0	39.8	15.2	15.2	
		7.2 X 7.2	4.0	46.1	16.0	16.0	
OCH-29+860 NCH-30+528	BH-CL	7.2 X 7.2	2.0	33.8	28.3	28.3	50
		7.2 X 7.2	3.0	39.8	30.4	30.0	
		7.2 X 7.2	4.0	46.1	31.9	30.0	

SYMBOL	DESCRIPTION
	SM- Silty Sand (Having fines Less Than 50% and no plasticity or below A-line)
	SM-SC -Clayey Sand (Having fines Less Than 50% and in the hatched zone (4<PI<7)
	ML-CL -Sandy with clay (Having fines greater than 50% and in the hatched zone (LL<35 & 4<PI<7)
	CL-Silty Clay of low plasticity (Above A-line, LL<35)
	CI- Clay of medium plasticity (Above A-line, 35≤LL<50)
	BOREHOLE REQUIRED / WATER TABLE

Note:- Fines= Percentage of Silty + Clay A-line=.73(wl-20)

SCALE:- HOR:- 1:2850 SCALE:- VER:- 1:285

CONDUCTING GEOTECHNICAL INVESTIGATION, PREPARATION OF GEOTECHNICAL REPORT FOR DESIGNING OF BRIDGES AND FOR EMBANKMENT IN CONNECTION WITH CONSTRUCTION OF HARYANA ORBITAL RAIL CORRIDOR (HORC) PROJECT FROM PALWAL TO HARSANA KALAN INCLUDING CONNECTIVITY TO EXISTING IR NETWORK IN THE STATE OF HARYANA.



Recommended Net Allowable Bearing Capacity for shallow foundation for allowable settlement 25mm & 50mm (Replaced / Compacted Soil)

Chainage	BH No.	Size (mxm)	Depth from EGL (m)	SBC in Shear (t/m^2)	SBC from Permissible Settlement (t/m^2)	Recommended Net safe Bearing Capacity (t/m^2)	Allowable Settlement (mm)
OCH-30+176 NCH-30+839	BH-CL	12 X 12	1.0	44.5	19.9	19.9	25
		12 X 12	1.5	47.6	20.1	20.1	
		12 X 12	2.0	51.2	20.6	20.6	
OCH-30+176 NCH-30+839	BH CL	12 X 12	1.0	44.5	39.8	30.0	50
		12 X 12	1.5	47.6	40.7	30.0	
		12 X 12	2.0	51.2	41.7	30.0	

Chainage	BH No.	Size (mxm)	Depth from EGL (m)	SBC in Shear (t/m^2)	SBC from Permissible Settlement (t/m^2)	Recommended Net safe Bearing Capacity (t/m^2)	Allowable Settlement (mm)
OCH-30+478 NCH-31+145	BH-CL	7.2 X 7.2	1.0	17.7	9.9	9.9	25
		7.2 X 7.2	1.5	18.1	12.0	12.0	
		7.2 X 7.2	2.0	18.5	14.9	14.9	
		7.2 X 7.2	1.0	17.7	19.8	17.7	
OCH-30+478 NCH-31+145	BH CL	7.2 X 7.2	1.5	18.1	23.9	18.1	50
		7.2 X 7.2	2.0	18.5	29.8	18.5	

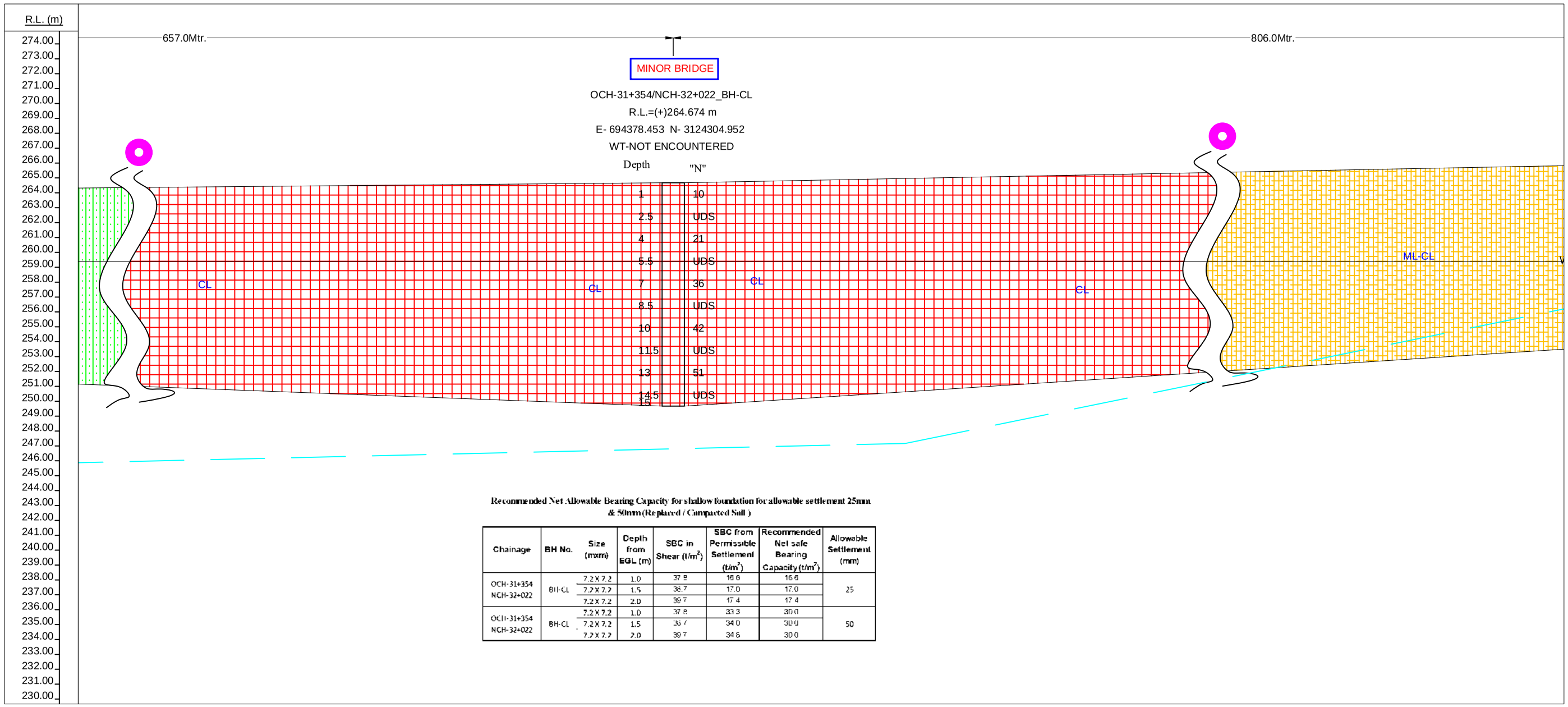
Chainage	BH No.	Size (mxm)	Depth from EGL (m)	SBC in Shear (t/m^2)	SBC from Permissible Settlement (t/m^2)	Recommended Net safe Bearing Capacity (t/m^2)	Allowable Settlement (mm)
OCH-30+697 NCH-31+365	BH-CL	7.2 X 7.2	2.0	31.9	22.1	22.1	25
		7.2 X 7.2	3.0	39.6	23.3	23.3	
		7.2 X 7.2	4.0	47.7	24.6	24.6	
		7.2 X 7.2	2.0	31.9	44.2	30.0	
OCH-30+697 NCH-31+365	BH CL	7.2 X 7.2	3.0	39.6	46.6	30.0	50
		7.2 X 7.2	4.0	47.7	49.2	30.0	

SYMBOL	DESCRIPTION
	SM- Silty Sand (Having fines Less Than 50% and no plasticity or below A-line)
	SM-SC -Clayey Sand (Having fines Less Than 50% and in the hatched zone (4<PI<7)
	ML-CL -Sandy with clay (Having fines greater than 50% and in the hatched zone (LL<35 & 4<PI<7)
	CL-Silty Clay of low plasticity (Above A-line, LL<35)
	CI- Clay of medium plasticity (Above A-line, 35≤LL<50)
	BOREHOLE REQUIRED / WATER TABLE

Note:- Fines= Percentage of Silty + Clay A-line=.73(wl-20)

SCALE:- HOR:- 1:2850 SCALE:- VER:- 1:285

CONDUCTING GEOTECHNICAL INVESTIGATION, PREPARATION OF GEOTECHNICAL REPORT FOR DESIGNING OF BRIDGES AND FOR EMBANKMENT IN CONNECTION WITH CONSTRUCTION OF HARYANA ORBITAL RAIL CORRIDOR (HORC) PROJECT FROM PALWAL TO HARSANA KALAN INCLUDING CONNECTIVITY TO EXISTING IR NETWORK IN THE STATE OF HARYANA.



Recommended Net Allowable Bearing Capacity for shallow foundation for allowable settlement 25mm & 50mm (Replaced / Compacted Soil)

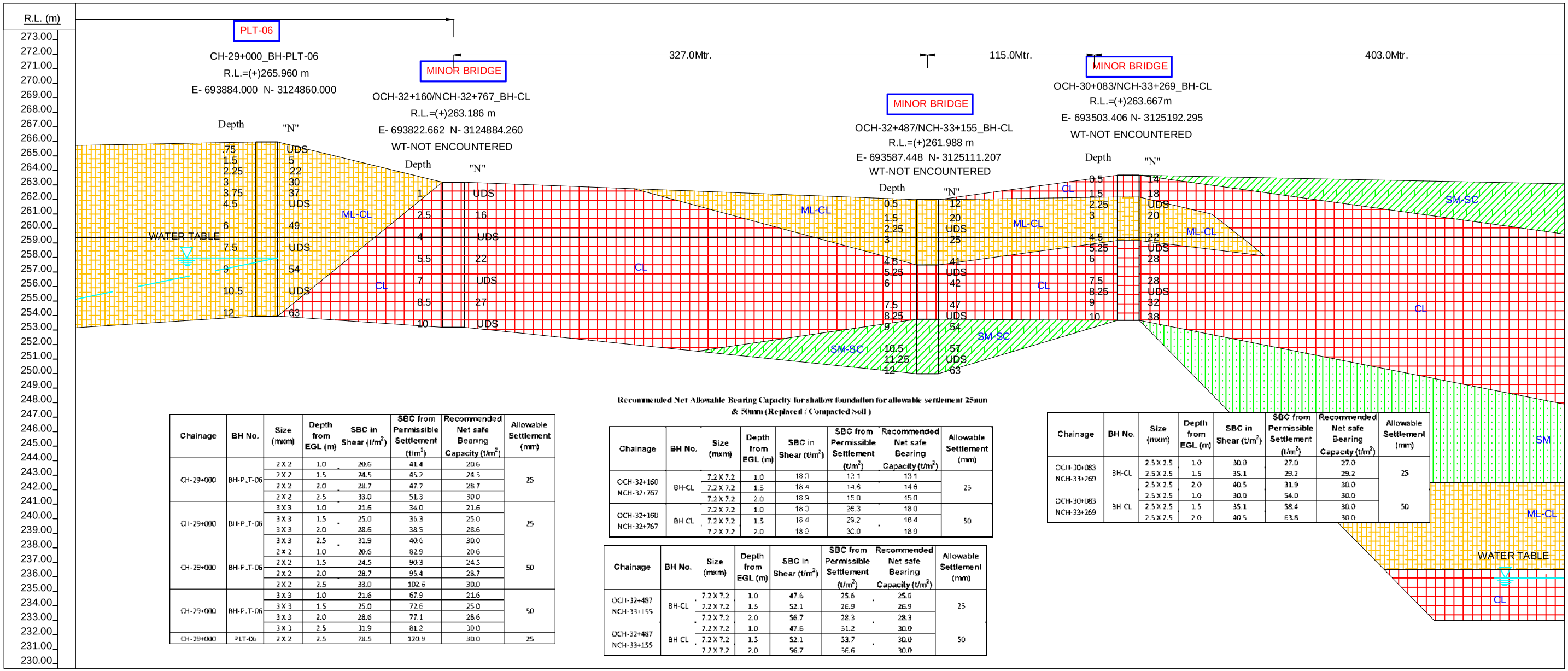
Chainage	BH No.	Size (mxm)	Depth from EGL (m)	SBC in Shear (t/m^2)	SBC from Permissible Settlement (t/m^2)	Recommended Net safe Bearing Capacity (t/m^2)	Allowable Settlement (mm)
OCH-31+354 NCH-32+022	BH-CL	7.2 X 7.2	1.0	37.8	16.6	16.6	25
		7.2 X 7.2	1.5	38.7	17.0	17.0	
		7.2 X 7.2	2.0	39.7	17.4	17.4	
OCH-31+354 NCH-32+022	BH-CL	7.2 X 7.2	1.0	37.8	33.3	30.0	50
		7.2 X 7.2	1.5	38.7	34.0	30.0	
		7.2 X 7.2	2.0	39.7	34.6	30.0	

SYMBOL	DESCRIPTION
	SM- Silty Sand (Having fines Less Than 50% and no plasticity or below A-line)
	SM-SC -Clayey Sand (Having fines Less Than 50% and in the hatched zone (4<PI<7)
	ML-CL -Sandy with clay (Having fines greater than 50% and in the hatched zone (LL<35 & 4<PI<7)
	CL-Silty Clay of low plasticity (Above A-line, LL<35)
	CI- Clay of medium plasticity (Above A-line, 35≤LL<50)
	BOREHOLE REQUIRED / WATER TABLE

Note:- Fines= Percentage of Silty + Clay A-line=.73(wl-20)

SCALE:- HOR:- 1:2850 SCALE:- VER:- 1:285

CONDUCTING GEOTECHNICAL INVESTIGATION, PREPARATION OF GEOTECHNICAL REPORT FOR DESIGNING OF BRIDGES AND FOR EMBANKMENT IN CONNECTION WITH CONSTRUCTION OF HARYANA ORBITAL RAIL CORRIDOR (HORC) PROJECT FROM PALWAL TO HARSANA KALAN INCLUDING CONNECTIVITY TO EXISTING IR NETWORK IN THE STATE OF HARYANA.



Chainage	BH No.	Size (mxm)	Depth from EGL (m)	SBC in Shear (t/m²)	SBC from Permissible Settlement (t/m²)	Recommended Net safe Bearing Capacity (t/m²)	Allowable Settlement (mm)
CH-29+000	BH-P_T-06	2 X 2	1.0	20.6	41.4	20.6	25
		2 X 2	1.5	24.5	45.2	24.5	
		2 X 2	2.0	28.7	47.7	28.7	
		2 X 2	2.5	33.0	51.3	30.0	
CH-29+000	BH-P_T-06	3 X 3	1.0	21.6	34.0	21.6	25
		3 X 3	1.5	25.0	35.3	25.0	
		3 X 3	2.0	28.6	38.5	28.6	
		3 X 3	2.5	31.9	40.6	30.0	
CH-29+000	BH-P_T-06	2 X 2	1.0	20.6	82.9	20.6	50
		2 X 2	1.5	24.5	90.3	24.5	
		2 X 2	2.0	28.7	95.4	28.7	
		2 X 2	2.5	33.0	102.6	30.0	
CH-29+000	BH-P_T-06	3 X 3	1.0	21.6	67.9	21.6	50
		3 X 3	1.5	25.0	72.6	25.0	
		3 X 3	2.0	28.6	77.1	28.6	
		3 X 3	2.5	31.9	81.2	30.0	
CH-29+000	PLT-06	2 X 2	2.5	78.5	120.9	30.0	25

Recommended Net Allowable Bearing Capacity for shallow foundation for allowable settlement 25mm & 50mm (Replaced / Compacted Soil)

Chainage	BH No.	Size (mxm)	Depth from EGL (m)	SBC in Shear (t/m²)	SBC from Permissible Settlement (t/m²)	Recommended Net safe Bearing Capacity (t/m²)	Allowable Settlement (mm)
OCH-32+160 NCH-32+767	BH-CL	7.2 X 7.2	1.0	18.0	13.1	13.1	25
		7.2 X 7.2	1.5	18.4	14.6	14.6	
		7.2 X 7.2	2.0	18.9	15.0	15.0	
OCH-32+160 NCH-32+767	BH CL	7.2 X 7.2	1.0	18.0	26.3	18.0	50
		7.2 X 7.2	1.5	18.4	29.2	18.4	
		7.2 X 7.2	2.0	18.9	30.0	18.9	

Chainage	BH No.	Size (mxm)	Depth from EGL (m)	SBC in Shear (t/m²)	SBC from Permissible Settlement (t/m²)	Recommended Net safe Bearing Capacity (t/m²)	Allowable Settlement (mm)
OCH-32+487 NCH-33+155	BH-CL	7.2 X 7.2	1.0	47.6	25.6	25.6	25
		7.2 X 7.2	1.5	52.1	26.9	26.9	
		7.2 X 7.2	2.0	56.7	28.3	28.3	
OCH-32+487 NCH-33+155	BH CL	7.2 X 7.2	1.0	47.6	51.2	30.0	50
		7.2 X 7.2	1.5	52.1	53.7	30.0	
		7.2 X 7.2	2.0	56.7	56.6	30.0	

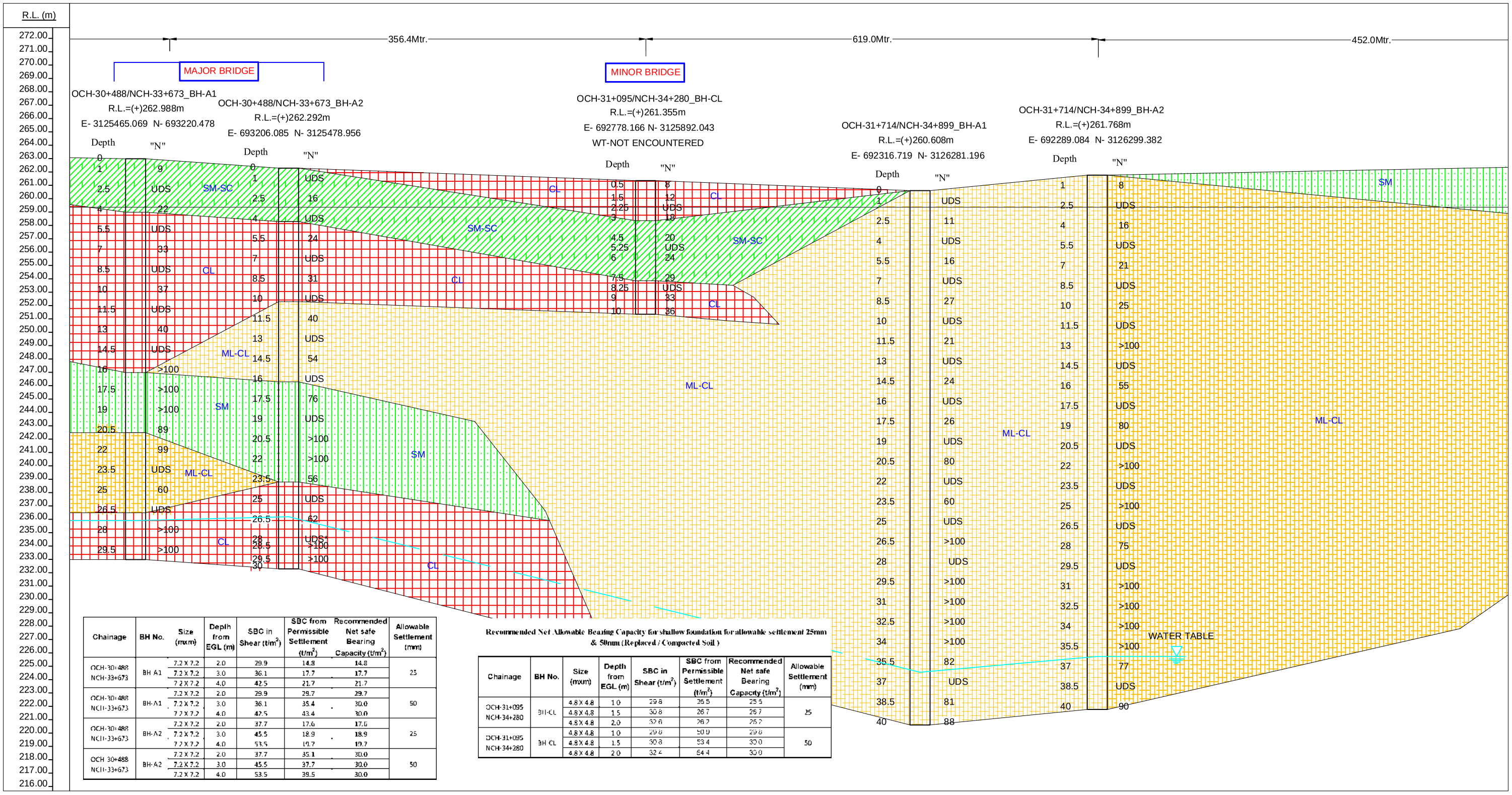
Chainage	BH No.	Size (mxm)	Depth from EGL (m)	SBC in Shear (t/m²)	SBC from Permissible Settlement (t/m²)	Recommended Net safe Bearing Capacity (t/m²)	Allowable Settlement (mm)
OCH-30+083 NCH-33+269	BH-CL	2.5 X 2.5	1.0	30.0	27.0	27.0	25
		2.5 X 2.5	1.5	35.1	29.2	29.2	
		2.5 X 2.5	2.0	40.5	31.9	30.0	
OCH-30+083 NCH-33+269	BH CL	2.5 X 2.5	1.0	30.0	54.0	30.0	50
		2.5 X 2.5	1.5	35.1	58.4	30.0	
		2.5 X 2.5	2.0	40.5	63.8	30.0	

SYMBOL	DESCRIPTION
	SM- Silty Sand (Having fines Less Than 50% and no plasticity or below A-line)
	SM-SC -Clayey Sand (Having fines Less Than 50% and in the hatched zone (4<PI<7)
	ML-CL -Sandy with clay (Having fines greater than 50% and in the hatched zone (LL<35 & 4<PI<7)
	CL-Silty Clay of low plasticity (Above A-line, LL<35)
	CI- Clay of medium plasticity (Above A-line, 35≤LL<50)
	BOREHOLE REQUIRED / WATER TABLE

Note:- Fines= Percentage of Silty + Clay A-line=.73(wl-20)

SCALE:- HOR:- 1:2850 SCALE:- VER:- 1:285

CONDUCTING GEOTECHNICAL INVESTIGATION, PREPARATION OF GEOTECHNICAL REPORT FOR DESIGNING OF BRIDGES AND FOR EMBANKMENT IN CONNECTION WITH CONSTRUCTION OF HARYANA ORBITAL RAIL CORRIDOR (HORC) PROJECT FROM PALWAL TO HARSANA KALAN INCLUDING CONNECTIVITY TO EXISTING IR NETWORK IN THE STATE OF HARYANA.



Chainage	BH No.	Size (mxm)	Depth from EGL (m)	SBC in Shear (t/m²)	SBC from Permissible Settlement (t/m²)	Recommended Net safe Bearing Capacity (t/m²)	Allowable Settlement (mm)
OCH-30+488 NCH-33+673	BH-A1	7.2 X 7.2	2.0	29.9	14.8	14.8	25
		7.2 X 7.2	3.0	36.1	17.7	17.7	
		7.2 X 7.2	4.0	42.5	21.7	21.7	
OCH-30+488 NCH-33+673	BH-A1	7.2 X 7.2	2.0	29.9	29.7	29.7	50
		7.2 X 7.2	3.0	36.1	35.4	30.0	
		7.2 X 7.2	4.0	42.5	43.4	30.0	
OCH-30+488 NCH-33+673	BH-A2	7.2 X 7.2	2.0	37.7	17.6	17.6	25
		7.2 X 7.2	3.0	45.5	18.9	18.9	
		7.2 X 7.2	4.0	53.5	19.7	19.7	
OCH-30+488 NCH-33+673	BH-A2	7.2 X 7.2	2.0	37.7	35.1	30.0	50
		7.2 X 7.2	3.0	45.5	37.7	30.0	
		7.2 X 7.2	4.0	53.5	39.5	30.0	

Recommended Net Allowable Bearing Capacity for shallow foundation for allowable settlement 25mm & 50mm (Replaced / Compacted Soil)

Chainage	BH No.	Size (mxm)	Depth from EGL (m)	SBC in Shear (t/m²)	SBC from Permissible Settlement (t/m²)	Recommended Net safe Bearing Capacity (t/m²)	Allowable Settlement (mm)
OCH-31+095 NCH-34+280	BH-CL	4.8 X 4.8	1.0	29.8	26.5	25.5	25
		4.8 X 4.8	1.5	30.8	26.7	26.7	
		4.8 X 4.8	2.0	32.6	26.7	26.7	
OCH-31+095 NCH-34+280	BH-CL	4.8 X 4.8	1.0	29.8	29.8	29.8	50
		4.8 X 4.8	1.5	30.8	53.4	30.0	
		4.8 X 4.8	2.0	32.6	54.4	30.0	

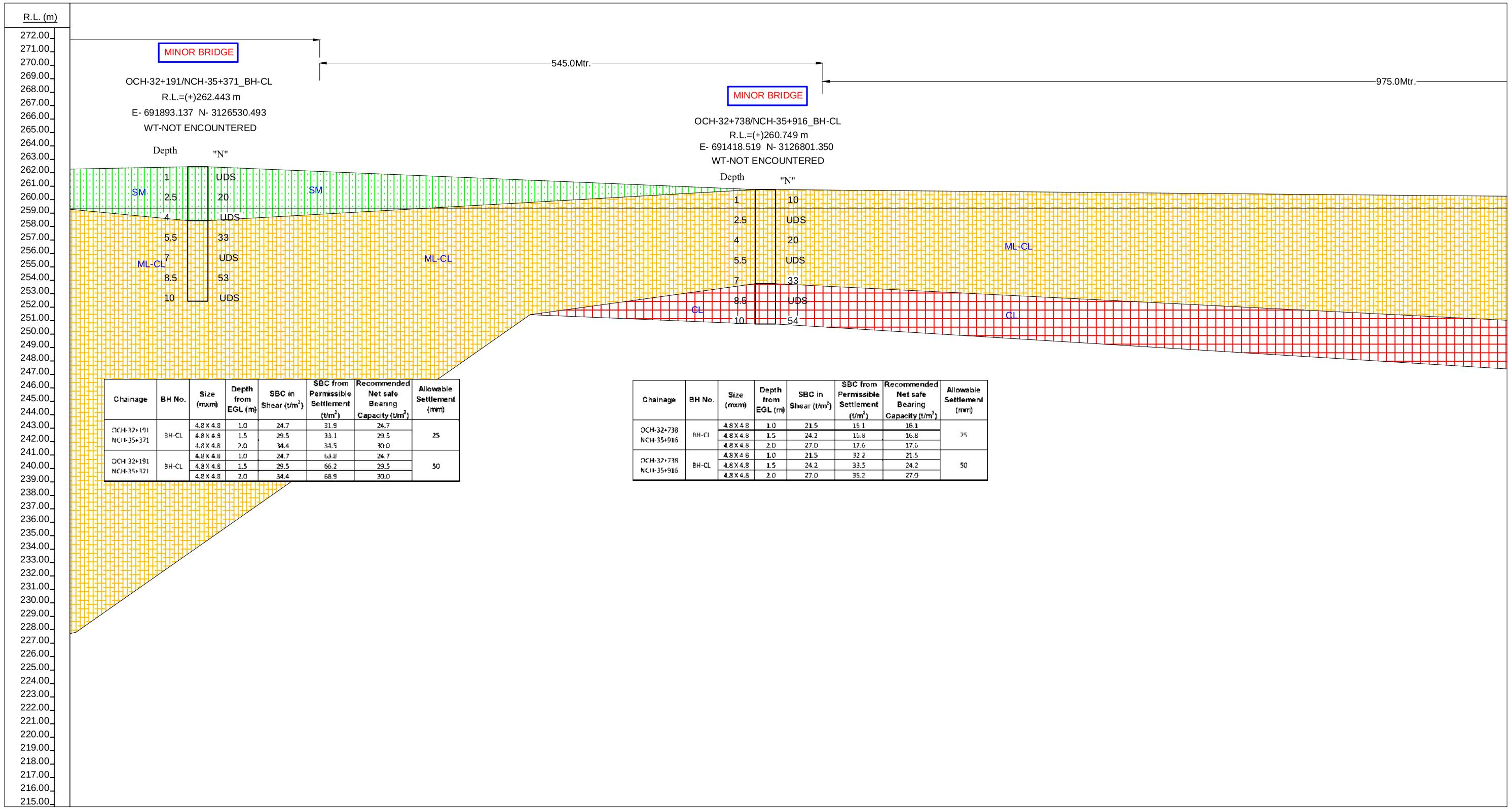
Chainage	BH No.	Size (mxm)	Depth from EGL (m)	SBC in Shear (t/m²)	SBC from Permissible Settlement (t/m²)	Recommended Net safe Bearing Capacity (t/m²)	Allowable Settlement (mm)
OCH-31+714 NCH-34+899	BH-A1	7.2 X 7.2	2.0	32.5	14.1	14.1	25
		7.2 X 7.2	3.0	38.4	14.9	14.9	
		7.2 X 7.2	4.0	44.4	15.7	15.7	
OCH-31+714 NCH-34+899	BH-A1	7.2 X 7.2	2.0	32.5	28.2	28.2	50
		7.2 X 7.2	3.0	38.4	29.7	29.7	
		7.2 X 7.2	4.0	44.4	31.4	30.0	
OCH-31+714 NCH-34+899	BH-A2	7.2 X 7.2	2.0	38.4	15.1	15.1	25
		7.2 X 7.2	3.0	45.1	16.3	15.3	
		7.2 X 7.2	4.0	52.2	17.9	17.9	
OCH 31+714 NCH-34+899	BH-A2	7.2 X 7.2	2.0	38.4	30.3	30.0	50
		7.2 X 7.2	3.0	45.1	32.6	30.0	
		7.2 X 7.2	4.0	52.2	35.7	30.0	

SYMBOL	DESCRIPTION
	SM- Silty Sand (Having fines Less Than 50% and no plasticity or below A-line)
	SM-SC -Clayey Sand (Having fines Less Than 50% and in the hatched zone (4<PI<7)
	ML-CL -Sandy with clay (Having fines greater than 50% and in the hatched zone (LL<35 & 4<PI<7)
	CL-Silty Clay of low plasticity (Above A-line, LL<35)
	CI- Clay of medium plasticity (Above A-line, 35≤LL<50)
	BOREHOLE REQUIRED / WATER TABLE

Note:- Fines= Percentage of Silty + Clay A-line=.73(wl-20)

SCALE:- HOR:- 1:2850 SCALE:- VER:- 1:285

CONDUCTING GEOTECHNICAL INVESTIGATION, PREPARATION OF GEOTECHNICAL REPORT FOR DESIGNING OF BRIDGES AND FOR EMBANKMENT IN CONNECTION WITH CONSTRUCTION OF HARYANA ORBITAL RAIL CORRIDOR (HORC) PROJECT FROM PALWAL TO HARSANA KALAN INCLUDING CONNECTIVITY TO EXISTING IR NETWORK IN THE STATE OF HARYANA.



Chainage	BH No.	Size (mxm)	Depth from EGL (m)	SBC in Shear (t/m^2)	SBC from Permissible Settlement (t/m^2)	Recommended Net safe Bearing Capacity (t/m^2)	Allowable Settlement (mm)
OCH-32+191 NCH-35+371	BH-CL	4.8 X 4.8	1.0	24.7	31.9	24.7	25
		4.8 X 4.8	1.5	29.5	33.1	29.5	
		4.8 X 4.8	2.0	34.4	34.5	30.0	
OCH 32+191 NCH-35+371	BH-CL	4.8 X 4.8	1.0	24.7	63.8	24.7	50
		4.8 X 4.8	1.5	29.5	66.2	29.5	
		4.8 X 4.8	2.0	34.4	68.9	30.0	

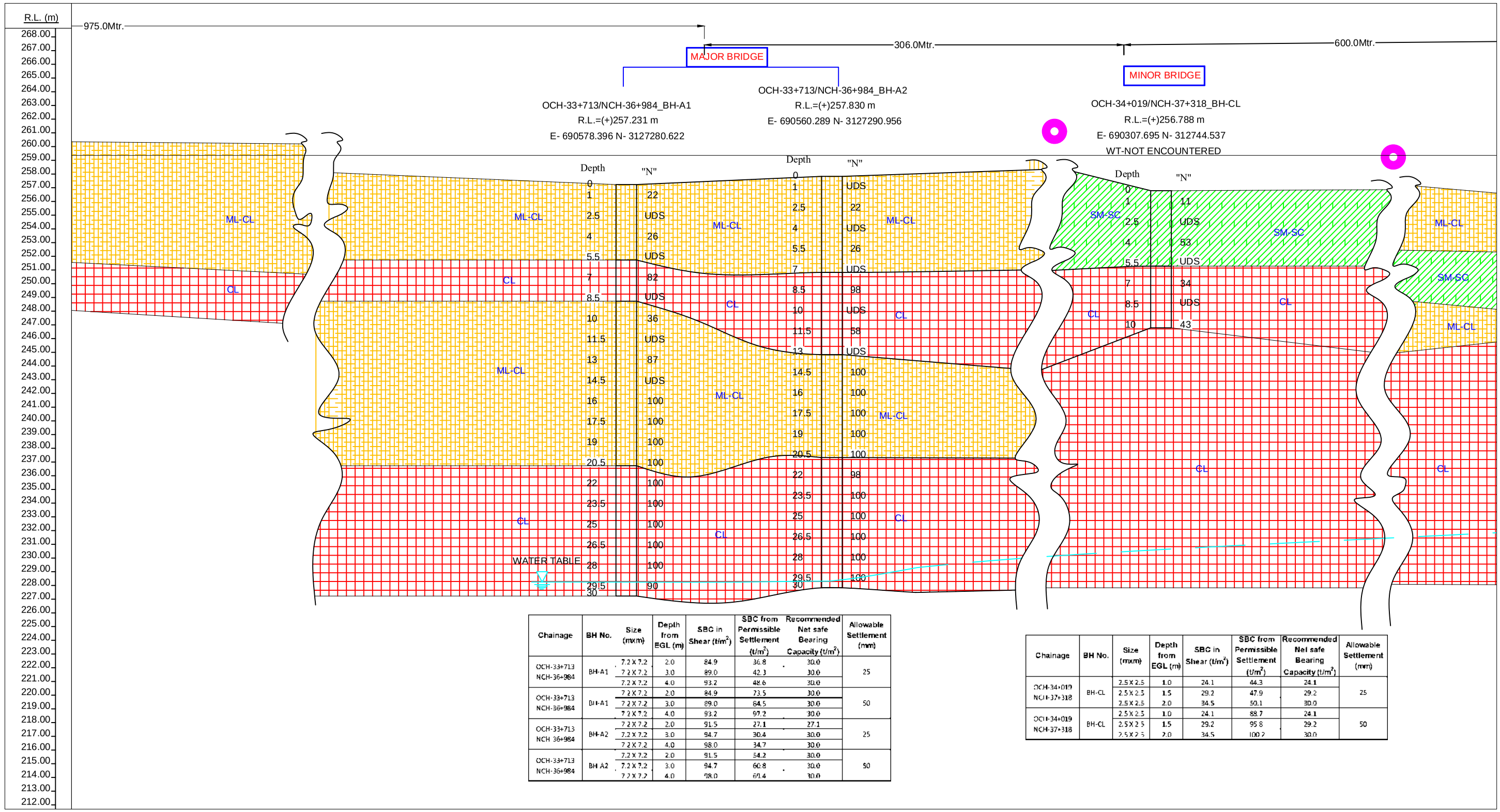
Chainage	BH No.	Size (mxm)	Depth from EGL (m)	SBC in Shear (t/m^2)	SBC from Permissible Settlement (t/m^2)	Recommended Net safe Bearing Capacity (t/m^2)	Allowable Settlement (mm)
OCH-32+738 NCH-35+916	BH-CL	4.8 X 4.8	1.0	21.5	15.1	16.1	25
		4.8 X 4.8	1.5	24.2	15.8	16.8	
		4.8 X 4.8	2.0	27.0	17.6	17.6	
OCH-32+738 NCH-35+916	BH-CL	4.8 X 4.8	1.0	21.5	32.2	21.5	50
		4.8 X 4.8	1.5	24.2	33.5	24.2	
		4.8 X 4.8	2.0	27.0	35.2	27.0	

SYMBOL	DESCRIPTION
	SM- Silty Sand (Having fines Less Than 50% and no plasticity or below A-line)
	SM-SC -Clayey Sand (Having fines Less Than 50% and in the hatched zone (4<PI<7)
	ML-CL -Sandy with clay (Having fines greater than 50% and in the hatched zone (LL<35 & 4<PI<7)
	CL-Silty Clay of low plasticity (Above A-line, LL<35)
	CI- Clay of medium plasticity (Above A-line, 35≤LL<50)
	BOREHOLE REQUIRED / WATER TABLE

Note:- Fines= Percentage of Silty + Clay A-line=.73(wl-20)

SCALE:- HOR:- 1:2850 SCALE:- VER:- 1:285

CONDUCTING GEOTECHNICAL INVESTIGATION, PREPARATION OF GEOTECHNICAL REPORT FOR DESIGNING OF BRIDGES AND FOR EMBANKMENT IN CONNECTION WITH CONSTRUCTION OF HARYANA ORBITAL RAIL CORRIDOR (HORC) PROJECT FROM PALWAL TO HARSANA KALAN INCLUDING CONNECTIVITY TO EXISTING IR NETWORK IN THE STATE OF HARYANA.



Chainage	BH No.	Size (m x m)	Depth from EGL (m)	SBC in Shear (t/m^2)	SBC from Permissible Settlement (t/m^2)	Recommended Net safe Bearing Capacity (t/m^2)	Allowable Settlement (mm)
OCH-33+713 NCH-36+984	BH-A1	7.2 X 7.2	2.0	84.9	36.8	30.0	25
		7.2 X 7.2	3.0	89.0	42.3	30.0	
		7.2 X 7.2	4.0	93.2	48.6	30.0	
OCH-33+713 NCH-36+984	BH-A1	7.2 X 7.2	2.0	84.9	73.5	30.0	50
		7.2 X 7.2	3.0	89.0	84.5	30.0	
		7.2 X 7.2	4.0	93.2	97.2	30.0	
OCH-33+713 NCH-36+984	BH-A2	7.2 X 7.2	2.0	91.5	27.1	27.1	25
		7.2 X 7.2	3.0	94.7	30.4	30.0	
		7.2 X 7.2	4.0	98.0	34.7	30.0	
OCH-33+713 NCH-36+984	BH-A2	7.2 X 7.2	2.0	91.5	54.2	30.0	50
		7.2 X 7.2	3.0	94.7	60.8	30.0	
		7.2 X 7.2	4.0	98.0	69.4	30.0	

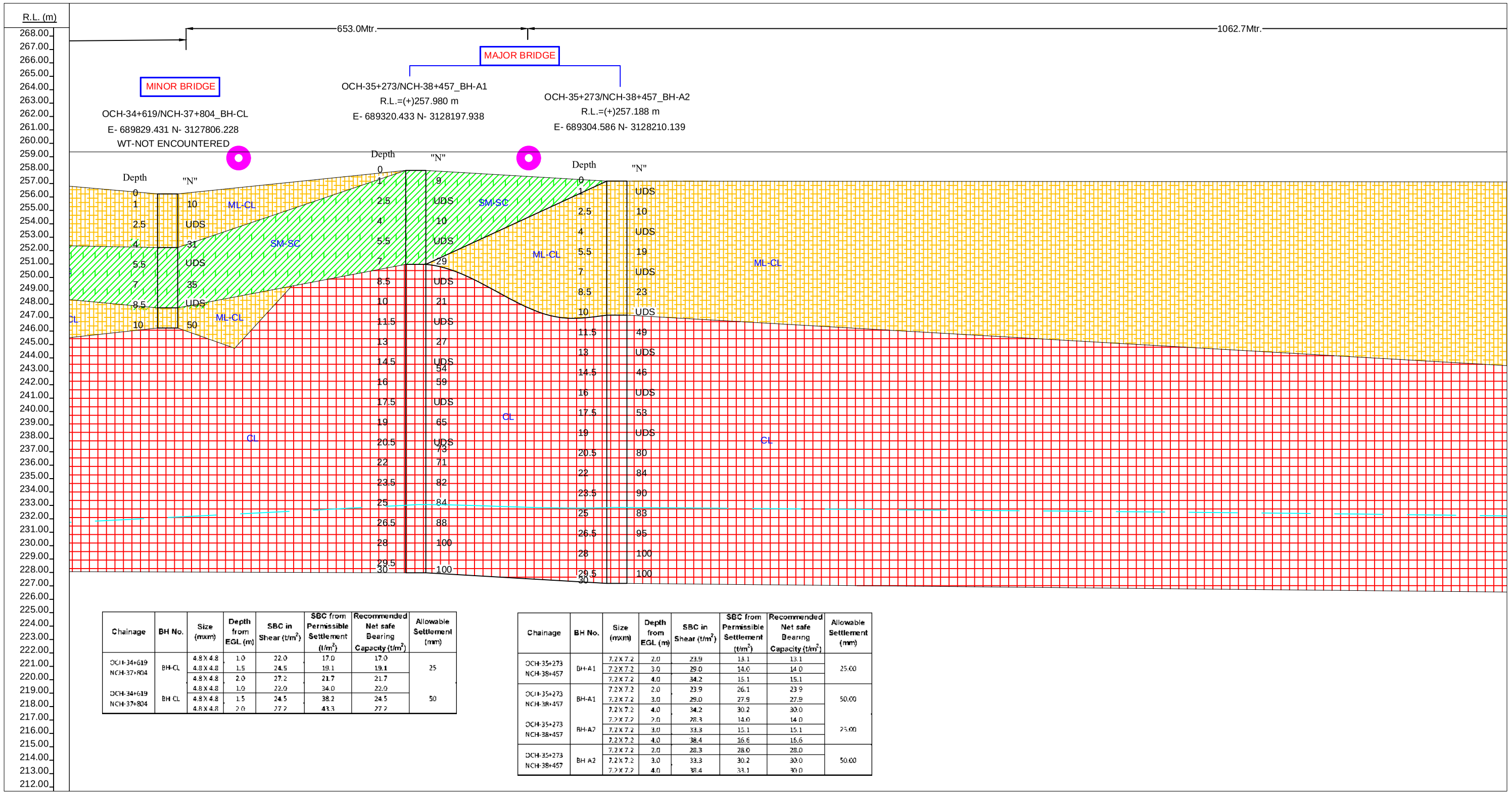
Chainage	BH No.	Size (m x m)	Depth from EGL (m)	SBC in Shear (t/m^2)	SBC from Permissible Settlement (t/m^2)	Recommended Net safe Bearing Capacity (t/m^2)	Allowable Settlement (mm)
OCH-34+019 NCH-37+318	BH-CL	2.5 X 2.5	1.0	24.1	44.3	24.1	25
		2.5 X 2.5	1.5	29.2	47.9	29.2	
		2.5 X 2.5	2.0	34.5	50.1	30.0	
OCH-34+019 NCH-37+318	BH-CL	2.5 X 2.5	1.0	24.1	88.7	24.1	50
		2.5 X 2.5	1.5	29.2	95.8	29.2	
		2.5 X 2.5	2.0	34.5	100.2	30.0	

SYMBOL	DESCRIPTION
	SM- Silty Sand (Having fines Less Than 50% and no plasticity or below A-line)
	SM-SC -Clayey Sand (Having fines Less Than 50% and in the hatched zone (4<PI<7)
	ML-CL -Sandy with clay (Having fines greater than 50% and in the hatched zone (LL<35 & 4<PI<7)
	CL-Silty Clay of low plasticity (Above A-line, LL<35)
	CI- Clay of medium plasticity (Above A-line, 35≤LL<50)
	BOREHOLE REQUIRED / WATER TABLE

Note:- Fines= Percentage of Silty + Clay A-line=.73(wl-20)

SCALE:- HOR:- 1:2850 SCALE:- VER:- 1:285

CONDUCTING GEOTECHNICAL INVESTIGATION, PREPARATION OF GEOTECHNICAL REPORT FOR DESIGNING OF BRIDGES AND FOR EMBANKMENT IN CONNECTION WITH CONSTRUCTION OF HARYANA ORBITAL RAIL CORRIDOR (HORC) PROJECT FROM PALWAL TO HARSANA KALAN INCLUDING CONNECTIVITY TO EXISTING IR NETWORK IN THE STATE OF HARYANA.



Chainage	BH No.	Size (mxm)	Depth from EGL (m)	SBC in Shear (t/m^2)	SBC from Permissible Settlement (t/m^2)	Recommended Net safe Bearing Capacity (t/m^2)	Allowable Settlement (mm)
OCH-34+619 NCH-37+804	BH-CL	4.8 X 4.8	1.0	22.0	17.0	17.0	25
		4.8 X 4.8	1.5	24.5	19.1	19.1	
		4.8 X 4.8	2.0	27.2	21.7	21.7	
OCH-34+619 NCH-37+804	BH CL	4.8 X 4.8	1.0	22.0	34.0	22.0	50
		4.8 X 4.8	1.5	24.5	38.2	24.5	
		4.8 X 4.8	2.0	27.2	43.3	27.2	

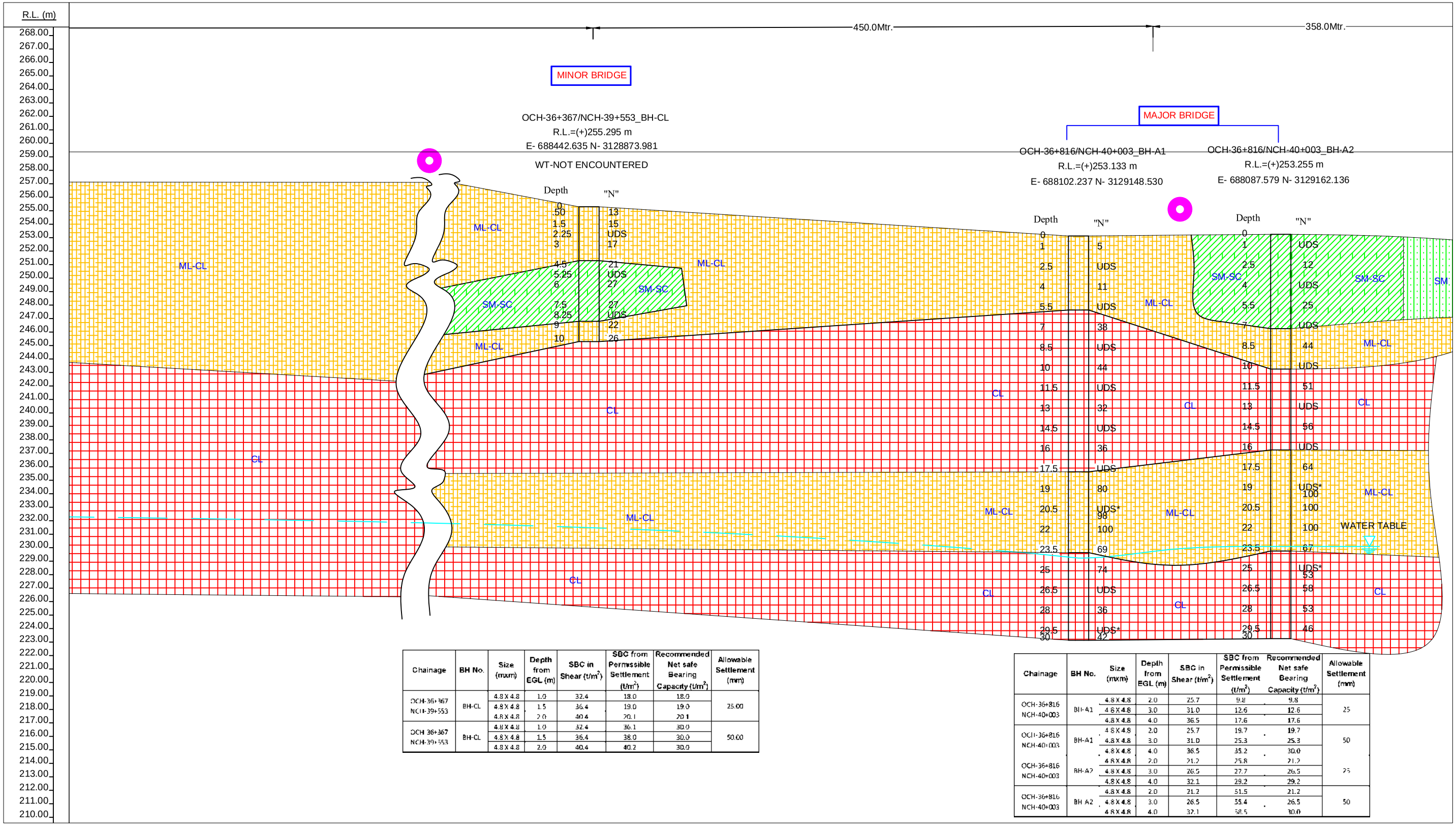
Chainage	BH No.	Size (mxm)	Depth from EGL (m)	SBC in Shear (t/m^2)	SBC from Permissible Settlement (t/m^2)	Recommended Net safe Bearing Capacity (t/m^2)	Allowable Settlement (mm)
OCH-35+273 NCH-38+457	BH-A1	7.2 X 7.2	2.0	23.9	13.1	13.1	25.00
		7.2 X 7.2	3.0	29.0	14.0	14.0	
		7.2 X 7.2	4.0	34.2	15.1	15.1	
OCH-35+273 NCH-38+457	BH-A1	7.2 X 7.2	2.0	23.9	26.1	23.9	50.00
		7.2 X 7.2	3.0	29.0	27.9	27.9	
		7.2 X 7.2	4.0	34.2	30.2	30.0	
OCH-35+273 NCH-38+457	BH-A2	7.2 X 7.2	2.0	28.3	14.0	14.0	25.00
		7.2 X 7.2	3.0	33.3	15.1	15.1	
		7.2 X 7.2	4.0	38.4	16.6	16.6	
OCH-35+273 NCH-38+457	BH A2	7.2 X 7.2	2.0	28.3	28.0	28.0	50.00
		7.2 X 7.2	3.0	33.3	30.2	30.0	
		7.2 X 7.2	4.0	38.4	33.1	30.0	

SYMBOL	DESCRIPTION
	SM- Silty Sand (Having fines Less Than 50% and no plasticity or below A-line)
	SM-SC -Clayey Sand (Having fines Less Than 50% and in the hatched zone (4<PI<7)
	ML-CL -Sandy with clay (Having fines greater than 50% and in the hatched zone (LL<35 & 4<PI<7)
	CL-Silty Clay of low plasticity (Above A-line, LL<35)
	CI- Clay of medium plasticity (Above A-line, 35≤LL<50)
	BOREHOLE REQUIRED / WATER TABLE

Note:- Fines= Percentage of Silty + Clay A-line=.73(wl-20)

SCALE:- HOR:- 1:2850 SCALE:- VER:- 1:285

CONDUCTING GEOTECHNICAL INVESTIGATION, PREPARATION OF GEOTECHNICAL REPORT FOR DESIGNING OF BRIDGES AND FOR EMBANKMENT IN CONNECTION WITH CONSTRUCTION OF HARYANA ORBITAL RAIL CORRIDOR (HORC) PROJECT FROM PALWAL TO HARSANA KALAN INCLUDING CONNECTIVITY TO EXISTING IR NETWORK IN THE STATE OF HARYANA.



Chainage	BH No.	Size (mxm)	Depth from EGL (m)	SBC in Shear (t/m^2)	SBC from Permissible Settlement (t/m^2)	Recommended Net safe Bearing Capacity (t/m^2)	Allowable Settlement (mm)
OCH-36+367 NCH-39+553	BH-CL	4.8 X 4.8	1.0	32.4	18.0	18.0	25.00
		4.8 X 4.8	1.5	36.4	19.0	19.0	
		4.8 X 4.8	2.0	40.4	20.1	20.1	
OCH-36+367 NCH-39+553	BH-CL	4.8 X 4.8	1.0	32.4	36.1	30.0	50.00
		4.8 X 4.8	1.5	36.4	38.0	30.0	
		4.8 X 4.8	2.0	40.4	40.2	30.0	

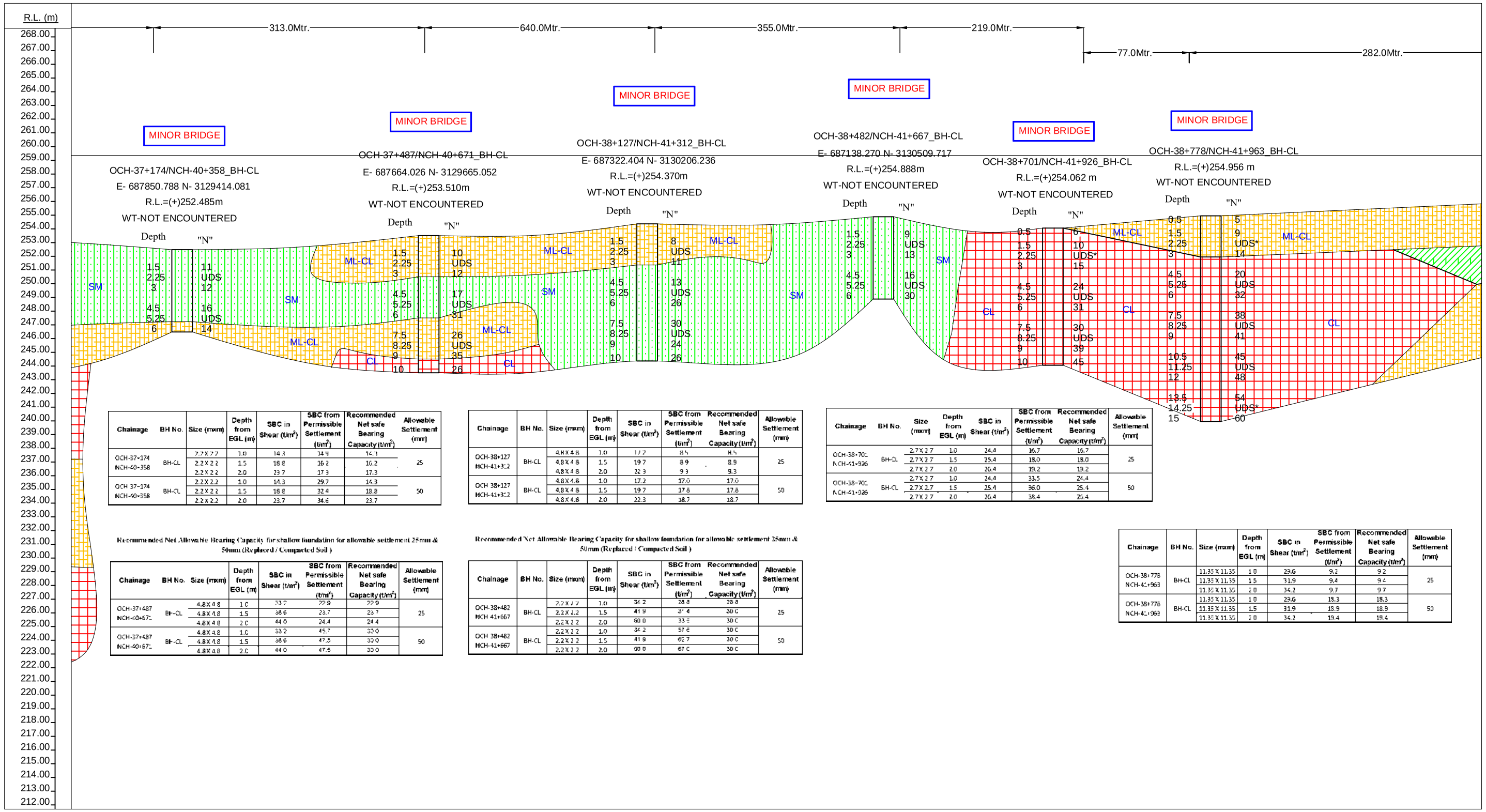
Chainage	BH No.	Size (mxm)	Depth from EGL (m)	SBC in Shear (t/m^2)	SBC from Permissible Settlement (t/m^2)	Recommended Net safe Bearing Capacity (t/m^2)	Allowable Settlement (mm)
OCH-36+816 NCH-40+003	BH-A1	4.8 X 4.8	2.0	25.7	9.8	9.8	25
		4.8 X 4.8	3.0	31.0	12.6	12.6	
		4.8 X 4.8	4.0	36.5	17.6	17.6	
OCH-36+816 NCH-40+003	BH-A1	4.8 X 4.8	2.0	25.7	19.7	19.7	50
		4.8 X 4.8	3.0	31.0	25.3	25.3	
		4.8 X 4.8	4.0	36.5	35.2	30.0	
OCH-36+816 NCH-40+003	BH-A2	4.8 X 4.8	2.0	21.2	25.8	21.2	25
		4.8 X 4.8	3.0	26.5	27.7	26.5	
		4.8 X 4.8	4.0	32.1	29.2	29.2	
OCH-36+816 NCH-40+003	BH-A2	4.8 X 4.8	2.0	21.2	51.5	21.2	50
		4.8 X 4.8	3.0	26.5	55.4	26.5	
		4.8 X 4.8	4.0	32.1	58.5	30.0	

SYMBOL	DESCRIPTION
	SM- Silty Sand (Having fines Less Than 50% and no plasticity or below A-line)
	SM-SC -Clayey Sand (Having fines Less Than 50% and in the hatched zone (4<PI<7)
	ML-CL -Sandy with clay (Having fines greater than 50% and in the hatched zone (LL<35 & 4<PI<7)
	CL-Silty Clay of low plasticity (Above A-line, LL<35)
	CI- Clay of medium plasticity (Above A-line, 35≤LL<50)
	BOREHOLE REQUIRED / WATER TABLE

Note:- Fines= Percentage of Silty + Clay A-line=.73(wl-20)

SCALE:- HOR:- 1:2850 SCALE:- VER:- 1:285

CONDUCTING GEOTECHNICAL INVESTIGATION, PREPARATION OF GEOTECHNICAL REPORT FOR DESIGNING OF BRIDGES AND FOR EMBANKMENT IN CONNECTION WITH CONSTRUCTION OF HARYANA ORBITAL RAIL CORRIDOR (HORC) PROJECT FROM PALWAL TO HARSANA KALAN INCLUDING CONNECTIVITY TO EXISTING IR NETWORK IN THE STATE OF HARYANA.



Chainage	BH No.	Size (mxm)	Depth from EGL (m)	SBC in Shear (t/m²)	SBC from Permissible Settlement (t/m²)	Recommended Net safe Bearing Capacity (t/m²)	Allowable Settlement (mm)
OCH-37+174 NCH-40+358	BH-CL	2.2 X 2.2	1.0	18.8	18.8	18.8	25
		2.2 X 2.2	1.5	18.8	18.2	18.2	
		2.2 X 2.2	2.0	23.7	17.3	17.3	
OCH 37+174 NCH-40+358	BH-CL	2.2 X 2.2	1.0	14.3	29.7	14.3	50
		2.2 X 2.2	1.5	18.8	32.4	18.8	
		2.2 X 2.2	2.0	23.7	34.6	23.7	

Chainage	BH No.	Size (mxm)	Depth from EGL (m)	SBC in Shear (t/m²)	SBC from Permissible Settlement (t/m²)	Recommended Net safe Bearing Capacity (t/m²)	Allowable Settlement (mm)
OCH-38+127 NCH-41+312	BH-CL	4.8 X 4.8	1.0	17.2	8.9	8.9	25
		4.8 X 4.8	1.5	19.7	8.9	8.9	
		4.8 X 4.8	2.0	22.3	9.3	9.3	
OCH 38+127 NCH-41+312	BH-CL	4.8 X 4.8	1.0	17.2	17.0	17.0	50
		4.8 X 4.8	1.5	19.7	17.8	17.8	
		4.8 X 4.8	2.0	22.3	18.7	18.7	

Chainage	BH No.	Size (mxm)	Depth from EGL (m)	SBC in Shear (t/m²)	SBC from Permissible Settlement (t/m²)	Recommended Net safe Bearing Capacity (t/m²)	Allowable Settlement (mm)
OCH-38+701 NCH-41+926	BH-CL	2.7 X 2.7	1.0	24.4	16.7	16.7	25
		2.7 X 2.7	1.5	25.4	18.0	18.0	
		2.7 X 2.7	2.0	26.4	19.2	19.2	
OCH-38+701 NCH-41+926	BH-CL	2.7 X 2.7	1.0	24.4	33.5	24.4	50
		2.7 X 2.7	1.5	25.4	36.0	25.4	
		2.7 X 2.7	2.0	26.4	38.4	26.4	

Recommended Net Allowable Bearing Capacity for shallow foundation for allowable settlement 25mm & 50mm (Replaced / Compacted Soil)

Chainage	BH No.	Size (mxm)	Depth from EGL (m)	SBC in Shear (t/m²)	SBC from Permissible Settlement (t/m²)	Recommended Net safe Bearing Capacity (t/m²)	Allowable Settlement (mm)
OCH-37+487 NCH-40+671	BH-CL	4.8 X 4.8	1.0	33.2	22.9	22.9	25
		4.8 X 4.8	1.5	38.6	23.7	23.7	
		4.8 X 4.8	2.0	44.0	24.4	24.4	
OCH-37+487 NCH-40+671	BH-CL	4.8 X 4.8	1.0	33.2	45.7	33.0	50
		4.8 X 4.8	1.5	38.6	47.5	33.0	
		4.8 X 4.8	2.0	44.0	47.5	33.0	

Recommended Net Allowable Bearing Capacity for shallow foundation for allowable settlement 25mm & 50mm (Replaced / Compacted Soil)

Chainage	BH No.	Size (mxm)	Depth from EGL (m)	SBC in Shear (t/m²)	SBC from Permissible Settlement (t/m²)	Recommended Net safe Bearing Capacity (t/m²)	Allowable Settlement (mm)
OCH-38+482 NCH 41+667	BH-CL	2.2 X 2.2	1.0	34.2	28.8	28.8	25
		2.2 X 2.2	1.5	41.9	37.4	30.0	
		2.2 X 2.2	2.0	50.0	33.5	30.0	
OCH 38+482 NCH-41+667	BH-CL	2.2 X 2.2	1.0	34.2	57.5	30.0	50
		2.2 X 2.2	1.5	41.9	62.7	30.0	
		2.2 X 2.2	2.0	50.0	67.0	30.0	

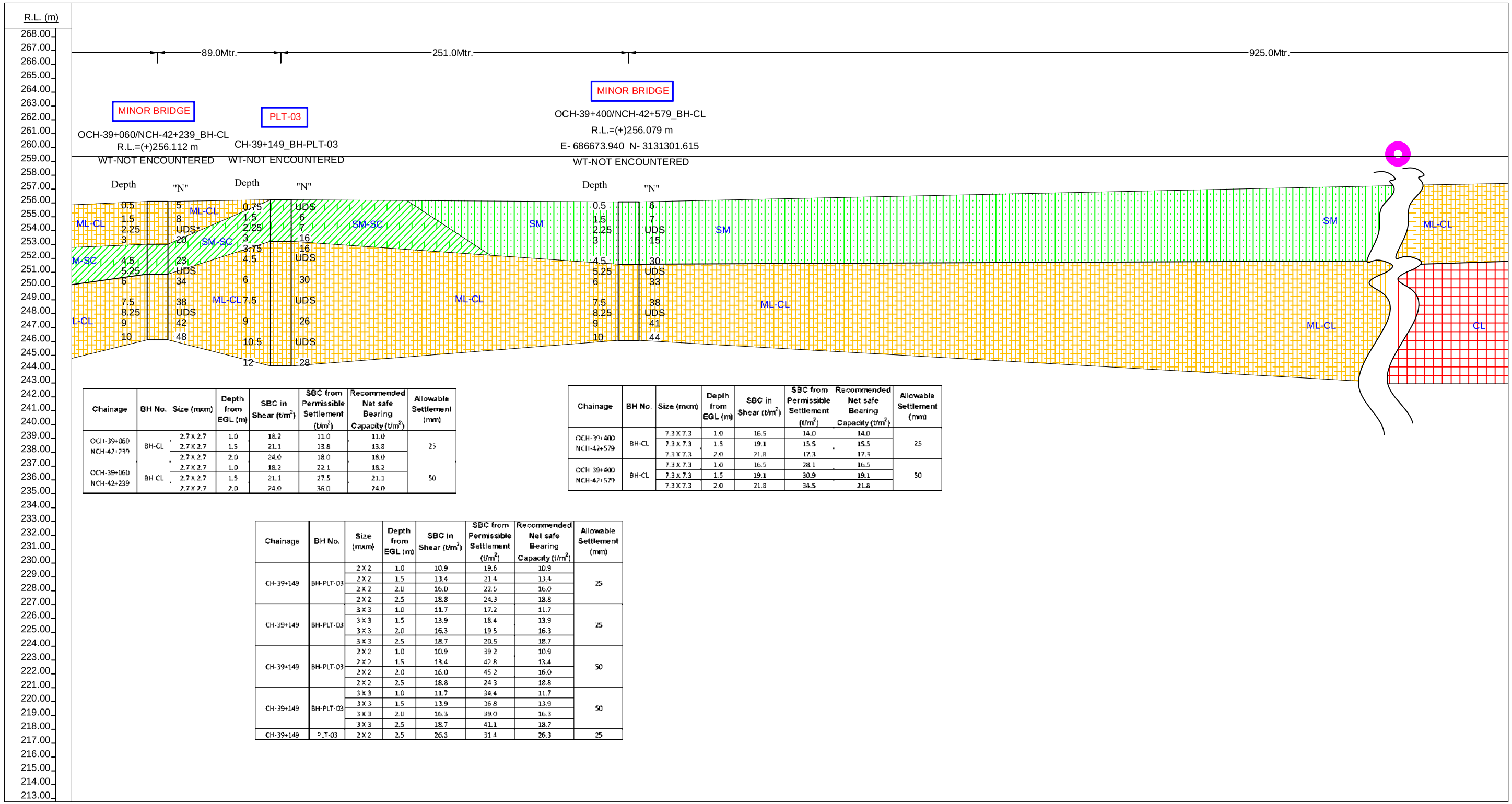
Chainage	BH No.	Size (mxm)	Depth from EGL (m)	SBC in Shear (t/m²)	SBC from Permissible Settlement (t/m²)	Recommended Net safe Bearing Capacity (t/m²)	Allowable Settlement (mm)
OCH-38+778 NCH-41+963	BH-CL	11.35 X 11.35	1.0	23.6	9.2	9.2	25
		11.35 X 11.35	1.5	31.9	9.4	9.4	
		11.35 X 11.35	2.0	34.2	9.7	9.7	
OCH-38+778 NCH-41+963	BH-CL	11.35 X 11.35	1.0	23.6	18.3	18.3	50
		11.35 X 11.35	1.5	31.9	18.9	18.9	
		11.35 X 11.35	2.0	34.2	19.4	19.4	

SYMBOL	DESCRIPTION
	SM- Silty Sand (Having fines Less Than 50% and no plasticity or below A-line)
	SM-SC -Clayey Sand (Having fines Less Than 50% and in the hatched zone (4<PI<7)
	ML-CL -Sandy with clay (Having fines greater than 50% and in the hatched zone (LL<35 & 4<PI<7)
	CL-Silty Clay of low plasticity (Above A-line, LL<35)
	CI- Clay of medium plasticity (Above A-line, 35≤LL<50)
	BOREHOLE REQUIRED / WATER TABLE

Note:- Fines= Percentage of Silty + Clay A-line=.73(wl-20)

SCALE:- HOR:- 1:2850 SCALE:- VER:- 1:285

CONDUCTING GEOTECHNICAL INVESTIGATION, PREPARATION OF GEOTECHNICAL REPORT FOR DESIGNING OF BRIDGES AND FOR EMBANKMENT IN CONNECTION WITH CONSTRUCTION OF HARYANA ORBITAL RAIL CORRIDOR (HORC) PROJECT FROM PALWAL TO HARSANA KALAN INCLUDING CONNECTIVITY TO EXISTING IR NETWORK IN THE STATE OF HARYANA.



Chainage	BH No.	Size (mxm)	Depth from EGL (m)	SBC in Shear (t/m²)	SBC from Permissible Settlement (t/m²)	Recommended Net safe Bearing Capacity (t/m²)	Allowable Settlement (mm)
OCH-39+060 NCH-42+239	BH-CL	2.7 X 2.7	1.0	18.2	11.0	11.0	25
		2.7 X 2.7	1.5	21.1	13.8	13.8	
		2.7 X 2.7	2.0	24.0	18.0	18.0	
		2.7 X 2.7	1.0	18.2	22.1	18.2	
OCH-39+060 NCH-42+239	BH CL	2.7 X 2.7	1.5	21.1	27.5	21.1	50
		2.7 X 2.7	2.0	24.0	36.0	24.0	

Chainage	BH No.	Size (mxm)	Depth from EGL (m)	SBC in Shear (t/m²)	SBC from Permissible Settlement (t/m²)	Recommended Net safe Bearing Capacity (t/m²)	Allowable Settlement (mm)
OCH-39+400 NCH-42+579	BH-CL	7.3 X 7.3	1.0	16.5	14.0	14.0	25
		7.3 X 7.3	1.5	19.1	15.5	15.5	
		7.3 X 7.3	2.0	21.8	17.3	17.3	
OCH 39+400 NCH-42+579	BH-CL	7.3 X 7.3	1.0	16.5	28.1	16.5	50
		7.3 X 7.3	1.5	19.1	30.9	19.1	
		7.3 X 7.3	2.0	21.8	34.5	21.8	

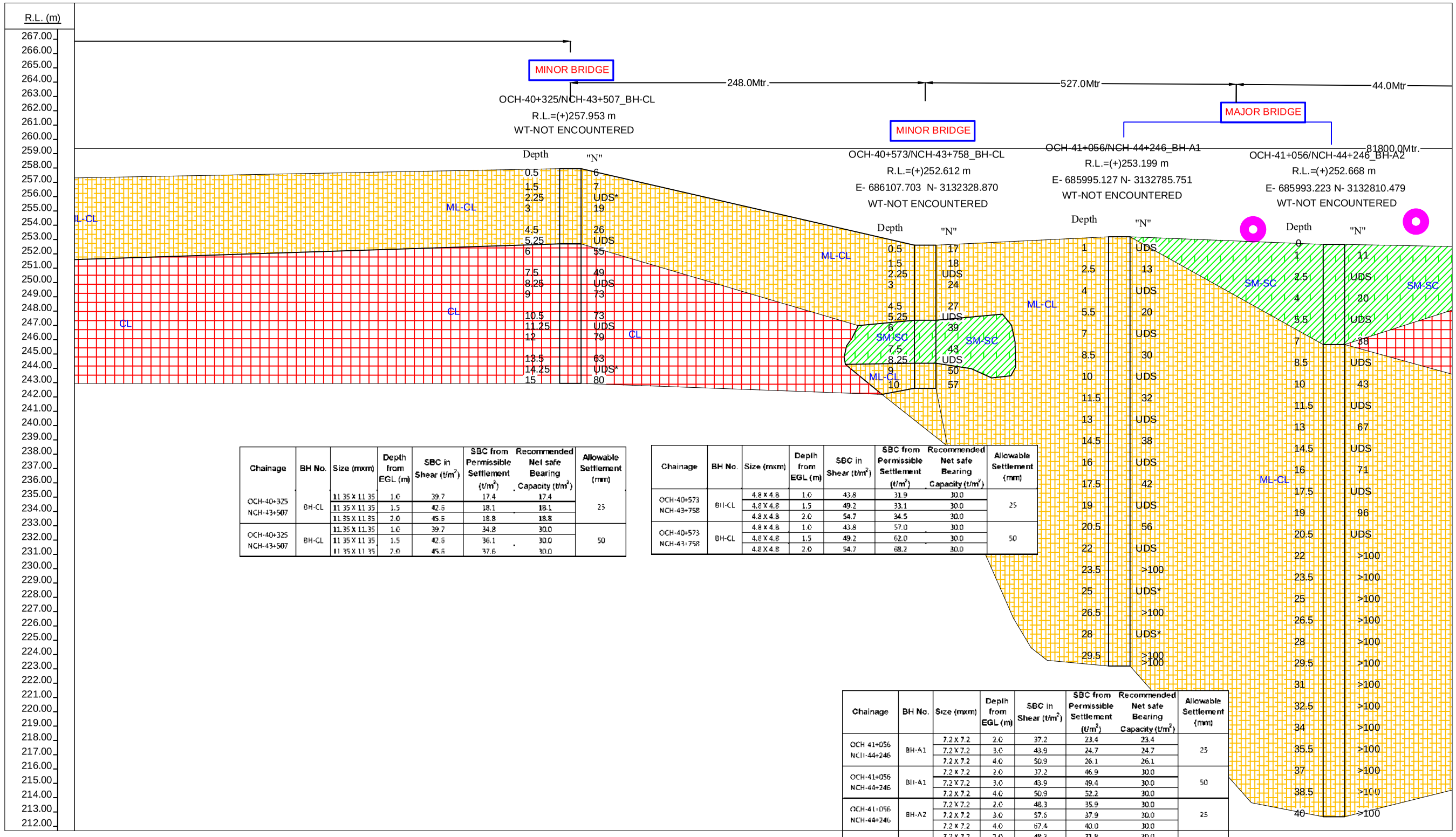
Chainage	BH No.	Size (mxm)	Depth from EGL (m)	SBC in Shear (t/m²)	SBC from Permissible Settlement (t/m²)	Recommended Net safe Bearing Capacity (t/m²)	Allowable Settlement (mm)
CH-39+149	BH-PLT-03	2 X 2	1.0	10.9	19.5	10.9	25
		2 X 2	1.5	13.4	21.4	13.4	
		2 X 2	2.0	16.0	22.5	16.0	
		2 X 2	2.5	18.8	24.3	18.8	
CH-39+149	BH-PLT-03	3 X 3	1.0	11.7	17.2	11.7	25
		3 X 3	1.5	13.9	18.4	13.9	
		3 X 3	2.0	16.3	19.5	16.3	
		3 X 3	2.5	18.7	20.5	18.7	
CH-39+149	BH-PLT-03	2 X 2	1.0	10.9	39.2	10.9	50
		2 X 2	1.5	13.4	42.8	13.4	
		2 X 2	2.0	16.0	45.2	16.0	
		2 X 2	2.5	18.8	24.3	18.8	
CH-39+149	BH-PLT-03	3 X 3	1.0	11.7	34.4	11.7	50
		3 X 3	1.5	13.9	36.8	13.9	
		3 X 3	2.0	16.3	39.0	16.3	
		3 X 3	2.5	18.7	41.1	18.7	
CH-39+149	P_T-03	2 X 2	2.5	26.3	31.4	26.3	25

SYMBOL	DESCRIPTION
	SM- Silty Sand (Having fines Less Than 50% and no plasticity or below A-line)
	SM-SC -Clayey Sand (Having fines Less Than 50% and in the hatched zone (4<PI<7)
	ML-CL -Sandy with clay (Having fines greater than 50% and in the hatched zone (LL<35 & 4<PI<7)
	CL-Silty Clay of low plasticity (Above A-line, LL<35)
	CI- Clay of medium plasticity (Above A-line, 35≤LL<50)
	BOREHOLE REQUIRED / WATER TABLE

Note:- Fines= Percentage of Silty + Clay A-line=.73(wl-20)

SCALE:- HOR:- 1:2850 SCALE:- VER:- 1:285

CONDUCTING GEOTECHNICAL INVESTIGATION, PREPARATION OF GEOTECHNICAL REPORT FOR DESIGNING OF BRIDGES AND FOR EMBANKMENT IN CONNECTION WITH CONSTRUCTION OF HARYANA ORBITAL RAIL CORRIDOR (HORC) PROJECT FROM PALWAL TO HARSANA KALAN INCLUDING CONNECTIVITY TO EXISTING IR NETWORK IN THE STATE OF HARYANA.



Chainage	BH No.	Size (mxm)	Depth from EGL (m)	SBC in Shear (t/m²)	SBC from Permissible Settlement (t/m²)	Recommended Net safe Bearing Capacity (t/m²)	Allowable Settlement (mm)
OCH-40+325 NCH-43+507	BH-CL	11.35 X 11.35	1.0	39.7	17.4	17.4	25
		11.35 X 11.35	1.5	42.6	18.1	18.1	
		11.35 X 11.35	2.0	45.5	18.8	18.8	
OCH-40+325 NCH-43+507	BH-CL	11.35 X 11.35	1.0	39.7	34.8	30.0	50
		11.35 X 11.35	1.5	42.6	36.1	30.0	
		11.35 X 11.35	2.0	45.5	37.6	30.0	

Chainage	BH No.	Size (mxm)	Depth from EGL (m)	SBC in Shear (t/m²)	SBC from Permissible Settlement (t/m²)	Recommended Net safe Bearing Capacity (t/m²)	Allowable Settlement (mm)
OCH-40+573 NCH-43+758	BH-CL	4.8 x 4.8	1.0	43.8	31.9	30.0	25
		4.8 X 4.8	1.5	49.2	33.1	30.0	
		4.8 X 4.8	2.0	54.7	34.5	30.0	
OCH-40+573 NCH-43+758	BH-CL	4.8 x 4.8	1.0	43.8	57.0	30.0	50
		4.8 X 4.8	1.5	49.2	62.0	30.0	
		4.8 X 4.8	2.0	54.7	68.2	30.0	

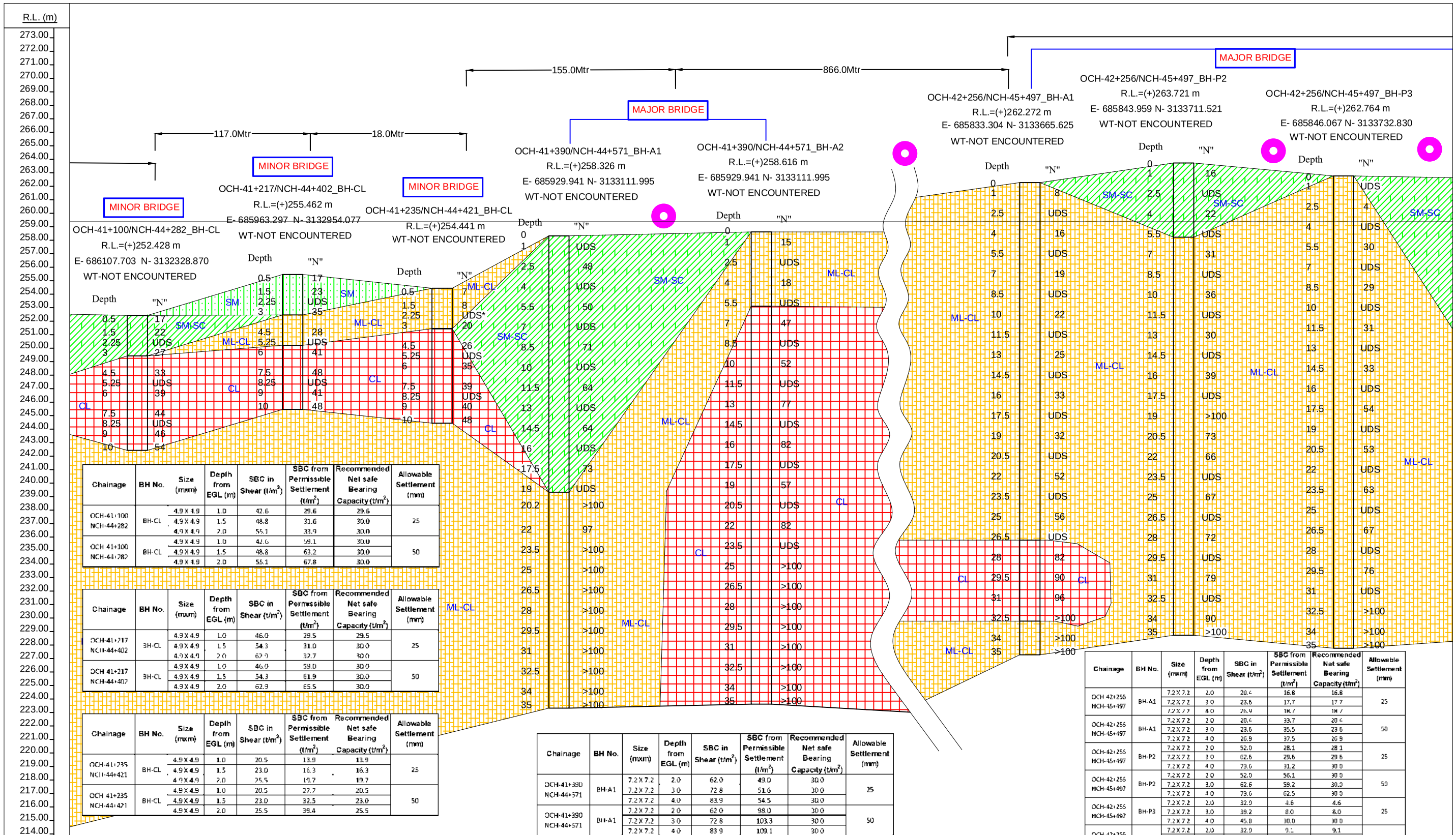
Chainage	BH No.	Size (mxm)	Depth from EGL (m)	SBC in Shear (t/m²)	SBC from Permissible Settlement (t/m²)	Recommended Net safe Bearing Capacity (t/m²)	Allowable Settlement (mm)
OCH 41+056 NCH-44+246	BH-A1	7.2 x 7.2	2.0	37.2	23.4	23.4	25
		7.2 X 7.2	3.0	43.9	24.7	24.7	
		7.2 X 7.2	4.0	50.9	26.1	26.1	
OCH-41+056 NCH-44+246	BH-A1	7.2 x 7.2	2.0	37.2	46.9	30.0	50
		7.2 X 7.2	3.0	43.9	49.4	30.0	
		7.2 X 7.2	4.0	50.9	52.2	30.0	
OCH-41+056 NCH-44+246	BH-A2	7.2 X 7.2	2.0	48.3	35.9	30.0	25
		7.2 X 7.2	3.0	57.6	37.9	30.0	
		7.2 X 7.2	4.0	67.4	40.0	30.0	
OCH 41+056 NCH-44+246	BH-A2	7.2 X 7.2	2.0	48.3	71.8	30.0	50
		7.2 X 7.2	3.0	57.6	75.7	30.0	
		7.2 X 7.2	4.0	67.4	80.0	30.0	

SYMBOL	DESCRIPTION
	SM- Silty Sand (Having fines Less Than 50% and no plasticity or below A-line)
	SM-SC -Clayey Sand (Having fines Less Than 50% and in the hatched zone (4<PI<7)
	ML-CL -Sandy with clay (Having fines greater than 50% and in the hatched zone (LL<35 & 4<PI<7)
	CL-Silty Clay of low plasticity (Above A-line, LL<35)
	CI- Clay of medium plasticity (Above A-line, 35≤LL<50)
	BOREHOLE REQUIRED / WATER TABLE

Note:- Fines= Percentage of Silty + Clay A-line=.73(wl-20)

SCALE:- HOR:- 1:2850 SCALE:- VER:- 1:285

CONDUCTING GEOTECHNICAL INVESTIGATION, PREPARATION OF GEOTECHNICAL REPORT FOR DESIGNING OF BRIDGES AND FOR EMBANKMENT IN CONNECTION WITH CONSTRUCTION OF HARYANA ORBITAL RAIL CORRIDOR (HORC) PROJECT FROM PALWAL TO HARSANA KALAN INCLUDING CONNECTIVITY TO EXISTING IR NETWORK IN THE STATE OF HARYANA.



Chainage	BH No.	Size (mxm)	Depth from EGL (m)	SBC in Shear (t/m²)	SBC from Permissible Settlement (t/m²)	Recommended Net safe Bearing Capacity (t/m²)	Allowable Settlement (mm)
OCH-41+100 NCH-44+282	BH-CL	4.9 X 4.9	1.0	42.6	29.6	29.6	25
		4.9 X 4.9	1.5	48.8	31.6	30.0	
		4.9 X 4.9	2.0	55.1	33.9	30.0	
OCH 41+100 NCH-44+282	BH-CL	4.9 X 4.9	1.0	42.6	59.1	30.0	50
		4.9 X 4.9	1.5	48.8	63.2	30.0	
		4.9 X 4.9	2.0	55.1	67.8	30.0	

Chainage	BH No.	Size (mxm)	Depth from EGL (m)	SBC in Shear (t/m²)	SBC from Permissible Settlement (t/m²)	Recommended Net safe Bearing Capacity (t/m²)	Allowable Settlement (mm)
OCH-41+217 NCH-44+402	BH-CL	4.9 X 4.9	1.0	46.0	29.5	29.5	25
		4.9 X 4.9	1.5	54.3	31.0	30.0	
		4.9 X 4.9	2.0	62.9	32.7	30.0	
OCH 41+217 NCH-44+402	BH-CL	4.9 X 4.9	1.0	46.0	59.0	30.0	50
		4.9 X 4.9	1.5	54.3	61.9	30.0	
		4.9 X 4.9	2.0	62.9	65.5	30.0	

Chainage	BH No.	Size (mxm)	Depth from EGL (m)	SBC in Shear (t/m²)	SBC from Permissible Settlement (t/m²)	Recommended Net safe Bearing Capacity (t/m²)	Allowable Settlement (mm)
OCH-41+235 NCH-44+421	BH-CL	4.9 X 4.9	1.0	20.5	13.9	13.9	25
		4.9 X 4.9	1.5	23.0	16.3	16.3	
		4.9 X 4.9	2.0	25.5	19.7	19.7	
OCH 41+235 NCH-44+421	BH-CL	4.9 X 4.9	1.0	20.5	27.7	20.5	50
		4.9 X 4.9	1.5	23.0	32.5	23.0	
		4.9 X 4.9	2.0	25.5	39.4	25.5	

Chainage	BH No.	Size (mxm)	Depth from EGL (m)	SBC in Shear (t/m²)	SBC from Permissible Settlement (t/m²)	Recommended Net safe Bearing Capacity (t/m²)	Allowable Settlement (mm)
OCH-41+390 NCH-44+571	BH-A1	7.2 X 7.2	2.0	62.0	49.0	30.0	25
		7.2 X 7.2	3.0	72.8	51.6	30.0	
		7.2 X 7.2	4.0	83.9	54.5	30.0	
OCH-41+390 NCH-44+571	BH-A1	7.2 X 7.2	2.0	62.0	98.0	30.0	50
		7.2 X 7.2	3.0	72.8	103.3	30.0	
		7.2 X 7.2	4.0	83.9	109.1	30.0	
OCH-41+390 NCH 44+571	BH-A2	7.2 X 7.2	2.0	28.9	24.5	24.5	25
		7.2 X 7.2	3.0	33.9	28.7	28.7	
		7.2 X 7.2	4.0	39.1	34.6	30.0	
OCH-41+390 NCH-44+571	BH-A2	7.2 X 7.2	2.0	28.9	49.0	28.9	50
		7.2 X 7.2	3.0	33.9	57.4	30.0	
		7.2 X 7.2	4.0	39.1	69.2	30.0	

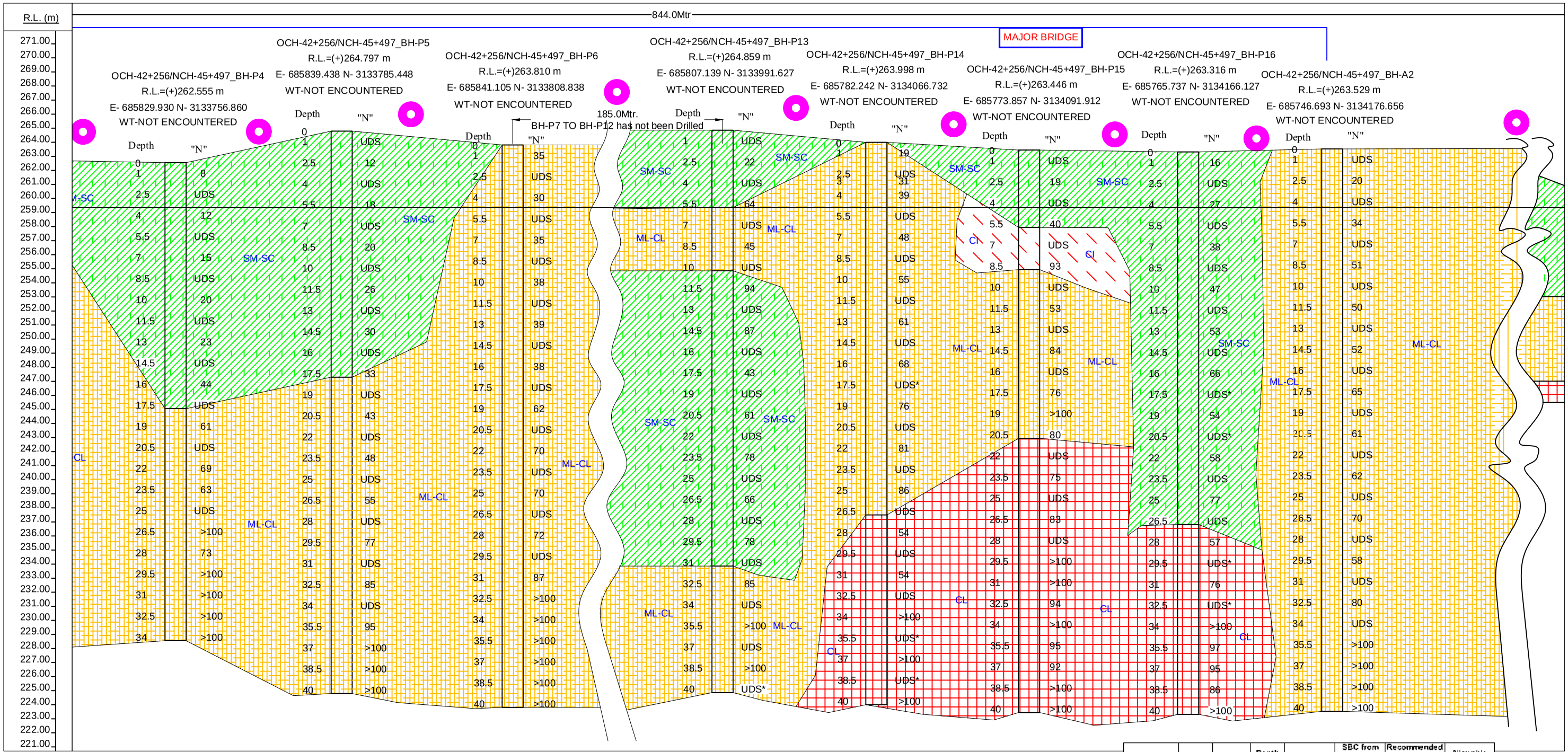
Chainage	BH No.	Size (mxm)	Depth from EGL (m)	SBC in Shear (t/m²)	SBC from Permissible Settlement (t/m²)	Recommended Net safe Bearing Capacity (t/m²)	Allowable Settlement (mm)
OCH 42+256 NCH-45+497	BH-A1	7.2 X 7.2	2.0	20.4	16.8	16.8	25
		7.2 X 7.2	3.0	23.6	17.7	17.7	
		7.2 X 7.2	4.0	26.9	18.7	18.7	
OCH-42+256 NCH-45+497	BH-A1	7.2 X 7.2	2.0	20.4	33.7	20.4	50
		7.2 X 7.2	3.0	23.6	35.5	23.6	
		7.2 X 7.2	4.0	26.9	37.5	26.9	
OCH-42+256 NCH-45+497	BH-P2	7.2 X 7.2	2.0	52.0	28.1	28.1	25
		7.2 X 7.2	3.0	62.6	29.6	29.6	
		7.2 X 7.2	4.0	73.6	31.2	30.0	
OCH-42+256 NCH-45+497	BH-P2	7.2 X 7.2	2.0	52.0	56.1	30.0	50
		7.2 X 7.2	3.0	62.6	59.2	30.0	
		7.2 X 7.2	4.0	73.6	62.5	30.0	
OCH-42+256 NCH-45+497	BH-P3	7.2 X 7.2	2.0	32.9	4.6	4.6	25
		7.2 X 7.2	3.0	39.2	8.0	8.0	
		7.2 X 7.2	4.0	45.8	30.0	30.0	
OCH-42+256 NCH-45+497	BH-P3	7.2 X 7.2	2.0	32.9	9.1	9.1	50
		7.2 X 7.2	3.0	39.2	15.9	15.9	
		7.2 X 7.2	4.0	45.8	60.0	30.0	

SYMBOL	DESCRIPTION
	SM- Silty Sand (Having fines Less Than 50% and no plasticity or below A-line)
	SM-SC -Clayey Sand (Having fines Less Than 50% and in the hatched zone (4<PI<7)
	ML-CL -Sandy with clay (Having fines greater than 50% and in the hatched zone (LL<35 & 4<PI<7)
	CL-Silty Clay of low plasticity (Above A-line, LL<35)
	CI- Clay of medium plasticity (Above A-line, 35≤LL<50)
	BOREHOLE REQUIRED / WATER TABLE

Note:- Fines= Percentage of Silty + Clay A-line=.73(wl-20)

SCALE:- HOR:- 1:2850 SCALE:- VER:- 1:285

CONDUCTING GEOTECHNICAL INVESTIGATION, PREPARATION OF GEOTECHNICAL REPORT FOR DESIGNING OF BRIDGES AND FOR EMBANKMENT IN CONNECTION WITH CONSTRUCTION OF HARYANA ORBITAL RAIL CORRIDOR (HORC) PROJECT FROM PALWAL TO HARSANA KALAN INCLUDING CONNECTIVITY TO EXISTING IR NETWORK IN THE STATE OF HARYANA.



Chainage	BH No.	Size (mxm)	Depth from EGL (m)	SBC in Shear (t/m²)	SBC from Permissible Settlement (t/m²)	Recommended Net safe Bearing Capacity (t/m²)	Allowable Settlement (mm)
OCH-42+256 NCH-45+497	BH-P4	7.2 X 7.2	2.0	25.5	12.2	12.2	25
		7.2 X 7.2	3.0	31.0	12.9	12.9	
		7.2 X 7.2	4.0	36.7	13.6	13.6	
OCH-42+256 NCH-45+497	BH-P4	7.2 X 7.2	2.0	25.5	24.5	24.5	50
		7.2 X 7.2	3.0	31.0	25.8	25.8	
		7.2 X 7.2	4.0	36.7	27.2	27.2	
OCH-42+256 NCH-45+497	BH-P5	7.2 X 7.2	2.0	37.9	15.0	15.0	25
		7.2 X 7.2	3.0	44.7	15.9	15.9	
		7.2 X 7.2	4.0	51.8	17.0	17.0	
OCH-42+256 NCH-45+497	BH-P5	7.2 X 7.2	2.0	37.9	30.1	30.0	50
		7.2 X 7.2	3.0	44.7	31.7	30.0	
		7.2 X 7.2	4.0	51.8	33.9	30.0	
OCH-42+256 NCH-45+497	BH-P6	7.2 X 7.2	2.0	64.4	30.6	30.6	25
		7.2 X 7.2	3.0	75.4	32.3	32.3	
		7.2 X 7.2	4.0	86.8	34.1	34.1	
OCH-42+256 NCH-45+497	BH-P6	7.2 X 7.2	2.0	64.4	51.2	51.2	50
		7.2 X 7.2	3.0	75.4	54.5	64.5	
		7.2 X 7.2	4.0	86.8	58.2	58.2	

Chainage	BH No.	Size (mxm)	Depth from EGL (m)	SBC in Shear (t/m²)	SBC from Permissible Settlement (t/m²)	Recommended Net safe Bearing Capacity (t/m²)	Allowable Settlement (mm)
OCH-42+256 NCH-45+497	BH-P13	7.2 X 7.2	2.0	56.2	37.4	30.0	25
		7.2 X 7.2	3.0	67.3	44.5	30.0	
		7.2 X 7.2	4.0	78.9	53.2	30.0	
OCH-42+256 NCH-45+497	BH-P13	7.2 X 7.2	2.0	56.2	74.8	30.0	50
		7.2 X 7.2	3.0	67.3	89.0	30.0	
		7.2 X 7.2	4.0	78.9	106.4	30.0	
OCH-42+256 NCH-45+497	BH-P14	7.2 X 7.2	2.0	63.2	41.0	30.0	25
		7.2 X 7.2	3.0	74.9	43.7	30.0	
		7.2 X 7.2	4.0	87.1	45.1	30.0	
OCH-42+256 NCH-45+497	BH-P14	7.2 X 7.2	2.0	63.2	82.0	30.0	50
		7.2 X 7.2	3.0	74.9	87.4	30.0	
		7.2 X 7.2	4.0	87.1	92.3	30.0	
OCH-42+256 NCH-45+497	BH-P15	7.2 X 7.2	2.0	49.4	32.9	30.0	25
		7.2 X 7.2	3.0	59.4	39.7	30.0	
		7.2 X 7.2	4.0	69.8	48.6	30.0	
OCH-42+256 NCH-45+497	BH-P15	7.2 X 7.2	2.0	49.4	65.8	30.0	50
		7.2 X 7.2	3.0	59.4	79.4	30.0	
		7.2 X 7.2	4.0	69.8	97.2	30.0	

Chainage	BH No.	Size (mxm)	Depth from EGL (m)	SBC in Shear (t/m²)	SBC from Permissible Settlement (t/m²)	Recommended Net safe Bearing Capacity (t/m²)	Allowable Settlement (mm)
OCH-42+256 NCH-45+497	BH-P16	7.2 X 7.2	2.0	54.1	31.7	30.0	25
		7.2 X 7.2	3.0	64.8	33.4	30.0	
		7.2 X 7.2	4.0	76.0	35.3	30.0	
OCH-42+256 NCH-45+497	BH-P16	7.2 X 7.2	2.0	54.1	63.4	30.0	50
		7.2 X 7.2	3.0	64.8	65.8	30.0	
		7.2 X 7.2	4.0	76.0	70.6	30.0	
OCH-42+256 NCH-45+497	BH-A2	7.2 X 7.2	2.0	70.4	19.4	19.4	25
		7.2 X 7.2	3.0	82.9	20.4	20.4	
		7.2 X 7.2	4.0	95.9	21.6	21.6	
OCH-42+256 NCH-45+497	BH-A2	7.2 X 7.2	2.0	70.4	38.8	30.0	50
		7.2 X 7.2	3.0	82.9	40.9	30.0	
		7.2 X 7.2	4.0	95.9	43.2	30.0	

SYMBOL	DESCRIPTION
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	SM-SC -Clayey Sand (Having fines Less Than 50% and in the hatched zone (4<PI<7)
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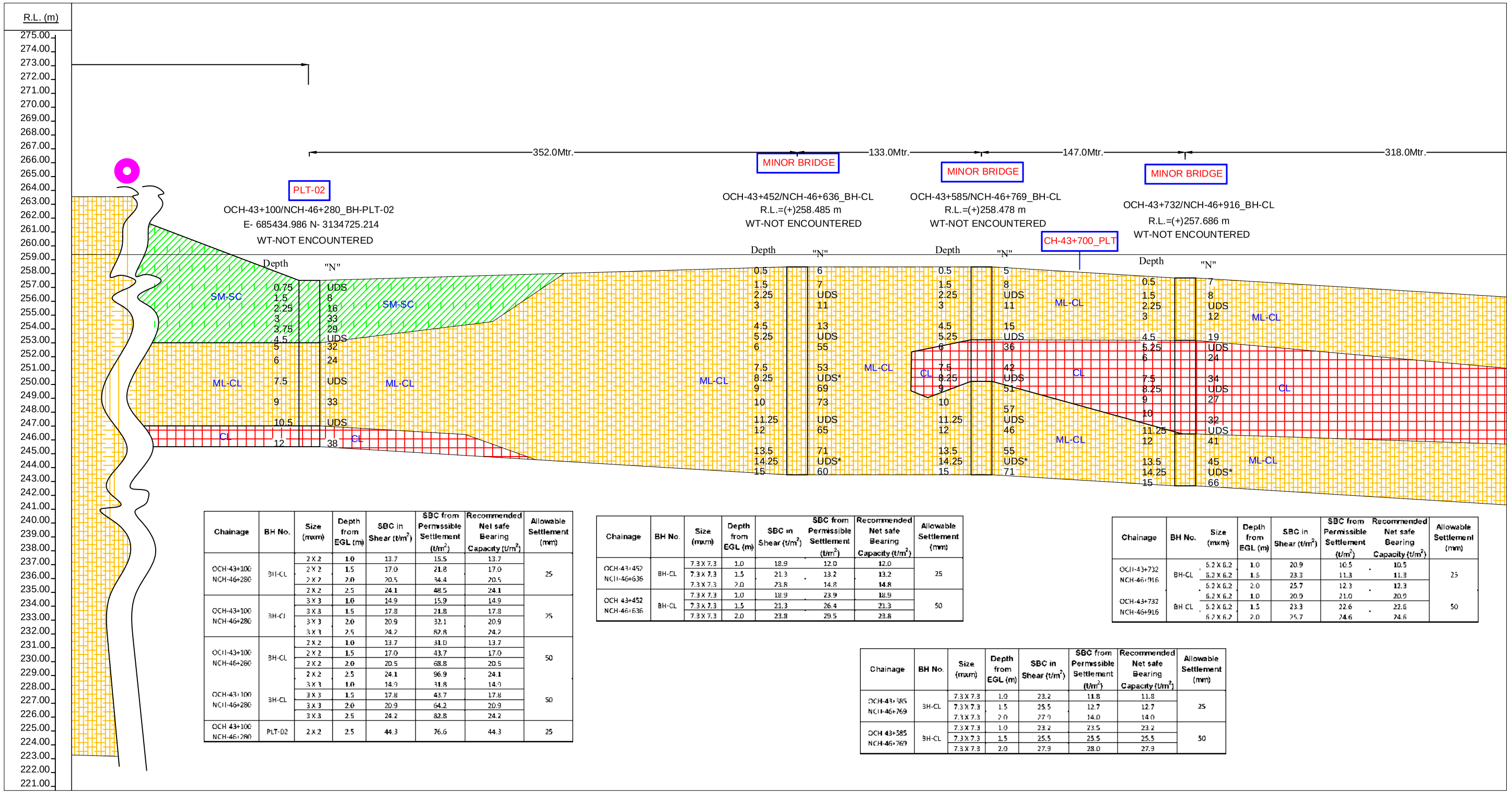
	CL-Silty Clay of low plasticity (Above A-line, LL<35)
	CI- Clay of medium plasticity (Above A-line, 35≤LL<50)
	BOREHOLE REQUIRED / WATER TABLE

Note:- Fines= Percentage of Silty + Clay A-line=.73(wl-20) SCALE:- HOR:- 1:2850 SCALE:- VER:- 1:285

CONDUCTING GEOTECHNICAL INVESTIGATION, PREPARATION OF GEOTECHNICAL REPORT FOR DESIGNING OF BRIDGES AND FOR EMBANKMENT IN CONNECTION WITH CONSTRUCTION OF HARYANA ORBITAL RAIL CORRIDOR (HORC) PROJECT FROM PALWAL TO HARSANA KALAN INCLUDING CONNECTIVITY TO EXISTING IR NETWORK IN THE STATE OF HARYANA.



Chainage	BH No.	Size (mxm)	Depth from EGL (m)	SBC in Shear (t/m²)	SBC from Permissible Settlement (t/m²)	Recommended Net safe Bearing Capacity (t/m²)	Allowable Settlement (mm)
OCH-43+100 NCH-46+280	BH-CL	2 X 2	1.0	13.7	15.5	13.7	25
		2 X 2	1.5	17.0	21.8	17.0	
		2 X 2	2.0	20.5	34.4	20.5	
		2 X 2	2.5	24.1	48.5	24.1	
OCH-43+100 NCH-46+280	BH-CL	3 X 3	1.0	14.9	15.9	14.9	25
		3 X 3	1.5	17.8	21.8	17.8	
		3 X 3	2.0	20.9	32.1	20.9	
		3 X 3	2.5	24.2	49.8	24.2	
OCH-43+100 NCH-46+280	BH-CL	2 X 2	1.0	13.7	31.0	13.7	50
		2 X 2	1.5	17.0	43.7	17.0	
		2 X 2	2.0	20.5	68.8	20.5	
		2 X 2	2.5	24.1	96.9	24.1	
OCH-43+100 NCH-46+280	BH-CL	3 X 3	1.0	14.9	31.8	14.9	50
		3 X 3	1.5	17.8	43.7	17.8	
		3 X 3	2.0	20.9	64.2	20.9	
		3 X 3	2.5	24.2	82.8	24.2	
OCH-43+100 NCH-46+280	PLT-02	2 X 2	2.5	44.3	76.6	44.3	25

Chainage	BH No.	Size (mxm)	Depth from EGL (m)	SBC in Shear (t/m²)	SBC from Permissible Settlement (t/m²)	Recommended Net safe Bearing Capacity (t/m²)	Allowable Settlement (mm)
OCH-43+452 NCH-46+636	BH-CL	7.3 X 7.3	1.0	18.9	12.0	12.0	25
		7.3 X 7.3	1.5	21.3	13.2	13.2	
		7.3 X 7.3	2.0	23.8	14.8	14.8	
OCH-43+452 NCH-46+636	BH-CL	7.3 X 7.3	1.0	18.9	23.9	18.9	50
		7.3 X 7.3	1.5	21.3	26.4	21.3	
		7.3 X 7.3	2.0	23.8	29.5	23.8	

Chainage	BH No.	Size (mxm)	Depth from EGL (m)	SBC in Shear (t/m²)	SBC from Permissible Settlement (t/m²)	Recommended Net safe Bearing Capacity (t/m²)	Allowable Settlement (mm)
OCH-43+732 NCH-46+916	BH-CL	5.2 X 6.2	1.0	20.9	10.5	10.5	25
		5.2 X 6.2	1.5	23.3	11.3	11.3	
		5.2 X 6.2	2.0	25.7	12.3	12.3	
OCH-43+732 NCH-46+916	BH CL	5.2 X 6.2	1.0	20.9	21.0	20.9	50
		5.2 X 6.2	1.5	23.3	22.6	22.6	
		5.2 X 6.2	2.0	25.7	24.6	24.6	

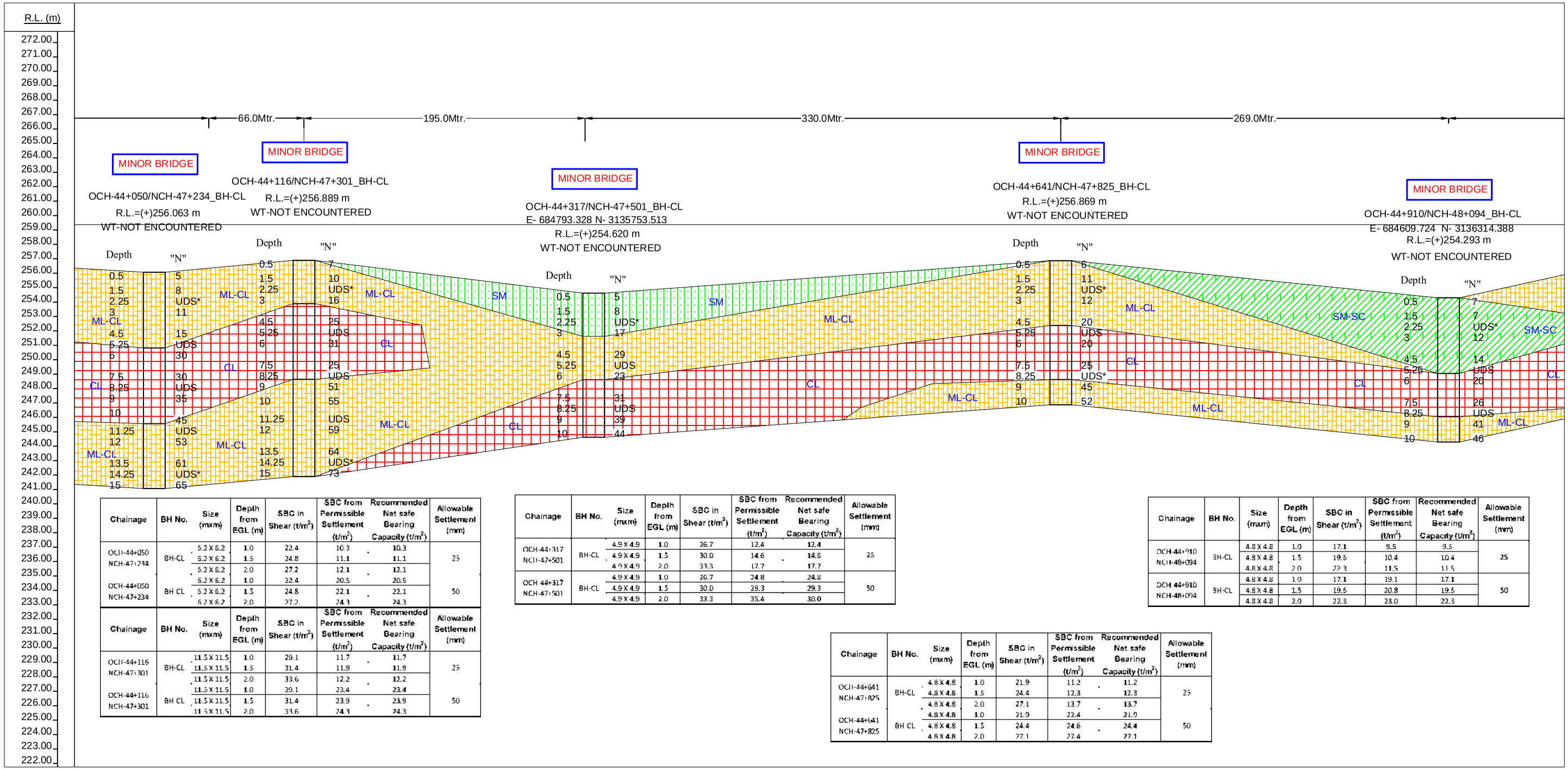
Chainage	BH No.	Size (mxm)	Depth from EGL (m)	SBC in Shear (t/m²)	SBC from Permissible Settlement (t/m²)	Recommended Net safe Bearing Capacity (t/m²)	Allowable Settlement (mm)
OCH-43+585 NCH-46+769	BH-CL	7.3 X 7.3	1.0	23.2	11.8	11.8	25
		7.3 X 7.3	1.5	25.5	12.7	12.7	
		7.3 X 7.3	2.0	27.9	14.0	14.0	
OCH 43+585 NCH-46+769	BH-CL	7.3 X 7.3	1.0	23.2	23.5	23.2	50
		7.3 X 7.3	1.5	25.5	25.5	25.5	
		7.3 X 7.3	2.0	27.9	28.0	27.9	

SYMBOL	DESCRIPTION
	SM- Silty Sand (Having fines Less Than 50% and no plasticity or below A-line)
	SM-SC -Clayey Sand (Having fines Less Than 50% and in the hatched zone (4<PI<7)
	ML-CL -Sandy with clay (Having fines greater than 50% and in the hatched zone (LL<35 & 4<PI<7)
	CL-Silty Clay of low plasticity (Above A-line, LL<35)
	CI- Clay of medium plasticity (Above A-line, 35≤LL<50)
	BOREHOLE REQUIRED / WATER TABLE

Note:- Fines= Percentage of Silty + Clay A-line=.73(wl-20)

SCALE:- HOR:- 1:2850 SCALE:- VER:- 1:285

CONDUCTING GEOTECHNICAL INVESTIGATION, PREPARATION OF GEOTECHNICAL REPORT FOR DESIGNING OF BRIDGES AND FOR EMBANKMENT IN CONNECTION WITH CONSTRUCTION OF HARYANA ORBITAL RAIL CORRIDOR (HORC) PROJECT FROM PALWAL TO HARSANA KALAN INCLUDING CONNECTIVITY TO EXISTING IR NETWORK IN THE STATE OF HARYANA.



Chainage	BH No.	Size (mxm)	Depth from EGL (m)	SBC in Shear (t/m²)	SBC from Permissible Settlement (t/m²)	Recommended Net safe Bearing Capacity (t/m²)	Allowable Settlement (mm)
OCH-44+050 NCH-47+234	BH-CL	5.2 X 6.2	1.0	22.4	10.3	10.3	25
		5.2 X 6.2	1.5	24.8	11.1	11.1	
		5.2 X 6.2	2.0	27.2	12.1	12.1	
OCH-44+050 NCH-47+234	BH CL	5.2 X 6.2	1.0	22.4	20.5	20.5	50
		5.2 X 6.2	1.5	24.8	22.1	22.1	
		5.2 X 6.2	2.0	27.2	24.3	24.3	

Chainage	BH No.	Size (mxm)	Depth from EGL (m)	SBC in Shear (t/m²)	SBC from Permissible Settlement (t/m²)	Recommended Net safe Bearing Capacity (t/m²)	Allowable Settlement (mm)
OCH-44+116 NCH-47+301	BH-CL	11.5 X 11.5	1.0	29.1	11.7	11.7	25
		11.5 X 11.5	1.5	31.4	11.9	11.9	
		11.5 X 11.5	2.0	33.6	12.2	12.2	
OCH-44+116 NCH-47+301	BH CL	11.5 X 11.5	1.0	29.1	23.4	23.4	50
		11.5 X 11.5	1.5	31.4	23.9	23.9	
		11.5 X 11.5	2.0	33.6	24.3	24.3	

Chainage	BH No.	Size (mxm)	Depth from EGL (m)	SBC in Shear (t/m²)	SBC from Permissible Settlement (t/m²)	Recommended Net safe Bearing Capacity (t/m²)	Allowable Settlement (mm)
OCH-44+317 NCH-47+501	BH-CL	4.9 X 4.9	1.0	26.7	12.4	12.4	25
		4.9 X 4.9	1.5	30.0	14.6	14.6	
		4.9 X 4.9	2.0	33.3	17.7	17.7	
OCH 44+317 NCH-47+501	BH-CL	4.9 X 4.9	1.0	26.7	24.8	24.8	50
		4.9 X 4.9	1.5	30.0	29.3	29.3	
		4.9 X 4.9	2.0	33.3	35.4	30.0	

Chainage	BH No.	Size (mxm)	Depth from EGL (m)	SBC in Shear (t/m²)	SBC from Permissible Settlement (t/m²)	Recommended Net safe Bearing Capacity (t/m²)	Allowable Settlement (mm)
OCH-44+910 NCH-48+094	BH-CL	4.8 X 4.8	1.0	17.1	9.5	9.5	25
		4.8 X 4.8	1.5	19.6	10.4	10.4	
		4.8 X 4.8	2.0	22.3	11.5	11.5	
OCH 44+910 NCH-48+094	BH-CL	4.8 X 4.8	1.0	17.1	19.1	17.1	50
		4.8 X 4.8	1.5	19.6	20.8	19.6	
		4.8 X 4.8	2.0	22.3	23.0	22.3	

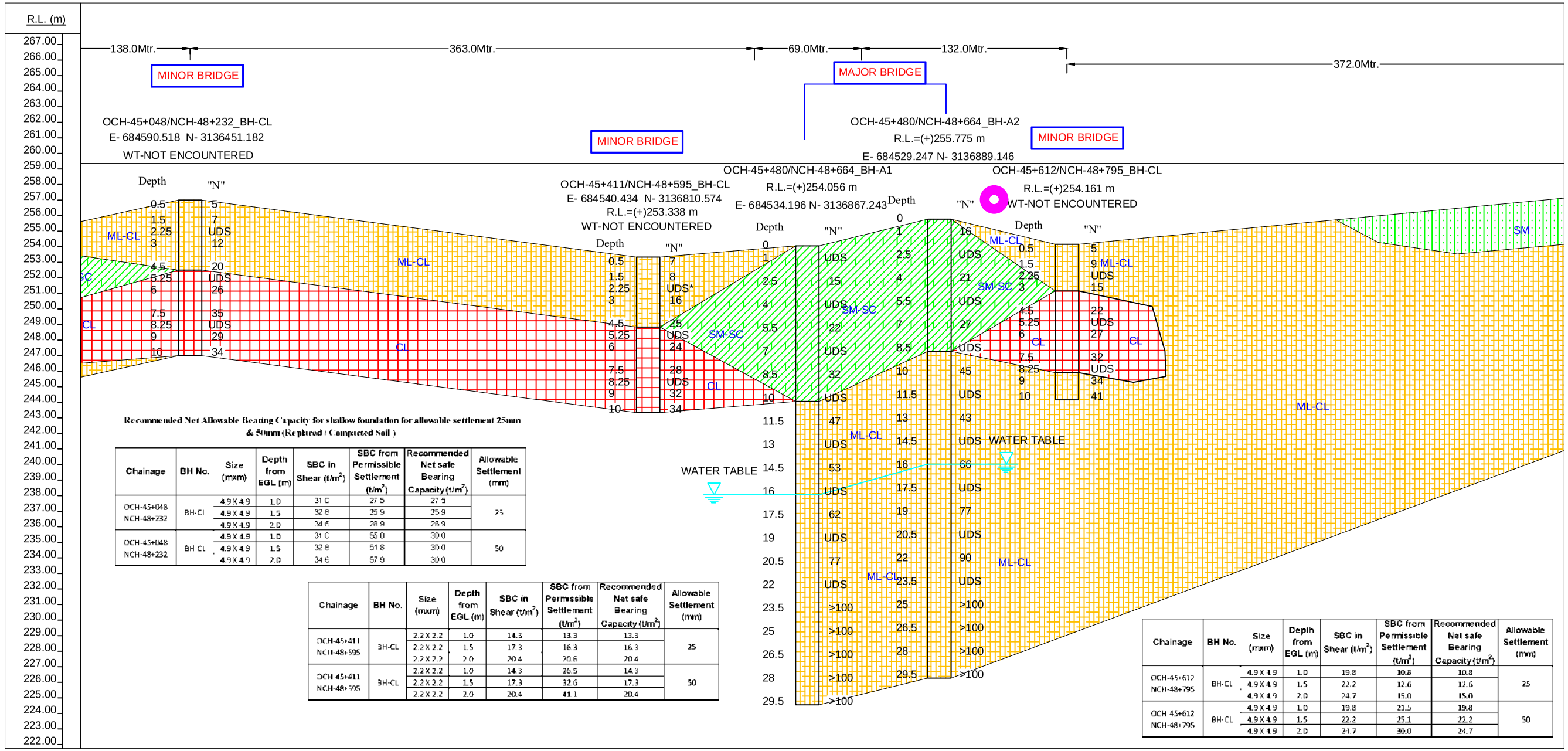
Chainage	BH No.	Size (mxm)	Depth from EGL (m)	SBC in Shear (t/m²)	SBC from Permissible Settlement (t/m²)	Recommended Net safe Bearing Capacity (t/m²)	Allowable Settlement (mm)
OCH-44+641 NCH-47+825	BH-CL	4.8 X 4.8	1.0	21.9	11.2	11.2	25
		4.8 X 4.8	1.5	24.4	12.3	12.3	
		4.8 X 4.8	2.0	27.1	13.7	13.7	
OCH-44+641 NCH-47+825	BH CL	4.8 X 4.8	1.0	21.9	22.4	21.9	50
		4.8 X 4.8	1.5	24.4	24.6	24.4	
		4.8 X 4.8	2.0	27.1	27.4	27.1	

SYMBOL	DESCRIPTION
	SM- Silty Sand (Having fines Less Than 50% and no plasticity or below A-line)
	SM-SC -Clayey Sand (Having fines Less Than 50% and in the hatched zone (4<PI<7)
	ML-CL -Sandy with clay (Having fines greater than 50% and in the hatched zone (LL<35 & 4<PI<7)
	CL-Silty Clay of low plasticity (Above A-line, LL<35)
	CI- Clay of medium plasticity (Above A-line, 35≤LL<50)
	BOREHOLE REQUIRED / WATER TABLE

Note:- Fines= Percentage of Silty + Clay A-line=.73(wl-20)

SCALE:- HOR:- 1:2850 SCALE:- VER:- 1:285

CONDUCTING GEOTECHNICAL INVESTIGATION, PREPARATION OF GEOTECHNICAL REPORT FOR DESIGNING OF BRIDGES AND FOR EMBANKMENT IN CONNECTION WITH CONSTRUCTION OF HARYANA ORBITAL RAIL CORRIDOR (HORC) PROJECT FROM PALWAL TO HARSANA KALAN INCLUDING CONNECTIVITY TO EXISTING IR NETWORK IN THE STATE OF HARYANA.



Recommended Net Allowable Bearing Capacity for shallow foundation for allowable settlement 25mm & 50mm (Replaced / Compacted Soil)

Chainage	BH No.	Size (mxm)	Depth from EGL (m)	SBC in Shear (t/m²)	SBC from Permissible Settlement (t/m²)	Recommended Net safe Bearing Capacity (t/m²)	Allowable Settlement (mm)
OCH-45+048 NCH-48+232	BH-CL	4.9 X 4.9	1.0	31.0	27.5	27.5	25
		4.9 X 4.9	1.5	32.8	25.9	25.9	
		4.9 X 4.9	2.0	34.6	28.9	28.9	
OCH-45+048 NCH-48+232	BH-CL	4.9 X 4.9	1.0	31.0	55.0	30.0	50
		4.9 X 4.9	1.5	32.8	51.8	30.0	
		4.9 X 4.9	2.0	34.6	57.9	30.0	

Chainage	BH No.	Size (mxm)	Depth from EGL (m)	SBC in Shear (t/m²)	SBC from Permissible Settlement (t/m²)	Recommended Net safe Bearing Capacity (t/m²)	Allowable Settlement (mm)
OCH-45+411 NCH-48+595	BH-CL	2.2 X 2.2	1.0	14.3	13.3	13.3	25
		2.2 X 2.2	1.5	17.3	16.3	16.3	
		2.2 X 2.2	2.0	20.4	20.6	20.4	
OCH 45+411 NCH-48+595	BH-CL	2.2 X 2.2	1.0	14.3	26.5	14.3	50
		2.2 X 2.2	1.5	17.3	32.6	17.3	
		2.2 X 2.2	2.0	20.4	41.1	20.4	

Chainage	BH No.	Size (mxm)	Depth from EGL (m)	SBC in Shear (t/m²)	SBC from Permissible Settlement (t/m²)	Recommended Net safe Bearing Capacity (t/m²)	Allowable Settlement (mm)
OCH-45+480 NCH-48+664	BH-A1	7.2 X 7.2	2.0	41.2	26.4	26.4	25
		7.2 X 7.2	3.0	49.6	27.8	27.8	
		7.2 X 7.2	4.0	58.3	29.4	29.4	
OCH-45+480 NCH-48+664	BH-A1	7.2 X 7.2	2.0	41.2	52.8	30.0	50
		7.2 X 7.2	3.0	49.5	55.7	30.0	
		7.2 X 7.2	4.0	58.3	58.8	30.0	
OCH-45+480 NCH 48+664	BH-A2	7.2 X 7.2	2.0	53.4	26.9	26.9	25
		7.2 X 7.2	3.0	64.1	28.4	28.4	
		7.2 X 7.2	4.0	75.3	30.0	30.0	
OCH-45+480 NCH-48+664	BH-A2	7.2 X 7.2	2.0	53.4	53.9	30.0	50
		7.2 X 7.2	3.0	64.1	56.8	30.0	
		7.2 X 7.2	4.0	75.3	60.0	30.0	

Chainage	BH No.	Size (mxm)	Depth from EGL (m)	SBC in Shear (t/m²)	SBC from Permissible Settlement (t/m²)	Recommended Net safe Bearing Capacity (t/m²)	Allowable Settlement (mm)
OCH-45+612 NCH-48+795	BH-CL	4.9 X 4.9	1.0	19.8	10.8	10.8	25
		4.9 X 4.9	1.5	22.2	12.6	12.6	
		4.9 X 4.9	2.0	24.7	15.0	15.0	
OCH 45+612 NCH-48+795	BH-CL	4.9 X 4.9	1.0	19.8	21.5	19.8	50
		4.9 X 4.9	1.5	22.2	25.1	22.2	
		4.9 X 4.9	2.0	24.7	30.0	24.7	

SYMBOL	DESCRIPTION
	SM- Silty Sand (Having fines Less Than 50% and no plasticity or below A-line)
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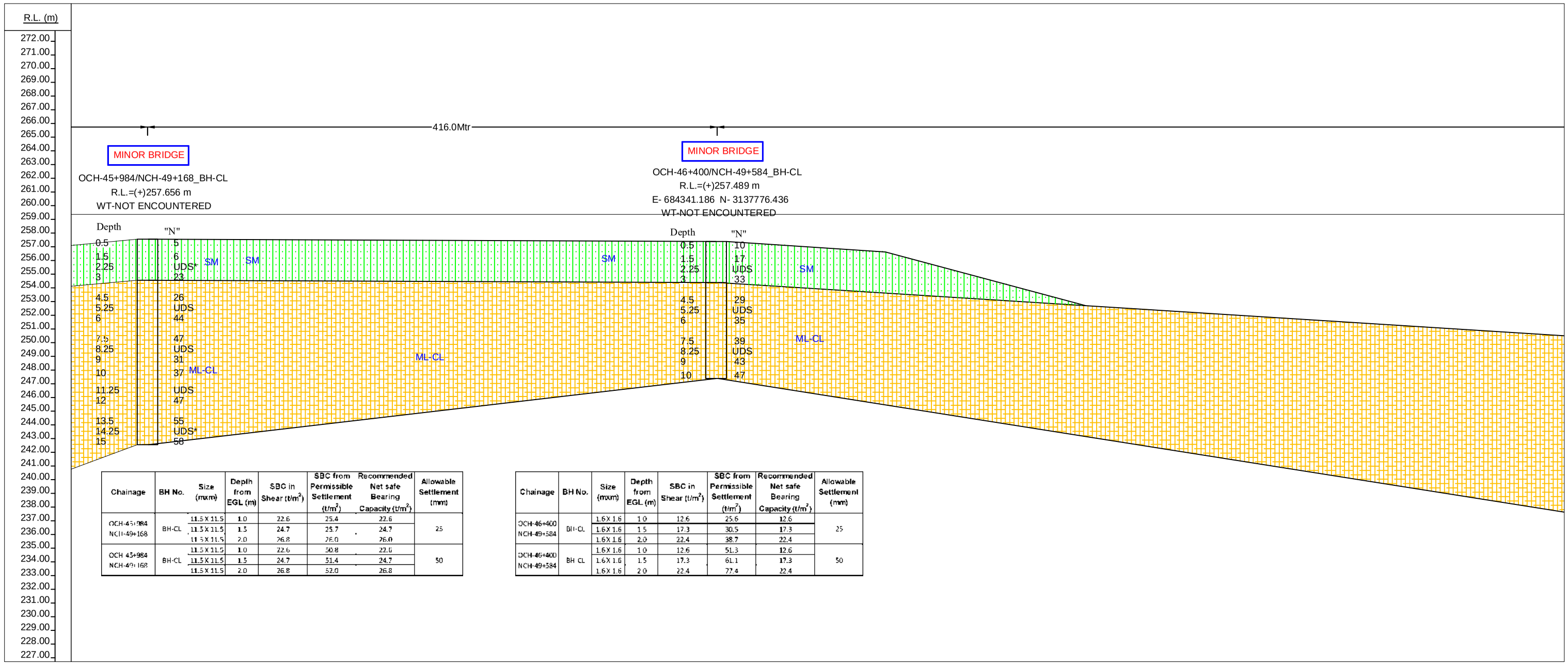
	CL-Silty Clay of low plasticity (Above A-line, LL<35)
	CI- Clay of medium plasticity (Above A-line, 35≤LL<50)
	BOREHOLE REQUIRED / WATER TABLE

Note:- Fines= Percentage of Silty + Clay A-line=.73(wl-20)

SCALE:- HOR:- 1:2850 SCALE:- VER:- 1:285

CONDUCTING GEOTECHNICAL INVESTIGATION, PREPARATION OF GEOTECHNICAL REPORT FOR DESIGNING OF BRIDGES AND FOR EMBANKMENT IN CONNECTION WITH CONSTRUCTION OF HARYANA ORBITAL RAIL CORRIDOR (HORC) PROJECT FROM PALWAL TO HARSANA KALAN INCLUDING CONNECTIVITY TO EXISTING IR NETWORK IN THE STATE OF HARYANA.



Chainage	BH No.	Size (mxm)	Depth from EGL (m)	SBC in Shear (t/m^2)	SBC from Permissible Settlement (t/m^2)	Recommended Net safe Bearing Capacity (t/m^2)	Allowable Settlement (mm)
OCH-45+984 NCH-49+168	BH-CL	11.5 X 11.5	1.0	22.6	25.4	22.6	25
		11.5 X 11.5	1.5	24.7	25.7	24.7	
		11.5 X 11.5	2.0	26.8	26.0	26.0	
OCH-45+984 NCH-49+168	BH-CL	11.5 X 11.5	1.0	22.6	50.8	22.6	50
		11.5 X 11.5	1.5	24.7	51.4	24.7	
		11.5 X 11.5	2.0	26.8	52.0	26.8	

Chainage	BH No.	Size (mxm)	Depth from EGL (m)	SBC in Shear (t/m^2)	SBC from Permissible Settlement (t/m^2)	Recommended Net safe Bearing Capacity (t/m^2)	Allowable Settlement (mm)
OCH-46+400 NCH-49+584	BH-CL	1.6X 1.6	1.0	12.6	25.6	12.6	25
		1.6X 1.6	1.5	17.3	30.5	17.3	
		1.6X 1.6	2.0	22.4	38.7	22.4	
OCH-46+400 NCH-49+584	BH CL	1.6X 1.6	1.0	12.6	51.3	12.6	50
		1.6X 1.6	1.5	17.3	61.1	17.3	
		1.6X 1.6	2.0	22.4	77.4	22.4	

SYMBOL	DESCRIPTION
	SM- Silty Sand (Having fines Less Than 50% and no plasticity or below A-line)
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	CL-Silty Clay of low plasticity (Above A-line, LL<35)
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	BOREHOLE REQUIRED / WATER TABLE

Note:- Fines= Percentage of Silty + Clay A-line=.73(wl-20)

SCALE:- HOR:- 1:2850 SCALE:- VER:- 1:285

APPENDIX – B (LAB TEST RESULTS)

Appendix No.	ITEMS
B-1	SOIL CHARACTERISTICS SHEETS
B-2	RESULT OF CHEMICAL ANALYSIS OF SOIL SAMPLES
B-3	RESULT OF CHEMICAL ANALYSIS OF WATER SAMPLES
B-4	GSD CURVES
B-5	SHEAR CURVE
B-6	CONSOLIDATION CURVE
B-7	PLT TEST CURVE

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		19-12-2021	to	19-12-2021	Dhulawat	PLT-06	8.00 m	12.45 m	693884.000 m	3124860.000 m	(+)265.960 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																			
DS	0.00	-	-	Yellowish brown, Loose, Sandy silt	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	0.75	-	-		ML-CL		7	58	32	1	0	2	0	28	22	6	-	1.65	10.90	1.49	2.66	DST	0.19	24	-	-	-	-	-	-	-	-
SPT-1	1.50	5	7		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-2	2.25	22	29	Yellowish brown, Medium dense to Very dense, Sandy silt	ML-CL		8	56	31	1	2	1	1	26	21	5	-	1.69	11.50	1.52	2.65	DST+	0.18	25	-	-	-	-	-	-	-	-
SPT-3	3.00	30	37		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-4	3.75	37	43		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	4.50	-	-		ML-CL		8	51	34	1	1	2	3	26	22	4	-	1.73	12.40	1.54	2.65	DST	0.21	26	-	-	-	-	-	-	-	-
SPT-5	6.00	49	49		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	7.50	-	-		ML-CL		9	53	32	2	1	0	3	25	21	4	-	1.75	12.80	1.55	2.65	DST	0.22	26	-	-	-	-	-	-	-	-
SPT-6	9.00	54	32		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	10.50	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-7	12.00	63	34		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEGTH
CEG TEST HOUSE
AND RESEARCH CENTRE PVT LTD

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.						Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
							03-10-2021	to	05-10-2021	29+487 Major Bridge	BH-A1	27.53 m	53.00 m	696007.240 m	3123405.825 m	(+)263.946 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Brown, Loose, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	1.00	9	14		ML-CL		6	61	29	2	1	1	0	26	20	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.50	-	-	Brown, Medium dense, Sandy silt of low plasticity	ML-CL		7	59	27	3	2	2	0	27	20	7	-	1.79	12.34	1.59	2.67	DST	0.19	25	-	-	-	-	-	-	-	-	-
SPT-2	4.00	25	28		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	5.50	-	-	Brown, Dense to very dense, Sandy silt of low plasticity with gravel	ML-CL		6	52	33	3	1	4	1	26	20	6	-	1.85	13.42	1.63	2.66	DST	0.20	27	-	-	-	-	-	-	-	-	-
SPT-3	7.00	49	45		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	8.50	-	-		ML-CL		8	51	30	4	2	5	0	28	21	7	-	1.86	14.13	1.63	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-4	10.00	57	46		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	11.50	-	-		ML-CL		7	49	31	3	2	8	0	26	19	7	-	1.87	14.96	1.63	2.65	DST	0.19	28	-	-	-	-	-	-	-	-	-
SPT-5	13.00	63	45		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-5	14.50	-	-		ML-CL		6	51	33	2	1	6	1	27	21	6	-	1.89	15.26	1.64	2.66	DST	0.23	29	-	-	-	-	-	-	-	-	-
SPT-6	16.00	82	53		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-6	17.50	-	-		ML-CL		7	46	29	5	3	9	1	27	20	7	-	1.94	16.67	1.66	2.65	DST	0.20	30	-	-	-	-	-	-	-	-	-
SPT-7	19.00	100 (23cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	20.50	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	22.00	100 (22cm)	-		ML-CL		7	50	30	3	2	6	2	26	19	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-9	23.50	100 (22cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-10	25.00	>100	-		ML-CL		8	50	27	4	3	8	0	27	20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEGTH
CEG TEST HOUSE
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SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.					Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
						03-10-2021	to	05-10-2021	29+487 Major Bridge	BH-A1	27.53 m	53.00 m	696007.240 m	3123405.825 m	(+)263.946 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
UDS*	26.50	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-11	28.00	100 (19cm)	100 (19cm)		CL		11	60	18	4	1	6	0	31	20	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	29.50	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-12	31.00	100 (21cm)	100 (21cm)		CL		10	61	16	3	2	8	0	30	20	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	32.50	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-13	34.00	>100	-		CL		12	60	14	4	3	5	2	33	22	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-14	35.50	100 (26cm)	100 (26cm)		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-15	37.00	100 (21cm)	100 (21cm)		CL		9	64	18	1	1	7	0	30	20	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	38.50	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-16	40.00	100 (24cm)	100 (24cm)	Brown, Hard, Silty clay of low plasticity with gravel	CL		10	58	17	4	2	9	0	31	20	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	41.50	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-17	43.00	100 (20cm)	100 (20cm)		CL		12	58	18	2	3	7	0	32	21	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	43.50	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-18	46.00	100 (21cm)	100 (21cm)		CL		11	59	15	5	2	6	2	31	21	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	47.50	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-19	49.00	100 (20cm)	100 (20cm)		CL		9	59	17	4	3	8	0	29	20	9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-20	50.50	100 (24cm)	100 (24cm)		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-21	52.00	>100	-		CL		10	55	20	3	2	10	0	31	20	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	52.30	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

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SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.						Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
							03-10-2021	to	06-10-2021	29+487 Major Bridge	BH-A2	27.39 m	53.00 m	695931.872 m	3123393.836 m	(+)266.542 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS-1	0.00	-	-	Brown, Medium dense, Silty sand with clay	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	1.00	-	-		SM-SC		5	34	55	3	1	2	0	25	20	5	-	1.70	11.36	1.53	2.65	DST	0.10	26	-	-	-	-	-	-	-	-	-
SPT-1	2.50	13	17		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	4.00	-	-	Brown, Very dense, Sandy silt of low plasticity with gravel	ML-CL		7	54	28	4	1	6	0	27	21	6	-	1.84	12.40	1.64	2.66	DST	0.22	27	-	-	-	-	-	-	-	-	-
SPT-2	5.50	52	52		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	7.00	-	-		ML-CL		6	49	31	5	2	5	2	26	20	6	-	1.84	12.89	1.63	2.66	DST	0.18	28	-	-	-	-	-	-	-	-	-
SPT-3	8.50	52	45		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	10.00	-	-		ML-CL		7	50	30	4	3	6	0	27	20	7	-	1.85	13.25	1.63	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-4	11.50	56	42		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-5	13.00	-	-	Brown, Very dense, Silty sand with clay & gravel	SM-SC		5	37	44	4	3	7	0	25	20	5	-	1.89	14.06	1.66	2.65	DST	0.11	32	-	-	-	-	-	-	-	-	-
SPT-5	14.50	100 (30cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-6	16.00	>100	-		SM-SC		4	37	43	5	2	8	1	26	20	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-7	17.50	100 (21cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	19.00	>100	-		SM-SC		5	37	42	3	4	9	0	26	21	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-9	20.50	>100	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-10	22.00	>100	-	Brown, Very dense, Sandy silt of low plasticity with gravel	ML-CL		6	46	34	4	4	6	0	26	20	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-11	23.50	>100	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-12	25.00	>100	-		ML-CL		8	48	29	3	2	10	0	28	21	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-13	26.50	>100	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
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CEGTH
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SOIL CHARACTERISTICS

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							03-10-2021	to	06-10-2021	29+487 Major Bridge	BH-A2	27.39 m	53.00 m	695931.872 m	3123393.836 m	(+)266.542 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																			
SPT-14	28.00	>100	-	Brown, Very dense, Sandy silt of low plasticity with gravel	ML-CL		7	53	28	2	1	7	2	27	20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-15	29.50	>100	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-16	31.00	>100	-	Brown, Hard, Silty clay of low plasticity with gravel	CL		11	59	19	1	2	8	0	32	21	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-17	32.50	100 (28cm)	100 (28cm)		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-18	34.00	100 (23cm)	100 (23cm)		CL		10	56	20	3	2	8	1	30	20	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-19	35.50	100 (25cm)	100 (25cm)		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-20	37.00	>100	-		CL		11	52	17	4	5	9	2	31	20	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-21	38.50	>100	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-22	40.00	>100	-		CL		10	53	22	3	2	10	0	31	21	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-23	41.50	>100	-	Brown, Very dense, Sandy silt of low plasticity with gravel	ML-CL		6	54	32	4	2	2	0	26	21	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-24	43.00	>100	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-25	44.50	100 (20cm)	-		ML-CL		7	52	34	5	1	1	0	27	20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-26	46.00	100 (24cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-27	47.50	100 (22cm)	100 (22cm)	Brown, Hard, Silty clay of low plasticity with gravel	CL		10	51	19	9	2	5	4	31	20	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-28	48.00	100 (24cm)	100 (24cm)		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-29	50.50	100 (27cm)	100 (27cm)		CL		11	50	20	7	4	6	2	32	21	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-30	52.00	>100	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
DS-2	52.26	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

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CEG TEST HOUSE AND RESEARCH CENTRE PVT LTD

SOIL CHARACTERISTICS

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						20-11-2021	to	20-11-2021	29+860 Minor Bridge	BH-CL	Not Encountered	10.00 m	695623.682 m	3123534.155 m	(+)263.108 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Brown, Loose to medium dense, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	0.50	9	16		ML-CL		7	45	40	6	1	1	0	26	20	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-2	1.50	12	17		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.25	-	-		ML-CL		9	55	28	6	1	1	0	28	21	7	-	1.73	13.10	1.53	2.66	DST	0.20	24	-	-	-	-	-	-	-	-	-
SPT-3	3.00	14	17		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-4	4.50	26	28	Brown, Very stiff to hard, Silty clay of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	5.25	-	-		CL		11	50	25	5	3	6	0	32	21	11	-	1.86	16.23	1.60	2.67	UUT	1.02	5	-	-	-	-	-	-	-	-	-
SPT-5	6.00	33	33		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-6	7.50	43	39	Brown, Dense to very dense, Sandy silt of low plasticity	ML-CL		6	49	35	4	2	4	0	26	20	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	8.25	-	-		ML-CL		7	45	38	6	1	3	0	27	20	7	-	1.90	16.70	1.63	2.66	DST	0.20	28	-	-	-	-	-	-	-	-	-
SPT-7	9.00	60	50		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	10.00	55	44		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEGTH
CEG TEST HOUSE
AND RESEARCH CENTRE PVT LTD

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.					Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
						21-11-2021	to	21-11-2021	30+176 Minor Bridge	BH-CL	Not Encountered	20.00 m	695330.324 m	3123643.872 m	(+)263.553 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																			
DS	0.00	-	-	Brown, Medium dense, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	0.50	10	18		ML-CL		6	45	43	3	2	1	0	26	20	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-2	1.50	13	19		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.25	-	-		ML-CL		7	46	39	5	1	2	0	27	20	7	-	1.74	12.40	1.55	2.66	DST	0.22	24	-	-	-	-	-	-	-	-
SPT-3	3.00	16	20		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-4	4.50	26	28		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	5.25	-	-		CL		11	48	30	4	2	5	0	32	21	11	-	1.87	15.26	1.62	2.68	UUT	1.36	5	-	-	-	-	-	-	-	-
SPT-5	6.00	38	38		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-6	7.50	43	43		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	8.25	-	-		CL		10	49	27	4	3	7	0	30	20	10	-	1.93	16.56	1.66	2.67	UUT	1.91	4	-	-	-	-	-	-	-	-
SPT-7	9.00	57	57		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	10.50	59	59		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	11.25	-	-		CL		12	51	23	3	2	9	0	33	22	11	-	1.98	17.85	1.68	2.67	UUT	2.30	4	-	-	-	-	-	-	-	-
SPT-9	12.00	67	67	Brown, Hard, Silty clay of low plasticity with gravel	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-10	13.50	77	77		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-5	14.25	-	-		CL		11	50	25	5	1	8	0	31	20	11	-	2.03	19.22	1.70	2.68	UUT	3.18	4	-	-	-	-	-	-	-	-
SPT-11	15.00	100 (27cm)	100 (27cm)		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-12	16.50	100 (25cm)	100 (25cm)		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	17.25	-	-		CL		12	49	22	4	3	10	0	32	21	11	-	2.04	20.04	1.70	-	-	-	-	-	-	-	-	-	-	-	-
SPT-13	18.00	100 (30cm)	100 (30cm)		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-14	19.50	100 (22cm)	100 (22cm)		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEGTH
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SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		16-10-2021	to	16-10-2021	30+478 Minor Bridge	BH-CL	Not Encountered	12.00 m	695041.409 m	3123752.008 m	(+)264.728 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Brown, Very stiff, Silty clay of low plasticity with gravel	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	1.00	-	-		CL		10	55	27	2	2	4	0	31	21	10	-	1.76	13.24	1.55	2.67	UUT	0.72	5	-	-	-	0.725	0.5-1.0 1.0-2.0 2.0-4.0 4.0-8.0	8.52 6.86 5.57 4.54	2.00 1.48 0.99 0.62	0.133
SPT-1	2.50	21	21		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	4.00	-	-	Brown, Medium dense, Sandy silt of low plasticity with gravel	ML-CL		8	48	31	5	3	5	0	28	21	7	-	1.79	13.60	1.58	2.66	DST	0.18	24	-	-	-	-	-	-	-	-	-
SPT-2	5.50	28	28		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	7.00	-	-		ML-CL		7	49	36	2	2	4	0	27	20	7	-	1.78	14.60	1.55	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-3	8.50	23	20		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	10.00	-	-		ML-CL		7	52	30	3	2	5	1	26	19	7	-	1.78	15.03	1.55	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-4	11.50	28	21		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	11.95	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEGTH
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SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		16-10-2021	to	16-10-2021	30+697 Minor Bridge	BH-CL	Not Encountered	12.00 m	694847.555 m	3123845.139 m	(+)264.094 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Brown, Loose, Silty sand	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	1.00	10	16		SM		0	33	65	1	1	0	0	-	Nil	NP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.50	-	-		SM		0	26	70	2	1	1	0	-	Nil	NP	-	1.69	11.06	1.52	2.63	DST	0.00	29	-	-	-	-	-	-	-	-	-
SPT-2	4.00	16	18	Brown, Medium dense, Silty sand	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	5.50	-	-		SM		0	21	71	2	2	4	0	-	Nil	NP	-	1.75	12.10	1.56	2.62	DST	0.00	30	-	-	-	-	-	-	-	-	-
SPT-3	7.00	29	27		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	8.50	-	-	Brown, Dense, Silty sand	SM		0	21	69	3	1	6	0	-	Nil	NP	-	1.81	12.97	1.60	2.62	DST	0.00	31	-	-	-	-	-	-	-	-	-
SPT-4	10.00	41	33		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	11.50	-	-		SM		0	16	70	4	3	5	2	-	Nil	NP	-	1.83	13.64	1.61	-	-	-	-	-	-	-	-	-	-	-	-	-
-	11.95	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEG TEST HOUSE AND RESEARCH CENTRE PVT LTD

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		17-10-2021	to	17-10-2021	31+354 Minor Bridge	BH-CL	Not Encountered	15.00 m	694378.453 m	3124304.952 m	(+)264.674 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Brown, Stiff to very stiff, Silty clay of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	1.00	10	10		CL		9	58	26	3	3	1	0	29	20	9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.50	-	-		CL		10	58	23	4	2	2	1	30	20	10	-	1.70	12.10	1.52	2.67	UUT	0.56	4	-	-	-	-	-	-	-	-	-
SPT-2	4.00	21	21		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	5.50	-	-	Brown, Hard, Silty clay of low plasticity with gravel	CL		12	59	21	4	1	3	0	33	22	11	-	1.82	12.89	1.61	2.68	UUT	1.23	5	-	-	-	-	-	-	-	-	-
SPT-3	7.00	36	36		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	8.50	-	-		CL		11	55	22	5	2	5	0	32	21	11	-	1.83	13.16	1.62	2.67	UUT	1.40	4	-	-	-	-	-	-	-	-	-
SPT-4	10.00	42	42		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	11.50	-	-		CL		10	62	20	1	1	5	1	31	21	10	-	1.87	13.74	1.64	2.68	UUT	1.69	5	-	-	-	-	-	-	-	-	-
SPT-5	13.00	51	51		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-5	14.50	-	-		CL		11	56	19	6	2	6	0	32	21	11	-	1.89	14.26	1.65	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	15.00	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEG TEST HOUSE AND RESEARCH CENTRE PVT LTD

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		17-10-2021	to	17-10-2021	32+160	BH-CL	Not Encountered	10.00 m	693822.662 m	3124884.260 m	(+)263.186 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																			
DS	0.00	-	-	Brown, Very stiff, Silty clay of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	1.00	-	-		CL		10	58	24	4	2	2	0	31	21	10	-	1.70	12.10	1.52	2.67	UUT	0.56	5	-	-	-	0.755	0.5-1.0 1.0-2.0 2.0-4.0 4.0-8.0	7.06 5.77 4.72 4.16	2.07 1.69 1.18 0.68	0.150
SPT-1	2.50	16	16		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	4.00	-	-		CL		9	53	26	6	2	4	0	29	20	9	-	1.77	13.26	1.56	2.68	UUT	0.75	4	-	-	-	-	-	-	-	-
SPT-2	5.50	22	22		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	7.00	-	-		CL		12	52	19	9	2	6	0	33	22	11	-	1.81	14.28	1.58	2.67	UUT	0.92	5	-	-	-	-	-	-	-	-
SPT-3	8.50	27	27		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	10.00	-	-		CL		11	54	20	7	3	5	0	32	21	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEGTH
CEG TEST HOUSE

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		16-11-2021	to	16-11-2021	32+487	BH-CL	Not Encountered	12.00 m	69358.448 m	3125111.207 m	(+)261.988 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Brown, Medium dense, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	0.50	12	22		ML-CL		6	47	33	12	0	2	0	26	20	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-2	1.50	20	29		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.25	-	-		ML-CL		7	48	33	8	1	3	0	27	20	7	-	1.80	12.94	1.59	2.66	DST	0.23	25	-	-	-	-	-	-	-	-	-
SPT-3	3.00	25	30		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-4	4.50	41	44	Brown, Hard, Silty clay of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	5.25	-	-		CL		11	58	18	6	2	5	0	33	22	11	-	1.88	15.20	1.63	2.68	UUT	1.46	4	-	-	-	-	-	-	-	-	-
SPT-5	6.00	42	42		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-6	7.50	47	47		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	8.25	-	-	Brown, Very dense, Silty sand with clay	SM-SC		6	29	50	9	1	5	0	26	20	6	-	1.88	15.16	1.63	2.65	DST	0.11	30	-	-	-	-	-	-	-	-	-
SPT-7	9.00	54	45		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	10.50	57	45		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	11.25	-	-		SM-SC		7	23	51	11	1	7	0	27	20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-9	12.00	63	46		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEGTH
CEG TEST HOUSE

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		16-11-2021	to	16-11-2021	30+083	BH-CL	Not Encountered	10.00 m	693503.406 m	3125192.295 m	(+)263.667 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																			
DS	0.00	-	-	Brown, Very stiff, Silty clay of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	0.50	14	14		CL		12	56	25	6	1	0	0	34	23	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-2	1.50	18	26	Brown, Medium dense, Sandy silt of low plasticity	ML-CL		8	50	30	9	2	1	0	28	21	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.25	-	-		ML-CL		7	51	33	4	3	2	0	27	20	7	-	1.78	12.46	1.58	2.66	DST	0.18	25	-	-	-	-	-	-	-	-	-
SPT-3	3.00	20	24		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-4	4.50	22	22	Brown, Very stiff to hard, Silty clay of low plasticity	CL		11	51	28	6	2	2	0	32	21	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	5.25	-	-		CL		10	53	26	6	2	3	0	31	21	10	-	1.82	15.26	1.58	2.67	UUT	0.85	6	-	-	-	-	-	-	-	-	-
SPT-5	6.00	28	28		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-6	7.50	28	28		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	8.25	-	-		CL		12	51	24	6	2	5	0	33	22	11	-	1.87	16.89	1.60	2.68	UUT	1.16	5	-	-	-	-	-	-	-	-	-
SPT-7	9.00	32	32		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	10.00	38	38		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEGTH
CEG TEST HOUSE

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		28-09-2021	to	29-09-2021	30+488 km	BH-A1	27.84 m	30.00 m	693220.478 m	3125465.069 m	(+)262.988 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																			
DS	0.00	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	1.00	9	14	Brown, Loose, Silty sand with clay	SM-SC		5	40	50	4	1	0	0	26	19	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.50	-	-		SM-SC		4	35	52	4	4	1	0	27	21	6	-	1.68	11.23	1.51	2.65	DST	0.11	26	-	-	-	-	-	-	-	-	-
SPT-2	4.00	22	25		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	5.50	-	-		CL		10	59	24	3	1	3	0	30	20	10	-	1.81	14.62	1.58	2.67	UUT	0.90	5	26.0	-	-	-	-	-	-	-	-
SPT-3	7.00	33	33		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	8.50	-	-	Brown, Very stiff to hard, Silty clay of low plasticity with gravel	CL		12	58	23	1	2	4	0	33	22	11	-	1.85	15.04	1.61	2.68	UUT	1.24	4	-	-	-	0.665	0.5-1.0 1.0-2.0 2.0-4.0 4.0-8.0	10.57 8.39 6.18 4.66	1.58 1.23 0.74 0.52	0.110
SPT-4	10.00	37	37		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	11.50	-	-		CL		11	58	20	5	2	4	0	32	21	11	-	1.87	15.40	1.62	2.67	UUT	1.36	4	22.0	-	-	-	-	-	-	-	-
SPT-5	13.00	40	40		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-5	14.50	-	-		CL		10	56	24	3	2	5	0	30	20	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-6	16.00	100 (30cm)	100 (30cm)	Brown, Very dense, Silty sand with gravel	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-7	17.50	100 (20cm)	-		SM		0	36	48	5	2	9	0	-	Nil	NP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	19.00	>100	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-9	20.50	89	50	Brown, Very dense, Sandy silt of low plasticity with gravel	ML-CL		7	46	37	2	1	7	0	26	20	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-10	22.00	99	53		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-6	23.50	-	-		ML-CL		8	47	33	4	2	6	0	27	20	7	-	1.89	15.36	1.64	2.66	DST	0.22	27	-	-	-	-	-	-	-	-	-
SPT-11	25.00	60	30		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
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SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		28-09-2021	to	29-09-2021	30+488 km	BH-A1	27.84 m	30.00 m	693220.478 m	3125465.069 m	(+)262.988 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
UDS-7	26.50	-	-	Brown, Hard, Silty clay of low plasticity with gravel	CL		11	51	26	4	2	6	0	32	21	11	-	2.03	19.28	1.70	2.67	UUT	3.11	4	-	-	-	-	-	-	-	-
SPT-12	28.00	>100	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-13	29.50	>100	-		CL		12	43	31	3	2	8	1	33	22	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
DS-2	30.00	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

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		28-09-2021	to	29-09-2021	30+488 km	BH-A2	26.98 m	30.00 m	693206.085 m	3125478.956 m	(+)262.292 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																			
DS	0.00	-	-	Brown, Medium dense, Silty sand with clay	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	1.00	-	-		SM-SC		4	31	60	2	1	2	0	26	20	6	-	1.72	11.14	1.55	2.65	DST	0.09	27	-	-	-	-	-	-	-	-	-
SPT-1	2.50	16	21		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	4.00	-	-	Brown, Very stiff to hard, Silty clay of low plasticity	CL		13	63	14	4	3	3	0	34	23	11	-	1.80	14.22	1.58	2.67	UUT	0.80	5	23.0	-	-	-	-	-	-	-	-
SPT-2	5.50	24	24		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	7.00	-	-		CL		12	63	17	3	1	4	0	33	22	11	-	1.84	15.30	1.60	2.68	UUT	1.06	4	-	-	-	-	-	-	-	-	-
SPT-3	8.50	31	31		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	10.00	-	-	Brown, Dense to very dense, Sandy silt of low plasticity with gravel	ML-CL		7	51	30	4	3	4	1	26	19	7	-	1.84	14.80	1.60	2.66	DST	0.17	26	-	-	-	-	-	-	-	-	-
SPT-4	11.50	40	87\zx		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-5	13.00	-	-		ML-CL		8	50	32	3	2	5	0	27	20	7	-	1.86	15.24	1.61	2.66	DST	0.19	27	-	-	-	-	-	-	-	-	-
SPT-5	14.50	54	37		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-6	16.00	-	-	Brown, Very dense, Silty sand with gravel	SM		0	34	54	4	2	6	0	-	Nil	NP	-	1.84	13.04	1.63	2.62	DST	0.00	31	-	-	-	-	-	-	-	-	-
SPT-6	17.50	76	47		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-7	19.00	-	-		SM		0	23	63	2	3	9	0	-	Nil	NP	-	1.88	13.80	1.65	2.63	DST	0.00	32	-	-	-	-	-	-	-	-	-
SPT-7	20.50	100 (21cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	22.00	100 (19cm)	-		SM		0	32	57	1	3	7	0	-	Nil	NP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEGTH
CEG TEST HOUSE

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		28-09-2021	to	29-09-2021	30+488 km	BH-A2	26.98 m	30.00 m	693206.085 m	3125478.956 m	(+)262.292 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																			
SPT-9	23.50	56	56	Brown, Hard, Silty clay of low plasticity with gravel	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-8	25.00	-	-		CL		12	51	22	5	2	8	0	32	21	11	-	1.95	18.10	1.65	2.68	UUT	1.98	4	27.0	-	-	0.625	0.5-1.0 1.0-2.0 2.0-4.0 4.0-8.0	8.61 7.00 5.74 4.74	1.37 1.00 0.69 0.43	0.090
SPT-10	26.50	62	62		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	28.00	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-11	28.50	>100	-		CL		10	52	25	1	2	10	0	31	20	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-12	29.50	>100	-		CL		11	52	20	4	3	9	2	32	21	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
DS-2	30.00	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

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Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		16-11-2021	to	16-11-2021	31+095	BH-CL	Not Encountered	10.00 m	692778.166 m	3125892.043 m	(+)261.355 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Brown, Stiff, Silty clay of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	0.50	8	8		CL		12	53	28	6	1	0	0	32	21	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-2	1.50	12	12		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.25	-	-		CL		11	53	26	5	3	2	0	31	21	10	-	1.69	14.16	1.48	2.67	UUT	0.37	5	-	-	-	-	-	-	-	-	-
SPT-3	3.00	18	22	Brown, Medium dense, Silty sand with clay	SM-SC		5	37	48	7	1	2	0	25	20	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-4	4.50	20	22		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	5.25	-	-		SM-SC		6	37	45	6	3	3	0	26	20	6	-	1.81	15.10	1.57	2.65	DST	0.10	27	-	-	-	-	-	-	-	-	-
SPT-5	6.00	24	24		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-6	7.50	29	29	Brown, Very stiff to hard, Silty clay of low plasticity	CL		10	50	25	8	2	5	0	31	21	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	8.25	-	-		CL		12	50	27	4	3	4	0	33	22	11	-	1.87	16.22	1.61	2.68	UUT	1.09	6	-	-	-	-	-	-	-	-	-
SPT-7	9.00	33	33		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	10.00	36	36		CL		11	50	24	9	1	5	0	32	21	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEGTH
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SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		28-09-2021	to	29-09-2021	31+714 km	BH-A1	36.55 m	40.00 m	692316.719 m	3126281.196 m	(+)260.608 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																			
DS	0.00	-	-	Brown, Medium dense, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	1.00	-	-		ML-CL		7	55	35	2	1	0	0	26	19	7	-	1.70	12.06	1.52	2.66	DST	0.20	23	-	-	-	-	-	-	-	-	-
SPT-1	2.50	11	14		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	4.00	-	-		ML-CL		6	51	30	9	3	1	0	26	20	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-2	5.50	16	16		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	7.00	-	-		ML-CL		6	54	31	5	2	2	0	27	20	7	-	1.73	13.24	1.53	2.66	DST	0.21	24	-	-	-	-	-	-	-	-	-
SPT-3	8.50	27	24		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	10.00	-	-		ML-CL		7	51	33	7	1	1	0	26	20	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-4	11.50	21	16		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-5	13.00	-	-		ML-CL		7	53	30	5	3	2	0	27	20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-5	14.50	24	17		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-6	16.00	-	-		ML-CL		8	52	32	3	2	3	0	28	21	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-6	17.50	26	16		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-7	19.00	-	-	Brown, Very dense, Sandy silt of low plasticity with gravel	ML-CL		7	53	28	4	2	6	0	26	19	7	-	1.88	15.22	1.63	2.67	DST	0.19	27	-	-	-	-	-	-	-	-	-
SPT-7	20.50	80	46		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-8	22.00	-	-		ML-CL		6	56	26	6	1	5	0	26	20	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	23.50	60	32		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-9	25.00	-	-		ML-CL		7	57	24	2	3	7	0	27	20	7	-	1.94	17.34	1.65	2.66	DST	0.18	28	-	-	-	-	-	-	-	-	-
SPT-9	26.50	100 (17cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-10	28.00	-	-		ML-CL		6	53	22	6	3	8	2	27	20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

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		28-09-2021	to	29-09-2021	31+714 km	BH-A1	36.55 m	40.00 m	692316.719 m	3126281.196 m	(+)260.608 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																			
SPT-10	29.50	100 (24cm)	-	Brown, Very dense, Sandy silt of low plasticity with gravel	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-11	31.00	100 (23cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-12	32.50	100 (20cm)	-		ML-CL		6	51	26	5	2	10	0	26	20	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-13	34.00	>100	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-14	35.50	82	38		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-11	37.00	-	-		ML-CL		7	59	20	4	3	7	0	28	21	7	-	1.92	20.11	1.60	2.66	DST	0.20	27	-	-	-	-	-	-	-	-
SPT-15	38.50	81	26		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-16	40.00	88	28		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

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		28-09-2021	to	29-09-2021	31+714 km	BH-A2	36.33 m	40.00 m	692289.084 m	3126299.382 m	(+)261.768 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																			
DS	0.00	-	-	Brown, Loose to medium dense, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	1.00	8	13		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.50	-	-		ML-CL		6	62	24	5	2	1	0	27	20	7	-	1.71	12.30	1.52	2.65	DST	0.22	23	-	-	-	-	-	-	-	-	-
SPT-2	4.00	16	18		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	5.50	-	-		ML-CL		7	59	25	4	3	1	1	26	20	6	-	1.76	13.60	1.55	2.66	DST	0.19	24	-	-	-	-	-	-	-	-	-
SPT-3	7.00	21	20		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	8.50	-	-		ML-CL		7	58	28	2	2	3	0	26	19	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-4	10.00	25	20		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	11.50	-	-	Brown, Very dense, Sandy silt of low plasticity with gravel	ML-CL		8	55	24	5	2	6	0	28	21	7	-	1.84	14.13	1.61	2.67	DST	0.18	27	-	-	-	-	-	-	-	-	-
SPT-5	13.00	100 (23cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-5	14.50	-	-		ML-CL		6	61	23	2	2	5	1	26	20	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-6	16.00	55	36		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-6	17.50	-	-		ML-CL		7	56	22	4	3	8	0	26	19	7	-	1.89	15.18	1.64	2.66	DST	0.22	27	-	-	-	-	-	-	-	-	-
SPT-7	19.00	80	47		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-7	20.50	-	-		ML-CL		8	58	20	5	3	4	2	28	21	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	22.00	100 (21cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-8	23.50	-	-		ML-CL		7	55	23	3	1	11	0	27	20	7	-	1.93	16.37	1.66	2.66	DST	0.20	28	-	-	-	-	-	-	-	-	-
SPT-9	25.00	100 (27cm)	-			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-9	26.50	-	-		ML-CL		6	58	20	4	2	10	0	26	20	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-10	28.00	75	35		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEGTH
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SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		28-09-2021	to	29-09-2021	31+714 km	BH-A2	36.33 m	40.00 m	692289.084 m	3126299.382 m	(+)261.768 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
UDS-10	29.50	-	-	Brown, Very dense, Sandy silt of low plasticity with gravel	ML-CL		6	55	26	3	1	9	0	26	20	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-11	31.00	100 (22cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-12	32.50	100 (20cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-13	34.00	>100	-		ML-CL		7	50	28	3	2	8	2	27	20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-14	35.50	100 (20cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-15	37.00	77	25		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-11	38.50	-	-		ML-CL		7	49	29	5	1	9	0	26	19	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-16	40.00	90	28		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

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SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.						Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
							30-09-2021	to	30-09-2021	32+191	BH-CL	Not Encountered	10.00 m	691893.138 m	3126530.493 m	(+)262.443 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																			
DS	0.00	-	-	Brown, Medium dense, Silty sand	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	1.00	-	-		SM		0	37	58	5	0	0	0	-	Nil	NP	-	1.76	11.23	1.58	2.63	DST	0.00	29	-	-	-	-	-	-	-	-
SPT-1	2.50	20	26		SM		0	41	56	2	1	0	0	-	Nil	NP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	4.00	-	-	Brown, Medium dense to dense, Sandy silt of low plasticity with gravel	ML-CL		6	56	30	3	1	4	0	26	20	6	-	1.80	12.70	1.60	2.66	DST	0.22	26	-	-	-	-	-	-	-	-
SPT-2	5.50	33	33		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	7.00	-	-		ML-CL		7	52	28	5	3	5	0	26	19	7	-	1.85	13.46	1.63	2.66	DST	0.20	27	-	-	-	-	-	-	-	-
SPT-3	8.50	53	45		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	10.00	-	-		ML-CL		7	54	27	4	2	6	0	27	20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

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SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.					Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
						29-09-2021	to	29-09-2021	32+738 km	BH-CL	Not encountered	10.00 m	691418.519 m	3126801.350 m	(+)260.749 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Brown, Medium dense, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	1.00	10	16		ML-CL		7	53	35	4	1	0	0	27	20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.50	-	-		ML-CL		6	57	32	3	1	1	0	26	20	6	-	1.71	12.30	1.52	2.66	DST	0.19	23	-	-	-	-	-	-	-	-	-
SPT-2	4.00	20	23		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	5.50	-	-		ML-CL		6	52	33	5	2	2	0	26	20	6	-	1.76	13.14	1.56	2.66	DST	0.21	24	-	-	-	-	-	-	-	-	-
SPT-3	7.00	33	33	Brown, Hard, Silty clay of low plasticity with gravel	CL		11	58	24	2	1	4	0	31	20	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	8.50	-	-		CL		12	55	22	3	2	6	0	32	21	11	-	1.86	15.26	1.61	2.68	UUT	1.16	5	-	-	-	0.665	0.5-1.0 1.0-2.0 2.0-4.0 4.0-8.0	10.03 8.41 6.75 5.46	1.70 1.16 0.87 0.50	0.106	
SPT-4	10.00	54	54		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEG TEST HOUSE

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.						Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
							28-09-2021	to	29-09-2021	33+713 km	BH-A1	28.98 m	30.00 m	690578.397 m	3127280.622 m	(+)257.231 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																			
DS	0.00	-	-	Brown, Medium dense, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	1.00	22	35		ML-CL		7	50	36	4	1	1	1	27	20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.50	-	-		ML-CL		6	50	37	3	2	2	0	27	21	6	-	1.80	12.60	1.60	2.66	DST	0.21	26	-	-	-	-	-	-	-	-	-
SPT-2	4.00	26	29		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	5.50	-	-	Brown, Hard, Silty clay of low plasticity with gravel	CL		11	57	18	6	2	6	0	32	21	11	-	1.93	14.23	1.69	2.68	UUT	2.54	4	-	-	-	-	-	-	-	-	-
SPT-3	7.00	82	82		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	8.50	-	-	Brown, Dense, Sandy silt of low plasticity with gravel	ML-CL		8	56	29	3	1	3	0	28	21	7	-	1.82	13.74	1.60	2.66	DST	0.20	26	-	-	-	-	-	-	-	-	-
SPT-4	10.00	36	29		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	11.50	-	-	Brown, Very dense, Sandy silt of low plasticity with gravel	ML-CL		6	47	32	3	1	11	0	26	20	6	-	1.90	14.59	1.66	2.65	DST	0.21	27	-	-	-	-	-	-	-	-	-
SPT-5	13.00	87	61		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-5	14.50	-	-		ML-CL		7	47	33	4	2	7	0	27	20	7	-	1.94	15.44	1.68	2.66	DST	0.19	28	-	-	-	-	-	-	-	-	-
SPT-6	16.00	100 (17cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-7	17.50	>100	-		ML-CL		7	50	30	3	1	9	0	26	19	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	19.00	>100	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-9	20.50	100 (18cm)	100 (18cm)	Brown, Hard, Silty clay of low plasticity with gravel	CL		11	56	17	4	1	11	0	32	21	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-10	22.00	100 (22cm)	100 (22cm)		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-11	23.50	100 (20cm)	100 (20cm)		CL		12	52	20	5	3	8	0	33	22	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-12	25.00	>100	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-13	26.50	100 (28cm)	100 (28cm)		CL		11	58	16	3	1	9	2	32	21	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEGTH
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SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		28-09-2021	to	29-09-2021	33+713 km	BH-A1	28.98 m	30.00 m	690578.397 m	3127280.622 m	(+)257.231 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
SPT-14	28.00	>100	-	Brown, Hard, Silty clay of low plasticity with gravel	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-15	29.50	90	90		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
DS-2	30.00	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	#DIV/0!	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

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						28-09-2021	to	29-09-2021	33+713 km	BH-A2	29.52 m	30.00 m	690560.289 m	3127290.956 m	(+)257.830 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Brown, Medium dense, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	1.00	-	-		ML-CL		6	56	28	5	3	2	0	26	20	6	-	1.77	12.13	1.58	2.66	DST	0.20	25	-	-	-	-	-	-	-	-	-
SPT-1	2.50	22	28		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	4.00	-	-		ML-CL		7	64	17	6	3	2	1	27	20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-2	5.50	26	26		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	7.00	-	-	Brown, Hard, Silty clay of low plasticity with gravel	CL		11	61	15	4	2	7	0	32	21	11	-	1.94	14.16	1.70	2.67	UUT	3.04	4	-	-	-	-	-	-	-	-	-
SPT-3	8.50	98	98		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	10.00	-	-		CL		12	58	18	3	3	6	0	33	22	11	-	1.91	15.04	1.66	2.68	UUT	1.89	5	-	-	-	0.615	0.5-1.0 1.0-2.0 2.0-4.0 4.0-8.0	10.66 8.50 6.28 5.15	1.37 0.94 0.70 0.42	0.086
SPT-4	11.50	58	58		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-5	13.00	-	-	Brown, Very dense, Sandy silt of low plasticity with gravel	ML-CL		8	50	25	5	2	8	2	28	21	7	-	1.93	14.26	1.69	2.66	DST	0.20	28	-	-	-	-	-	-	-	-	-
SPT-5	14.50	100 (23cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-6	16.00	100 (27cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-7	17.50	100 (20cm)	-		ML-CL		7	45	30	6	3	9	0	27	20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	19.00	>100	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-9	20.50	>100	-	Brown, Hard, Silty clay of low plasticity with gravel	CL		11	51	26	2	1	7	2	31	21	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-10	22.00	98	98		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-11	23.50	100 (27cm)	100 (27cm)		CL		10	52	24	3	2	8	1	30	20	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-12	25.00	100 (28cm)	100 (28cm)				-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-13	26.50	100 (24cm)	100 (24cm)		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

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SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		28-09-2021	to	29-09-2021	33+713 km	BH-A2	29.52 m	30.00 m	690560.289 m	3127290.956 m	(+)257.830 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
SPT-14	28.00	100 (25cm)	100 (25cm)	Brown, Hard, Silty clay of low plasticity with gravel	CL		12	51	21	4	2	10	0	32	21	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-15	29.50	100 (24cm)	100 (24cm)		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
DS-2	30.00	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

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Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Brown, Medium dense, Silty sand with clay	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	1.00	11	17		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.50	-	-		SM-SC		4	44	50	1	1	0	0	25	20	5	-	1.72	12.30	1.53	2.65	DST	0.11	26	-	-	-	-	-	-	-	-
SPT-2	4.00	53	60	Brown, Very dense, Silty sand with clay	SM-SC		5	38	41	5	3	8	0	26	20	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	5.50	-	-	Brown, Hard, Silty clay of low plasticity with gravel	CL		11	58	23	2	1	5	0	32	21	11	-	1.86	15.41	1.61	2.67	UUT	1.14	5	-	-	-	0.655	0.5-1.0 1.0-2.0 2.0-4.0 4.0-8.0	8.50 7.55 6.12 5.42	1.84 1.18 0.78 0.51	0.106
SPT-3	7.00	34	34		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	8.50	-	-		CL		10	57	28	1	0	4	0	31	20	11	-	1.87	16.02	1.61	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-4	10.00	43	35	Brown, Dense, Sandy silt of low plasticity with gravel	ML-CL		6	53	33	2	1	5	0	26	20	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

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						29-09-2021	to	29-09-2021	34+619 km	BH-CL	Not encountered	10.00 m	689829.431 m	3127806.228 m	(+)256.661 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Brown, Medium dense, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	1.00	10	16		ML-CL		7	64	23	4	1	1	0	27	20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.50	-	-		ML-CL		6	65	24	2	1	2	0	26	20	6	-	1.71	12.26	1.52	2.66	DST	0.23	23	-	-	-	-	-	-	-	-	-
SPT-2	4.00	31	35	Brown, Dense, Silty sand with clay	SM-SC		5	38	49	3	2	3	0	25	19	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	5.50	-	-		SM-SC		5	33	55	2	1	4	0	25	20	5	-	1.82	13.68	1.60	2.65	DST	0.09	29	-	-	-	-	-	-	-	-	-
SPT-3	7.00	35	33		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	8.50	-	-	Brown, Very dense, Sandy silt of low plasticity	ML-CL		7	56	32	2	1	2	0	27	20	7	-	1.86	14.77	1.62	2.66	DST	0.20	26	-	-	-	-	-	-	-	-	-
SPT-4	10.00	50	40		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

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		27-09-2021	to	30-09-2021	35+273 km	BH-A1	24.92 m	30.00 m	689320.433 m	3128197.938 m	(+)257.980 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Brown, Loose, Silty sand with clay	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	1.00	9	14		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.50	-	-		SM-SC		4	44	49	3	0	0	0	26	20	6	-	1.68	11.68	1.50	2.65	DST	0.09	26	-	-	-	-	-	-	-	-	-
SPT-2	4.00	10	11		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	5.50	-	-		SM-SC		3	45	51	1	0	0	0	25	20	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-3	7.00	29	28	Brown, Very stiff, Silty clay of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	8.50	-	-		CL		11	63	23	1	1	1	0	31	20	11	-	1.81	14.71	1.58	2.68	UUT	0.85	5	-	-	-	0.695	0.5-1.0 1.0-2.0 2.0-4.0 4.0-8.0	9.46 7.56 5.60 3.94	1.91 1.45 0.95 0.59	0.126
SPT-4	10.00	21	21		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	11.50	-	-		CL		10	63	22	2	1	1	1	31	20	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-5	13.00	27	27		CL		12	61	21	3	1	2	0	32	21	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-5	14.50	-	-	Brown, Hard, Silty clay of low plasticity with gravel	CL		12	61	16	2	2	7	0	33	22	11	-	1.92	16.48	1.65	2.67	UUT	1.84	4	-	-	-	-	-	-	-	-	-
SPT-6	15.00	54	54		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-7	16.00	59	59		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-6	17.50	-	-		CL		12	54	24	3	1	4	2	32	21	11	-	1.96	17.22	1.67	2.68	UUT	2.09	4	-	-	-	-	-	-	-	-	-
SPT-8	19.00	65	65		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-7	20.50	-	-		CL		10	62	16	3	1	8	0	31	21	10	-	2.01	18.66	1.69	2.68	UUT	2.57	4	-	-	-	-	-	-	-	-	-
SPT-9	21.00	73	73		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-10	22.00	71	71		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-11	23.50	82	82		CL		11	52	19	5	3	10	0	32	21	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

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		27-09-2021	to	30-09-2021	35+273 km	BH-A1	24.92 m	30.00 m	689320.433 m	3128197.938 m	(+)257.980 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction ($\varphi°$)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
SPT-12	25.00	84	84	Brown, Hard, Silty clay of low plasticity with gravel	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-13	26.50	88	88		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-14	28.00	100 (27cm)	100 (27cm)		CL		10	55	20	3	4	8	0	30	20	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-15	30.00	47 (26cm)	47 (26cm)		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

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						27-09-2021	to	28-09-2021	35+273 km	BH-A2	24.36 m	30.00 m	689304.586 m	3128210.139 m	(+)215.188 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ °)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Brown, Medium dense, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	1.00	-	-		ML-CL		7	58	28	5	2	0	0	27	20	7	-	1.70	13.04	1.50	2.66	DST	0.21	23	-	-	-	-	-	-	-	-	-
SPT-1	2.50	10	13		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	4.00	-	-		ML-CL		6	54	30	6	2	1	1	27	21	6	-	1.76	13.71	1.55	2.66	DST	0.20	24	-	-	-	-	-	-	-	-	-
SPT-2	5.50	19	19		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	7.00	-	-		ML-CL		6	54	26	8	4	2	0	26	20	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-3	8.50	23	20		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	10.00	-	-	Brown, Hard, Silty clay of low plasticity with gravel	CL		10	53	24	3	4	6	0	31	20	11	-	1.91	16.22	1.64	2.68	UUT	1.65	5	-	-	-	0.635	0.5-1.0 1.0-2.0 2.0-4.0 4.0-8.0	7.14 5.44 4.55 3.82	1.36 0.99 0.69 0.46	0.096
SPT-4	11.50	49	49		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-5	13.00	-	-		CL		11	56	20	4	3	5	1	31	20	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-5	14.50	46	46		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-6	16.00	-	-		CL		10	53	22	5	2	8	0	30	20	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-6	17.50	53	53		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-7	19.00	-	-	Brown, Hard, Silty clay of low plasticity with gravel	CL		9	61	14	5	2	9	0	30	20	10	-	2.02	18.68	1.70	2.68	UUT	2.72	4	-	-	-	-	-	-	-	-	-
SPT-7	20.50	80	80		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	22.00	84	84		CL		11	56	19	3	4	7	0	31	20	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-9	23.50	90	90		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-10	25.00	83	83		CL		10	52	21	4	2	10	1	30	20	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-11	26.50	95	95		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-12	28.00	100 (25cm)	100 (25cm)		CL		12	57	16	3	1	11	0	33	22	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEGTH
CEG TEST HOUSE

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		27-09-2021	to	28-09-2021	35+273 km	BH-A2	24.36 m	30.00 m	689304.586 m	3128210.139 m	(+)215.188 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction ($\varphi°$)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
SPT-13	29.50	>100	-	Brown, Hard, Silty clay of low plasticity with gravel	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
DS-2	30.00	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

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DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

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		17-11-2021	to	17-11-2021	36+367	BH-CL	Not Encountered	10.00 m	688442.635 m	3128873.981 m	(+)255.925 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Brown, Medium dense, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	0.50	13	24		ML-CL		7	47	38	6	1	1	0	26	19	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-2	1.50	15	22		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.25	-	-		ML-CL		8	51	33	4	2	2	0	27	20	7	-	1.76	12.61	1.56	2.66	DST	0.21	24	-	-	-	-	-	-	-	-	-
SPT-3	3.00	17	21		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-4	4.50	21	21	Brown, Very stiff, Silty clay of low plasticity	CL		10	52	28	5	2	3	0	31	21	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	5.25	-	-		CL		11	49	27	7	3	3	0	32	21	11	-	1.81	14.26	1.58	2.68	UUT	0.85	5	-	-	-	-	-	-	-	-	-
SPT-5	6.00	27	27		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-6	7.50	27	27		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	8.25	-	-		CL		12	50	26	6	2	4	0	33	22	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-7	9.00	22	22		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	10.00	26	26		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEGTH
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SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.					Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
						27-09-2021	to	28-09-2021	36+816 km	BH-A1	23.89 m	30.00 m	688102.237 m	3129148.530 m	(+)253.133 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																			
DS	0.00	-	-	Brown, Loose to medium dense, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	1.00	5	8		ML-CL		6	59	29	2	3	1	0	26	20	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.50	-	-		ML-CL		7	51	31	7	3	1	0	27	20	7	-	1.66	12.30	1.48	2.66	DST	0.21	22	-	-	-	-	-	-	-	-	-
SPT-2	4.00	11	13		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	5.50	-	-	Brown, Hard, Silty clay of low plasticity with gravel	CL		10	60	23	3	1	3	0	30	20	10	-	1.85	14.26	1.62	2.68	UUT	1.35	4	-	-	-	-	-	-	-	-	-
SPT-3	7.00	38	38		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	8.50	-	-		CL		12	64	16	2	2	4	0	33	22	11	-	1.86	14.89	1.62	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-4	10.00	44	44		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	11.50	-	-		CL		10	54	24	6	2	3	1	31	20	11	-	1.86	15.43	1.61	2.67	UUT	1.16	4	-	-	-	0.655	0.5-1.0 1.0-2.0 2.0-4.0 4.0-8.0	8.61 7.65 6.21 5.07	1.58 1.23 0.71 0.52	0.110
SPT-5	13.00	32	32		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-5	14.50	-	-		CL		11	60	18	6	2	3	0	32	21	11	-	1.87	16.11	1.61	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-6	16.00	36	36		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-6	17.50	-	-	Brown, Very dense, Sandy silt of low plasticity with	ML-CL		7	49	31	4	3	6	0	27	20	7	-	1.90	15.60	1.64	2.66	DST	0.22	27	-	-	-	-	-	-	-	-	-
SPT-7	19.00	80	47		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	20.50	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	21.00	98	54		ML-CL		8	46	29	8	1	8	0	28	21	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-9	22.00	100 (25cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

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		27-09-2021	to	28-09-2021	36+816 km	BH-A1	23.89 m	30.00 m	688102.237 m	3129148.530 m	(+)253.133 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
SPT-10	23.50	69	69	Brown, Hard, Silty clay of low plasticity with gravel	CL		12	59	17	4	2	6	0	33	22	11	-	2.01	20.50	1.67	2.68	UUT+	2.24	4	-	-	-	-	-	-	-	-	-
SPT-11	25.00	74	74		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-7	26.50	-	-		CL		11	63	16	4	3	3	0	31	20	11	-	2.00	23.36	1.62	2.67	UUT	1.30	5	-	-	-	-	-	-	-	-	-
SPT-12	28.00	36	36		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	29.50	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-13	30.00	42	42		CL		11	58	20	5	2	4	0	31	21	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

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		27-09-2021	to	28-09-2021	36+816 km	BH-A2	23.16 m	30.00 m	688087.580 m	3129162.136 m	(+)253.255 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Brown, Medium dense, Silty sand with clay	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	1.00	-	-		SM-SC		5	44	44	4	2	1	0	26	20	6	-	1.70	11.79	1.52	2.65	DST	0.10	26	-	-	-	-	-	-	-	-	-
SPT-1	2.50	12	15		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	4.00	-	-		SM-SC		4	40	51	2	1	2	0	25	20	5	-	1.78	12.67	1.58	2.65	DST	0.12	27	-	-	-	-	-	-	-	-	-
SPT-2	5.50	25	25		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	7.00	-	-	Brown, Dense, Sandy silt of low plasticity with gravel	ML-CL		6	55	33	4	2	0	0	26	20	6	-	1.84	13.88	1.62	2.66	DST	0.23	26	-	-	-	-	-	-	-	-	-
SPT-3	8.50	44	38		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	10.00	-	-	Brown, Hard, Silty clay of low plasticity with gravel	CL		11	61	16	5	2	5	0	31	20	11	-	1.89	15.10	1.64	2.68	UUT	1.68	5	-	-	-	-	-	-	-	-	-
SPT-4	11.50	51	51		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-5	13.00	-	-		CL		10	56	21	4	3	6	0	30	20	10	-	1.91	16.22	1.64	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-5	14.50	56	56		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-6	16.00	-	-	Brown, Very dense, Sandy silt of low plasticity with	ML-CL		7	54	26	4	3	6	0	27	20	7	-	1.86	14.80	1.62	2.66	DST	0.21	26	-	-	-	-	-	-	-	-	-
SPT-6	17.50	64	39		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	19.00	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-7	19.50	100 (21cm)	-		ML-CL		6	55	23	6	2	8	0	26	20	6	-	1.91	16.00	1.65	2.66	DST+	0.20	27	-	-	-	-	-	-	-	-	-
SPT-8	20.50	100 (25cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-9	22.00	100 (26cm)	-		ML-CL		8	49	27	5	4	6	1	28	21	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEGTH
CEG TEST HOUSE
AND RESEARCH CENTRE PVT LTD

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		27-09-2021	to	28-09-2021	36+816 km	BH-A2	23.16 m	30.00 m	688087.580 m	3129162.136 m	(+)253.255 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
SPT-10	23.50	67	67	Brown, Hard, Silty clay of low plasticity with gravel	CL		13	58	18	4	1	5	1	34	23	11	-	2.01	22.00	1.65	2.68	UUT+	1.88	4	-	-	-	-	-	-	-	-
UDS*	25.00	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-11	25.50	53	53		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-12	26.50	58	58		CL		11	56	22	3	2	6	0	31	21	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-13	28.00	53	53		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-14	29.50	46	46		CL		12	58	17	4	3	5	1	32	21	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
DS-2	30.00	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEGTH
CEG TEST HOUSE

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		08-07-2022	to	08-07-2022	37+174 Minor Bridge	BH-CL	Not Encountered	6.00 m	687850.788 m	3129414.081 m	(+)252.485 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Reddish Brown,Medium dense,Silty Sand	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	1.50	11	16		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.25	-	-		SM		0	18	74	7	1	0	0	-	NIL	NP	-	1.71	12.60	1.52	2.59	DST	0.00	29	-	-	-	-	-	-	-	-
SPT-2	3.00	12	14		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-3	4.50	16	17		SM		0	25	70	5	0	0	0	-	NIL	NP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	5.25	-	-	Brown, Medium dense, Sandy silt of low plasticity	ML-CL		7	48	37	5	3	0	0	26	20	6	-	1.83	17.40	1.56	2.92	DST	0.15	18	-	-	-	-	-	-	-	-
SPT-4	6.00	14	14		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEG TEST HOUSE

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.						Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
							07-07-2022	to	07-07-2022	37+487 Minor Bridge	BH-CL	Not Encountered	10.00 m	687664.026 m	3129665.052 m	(+)253.510 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Brown, Medium dense, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	1.50	10	14		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.25	-	-		ML-CL		4	48	35	6	3	4	0	27	22	5	-	1.74	15.10	1.51	2.63	DST	0.15	22	-	-	-	-	-	-	-	-	-
SPT-2	3.00	12	14	Reddish Brown,Medium dense,Silty Sand	SM		0	19	76	4	1	0	0	-	NIL	NP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-3	4.50	17	18		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	5.25	-	-		SM		0	19	74	5	2	0	0	-	NIL	NP	-	1.77	11.10	1.59	2.62	DST	0.00	30	-	-	-	-	-	-	-	-	-
SPT-4	6.00	31	30	Brown, Dense, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-5	7.50	26	23		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	8.25	-	-		ML-CL		7	49	36	6	1	1	0	27	20	7	-	1.92	17.60	1.63	2.63	DST	0.17	21	-	-	-	-	-	-	-	-	-
SPT-6	9.00	35	29	Brown, Dense, Silty Clay of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-7	10.00	26	26		CL		11	53	29	6	1	0	0	34	21	13	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEGTH
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AND RESEARCH CENTRE PVT LTD

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.						Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
							06-07-2022	to	07-07-2022	38+127 Minor Bridge	BH-CL	Not Encountered	10.00 m	687322.404 m	3130206.236 m	(+)254.370 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																			
DS	0.00	-	-	Brown, Medium dense, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	1.50	8	12		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.25	-	-		ML-CL		7	47	35	9	1	1	0	27	21	6	-	1.78	16.20	1.53	2.60	DST	0.10	22	-	-	-	-	-	-	-	-
SPT-2	3.00	11	11	Brown, Dense, Silty Clay of low plasticity	CL		11	46	20	4	2	17	0	31	20	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-3	4.50	13	13		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	5.25	-	-		CL		12	46	21	4	1	16	0	31	21	10	-	1.92	20.60	1.59	2.64	UUT	0.98	5	-	-	-	-	-	-	-	-
SPT-4	6.00	26	26		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-5	7.50	30	30		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	8.25	-	-		CL		13	49	22	5	2	9	0	32	21	11	-	1.92	20.30	1.60	2.65	UUT	0.91	6	-	-	-	-	-	-	-	-
SPT-6	9.00	24	24		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-7	10.00	26	26		CL		12	47	20	4	2	15	0	32	22	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

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SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		08-07-2022	to	08-07-2022	38+482 Minor Bridge	BH-CL	Not Encountered	6.00 m	687138.270 m	3130509.717 m	(+)254.888 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Reddish Brown,Medium Dense,Silty Clay of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	1.50	9	9		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.25	-	-		CL		11	55	26	4	3	1	0	32	21	11	-	1.87	20.70	1.55	2.63	UUT	0.50	5	-	-	-	-	-	-	-	-	-
SPT-2	3.00	13	13		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-3	4.50	16	16		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	5.25	-	-		CL		12	52	20	2	0	14	0	32	21	11	-	1.89	20.30	1.57	2.64	UUT	1.14	6	-	-	-	-	-	-	-	-	-
SPT-4	6.00	30	30		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEGTH
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SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		30-01-2022	to	30-01-2022	38+701	BH-CL	Not Encountered	10.00 m	687027.281 m	3130698.508 m	(+)254.062 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Brown, Medium stiff to stiff, Silty clay of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	0.50	6	6		CL		11	54	27	5	3	0	0	31	20	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-2	1.50	10	10		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	2.25	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-3	3.00	15	15		CL		10	51	29	7	1	2	0	30	20	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-4	4.50	24	24	Brown, Very stiff to hard, Silty clay of low plasticity with gravel	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	5.25	-	-		CL		12	50	24	6	4	4	0	33	22	11	-	1.84	16.59	1.58	2.68	UUT	0.95	4	-	-	-	-	-	-	-	-	-
SPT-5	6.00	31	31		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-6	7.50	30	30		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	8.25	-	-		CL		11	49	26	5	3	6	0	32	21	11	-	1.91	17.68	1.62	2.67	UUT	1.38	5	-	-	-	-	-	-	-	-	-
SPT-7	9.00	39	39		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	10.00	45	45		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEGTH
CEG TEST HOUSE
AND RESEARCH CENTRE PVT LTD

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		30-01-2022	to	30-01-2022	38+778	BH-CL	Not Encountered	15.00 m	686988.257 m	3130764.000 m	(+)254.956 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																			
DS	0.00	-	-	Brown, Loose, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	0.50	5	9		ML-CL		7	47	39	4	3	0	0	27	20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-2	1.50	9	13		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	2.25	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-3	3.00	14	14	Brown, Very stiff to hard, Silty clay of low plasticity with gravel	CL		11	52	28	5	2	2	0	31	20	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-4	4.50	20	20		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	5.25	-	-		CL		10	48	30	4	4	4	0	30	20	10	-	1.80	15.24	1.56	2.67	UUT	0.75	5	-	-	-	-	-	-	-	-	-
SPT-5	6.00	32	32		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-6	7.50	38	38		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	8.25	-	-		CL		12	48	24	8	3	5	0	33	22	11	-	1.89	16.79	1.62	2.68	UUT	1.35	4	-	-	-	-	-	-	-	-	-
SPT-7	9.00	41	41		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	10.50	45	45		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	11.25	-	-		CL		11	50	26	5	3	5	0	32	21	11	-	1.94	17.66	1.65	2.67	UUT	1.78	4	-	-	-	-	-	-	-	-	-
SPT-9	12.00	48	48		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-10	13.50	54	54		CL		10	50	24	7	2	7	0	30	20	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	14.25	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-11	15.00	60	60		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEGTH
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SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		29-01-2022	to	29-01-2022	39+060	BH-CL	Not Encountered	10.00 m	686845.338 m	3131007.988 m	(+)256.112 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																			
DS	0.00	-	-	Brown, Loose, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	0.50	5	9		ML-CL		7	48	37	5	3	0	0	27	20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-2	1.50	8	12		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	2.25	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-3	3.00	20	25	Brown, Medium dense, Silty sand with clay	SM-SC		5	39	45	6	2	3	0	25	20	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-4	4.50	23	25		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	5.25	-	-	Brown, Hard, Silty clay of low plasticity with gravel	CL		11	54	24	5	2	4	0	31	20	11	-	1.86	15.76	1.61	2.67	UUT	1.22	4	-	-	-	-	-	-	-	-	-
SPT-5	6.00	34	34		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-6	7.50	38	38		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	8.25	-	-		CL		12	52	25	4	1	6	0	32	21	11	-	1.90	16.80	1.63	2.68	UUT	1.48	5	-	-	-	-	-	-	-	-	-
SPT-7	9.00	42	42		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	10.00	48	48		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEGTH
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SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		21-10-2021	to	21-10-2021	39+149	BH-PLT-03	Not encountered	12.00 m	686653.951 m	3131306.518 m	(+)255.863 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Brown, Loose, Silty sand with clay	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	0.75	-	-		SM-SC		5	42	44	8	1	0	0	26	20	6	-	1.64	11.67	1.47	2.65	DST	0.09	26	-	-	-	-	-	-	-	-	-
SPT-1	1.50	6	9		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-2	2.25	7	9		SM-SC		4	39	51	3	2	1	0	25	20	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-3	3.00	16	20	Brown, Medium dense, Sandy silt of low plasticity	ML-CL		7	57	27	4	3	2	0	27	20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-4	3.75	16	19		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	4.50	-	-		ML-CL		8	50	31	6	2	3	0	28	21	7	-	1.79	14.22	1.57	2.66	DST	0.21	25	-	-	-	-	-	-	-	-	-
SPT-5	6.00	30	30		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	7.50	-	-		ML-CL		7	53	27	5	4	3	1	26	19	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-6	9.00	26	22		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	10.50	-	-		ML-CL		6	48	30	10	2	4	0	26	20	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-7	12.00	28	21		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbrevjations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEGTH
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SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.						Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
							20-11-2021	to	20-11-2021	39+400	BH-CL	Not Encountered	10.00 m	686673.940 m	3131301.616 m	(+)256.079 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																			
DS	0.00	-	-	Brown, Loose to medium dense, Silty sand	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	0.50	6	11		SM		0	25	68	6	1	0	0	-	Nil	NP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-2	1.50	7	10		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.25	-	-		SM		0	21	72	4	2	1	0	-	Nil	NP	-	1.67	11.26	1.50	2.62	DST	0.00	29	-	-	-	-	-	-	-	-	-
SPT-3	3.00	15	18		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-4	4.50	30	33	Brown, Dense, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	5.25	-	-		ML-CL		7	48	38	6	1	0	0	27	20	7	-	1.84	14.16	1.61	2.66	DST	0.19	27	-	-	-	-	-	-	-	-	-
SPT-5	6.00	33	33		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-6	7.50	38	35		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	8.25	-	-		ML-CL		6	45	41	6	1	1	0	26	20	6	-	1.85	14.80	1.61	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-7	9.00	41	35		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	10.00	44	36		ML-CL		8	46	38	5	2	1	0	28	21	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

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SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.						Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
							29-01-2022	to	29-01-2022	40+325	BH-CL	Not Encountered	15.00 m	686221..0790	3132119.630 m	(+)257.953 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																			
DS	0.00	-	-	Brown, Loose to medium dense, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	0.50	6	11		ML-CL		6	51	37	4	2	0	0	26	20	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-2	1.50	7	10		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	2.25	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-3	3.00	19	23		ML-CL		7	48	35	3	5	2	0	27	20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-4	4.50	26	28		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	5.25	-	-	Brown, Hard, Silty clay of low plasticity with gravel	CL		12	50	24	4	3	7	0	33	22	11	-	1.90	15.67	1.64	2.68	UUT	1.72	5	-	-	-	-	-	-	-	-	-
SPT-5	6.00	55	55		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-6	7.50	49	49		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	8.25	-	-		CL		11	50	23	5	2	9	0	32	21	11	-	1.96	16.89	1.68	2.67	UUT	2.36	4	-	-	-	-	-	-	-	-	-
SPT-7	9.00	73	73		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	10.50	73	73		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	11.25	-	-		CL		13	50	24	3	2	8	0	33	22	11	-	1.97	17.22	1.68	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-9	12.00	79	79		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-10	13.50	63	63		CL		11	50	26	4	1	8	0	31	20	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	14.25	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-11	15.00	80	80		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	#DIV/0!	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEGTH
CEG TEST HOUSE
AND RESEARCH CENTRE PVT LTD

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.					Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
						19-11-2021	to	19-11-2021	40+573	BH-CL	Not Encountered	10.00 m	686107.704 m	3132328.870 m	(+)252.612 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																			
DS	0.00	-	-	Brown, Medium dense to very dense, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	0.50	17	31		ML-CL		7	48	38	6	1	0	0	27	20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-2	1.50	18	26		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.25	-	-		ML-CL		8	49	34	4	3	2	0	27	20	7	-	1.79	12.88	1.59	2.66	DST	0.21	26	-	-	-	-	-	-	-	-	-
SPT-3	3.00	24	29		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-4	4.50	27	29		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	5.25	-	-		SM-SC		6	43	40	5	1	5	0	26	20	6	-	1.83	13.64	1.61	2.65	DST	0.20	27	-	-	-	-	-	-	-	-	-
SPT-5	6.00	39	38		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-6	7.50	43	39		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	8.25	-	-		ML-CL		8	47	30	6	1	8	0	28	21	7	-	1.85	14.06	1.62	2.66	DST	0.20	28	-	-	-	-	-	-	-	-	-
SPT-7	9.00	50	42		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	10.00	57	46		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

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SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.						Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
							18-08-2021	to	19-08-2021	41+056 Major Bridge	BH-A1	Not Encountered	30.00 m	685995.127 m	3132785.751 m	(+)253.199 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																			
DS	0.00	-	-	Brown, Medium dense, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	1.00	-	-		ML-CL		7	61	32	0	0	0	0	27	20	7	-	1.72	11.89	1.54	2.66	DST	0.20	23	-	-	-	-	-	-	-	-	-
SPT-1	2.50	13	17		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	4.00	-	-		ML-CL		6	59	33	1	0	1	0	26	20	6	-	1.74	12.20	1.55	2.67	DST	0.18	24	-	-	-	-	-	-	-	-	-
SPT-2	5.50	20	20		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	7.00	-	-	Brown, Dense to very dense, Sandy silt of low plasticity with gravel	ML-CL		8	61	27	1	0	3	0	28	21	7	-	1.78	12.87	1.58	2.66	DST	0.19	25	-	-	-	-	-	-	-	-	-
SPT-3	8.50	30	26		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	10.00	-	-		ML-CL		7	54	28	3	2	6	0	27	20	7	-	1.79	13.11	1.58	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-4	11.50	32	25		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-5	13.00	-	-		ML-CL		7	58	30	1	0	4	0	26	19	7	-	1.79	13.46	1.58	2.67	DST	0.17	26	-	-	-	-	-	-	-	-	-
SPT-5	14.50	38	26		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-6	16.00	-	-		ML-CL		6	60	24	4	1	5	0	26	20	6	-	1.81	14.06	1.59	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-6	17.50	42	26		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-7	19.00	-	-		ML-CL		7	52	29	2	1	9	0	26	20	6	-	1.83	14.57	1.60	2.66	DST	0.20	26	-	-	-	-	-	-	-	-	-
SPT-7	20.50	56	32		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-8	22.00	-	-	Brown, Very dense, Sandy silt of low plasticity with gravel	ML-CL		9	54	23	5	2	7	0	28	21	7	-	1.96	15.02	1.70	2.66	DST	0.16	28	-	-	-	-	-	-	-	-	-
SPT-8	23.50	100 (18cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	25.00	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-9	26.50	100 (22cm)	-		ML-CL		10	48	28	2	1	11	0	29	22	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEGTH
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SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		18-08-2021	to	19-08-2021	41+056 Major Bridge	BH-A1	Not Encountered	30.00 m	685995.127 m	3132785.751 m	(+)253.199 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction ($\varphi°$)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
UDS*	28.00	-	-	Brown, Very dense, Sandy silt of low plasticity with gravel	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-10	29.50	100 (22cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-11	30.00	>100	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

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SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.						Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
							12-08-2021	to	14-08-2021	41+056 Major Bridge	BH-A2	Not Encountered	40.00 m	685993.223 m	3132810.479 m	(+)252.668 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																			
DS	0.00	-	-	Brown, Medium dense, Silty sand with clay	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	1.00	11	18		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.50	-	-		SM-SC		6	39	43	7	5	0	0	26	20	6	-	1.71	10.35	1.55	2.64	DST	0.09	27	-	-	-	-	-	-	-	-	-
SPT-2	4.00	20	23		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	5.50	-	-		SM-SC		5	43	41	6	4	1	0	25	20	5	-	1.73	10.80	1.56	2.65	DST	0.12	27	-	-	-	-	-	-	-	-	-
SPT-3	7.00	38	36	Brown, Dense to very dense, Sandy silt of low plasticity with gravel	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	8.50	-	-		ML-CL		8	54	33	4	1	0	0	28	21	7	-	1.81	12.63	1.61	2.66	DST	0.21	27	-	-	-	-	-	-	-	-	-
SPT-4	10.00	43	35		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	11.50	-	-		ML-CL		9	51	35	4	1	0	0	27	20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-5	13.00	67	49		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-5	14.50	-	-		ML-CL		7	52	30	6	3	2	0	26	20	6	-	1.86	13.67	1.64	2.66	DST	0.23	27	-	-	-	-	-	-	-	-	-
SPT-6	16.00	71	46		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-6	17.50	-	-		ML-CL		8	53	32	5	1	1	0	27	20	7	-	1.94	14.78	1.69	2.66	DST	0.17	28	-	-	-	-	-	-	-	-	-
SPT-7	19.00	96	57		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-7	20.50	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	22.00	110 (19cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-9	23.50	107 (20cm)	-		ML-CL		9	46	28	7	3	5	2	28	21	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-10	25.00	107 (19cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-11	26.50	>100	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
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		12-08-2021	to	14-08-2021	41+056 Major Bridge	BH-A2	Not Encountered	40.00 m	685993.223 m	3132810.479 m	(+)252.668 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
SPT-12	28.00	>100	-	Brown, Dense to very dense, Sandy silt of low plasticity with gravel	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-13	29.50	100 (23cm)	-		ML-CL		8	44	32	4	3	8	1	27	20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-14	31.00	100 (27cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-15	32.50	100 (22cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-16	34.00	>100	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-17	35.50	>100	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-18	37.00	>100	-		ML-CL		7	48	28	5	6	4	2	26	20	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-19	38.50	>100	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-20	40.00	>100	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEGTH
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SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.					Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
						18-11-2021	to	18-11-2021	41+100 Minor Bridge	BH-CL	Not Encountered	10.00 m	685985.307 m	3132839.175 m	(+)252.428 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Brown, Medium dense, Silty sand with clay	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	0.50	17	31		SM-SC		6	41	40	12	1	0	0	26	20	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-2	1.50	22	32		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.25	-	-		SM-SC		7	28	43	15	7	0	0	27	20	7	-	1.80	12.64	1.60	2.65	DST	0.11	28	-	-	-	-	-	-	-	-
SPT-3	3.00	27	27	Brown, Very stiff to hard, Silty clay of low plasticity with gravel	CL		11	51	28	7	1	2	0	32	21	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-4	4.50	33	33		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	5.25	-	-		CL		13	50	26	5	1	5	0	34	23	11	-	1.84	15.23	1.60	2.68	UUT	1.12	5	-	-	-	-	-	-	-	-
SPT-5	6.00	39	39		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-6	7.50	44	44		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	8.25	-	-		CL		12	48	22	11	1	6	0	33	22	11	-	1.90	16.80	1.63	2.67	UUT	1.58	4	-	-	-	-	-	-	-	-
SPT-7	9.00	46	46		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	10.00	54	54		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEGTH
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SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		18-11-2021	to	18-11-2021	41+217	BH-CL	Not Encountered	10.00 m	685963.297 m	3132954.077 m	(+)255.462 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Brown, Medium dense, Silty sand	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	0.50	17	31		SM		0	25	68	6	1	0	0	-	Nil	NP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-2	1.50	23	33		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.25	-	-		SM		0	19	72	4	3	2	0	-	Nil	NP	-	1.79	11.10	1.61	2.62	DST	0.00	30	-	-	-	-	-	-	-	-	-
SPT-3	3.00	35	42	Brown,Medium dense to dense, Sandy Silt of low plasticity	ML-CL		7	49	34	6	1	3	0	26	20	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-4	4.50	28	30		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	5.25	-	-	Brown, Hard, Silty clay of low plasticity	CL		10	51	28	6	1	4	0	31	21	10	-	1.90	16.41	1.63	2.67	UUT	1.47	5	-	-	-	-	-	-	-	-	-
SPT-5	6.00	41	41		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-6	7.50	48	48		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	8.25	-	-		CL		12	50	28	6	1	3	0	34	23	11	-	1.91	17.10	1.63	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-7	9.00	41	41		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	10.00	48	48		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

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SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		28-01-2022	to	28-01-2022	41+235	BH-CL	Not Encountered	10.00 m	685959.452 m	3132971.662 m	(+)254.441 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Brown, Loose, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	0.50	7	13		ML-CL		7	50	37	4	2	0	0	27	20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-2	1.50	8	12		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	2.25	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-3	3.00	20	20	Brown, Very stiff to hard, Silty clay of low plasticity with gravel	CL		11	54	27	3	2	3	0	31	20	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-4	4.50	26	26		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	5.25	-	-		CL		12	48	24	8	3	5	0	32	21	11	-	1.82	15.30	1.58	2.68	UUT	0.85	5	-	-	-	-	-	-	-	-	-
SPT-5	6.00	35	35		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-6	7.50	39	39		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	8.25	-	-		CL		10	54	24	4	2	6	0	30	20	10	-	1.90	16.43	1.63	2.67	UUT	1.38	4	-	-	-	-	-	-	-	-	-
SPT-7	9.00	40	40		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	10.00	48	48		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

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SOIL CHARACTERISTICS

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						13-08-2021	to	16-08-2021	41+390 Major Bridge	BH-A1	Not Encountered	35.00 m	685929.941 m	3133111.995 m	(+)258.326 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Brown, Very dense, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	1.00	-	-		ML-CL		6	45	27	20	1	1	0	26	20	6	-	1.85	12.06	1.65	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	2.50	48	60		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	4.00	-	-		ML-CL		7	44	25	21	2	1	0	25	19	6	-	1.85	12.74	1.64	2.66	DST	0.19	27	-	-	-	-	-	-	-	-	-
SPT-2	5.50	50	50		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	7.00	-	-		ML-CL		8	49	36	2	1	4	0	27	20	7	-	1.87	13.24	1.65	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-3	8.50	71	60		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	10.00	-	-		ML-CL		9	45	37	1	1	7	0	28	21	7	-	1.86	13.68	1.64	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-4	11.50	64	48		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-5	13.00	-	-		ML-CL		7	46	35	3	4	5	0	27	20	7	-	1.86	14.26	1.63	2.67	DST	0.21	26	-	-	-	-	-	-	-	-	-
SPT-5	14.50	64	43		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-6	16.00	-	-		ML-CL		8	45	34	6	2	4	1	29	22	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-6	17.50	73	44		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-7	19.00	-	-	Brown, Hard, Silty clay of low plasticity	CL		11	71	15	1	1	1	0	31	20	11	-	1.98	16.33	1.70	2.68	UUT	3.11	5	-	-	-	-	-	-	-	-	-
SPT-7	20.20	>100	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	22.00	97	97		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-9	23.50	>100	-		CL		14	62	13	5	2	4	0	34	23	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-10	25.00	100 (27cm)	100 (27cm)		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-11	26.50	100 (18cm)	100 (18cm)		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

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SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		13-08-2021	to	16-08-2021	41+390 Major Bridge	BH-A1	Not Encountered	35.00 m	685929.941 m	3133111.995 m	(+)258.326 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction ($\varphi°$)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
SPT-12	28.00	100 (23cm)	100 (23cm)	Brown, Hard, Silty clay of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-13	29.50	100 (18cm)	100 (18cm)		CL		13	64	14	3	1	5	0	33	22	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-14	31.00	100 (22cm)	100 (22cm)		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-15	32.50	100 (22cm)	100 (22cm)		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-16	34.00	100 (20cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-17	35.00	100 (20cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEGTH
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SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		12-08-2021	to	14-08-2021	41+390 Major Bridge	BH-A2	Not Encountered	35.00 m	685920.014 m	3133135.325 m	(+)258.616 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Brown, Medium dense, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	1.00	15	24		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.50	-	-		ML-CL		6	46	38	7	2	1	0	25	20	5	-	1.75	12.06	1.56	2.66	DST	0.18	24	-	-	-	-	-	-	-	-	-
SPT-2	4.00	18	20		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	5.50	-	-	Brown, Hard, Silty clay of low plasticity	CL		12	68	16	2	1	1	0	31	20	11	-	1.86	13.45	1.64	2.68	UUT	1.65	5	-	-	-	-	-	-	-	-	-
SPT-3	7.00	47	47		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	8.50	-	-		CL		11	66	15	5	2	1	0	30	20	10	-	1.87	13.84	1.64	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-4	10.00	52	52		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	11.50	-	-		CL		10	63	19	4	2	2	0	30	20	10	-	1.92	14.22	1.68	2.67	UUT	2.48	4	-	-	-	-	-	-	-	-	-
SPT-5	13.00	77	77		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-5	14.50	-	-		CL		12	67	13	4	2	2	0	32	21	11	-	1.93	14.69	1.68	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-6	16.00	82	82		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-6	17.50	-	-		CL		10	65	18	4	2	1	0	30	20	10	-	1.91	15.14	1.66	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-7	19.00	57	57		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-7	20.50	-	-		CL		11	56	19	9	2	3	0	32	21	11	-	1.95	15.89	1.68	2.68	UUT	2.50	4	-	-	-	-	-	-	-	-	-
SPT-8	22.00	82	82		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-8	23.50	-	-		CL		12	66	13	5	3	1	0	33	21	12	-	1.98	16.24	1.70	2.68	UUT	3.10	5	-	-	-	0.575	0.5-1.0 1.0-2.0 2.0-4.0 4.0-8.0	7.80 5.89 4.92 4.13	1.28 0.84 0.55 0.38	0.076
SPT-9	25.00	100	100				-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-10	26.50	100 (18cm)	100 (18cm)		CL		10	67	11	4	5	3	0	30	19	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

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SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		12-08-2021	to	14-08-2021	41+390 Major Bridge	BH-A2	Not Encountered	35.00 m	685920.014 m	3133135.325 m	(+)258.616 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
SPT-11	28.00	100 (22cm)	100 (22cm)	Brown, Hard, Silty clay of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-12	29.50	100 (19cm)	100 (19cm)		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-13	31.00	100 (19cm)	100 (19cm)		CL		11	58	15	5	6	5	0	31	21	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-14	32.50	100 (28cm)	100 (28cm)		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-15	34.00	100 (20cm)	100 (20cm)		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-16	35.00	100 (20cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

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SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.					Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
						10-08-2021	to	12-08-2021	42+256 Major Bridge	BH-A1	Not Encountered	35.00 m	685833.304 m	3133665.625 m	(+)262.272 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																			
DS	0.00	-	-	Brown, Loose, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	1.00	8	13		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.50	-	-		ML-CL		6	55	21	8	7	3	0	26	20	6	-	1.68	11.23	1.51	2.66	DST	0.24	22	-	-	-	-	-	-	-	-	-
SPT-2	4.00	16	18	Brown, Medium dense to dense, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	5.50	-	-		ML-CL		5	47	38	7	2	1	0	25	20	5	-	1.72	11.80	1.54	2.67	DST	0.20	24	-	-	-	-	-	-	-	-	-
SPT-3	7.00	19	18		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	8.50	-	-		ML-CL		7	57	30	2	1	3	0	26	20	6	-	1.73	12.10	1.54	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-4	10.00	22	18		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	11.50	-	-		ML-CL		6	55	32	2	1	4	0	27	21	6	-	1.75	12.75	1.55	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-5	13.00	25	18		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-5	14.50	-	-		ML-CL		6	58	23	6	5	2	0	25	20	5	-	1.76	13.24	1.55	2.66	DST	0.21	25	-	-	-	-	-	-	-	-	-
SPT-6	16.00	33	22		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-6	17.50	-	-		ML-CL		7	51	30	3	2	7	0	27	20	7	-	1.78	13.80	1.56	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-7	19.00	32	19		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-7	20.50	-	-	Brown, Very dense, Sandy silt of low plasticity	ML-CL		8	49	30	2	4	7	0	27	20	7	-	1.83	14.56	1.60	2.66	DST	0.22	26	-	-	-	-	-	-	-	-	-
SPT-8	22.00	52	29		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-8	23.50	-	-		ML-CL		6	52	28	6	3	5	0	26	20	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-9	25.00	56	28		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
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SOIL CHARACTERISTICS

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		10-08-2021	to	12-08-2021	42+256 Major Bridge	BH-A1	Not Encountered	35.00 m	685833.304 m	3133665.625 m	(+)262.272 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
UDS-9	26.50	-	-	Brown, Hard, Silty clay of low plasticity	CL		14	57	16	5	4	4	0	32	19	13	-	1.96	15.10	1.70	2.69	UUT	2.63	4	-	-	-	0.580	0.5-1.0 1.0-2.0 2.0-4.0 4.0-8.0	8.65 7.05 5.81 4.16	1.15 0.90 0.52 0.38	0.076
SPT-10	28.00	82	82		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-11	29.50	90	90		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-12	31.00	96	96		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-13	32.50	101 (29cm)	-	Brown, Very dense, Sandy silt of low plasticity	ML-CL		8	59	21	6	3	3	0	27	20	7	-	2.00	16.00	1.72	2.66	DST+	0.19	28	-	-	-	-	-	-	-	-
SPT-14	34.00	100 (28cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-15	35.00	>100	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEG TEST HOUSE

SOIL CHARACTERISTICS

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							13-08-2021	to	16-08-2021	42+256 Major Bridge	BH-P2	Not Encountered	35.00 m	685843.959 m	3133711.521 m	(+)263.721 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																			
DS	0.00	-	-	Brown, Medium dense, Silty sand with clay	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	1.00	16	25		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.50	-	-		SM-SC		5	31	62	1	0	1	0	26	20	6	-	1.75	10.96	1.58	2.65	DST	0.08	27	-	-	-	-	-	-	-	-	-
SPT-2	4.00	22	25		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	5.50	-	-	Brown, Dense, Sandy silt of low plasticity	ML-CL		7	55	35	1	0	2	0	28	21	7	-	1.77	11.63	1.59	2.66	DST	0.18	25	-	-	-	-	-	-	-	-	-
SPT-3	7.00	31	29		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	8.50	-	-		ML-CL		6	58	28	2	1	5	0	27	20	7	-	1.78	12.01	1.59	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-4	10.00	36	29		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	11.50	-	-		ML-CL		8	56	26	4	2	3	1	28	21	7	-	1.77	12.46	1.57	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-5	13.00	30	22		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-5	14.50	-	-		ML-CL		7	56	29	3	1	4	0	27	20	7	-	1.77	12.97	1.57	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-6	16.00	39	26		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-6	17.50	-	-	Brown, Very dense, Sandy silt of low plasticity	ML-CL		6	50	38	3	1	2	0	26	20	6	-	1.84	13.41	1.62	2.66	DST	0.20	26	-	-	-	-	-	-	-	-	-
SPT-7	19.00	100 (18cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	20.50	73	41		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-9	22.00	66	36		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-7	23.50	-	-		ML-CL		9	53	31	3	1	3	0	29	22	7	-	1.84	13.88	1.62	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-10	25.00	67	33		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-8	26.50	-	-		ML-CL		8	47	33	4	3	5	0	28	21	7	-	1.84	14.26	1.61	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-11	28.00	72	33		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

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SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		13-08-2021	to	16-08-2021	42+256 Major Bridge	BH-P2	Not Encountered	35.00 m	685843.959 m	3133711.521 m	(+)263.721 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
UDS-9	29.50	-	-	Brown, Very dense, Sandy silt of low plasticity	ML-CL		7	47	30	6	4	6	0	26	19	7	-	1.87	15.23	1.62	2.67	DST	0.16	27	-	-	-	-	-	-	-	-	-
SPT-12	31.00	79	36		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-10	32.50	-	-		ML-CL		7	46	29	6	5	7	0	27	20	7	-	1.88	16.04	1.62	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-13	34.00	90	41		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-14	35.00	>100	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

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Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.						Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
							17-08-2021	to	18-08-2021	42+256 Major Bridge	BH-P3	Not Encountered	35.00 m	685846.067 m	3133732.830 m	(+)262.764 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																			
DS	0.00	-	-	Brown, Very loose, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	1.00	-	-		ML-CL		6	49	45	0	0	0	0	27	21	6	-	1.61	12.04	1.44	2.66	DST	0.23	21	-	-	-	-	-	-	-	-	-
SPT-1	2.50	4	5		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	4.00	-	-	Brown, Dense, Sandy silt of low plasticity	ML-CL		8	45	38	7	1	1	0	28	21	7	-	1.80	12.64	1.60	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-2	5.50	30	31		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	7.00	-	-		ML-CL		5	50	44	1	0	0	0	26	20	6	-	1.79	13.22	1.58	2.67	DST	0.15	26	-	-	-	-	-	-	-	-	-
SPT-3	8.50	29	25		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	10.00	-	-		ML-CL		7	53	40	0	0	0	0	26	19	7	-	1.80	13.89	1.58	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-4	11.50	31	24		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-5	13.00	-	-		ML-CL		6	48	41	3	2	0	0	27	20	7	-	1.80	14.39	1.57	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-5	14.50	33	23		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-6	16.00	-	-	Brown, Very dense, Sandy silt of low plasticity	ML-CL		6	51	41	2	0	0	0	27	20	7	-	1.85	15.10	1.61	2.66	DST	0.21	26	-	-	-	-	-	-	-	-	-
SPT-6	17.50	54	34		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-7	19.00	-	-		ML-CL		8	51	35	3	1	2	0	28	21	7	-	1.86	15.34	1.61	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-7	20.50	53	30		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-8	22.00	-	-		ML-CL		7	47	33	6	4	2	1	27	20	7	-	1.86	15.77	1.61	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	23.50	63	33		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-9	25.00	-	-		ML-CL		6	58	29	1	1	5	0	26	19	7	-	1.87	16.11	1.61	2.67	DST	0.17	27	-	-	-	-	-	-	-	-	-
SPT-9	26.50	67	32		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-10	28.00	-	-		ML-CL		7	55	25	3	2	8	0	27	20	7	-	1.87	16.45	1.61	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
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SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		17-08-2021	to	18-08-2021	42+256 Major Bridge	BH-P3	Not Encountered	35.00 m	685846.067 m	3133732.830 m	(+)262.764 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
SPT-10	29.50	76	35	Brown, Very dense, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-11	31.00	-	-		ML-CL		6	57	23	2	1	11	0	26	20	6	-	1.93	16.79	1.65	2.66	DST	0.18	28	-	-	-	-	-	-	-	-	-
SPT-11	32.50	100 (27cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-12	34.00	100 (19cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-13	35.50	100 (17cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

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							09-08-2021	to	12-08-2021	42+256 Major Bridge	BH-P4	Not Encountered	34.00 m	685829.930 m	3133756.860 m	(+)262.555 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																			
DS	0.00	-	-	Brown, Loose, Silty sand with clay	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	1.00	8	13		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.50	-	-		SM-SC		5	35	48	6	4	2	0	25	19	6	-	1.67	11.23	1.50	2.64	DST	0.08	26	-	-	-	-	-	-	-	-
SPT-2	4.00	12	14	Brown, Medium dense, Silty sand with clay	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	5.50	-	-		SM-SC		6	33	46	9	5	1	0	26	20	6	-	1.70	11.80	1.52	2.65	DST	0.10	26	-	-	-	-	-	-	-	-
SPT-3	7.00	15	14		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	8.50	-	-		SM-SC		6	34	50	5	4	1	0	25	20	5	-	1.73	12.63	1.54	2.65	DST	0.12	27	-	-	-	-	-	-	-	-
SPT-4	10.00	20	16		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	11.50	-	-		SM-SC		7	38	43	6	5	1	0	26	20	6	-	1.74	12.86	1.54	-	-	-	-	-	-	-	-	-	-	-	-
SPT-5	13.00	23	17		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-5	14.50	-	-	Brown, Dense, Silty sand with clay	SM-SC		8	35	47	5	3	2	0	27	21	6	-	1.81	13.41	1.60	2.64	DST	0.09	28	-	-	-	-	-	-	-	-
SPT-6	16.00	44	29		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-6	17.50	-	-	Brown, Very dense, Sandy silt of low plasticity	ML-CL		9	58	29	2	0	2	0	27	20	7	-	1.87	15.20	1.62	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-7	19.00	61	37		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-7	20.50	-	-		ML-CL		10	49	35	2	0	4	0	28	21	7	-	1.88	15.76	1.62	2.66	DST	0.18	27	-	-	-	-	-	-	-	-
SPT-8	22.00	69	38		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-9	23.50	63	33		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-8	25.00	-	-		ML-CL		9	48	32	4	3	3	1	27	20	7	-	1.98	16.24	1.70	2.66	DST	0.17	28	-	-	-	-	-	-	-	-
SPT-10	26.50	101 (24cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

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Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
SPT-11	28.00	73	34	Brown, Very dense, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-12	29.50	101 (26cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-13	31.00	101 (28cm)	-		ML-CL		10	50	28	6	3	3	0	27	20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-14	32.50	101 (20cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-15	34.00	101 (19cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

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DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

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SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.					Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
						14-08-2021	to	17-08-2021	42+256 Major Bridge	BH-P5	Not Encountered	40.00 m	685839.438 m	3133785.448 m	(+)264.797 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																			
DS	0.00	-	-	Brown, Medium dense, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	1.00	-	-		ML-CL		6	53	38	2	1	0	0	26	20	6	-	1.71	12.03	1.53	2.66	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	2.50	12	15		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	4.00	-	-		ML-CL		8	54	33	4	1	0	0	27	20	7	-	1.73	12.46	1.54	2.67	DST	0.19	24	-	-	-	-	-	-	-	-	-
SPT-2	5.50	18	18		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	7.00	-	-		ML-CL		7	55	36	1	1	0	0	26	19	7	-	1.74	13.22	1.54	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-3	8.50	20	17		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	10.00	-	-		ML-CL		8	50	36	4	2	0	0	27	20	7	-	1.76	13.67	1.55	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-4	11.50	26	20		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-5	13.00	-	-	Brown, Dense, Sandy silt of low plasticity	ML-CL		6	50	38	3	2	1	0	26	19	7	-	1.78	14.11	1.56	2.67	DST	0.20	25	-	-	-	-	-	-	-	-	-
SPT-5	14.50	30	21		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-6	16.00	-	-		ML-CL		7	56	33	2	1	1	0	26	20	6	-	1.78	14.26	1.56	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-6	17.50	33	21		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-7	19.00	-	-		ML-CL		5	53	34	3	2	3	0	26	20	6	-	1.82	14.89	1.58	2.66	DST	0.18	26	-	-	-	-	-	-	-	-	-
SPT-7	20.50	43	25		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-8	22.00	-	-		ML-CL		7	51	30	6	4	2	0	26	19	7	-	1.82	15.12	1.58	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	23.50	48	25		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-9	25.00	-	-		ML-CL		6	51	36	3	2	1	1	27	20	7	-	1.83	15.36	1.59	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-9	26.50	55	27		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEGTH
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AND RESEARCH CENTRE PVT LTD

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.						Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
							14-08-2021	to	17-08-2021	42+256 Major Bridge	BH-P5	Not Encountered	40.00 m	685839.438 m	3133785.448 m	(+)264.797 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																			
UDS-10	28.00	-	-	Brown, Very dense, Sandy silt of low plasticity	ML-CL		8	51	35	2	1	3	0	28	21	7	-	1.87	15.94	1.61	2.66	DST	0.17	27	-	-	-	-	-	-	-	-
SPT-10	29.50	77	35		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-11	31.00	-	-		ML-CL		7	45	36	6	1	5	0	27	20	7	-	1.87	16.07	1.61	-	-	-	-	-	-	-	-	-	-	-	-
SPT-11	32.50	85	39		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-12	34.00	-	-		ML-CL		9	53	24	3	1	10	0	29	22	7	-	1.90	16.27	1.63	2.67	DST	0.18	28	-	-	-	-	-	-	-	-
SPT-12	35.50	95	44		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-13	37.00	100 (27cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-14	38.50	100 (21cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-15	40.00	>100	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

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SOIL CHARACTERISTICS

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						17-08-2021	to	19-08-2021	42+256 Major Bridge	BH-P6	Not Encountered	40.00 m	685841.105 m	3133808.838 m	(+)263.810 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Brown, Dense, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	1.00	35	55		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.50	-	-		ML-CL		5	60	28	3	2	2	0	26	20	6	-	1.79	11.84	1.60	2.66	DST	0.21	26	-	-	-	-	-	-	-	-	-
SPT-2	4.00	30	33		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	5.50	-	-		ML-CL		6	58	30	3	1	2	0	26	20	6	-	1.79	12.06	1.60	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-3	7.00	35	32		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	8.50	-	-		ML-CL		7	51	33	4	2	3	0	26	19	7	-	1.80	12.61	1.60	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-4	10.00	38	31		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	11.50	-	-		ML-CL		8	50	30	3	4	3	2	27	21	6	-	1.80	12.70	1.60	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-5	13.00	39	28		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-5	14.50	-	-		ML-CL		8	53	32	1	1	5	0	27	20	7	-	1.81	13.04	1.60	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-6	16.00	38	25		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-6	17.50	-	-	Brown, Very dense, Sandy silt of low plasticity	ML-CL		6	55	34	1	0	4	0	27	21	6	-	1.83	13.64	1.61	2.67	DST	0.18	27	-	-	-	-	-	-	-	-	-
SPT-7	19.00	62	37		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-7	20.50	-	-		ML-CL		5	58	31	2	1	3	0	26	20	6	-	1.83	13.88	1.61	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	22.00	70	38		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-8	23.50	-	-		ML-CL		7	50	34	6	2	1	0	27	20	7	-	1.84	14.12	1.61	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-9	25.00	70	35		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-9	26.50	-	-		ML-CL		6	48	36	3	1	6	0	26	19	7	-	1.86	14.63	1.62	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-10	28.00	72	33		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

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							17-08-2021	to	19-08-2021	42+256 Major Bridge	BH-P6	Not Encountered	40.00 m	685841.105 m	3133808.838 m	(+)263.810 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																			
UDS-10	29.50	-	-	Brown, Very dense, Sandy silt of low plasticity	ML-CL		8	47	35	1	0	9	0	28	21	7	-	1.88	15.04	1.63	2.66	DST	0.16	28	-	-	-	-	-	-	-	-
SPT-11	31.00	87	40		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-12	32.50	100 (20cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-13	34.00	100 (19cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-14	35.50	100 (18cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-15	37.00	100 (26cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-16	38.50	100 (25cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-17	40.00	100 (27cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

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Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.						Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
							11-08-2021	to	12-08-2021	42+256 Major Bridge	BH-P13	Not Encountered	40.00 m	685807.139 m	3133991.627 m	(+)264.859 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																			
DS	0.00	-	-	Brown, Medium dense, Silty sand with clay	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	1.00	-	-		SM-SC		6	31	43	9	6	5	0	25	19	6	-	1.76	11.35	1.58	2.64	DST	0.10	27	-	-	-	-	-	-	-	-	-
SPT-1	2.50	22	28		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	4.00	-	-		SM-SC		5	26	45	10	8	6	0	26	20	6	-	1.77	11.86	1.58	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-2	5.50	64	65	Brown, Very dense, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	7.00	-	-		ML-CL		7	46	33	6	5	3	0	26	20	6	-	1.82	12.47	1.62	2.66	DST	0.19	27	-	-	-	-	-	-	-	-	-
SPT-3	8.50	45	39		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	10.00	-	-	Brown, Very dense, Silty sand with clay	SM-SC		8	40	41	5	4	2	0	27	20	7	-	1.89	13.13	1.67	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-4	11.50	94	71		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-5	13.00	-	-		SM-SC		6	35	51	5	2	1	0	26	19	7	-	1.88	13.47	1.66	2.65	DST	0.11	30	-	-	-	-	-	-	-	-	-
SPT-5	14.50	87	59		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-6	16.00	-	-		SM-SC		7	39	45	3	4	2	0	27	21	6	-	1.81	14.26	1.58	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-6	17.50	43	26		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-7	19.00	-	-		SM-SC		5	33	48	5	6	3	0	25	19	6	-	1.85	14.87	1.61	2.65	DST	0.08	29	-	-	-	-	-	-	-	-	-
SPT-7	20.50	61	34		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-8	22.00	-	-		SM-SC		5	36	50	6	2	1	0	26	20	6	-	1.86	15.10	1.62	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	23.50	78	40		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-9	25.00	-	-		SM-SC		6	36	51	3	1	1	2	26	19	7	-	1.85	15.63	1.60	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-9	26.50	66	31		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEGTH
CEG TEST HOUSE
AND RESEARCH CENTRE PVT LTD

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.						Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
							11-08-2021	to	12-08-2021	42+256 Major Bridge	BH-P13	Not Encountered	40.00 m	685807.139 m	3133991.627 m	(+)264.859 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																			
UDS-10	28.00	-	-	Brown, Very dense, Silty sand with clay	SM-SC		7	34	46	4	6	3	0	27	20	7	-	1.86	15.80	1.61	-	-	-	-	-	-	-	-	-	-	-	-
SPT-10	29.50	78	36		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-11	31.00	-	-	Brown, Very dense, Sandy silt of low plasticity	ML-CL		8	50	32	5	3	2	0	27	20	7	-	1.88	16.23	1.62	2.67	DST	0.16	27	-	-	-	-	-	-	-	-
SPT-11	32.50	85	39		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-12	34.00	-	-		ML-CL		10	49	30	6	2	3	0	28	21	7	-	1.97	16.74	1.69	2.66	DST	0.23	27	-	-	-	-	-	-	-	-
SPT-12	35.50	>100	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-13	37.00	-	-		ML-CL		9	50	29	4	3	5	0	27	20	7	-	1.99	17.01	1.70	-	-	-	-	-	-	-	-	-	-	-	-
SPT-13	38.50	101 (22cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	40.00	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

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						07-08-2021	to	10-08-2021	42+256 Major Bridge	BH-P14	Not Encountered	40.00 m	685782.242 m	3134066.732 m	(+)263.998 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Brown, Medium dense, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	1.00	19	30		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.50	-	-		ML-CL		8	56	23	6	4	3	0	28	21	7	-	1.80	12.34	1.60	2.67	DST	0.15	26	-	-	-	-	-	-	-	-	-
SPT-2	3.00	31	37	Brown, Dense to very dense, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-3	4.00	39	43		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	5.50	-	-		ML-CL		7	62	22	5	3	1	0	27	20	7	-	1.84	13.12	1.63	2.66	DST	0.17	27	-	-	-	-	-	-	-	-	-
SPT-4	7.00	48	44		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	8.50	-	-		ML-CL		9	63	20	3	3	2	0	29	22	7	-	1.85	13.56	1.63	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-5	10.00	55	44		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	11.50	-	-		ML-CL		8	62	24	4	1	1	0	28	21	7	-	1.87	14.04	1.64	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-6	13.00	61	43		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-5	14.50	-	-		ML-CL		9	56	26	3	4	2	0	28	21	7	-	1.87	14.26	1.64	2.66	DST	0.19	27	-	-	-	-	-	-	-	-	-
SPT-7	16.00	68	44		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	17.50	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	19.00	76	44		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-6	20.50	-	-		ML-CL		8	56	24	5	3	3	1	27	20	7	-	1.89	15.04	1.64	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-9	22.00	81	43		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-7	23.50	-	-		ML-CL		10	58	20	4	2	6	0	28	21	7	-	1.89	15.30	1.64	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-10	25.00	86	42		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

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						07-08-2021	to	10-08-2021	42+256 Major Bridge	BH-P14	Not Encountered	40.00 m	685782.242 m	3134066.732 m	(+)263.998 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
UDS-8	26.50	-	-	Brown, Hard, Silty clay of low plasticity	CL		12	58	19	2	3	5	1	31	20	11	-	1.92	16.45	1.65	2.68	UUT	1.76	5	-	-	-	0.625	0.5-1.0 1.0-2.0 2.0-4.0 4.0-8.0	8.60 6.38 4.87 4.22	1.61 1.06 0.70 0.45	0.093
SPT-11	28.00	54	54		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-9	29.50	-	-		CL		10	61	18	4	3	4	0	30	20	10	-	1.93	16.86	1.65	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-12	31.00	54	54		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-10	32.50	-	-		CL		11	54	24	6	3	2	0	30	20	10	-	1.99	17.06	1.70	2.67	UUT	3.13	4	-	-	-	-	-	-	-	-	-
SPT-13	34.00	100 (19cm)	100 (19cm)		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	35.50	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-14	37.00	100 (19cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	38.50	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-15	40.00	100 (25cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

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		11-08-2021	to	13-08-2021	42+256 Major Bridge	BH-P15	Not Encountered	40.00 m	685773.857 m	3134091.912 m	(+)263.446 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																			
DS	0.00	-	-	Brown, Medium dense, Silty sand with clay	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	1.00	-	-		SM-SC		5	29	51	10	3	2	0	25	20	5	-	1.75	11.29	1.57	2.65	DST	0.09	27	-	-	-	-	-	-	-	-	-
SPT-1	2.50	19	24		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	4.00	-	-		SM-SC		6	42	40	9	2	1	0	26	20	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-2	5.50	40	41	Brown, Hard, Silty clay of medium plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	7.00	-	-		CI		16	62	4	2	5	11	0	38	24	14	-	1.83	13.26	1.62	2.70	UUT	1.40	3	-	-	-	0.665	0.5-1.0 1.0-2.0 2.0-4.0 4.0-8.0	5.94 4.26 3.15 2.67	1.94 1.41 1.06 0.59	0.1230
SPT-3	8.50	93	80	Brown, Very dense, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	10.00	-	-		ML-CL		9	46	42	1	0	2	0	28	21	7	-	1.83	12.84	1.62	2.67	DST	0.20	27	-	-	-	-	-	-	-	-	-
SPT-4	11.50	53	40		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-5	13.00	-	-		ML-CL		8	46	40	2	1	3	0	27	20	7	-	1.86	13.24	1.64	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-5	14.50	84	57		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-6	16.00	-	-		ML-CL		10	45	34	3	4	3	1	28	21	7	-	1.87	13.87	1.64	2.66	DST	0.23	27	-	-	-	-	-	-	-	-	-
SPT-6	17.50	76	47		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-7	19.00	100	59		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	20.50	80	80	Brown, Hard, Silty clay of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-7	22.00	-	-		CL		14	72	6	4	3	1	0	34	22	12	-	1.93	14.91	1.68	2.68	UUT	2.49	5	-	-	-	-	-	-	-	-	-
SPT-9	23.50	75	75		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-8	25.00	-	-		CL		12	64	12	3	5	4	0	32	21	11	-	1.94	15.23	1.68	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-10	26.50	83	83		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-9	28.00	-	-		CL		13	70	8	4	2	3	0	33	22	11	-	1.97	16.10	1.70	2.67	UUT	3.11	5	-	-	-	-	-	-	-	-	-

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							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
SPT-11	29.50	101 (28cm)	101 (28cm)	Brown, Hard, Silty clay of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-12	31.00	101 (27cm)	101 (27cm)		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-13	32.50	94	94		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-14	34.00	101 (25cm)	101 (25cm)		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-15	35.50	95	95		CL		15	66	9	5	3	2	0	34	23	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-16	37.00	92	92		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-17	38.50	101 (19cm)	101 (19cm)		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-18	40.00	101 (21cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEGTH
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SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		11-08-2021	to	13-08-2021	42+256 Major Bridge	BH-P16	Not Encountered	40.00 m	685765.737 m	3134166.127 m	(+)263.316 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	1.00	16	25		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.50	-	-		SM-SC		5	41	45	6	2	1	0	26	20	6	-	1.76	11.20	1.58	2.65	DST	0.10	27	-	-	-	-	-	-	-	-	-
SPT-2	4.00	27	30		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	5.50	-	-		SM-SC		6	38	53	1	0	2	0	25	19	6	-	1.80	11.86	1.61	2.64	DST	0.08	28	-	-	-	-	-	-	-	-	-
SPT-3	7.00	38	35		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	8.50	-	-		SM-SC		5	39	48	2	1	5	0	27	20	7	-	1.81	12.34	1.61	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-4	10.00	47	38		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	11.50	-	-	Brown, Medium dense to very dense, Silty sand with clay	SM-SC		6	42	40	7	1	4	0	26	19	7	-	1.81	12.60	1.61	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-5	13.00	53	38		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-5	14.50	-	-		SM-SC		6	30	53	6	2	3	0	26	20	6	-	1.83	13.12	1.62	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-6	16.00	66	43		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	17.50	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-7	19.00	54	32		SM-SC		5	44	44	4	2	1	0	25	20	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	20.50	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	22.00	58	31		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-6	23.50	-	-		SM-SC		5	41	38	8	5	3	0	26	21	5	-	1.82	13.81	1.60	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-9	25.00	77	38		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
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SOIL CHARACTERISTICS

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		11-08-2021	to	13-08-2021	42+256 Major Bridge	BH-P16	Not Encountered	40.00 m	685765.737 m	3134166.127 m	(+)263.316 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction ($\varphi°$)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
UDS-7	26.50	-	-	Brown, Hard, Silty clay of low plasticity	CL		12	53	20	10	3	2	0	33	22	11	-	1.89	14.63	1.65	2.67	UUT	2.04	5	-	-	-	-	-	-	-	-	-
SPT-10	28.00	57	57		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	29.50	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-11	31.00	76	76		CL		14	46	17	12	5	6	0	34	23	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	32.50	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-12	34.00	100 (27cm)	100 (27cm)		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-13	35.50	97	97		CL		13	44	19	15	4	3	2	34	22	12	-	1.95	16.00	1.68	2.68	UUT+	2.80	4	-	-	-	-	-	-	-	-
SPT-14	37.00	95	95		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-15	38.50	86	86		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-16	40.00	101 (27cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
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SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.					Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
						14-08-2021	to	16-08-2021	42+256 Major Bridge	BH-A2	Not Encountered	40.00 m	685746.693 m	3134176.656 m	(+)263.529 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																			
DS	0.00	-	-	Brown, Medium dense to dense, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	1.00	-	-		ML-CL		5	55	35	2	1	2	0	26	19	7	-	1.76	11.23	1.58	2.66	DST	0.21	24	-	-	-	-	-	-	-	-	-
SPT-1	2.50	20	26		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	4.00	-	-		ML-CL		6	55	33	2	1	3	0	26	20	6	-	1.80	11.86	1.61	2.67	DST	0.18	26	-	-	-	-	-	-	-	-	-
SPT-2	5.50	34	34		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	7.00	-	-	Brown, very dense, Sandy silt of low plasticity	ML-CL		8	60	25	3	2	2	0	28	21	7	-	1.82	12.46	1.62	2.66	DST	0.19	27	-	-	-	-	-	-	-	-	-
SPT-3	8.50	51	44		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	10.00	-	-		ML-CL		6	59	29	2	2	2	0	27	20	7	-	1.83	12.91	1.62	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-4	11.50	50	38		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-5	13.00	-	-		ML-CL		6	52	33	4	2	3	0	26	20	6	-	1.83	13.44	1.61	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-5	14.50	52	35		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-6	16.00	-	-		ML-CL		5	53	37	2	1	2	0	26	19	7	-	1.84	13.88	1.62	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-6	17.50	65	40		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-7	19.00	-	-		ML-CL		7	49	32	6	2	3	1	27	20	7	-	1.84	14.26	1.61	2.66	DST	0.16	27	-	-	-	-	-	-	-	-	-
SPT-7	20.50	61	34		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-8	22.00	-	-		ML-CL		7	46	35	3	4	5	0	27	21	6	-	1.84	14.79	1.60	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	23.50	62	32		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-9	25.00	-	-		ML-CL		6	66	24	2	1	1	0	26	21	5	-	1.84	15.13	1.60	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-9	26.50	70	33		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-10	28.00	-	-		ML-CL		8	55	26	3	2	6	0	28	22	6	-	1.84	15.88	1.59	-	-	-	-	-	-	-	-	-	-	-	-	-

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SOIL CHARACTERISTICS

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							14-08-2021	to	16-08-2021	42+256 Major Bridge	BH-A2	Not Encountered	40.00 m	685746.693 m	3134176.656 m	(+)263.529 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction ($\varphi°$)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																			
SPT-10	29.50	58	27	Brown, very dense, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-11	31.00	-	-		ML-CL		7	64	22	3	1	3	0	28	21	7	-	1.88	16.23	1.62	2.66	DST	0.20	27	-	-	-	-	-	-	-	-	-
SPT-11	32.50	80	37		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-12	34.00	-	-		ML-CL		6	47	29	4	2	12	0	27	20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-12	35.50	100 (22cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-13	37.00	100 (23cm)	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-14	38.50	>100	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-15	40.00	>100	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

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		21-10-2021	to	21-10-2021	43+100	BH-PLT-02	Not encountered	12.00 m	685434.986 m	3134725.214 m	-	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Brown, Loose, Silty sand with clay	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	0.75	-	-		SM-SC		4	43	45	6	1	1	0	25	20	5	-	1.67	11.31	1.50	2.65	DST	0.09	26	-	-	-	-	-	-	-	-	-
SPT-1	1.50	8	12		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-2	2.25	16	21	Brown, Medium dense to dense, Silty sand with clay	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-3	3.00	33	40		SM-SC		5	38	48	3	2	4	0	26	20	6	-	1.80	12.47	1.60	2.65	DST	0.11	28	-	-	-	-	-	-	-	-	-
SPT-4	3.75	29	33		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	4.50	-	-	Brown, Medium dense to dense, Sandy silt of low plasticity	ML-CL		7	56	27	4	2	4	0	27	20	7	-	1.83	14.61	1.60	2.66	DST	0.18	26	-	-	-	-	-	-	-	-	-
SPT-5	5.00	32	33		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-6	6.00	24	24		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	7.50	-	-		ML-CL		6	57	31	1	2	3	0	26	20	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-7	9.00	33	28		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	10.50	-	-	Brown, Hard, Silty clay of low plasticity with gravel	CL		9	55	23	6	2	5	0	31	20	11	-	1.90	18.20	1.61	2.68	UUT	1.30	5	-	-	-	-	-	-	-	-	-
SPT-8	12.00	38	38		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEGTH
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SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.						Date of Boring			Chainage (km.)/Location		B.H. No.		Depth of Water Table		Termination Depth		Cordinates (E,N)						R.L.		Ref. Code			
							27-01-2022	to	27-01-2022	43+452		BH-CL		Not Encountered		15.00 m		685239.663 m						(+)258.485 m		SR-544_21-22			
Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction ($\varphi°$)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																			
DS	0.00	-	-	Brown, Loose to medium dense, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	0.50	6	11		ML-CL		7	48	36	5	3	1	0	27	20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-2	1.50	7	10		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.25	-	-		ML-CL		6	49	38	4	2	1	0	26	20	6	-	1.70	13.46	1.50	2.66	DST	0.08	28	-	-	-	-	-	-	-	-	-
SPT-3	3.00	11	13		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-4	4.50	13	14		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	5.25	-	-		ML-CL		6	49	32	2	3	8	0	26	20	6	-	1.89	15.23	1.64	2.65	DST	0.21	29	-	-	-	-	-	-	-	-	-
SPT-5	6.00	55	54		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-6	7.50	53	48		ML-CL		7	48	33	4	1	7	0	26	19	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	8.25	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-7	9.00	69	58		ML-CL		7	45	36	4	2	6	0	27	20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	10.00	73	59	Brown, Very dense, Sandy silt of low plasticity with gravel	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	11.25	-	-		ML-CL		8	43	34	5	3	7	0	28	21	7	-	1.94	18.22	1.64	2.66	DST	0.19	30	-	-	-	-	-	-	-	-	-
SPT-9	12.00	65	48		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-10	13.50	71	50		ML-CL		6	45	31	7	2	9	0	26	20	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	14.25	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-11	15.00	60	40		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEGTH
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SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		25-01-2022	to	25-01-2022	43+585	BH-CL	Not Encountered	15.00 m	685158.018 m	3135122.226 m	(+)258.478 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction ($\varphi°$)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Brown, Loose to medium dense, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	0.50	5	9		ML-CL		6	50	38	4	2	0	0	26	20	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-2	1.50	8	12		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.25	-	-		ML-CL		7	44	36	8	4	1	0	27	20	7	-	1.70	13.06	1.50	2.66	DST	0.20	24	-	-	-	-	-	-	-	-	-	-
SPT-3	3.00	11	14		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-4	4.50	15	16		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	5.25	-	-	Brown, Very stiff to hard, Silty clay of low plasticity	CL		11	47	28	3	6	5	0	31	20	11	-	1.88	16.48	1.61	2.68	UUT	1.29	4	-	-	-	-	-	-	-	-	-	-
SPT-5	6.00	36	36		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-6	7.50	42	42		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	8.25	-	-	Brown, Dense to very dense, Sandy silt of low plasticity	ML-CL		8	44	35	4	2	7	0	28	21	7	-	1.91	17.13	1.63	2.65	DST	0.18	29	-	-	-	-	-	-	-	-	-	-
SPT-7	9.00	51	43		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	10.50	57	45		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	11.25	-	-		ML-CL		7	44	33	7	3	6	0	26	19	7	-	1.92	17.65	1.63	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-9	12.00	46	34		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-10	13.50	55	38		ML-CL		7	44	35	4	2	8	0	27	20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	14.25	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-11	15.00	71	47		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

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SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		24-01-2022	to	24-01-2022	43+732	BH-CL	Not Encountered	15.00 m	685068.353 m	31352318.709 m	(+)257.686 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Brown, Loose to medium dense, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	0.50	7	13		ML-CL		6	48	38	5	3	0	0	26	20	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-2	1.50	8	12		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.25	-	-		ML-CL		7	47	36	7	2	1	0	27	20	7	-	1.69	12.86	1.50	2.66	DST	0.18	24	-	-	-	-	-	-	-	-	-	-
SPT-3	3.00	12	15		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-4	4.50	19	19	Brown, Very stiff to hard, Silty clay of low plasticity	CL		10	49	31	3	5	2	0	30	20	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	5.25	-	-		CL		12	50	27	7	2	2	0	33	22	11	-	1.81	15.91	1.56	2.67	UUT	0.75	5	-	-	-	-	-	-	-	-	-	-
SPT-5	6.00	24	24		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-6	7.50	34	34		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	8.25	-	-		CL		11	47	26	8	4	4	0	32	21	11	-	1.87	16.78	1.60	2.68	UUT	1.05	4	-	-	-	-	-	-	-	-	-	-
SPT-7	9.00	27	27		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	10.50	32	32		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	11.25	-	-	Brown, Dense to very dense, Sandy silt of low plasticity	ML-CL		8	43	37	6	2	4	0	28	21	7	-	1.89	17.19	1.61	2.65	DST	0.19	28	-	-	-	-	-	-	-	-	-	-
SPT-9	12.00	41	31		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-10	13.50	45	32		ML-CL		7	46	36	2	4	5	0	27	20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	14.25	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-11	15.00	66	44		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEGTH
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SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		23-01-2022	to	23-01-2022	44+050	BH-CL	Not Encountered	15.00 m	684905.712 m	3135511.319 m	(+)256.063 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Brown, Loose to medium dense, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	0.50	5	9		ML-CL		6	50	38	4	2	0	0	26	20	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-2	1.50	8	12		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	2.25	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-3	3.00	11	14		ML-CL		7	47	36	7	1	2	0	27	20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-4	4.50	15	16		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	5.25	-	-	Brown, Hard, Silty clay of low plasticity	CL		11	49	29	5	2	4	0	31	20	11	-	1.86	16.23	1.60	2.68	UUT	1.02	5	-	-	-	-	-	-	-	-	-	-	-
SPT-5	6.00	30	30		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-6	7.50	30	30		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	8.25	-	-		CL		12	48	24	8	4	4	0	32	21	11	-	1.89	17.10	1.61	2.67	UUT	1.19	4	-	-	-	-	-	-	-	-	-	-	-
SPT-7	9.00	35	35		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	10.50	45	45	Brown, Very dense, Sandy silt of low plasticity with grvael	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	11.25	-	-		ML-CL		8	45	31	6	3	7	0	28	21	7	-	1.92	17.86	1.63	2.65	DST	0.19	29	-	-	-	-	-	-	-	-	-	-	-
SPT-9	12.00	53	39		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-10	13.50	61	43		ML-CL		7	45	34	4	2	8	0	27	20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	14.25	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-11	15.00	65	43		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEGTH
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AND RESEARCH CENTRE PVT LTD

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		21-01-2022	to	21-01-2022	44+116	BH-CL	Not Encountered	15.00 m	684877.774 m	3135571.113 m	(+)256.889 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Brown, Loose, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	0.50	7	13		ML-CL		7	46	38	5	3	1	0	27	20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-2	1.50	10	15		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	2.25	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-3	3.00	16	16	Brown, Very stiff, Silty clay of low plasticity	CL		11	49	30	6	2	2	0	31	20	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-4	4.50	25	25		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	5.25	-	-		CL		12	51	26	3	5	3	0	32	21	11	-	1.85	16.85	1.58	2.68	UUT	0.82	5	-	-	-	-	-	-	-	-	-
SPT-5	6.00	31	31		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-6	7.50	25	25		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	8.25	-	-	Brown, Very dense, Sandy silt of low plasticity	ML-CL		8	54	27	4	1	6	0	28	21	7	-	1.92	17.63	1.63	2.65	DST	0.22	28	-	-	-	-	-	-	-	-	-
SPT-7	9.00	51	43		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	10.00	55	44		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	11.25	-	-		ML-CL		6	46	31	7	2	8	0	26	20	6	-	1.94	18.10	1.64	2.65	DST	0.24	28	-	-	-	-	-	-	-	-	-
SPT-9	12.00	59	44		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-10	13.50	64	45		ML-CL		7	48	29	5	3	8	0	27	20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	14.25	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-11	15.00	73	48		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEGTH
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SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		20-01-2022	to	20-01-2022	44+317 Minor Bridge	BH-CL	Not Encountered	10.00 m	684793.328 m	3135753.513 m	(+)254.620 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Brown, Loose, Silty sand	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	0.50	5	9		SM		0	14	76	8	2	0	0	-	Nil	NP	-	1.64	11.00	1.48	2.62	DST+	0.00	28	-	-	-	-	-	-	-	-
SPT-2	1.50	8	12		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	2.25	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-3	3.00	17	21	Brown, Medium dense, Sandy silt of low plasticity	ML-CL		6	53	31	5	3	2	0	26	20	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-4	4.50	29	32		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	5.25	-	-		ML-CL		7	56	26	7	1	3	0	27	20	7	-	1.82	15.23	1.58	2.66	DST	0.18	25	-	-	-	-	-	-	-	-
SPT-5	6.00	23	23	Brown, Very stiff to hard, Silty clay of low plasticity	CL		11	49	31	4	2	3	0	31	20	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-6	7.50	31	31		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	8.25	-	-		CL		12	48	26	6	3	5	0	32	21	11	-	1.89	17.25	1.61	2.68	UUT	1.16	5	-	-	-	-	-	-	-	-
SPT-7	9.00	39	39		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	10.00	44	44		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEGTH
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SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		19-01-2022	to	19-01-2022	44+641	BH-CL	Not Encountered	10.00 m	684668.530 m	3136052.232 m	(+)256.869 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Brown, Loose to medium dense, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	0.50	6	11		ML-CL		7	50	36	4	2	1	0	27	20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-2	1.50	11	16		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	2.25	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-3	3.00	12	15		ML-CL		8	45	38	4	3	2	0	28	21	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-4	4.50	20	22	Brown, Very stiff, Silty clay of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	5.25	-	-		CL		12	51	27	6	2	2	0	32	21	11	-	1.82	16.74	1.56	2.67	UUT	0.75	5	-	-	-	-	-	-	-	-	-	-	-
SPT-5	6.00	20	20		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-6	7.50	25	25		CL		11	48	29	5	3	4	0	31	20	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	8.25	-	-	Brown, Dense to very dense, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-7	9.00	45	38		ML-CL		7	45	34	7	1	6	0	27	20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	10.00	52	42		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

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SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		18-01-2022	to	18-01-2022	44+910	BH-CL	Not Encountered	10.00 m	684609.724 m	3136314.389 m	(+)254.293 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Brown, Loose to medium dense, Silty sand with clay	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	0.50	7	13		SM-SC		5	43	45	6	1	0	0	25	20	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-2	1.50	7	10		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	2.25	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-3	3.00	12	15		SM-SC		6	38	43	8	3	2	0	26	20	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-4	4.50	14	15		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	5.25	-	-	Brown, Very stiff, Silty clay of low plasticity	CL		11	52	27	4	3	3	0	32	21	11	-	1.82	16.45	1.56	2.67	UUT	0.75	4	-	-	-	-	-	-	-	-	-	-	-
SPT-5	6.00	20	20		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-6	7.50	26	26		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	8.25	-	-	Brown, Dense, Sandy silt of low plasticity	ML-CL		8	43	37	3	4	5	0	28	21	7	-	1.89	17.63	1.61	2.66	DST	0.20	28	-	-	-	-	-	-	-	-	-	-	-
SPT-7	9.00	41	35		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	10.00	46	37		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

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SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		15-11-2021	to	15-11-2021	45+048	BH-CL	Not Encountered	10.00 m	684590.519 m	3136451.182 m	(+)253.929 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Brown, Loose to medium dense, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	0.50	5	9		ML-CL		7	54	31	6	1	1	0	27	20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-2	1.50	7	10		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.25	-	-		ML-CL		8	53	30	4	3	2	0	28	21	7	-	1.71	12.70	1.52	2.66	DST	0.20	24	-	-	-	-	-	-	-	-	-
SPT-3	3.00	12	14		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-4	4.50	20	20	Brown, Very stiff to hard, Silty clay of low plasticity with gravel	CL		10	52	28	5	2	3	0	31	21	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	5.25	-	-		CL		11	51	26	6	1	4	1	32	22	10	-	1.83	16.10	1.58	2.68	UUT	0.86	6	-	-	-	-	-	-	-	-	-
SPT-5	6.00	26	26		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-6	7.50	35	35		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	8.25	-	-		CL		12	49	24	7	3	5	0	33	22	11	-	1.86	16.47	1.60	2.67	UUT	1.04	6	-	-	-	-	-	-	-	-	-
SPT-7	9.00	29	29		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	10.00	34	34		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEGTH
CEG TEST HOUSE
AND RESEARCH CENTRE PVT LTD

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.						Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
							17-01-2022	to	17-01-2022	45+411 Minor Bridge	BH-CL	Not Encountered	10.00 m	684540.434 m	3136810.574 m	(+)253.338 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																			
DS	0.00	-	-	Brown, Loose, Silty sand	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	0.50	7	13		SM		0	20	67	11	2	0	0	-	Nil	NP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-2	1.50	8	12		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	2.25	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-3	3.00	16	20	Brown, Medium dense, Sandy silt of low plasticity	ML-CL		7	46	38	4	3	2	0	27	20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-4	4.50	25	27		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	5.25	-	-		ML-CL		6	45	33	12	1	3	0	26	20	6	-	1.81	14.26	1.58	2.66	DST	0.20	25	-	-	-	-	-	-	-	-	-
SPT-5	6.00	24	24		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-6	7.50	28	28	Brown, Very stiff to hard, Silty clay of low plasticity	CL		11	47	31	5	2	4	0	32	21	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	8.25	-	-		CL		12	50	26	4	3	5	0	33	22	11	-	1.88	17.25	1.60	2.68	UUT	1.06	4	-	-	-	-	-	-	-	-	-
SPT-7	9.00	32	32		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	10.00	34	34		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEGTH
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SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.					Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
						17-08-2021	to	18-08-2021	45+480 Major Bridge	BH-A1	16.00 m	29.50 m	684534.196 m	3136867.243 m	(+)254.056 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																			
DS	0.00	-	-	Brown, Medium dense to dense, Silty sand with clay	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	1.00	-	-		SM-SC		7	39	48	3	2	1	0	27	20	7	-	1.73	11.66	1.55	2.65	DST	0.09	27	-	-	-	-	-	-	-	-	-
SPT-1	2.50	15	19		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	4.00	-	-		SM-SC		6	37	52	2	3	0	0	26	20	6	-	1.75	11.89	1.56	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-2	5.50	22	22		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	7.00	-	-		SM-SC		7	34	47	6	4	2	0	26	19	7	-	1.77	12.16	1.58	2.64	DST	0.07	28	-	-	-	-	-	-	-	-	-
SPT-3	8.50	32	28		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	10.00	-	-	Brown, Dense to very dense, Sandy silt of low plasticity	ML-CL		7	52	29	3	5	3	1	27	20	7	-	1.84	14.19	1.61	2.67	DST	0.19	26	-	-	-	-	-	-	-	-	-
SPT-4	11.50	47	36		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-5	13.00	-	-		ML-CL		8	53	27	4	1	7	0	28	21	7	-	1.86	15.34	1.61	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-5	14.50	53	36		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-6	16.00	-	-		ML-CL		9	54	22	8	3	4	0	29	22	7	-	1.89	18.22	1.60	2.66	DST	0.20	27	-	-	-	-	-	-	-	-	-
SPT-6	17.50	62	28		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-7	19.00	-	-		ML-CL		7	55	30	2	1	5	0	27	20	7	-	1.90	19.06	1.60	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-7	20.50	77	31		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-8	22.00	-	-		ML-CL		6	57	27	5	3	2	0	26	20	6	-	1.98	20.11	1.65	2.66	DST	0.16	28	-	-	-	-	-	-	-	-	-
SPT-8	23.50	>100	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-9	25.00	>100	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-10	26.50	>100	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEGTH
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SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		17-08-2021	to	18-08-2021	45+480 Major Bridge	BH-A1	16.00 m	29.50 m	684534.196 m	3136867.243 m	(+)254.056 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
SPT-11	28.00	>100	-	Brown, Dense to very dense, Sandy silt of low plasticity	ML-CL		7	55	24	3	3	8	0	27	20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-12	29.50	>100	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEG TEST HOUSE

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.						Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
							17-08-2021	to	18-08-2021	45+480 Major Bridge	BH-A2	15.75 m	29.50 m	684529.247 m	3136889.146 m	(+)255.775 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																			
DS	0.00	-	-	Brown, Medium dense, Silty sand with clay	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	1.00	16	25		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.50	-	-		SM-SC		5	40	52	1	2	0	0	25	20	5	-	1.76	11.56	1.58	2.65	DST	0.09	28	-	-	-	-	-	-	-	-	-
SPT-2	4.00	21	23		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	5.50	-	-		SM-SC		5	39	50	3	2	1	0	25	20	5	-	1.77	11.92	1.58	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-3	7.00	27	25		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	8.50	-	-	Brown, Dense to very dense, Sandy silt of low plasticity	ML-CL		6	51	36	6	1	0	0	26	20	6	-	1.82	12.80	1.61	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-4	10.00	45	36		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	11.50	-	-		ML-CL		8	50	30	7	2	3	0	27	20	7	-	1.83	14.26	1.60	2.67	DST	0.21	26	-	-	-	-	-	-	-	-	-
SPT-5	13.00	43	31		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-5	14.50	-	-		ML-CL		7	55	28	1	3	6	0	26	19	7	-	1.86	16.22	1.60	2.67	-	-	-	-	-	-	-	-	-	-	-	-
SPT-6	16.00	66	29		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-6	17.50	-	-		ML-CL		8	55	25	5	2	4	1	28	21	7	-	1.90	18.04	1.61	2.66	DST	0.18	27	-	-	-	-	-	-	-	-	-
SPT-7	19.00	77	32		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-7	20.50	-	-		ML-CL		7	52	31	3	2	5	0	26	20	6	-	1.91	18.63	1.61	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	22.00	90	35		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-8	23.50	-	-		ML-CL		8	49	28	4	2	9	0	27	20	7	-	1.96	19.07	1.65	2.67	DST	0.15	28	-	-	-	-	-	-	-	-	-
SPT-9	25.00	>100	-				-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-10	26.50	>100	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

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		17-08-2021	to	18-08-2021	45+480 Major Bridge	BH-A2	15.75 m	29.50 m	684529.247 m	3136889.146 m	(+)255.775 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction ($\varphi°$)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
SPT-11	28.00	>100	-	Brown, Dense to very dense, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-12	29.50	>100	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

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DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

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						14-11-2021	to	15-11-2021	45+612 Minor Bridge	BH-CL	Not Encountered	10.00 m	684512.699 m	3137009.651 m	(+)254.161 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																			
DS	0.00	-	-	Brown, Loose, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	0.50	5	9		ML-CL		7	48	39	5	1	0	0	27	20	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-2	1.50	9	13		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.25	-	-		ML-CL		6	47	35	7	3	2	0	26	20	6	-	1.67	12.64	1.48	2.66	DST	0.19	24	-	-	-	-	-	-	-	-	-
SPT-3	3.00	15	15	Brown, Very stiff to hard, Silty clay of low plasticity	CL		11	48	31	4	3	3	0	31	20	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-4	4.50	22	22		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	5.25	-	-		CL		10	48	29	6	4	3	0	30	20	10	-	1.82	15.78	1.57	2.68	UUT	0.82	5	-	-	-	-	-	-	-	-	-
SPT-5	6.00	28	28		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-6	7.50	32	32		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	8.25	-	-	Brown, Dense, Sandy silt of low plasticity	ML-CL		8	56	24	5	2	5	0	28	21	7	-	1.86	16.12	1.60	2.65	DST	0.21	27	-	-	-	-	-	-	-	-	-
SPT-7	9.00	34	29		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	10.00	41	33		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

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SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		16-01-2022	to	16-01-2022	45+984	BH-CL	Not Encountered	15.00 m	684458.641 m	3137377.674 m	(+)257.656 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Brown, Loose, Silty sand	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	0.50	5	9		SM		0	15	74	9	2	0	0	-	Nil	NP	-	1.63	11.00	1.47	2.62	DST+	0.00	28	-	-	-	-	-	-	-	-
SPT-2	1.50	6	9		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	2.25	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-3	3.00	23	29	Brown, Medium dense to very dense, Sandy silt of low plasticity	ML-CL		6	46	39	4	2	3	0	26	20	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-4	4.50	26	29		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	5.25	-	-		ML-CL		7	45	35	5	3	5	0	27	20	7	-	1.84	15.26	1.60	2.65	DST	0.20	27	-	-	-	-	-	-	-	-
SPT-5	6.00	44	44		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-6	7.50	47	43		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	8.25	-	-		ML-CL		7	45	36	3	5	4	0	26	19	7	-	1.87	16.74	1.60	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-7	9.00	31	26		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	10.00	37	30		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	11.25	-	-		ML-CL		6	46	34	6	2	6	0	26	20	6	-	1.91	17.60	1.62	2.65	DST	0.20	28	-	-	-	-	-	-	-	-
SPT-9	12.00	47	35		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-10	13.50	55	39		ML-CL		8	45	35	5	2	5	0	28	21	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	14.25	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-11	15.00	58	39		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

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SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		14-11-2021	to	14-11-2021	46+400	BH-CL	Not Encountered	10.00 m	684341.186 m	3137776.436 m	(+)257.489 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Brown, Medium dense, Silty sand	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	0.50	10	18		SM		0	22	70	7	1	0	0	-	Nil	NP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-2	1.50	17	25		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.25	-	-		SM		0	26	67	4	2	1	0	-	Nil	NP	-	1.73	11.36	1.55	2.62	DST	0.00	29	-	-	-	-	-	-	-	-	-
SPT-3	3.00	33	40	Brown, Dense, Sandy silt of low plasticity	ML-CL		5	50	35	6	2	2	0	26	20	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-4	4.50	29	32		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	5.25	-	-		ML-CL		8	44	37	6	1	4	0	27	20	7	-	1.84	14.26	1.61	2.66	DST	0.21	26	-	-	-	-	-	-	-	-	-
SPT-5	6.00	35	34		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-6	7.50	39	35		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	8.25	-	-		ML-CL		7	44	35	7	2	5	0	28	21	7	-	1.86	15.34	1.61	2.66	DST	0.20	27	-	-	-	-	-	-	-	-	-
SPT-7	9.00	43	36		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	10.00	47	38		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbrevjations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

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RESULT OF CHEMICAL ANALYSIS OF SOIL SAMPLES

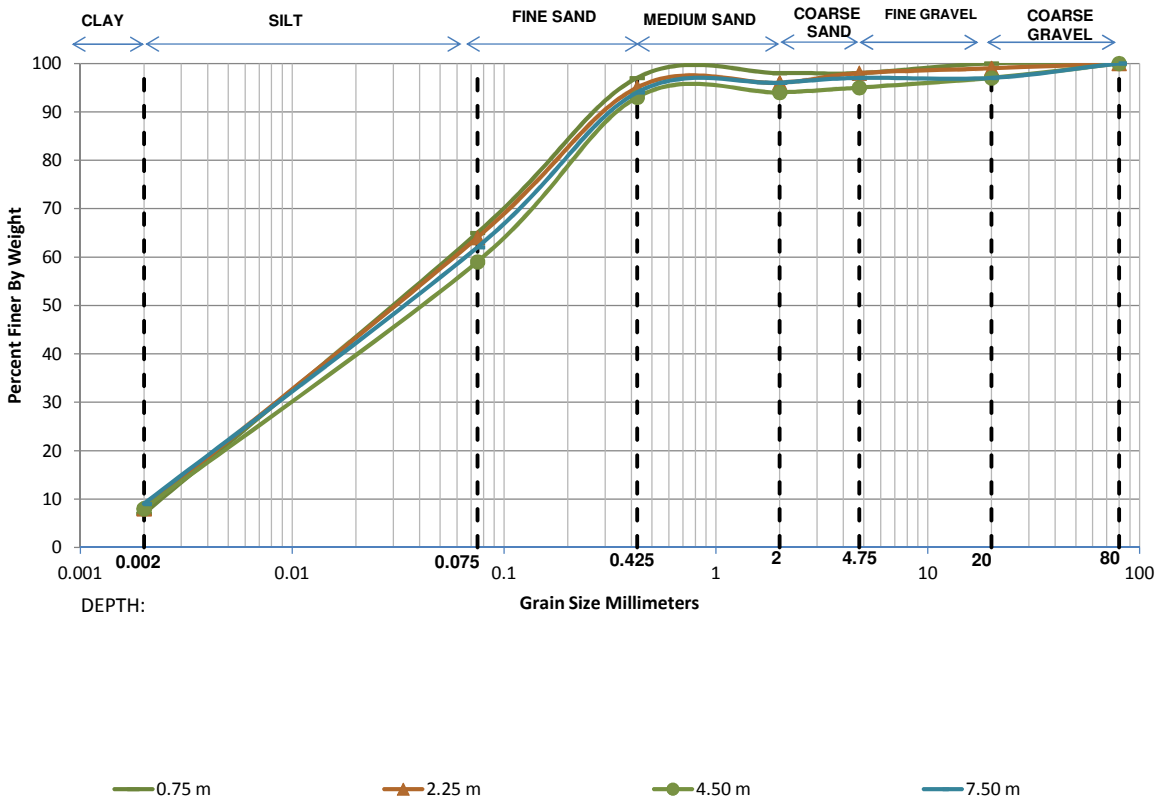
Sr. No	Chainage Old (km)	Chainage New (km)	BH No.	Depth of collected sample (m)	pH	Chlorides (Cl^-)		Sulphate (SO_3^{2-})	
						(mg/kg)	(%)	(mg/kg)	(%)
1.	29+487	30+155	BH-A1	2.50	8.67	59.28	0.0059	23.08	0.0023
2.			BH-A2	13.00	8.52	65.17	0.0065	25.46	0.0025
3.	30+488	33+673	BH-A1	2.50	9.10	72.23	0.0072	19.14	0.0019
4.			BH-A2	16.0	8.50	80.67	0.0080	28.31	0.0028
5.	31+714	34+899	BH-A1	1.0	7.95	50.11	0.0050	23.35	0.0023
6.			BH-A2	17.50	8.65	55.68	0.0055	23.21	0.0023
7.	33+713	36+984	BH-A1	2.50	9.01	64.55	0.0064	21.11	0.0021
8.			BH-A2	17.50	9.70	61.70	0.0062	30.20	0.0030
9.	35+273	38+457	BH-A1	2.50	7.11	78.43	0.0078	16.04	0.0016
10.			BH-A2	16.00	7.56	77.71	0.0077	21.40	0.0021
11.	36+816	40+003	BH-A1	2.50	8.21	65.23	0.0065	24.56	0.0024
12.			BH-A2	16.0	8.11	68.45	0.0068	29.54	0.0029
13.	41+056	42+246	BH-A1	1.00	7.58	72.15	0.0072	31.12	0.0031
14.			BH-A2	17.50	8.01	68.95	0.0068	32.45	0.0032
15.	41+390	44+571	BH-A1	1.00	7.55	58.46	0.0058	28.45	0.0028
16.			BH-A2	17.50	8.01	60.14	0.0060	29.44	0.0029
17.	42+256	45+497	BH-P1	2.50	8.12	58.22	0.0058	18.54	0.0018
18.			BH-P2	16.00	8.55	61.41	0.0061	19.44	0.0019
19.	45+480	48+664	BH-A1	1.00	7.41	55.00	0.0055	20.12	0.0020
20.			BH-A2	14.50	7.88	58.65	0.0058	17.44	0.0017

RESULT OF CHEMICAL ANALYSIS OF WATER SAMPLE

Sr. No	Chainage Old	Chainage New	BH No.	pH	Chlorides (Cl^-) (mg/l)	Sulphate (SO_3^{2-}) (mg/l)
1.	29+487	30+155	BH-A1	8.61	48.08	19.61
2.	30+488	33+673	BH-A1	8.80	55.25	17.07
3.	31+714	34+899	BH-A2	9.29	68.84	23.81
4.	33+713	36+984	BH-A1	8.69	52.81	23.09
5.	35+273	38+457	BH-A2	8.58	49.36	23.21
6.	36+816	40+003	BH-A2	9.31	62.55	29.66
7.	41+056	42+246	BH-A1	8.59	54.27	30.57
8.	41+390	44+571	BH-A2	7.67	38.55	18.38
9.	42+256	45+497	BH-A2	7.85	28.32	15.35
10.	45+480	48+664	BH-A1	7.38	48.80	17.88

GRAIN SIZE DISTRIBUTION CURVES

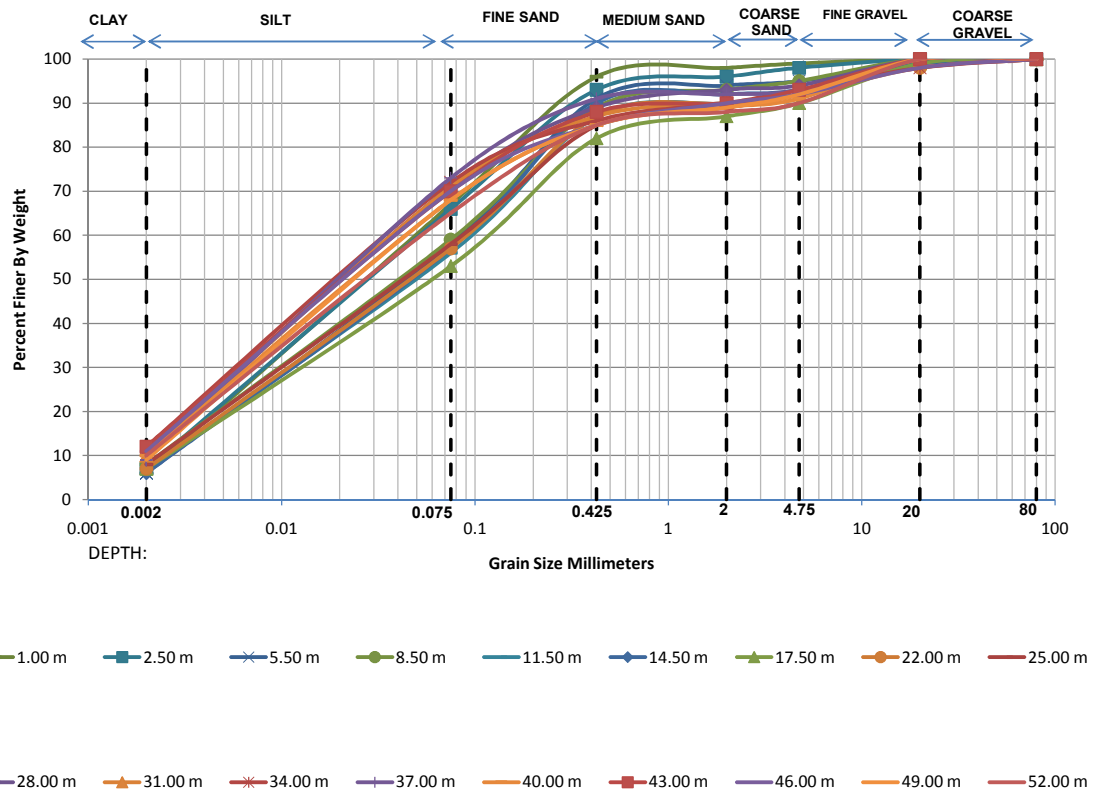
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	Dhulawat
B.H. No.	PLT-06



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
0.75 m	7.00	58.00	32.00	1.00	0.00	2.00	0.00	0.0035	0.0188	0.0642	18.40	1.58
2.25 m	8.00	56.00	31.00	1.00	2.00	1.00	1.00	0.0029	0.0181	0.0660	22.82	1.71
4.50 m	8.00	51.00	34.00	1.00	1.00	2.00	3.00	0.0029	0.0205	0.0777	26.56	1.85
7.50 m	9.00	53.00	32.00	2.00	1.00	0.00	3.00	0.0024	0.0179	0.0702	29.25	1.91

GRAIN SIZE DISTRIBUTION CURVES

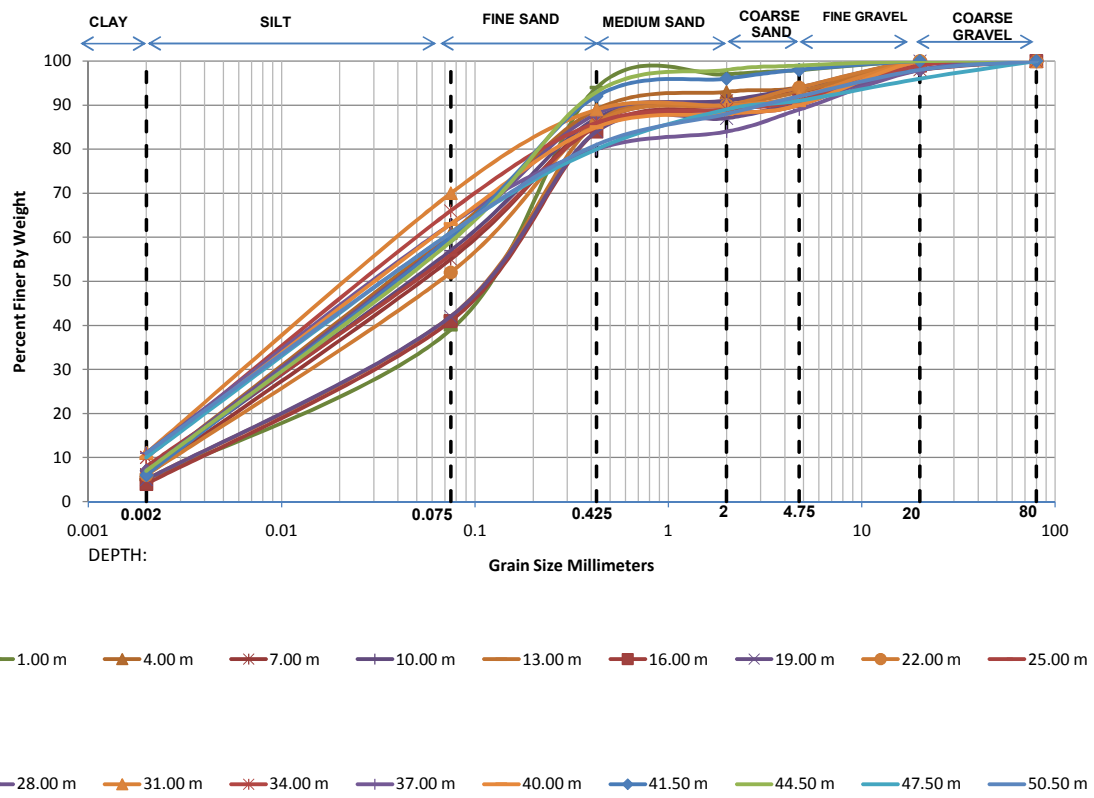
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	29+487 Major Bridge
B.H. No.	BH-A1



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
1.00 m	6.00	61.00	29.00	2.00	1.00	1.00	0.00	0.0042	0.0191	0.0608	14.51	1.44
2.50 m	7.00	59.00	27.00	3.00	2.00	2.00	0.00	0.0035	0.0182	0.0622	17.90	1.54
5.50 m	6.00	52.00	33.00	3.00	1.00	4.00	1.00	0.0044	0.0233	0.0807	18.51	1.54
8.50 m	8.00	51.00	30.00	4.00	2.00	5.00	0.00	0.0029	0.0203	0.0778	26.63	1.81
11.50 m	7.00	49.00	31.00	3.00	2.00	8.00	0.00	0.0036	0.0232	0.0890	24.72	1.68
14.50 m	6.00	51.00	33.00	2.00	1.00	6.00	1.00	0.0044	0.0238	0.0842	19.21	1.54
17.50 m	7.00	46.00	29.00	5.00	3.00	9.00	1.00	0.0036	0.0252	0.1078	29.56	1.61
22.00 m	7.00	50.00	30.00	3.00	2.00	6.00	2.00	0.0036	0.0225	0.0849	23.70	1.66
25.00 m	8.00	50.00	27.00	4.00	3.00	8.00	0.00	0.0029	0.0207	0.0815	27.86	1.79
28.00 m	11.00	60.00	18.00	4.00	1.00	6.00	0.00	-	0.0127	0.0523	-	-
31.00 m	10.00	61.00	16.00	3.00	2.00	8.00	0.00	0.0020	0.0135	0.0525	26.26	1.73
34.00 m	12.00	60.00	14.00	4.00	3.00	5.00	2.00	-	0.0116	0.0502	-	-
37.00 m	9.00	64.00	18.00	1.00	1.00	7.00	0.00	0.0024	0.0140	0.0502	21.08	1.63
40.00 m	10.00	58.00	17.00	4.00	2.00	9.00	0.00	0.0020	0.0143	0.0574	28.72	1.78
43.00 m	12.00	58.00	18.00	2.00	3.00	7.00	0.00	-	0.0121	0.0535	-	-
46.00 m	11.00	59.00	15.00	5.00	2.00	6.00	2.00	-	0.0129	0.0537	-	-
49.00 m	9.00	59.00	17.00	4.00	3.00	8.00	0.00	0.0024	0.0152	0.0577	24.18	1.68
52.00 m	10.00	55.00	20.00	3.00	2.00	10.00	0.00	0.0020	0.0153	0.0632	31.62	1.86

GRAIN SIZE DISTRIBUTION CURVES

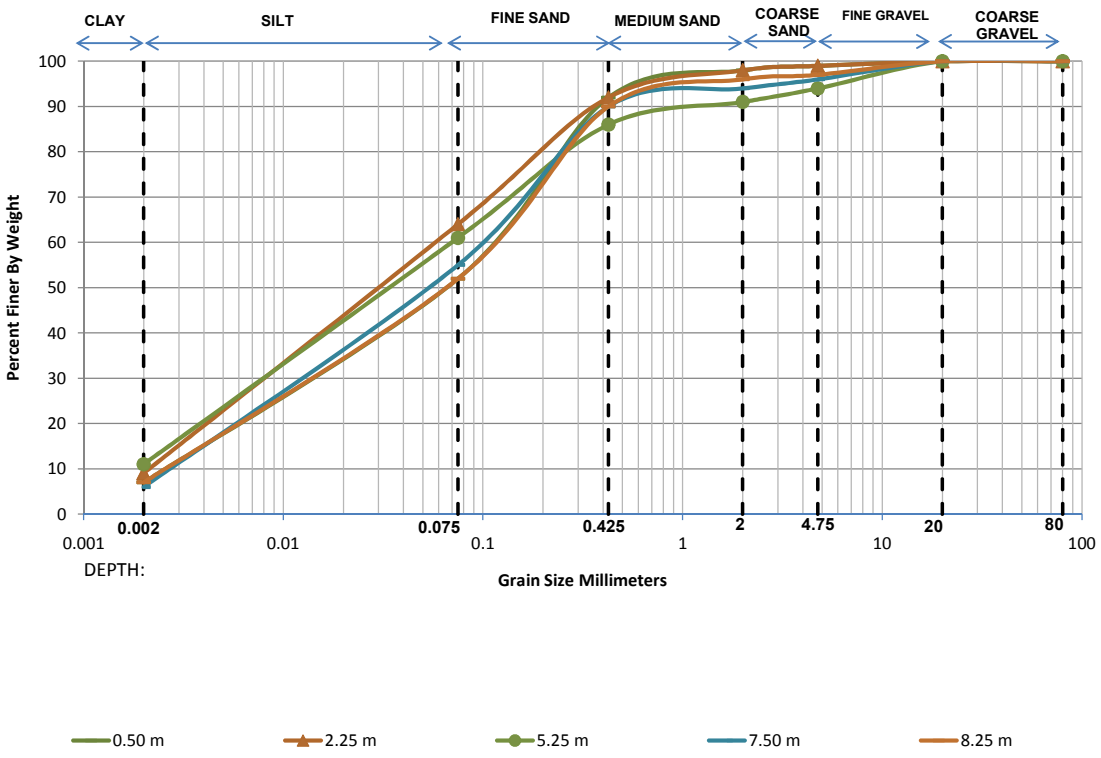
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	29+487 Major Bridge
B.H. No.	BH-A2



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
1.00 m	5.00	34.00	55.00	3.00	1.00	2.00	0.00	0.0067	0.0479	0.1525	22.73	2.24
4.00 m	7.00	54.00	28.00	4.00	1.00	6.00	0.00	0.0035	0.0203	0.0726	20.57	1.61
7.00 m	6.00	49.00	31.00	5.00	2.00	5.00	2.00	0.0044	0.0250	0.0939	21.20	1.50
10.00 m	7.00	50.00	30.00	4.00	3.00	6.00	0.00	0.0036	0.0225	0.0850	23.71	1.66
13.00 m	5.00	37.00	44.00	4.00	3.00	7.00	0.00	0.0063	0.0414	0.1548	24.66	1.76
16.00 m	4.00	37.00	43.00	5.00	2.00	8.00	1.00	0.0079	0.0441	0.1641	20.75	1.50
19.00 m	5.00	37.00	42.00	3.00	4.00	9.00	0.00	0.0063	0.0412	0.1592	25.42	1.70
22.00 m	6.00	46.00	34.00	4.00	4.00	6.00	0.00	0.0045	0.0274	0.1080	23.87	1.54
25.00 m	8.00	48.00	29.00	3.00	2.00	10.00	0.00	0.0029	0.0220	0.0899	30.57	1.82
28.00 m	7.00	53.00	28.00	2.00	1.00	7.00	2.00	0.0035	0.0208	0.0750	21.18	1.63
31.00 m	11.00	59.00	19.00	1.00	2.00	8.00	0.00	-	0.0130	0.0539	-	-
34.00 m	10.00	56.00	20.00	3.00	2.00	8.00	1.00	0.0020	0.0150	0.0613	30.63	1.84
37.00 m	11.00	52.00	17.00	4.00	5.00	9.00	2.00	-	0.0150	0.0673	-	-
40.00 m	10.00	53.00	22.00	3.00	2.00	10.00	0.00	0.0020	0.0161	0.0676	33.81	1.93
41.50 m	6.00	54.00	32.00	4.00	2.00	2.00	0.00	0.0043	0.0221	0.0750	17.38	1.51
44.50 m	7.00	52.00	34.00	5.00	1.00	1.00	0.00	0.0036	0.0216	0.0776	21.79	1.68
47.50 m	10.00	51.00	19.00	9.00	2.00	5.00	4.00	0.0020	0.0168	0.0724	36.19	1.95
50.50 m	11.00	50.00	20.00	7.00	4.00	6.00	2.00	-	0.0159	0.0723	-	-

GRAIN SIZE DISTRIBUTION CURVES

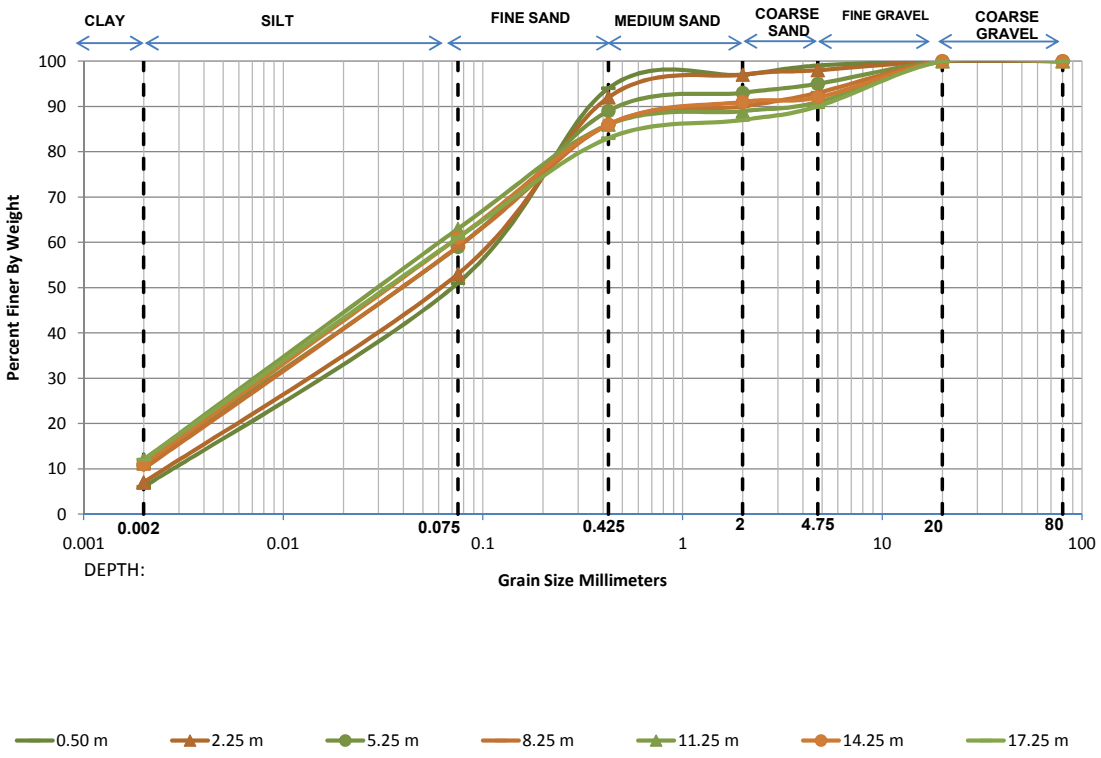
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	29+860 Minor Bridge
B.H. No.	BH-CL



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
0.50 m	7.00	45.00	40.00	6.00	1.00	1.00	0.00	0.0037	0.0267	0.1037	28.12	1.86
2.25 m	9.00	55.00	28.00	6.00	1.00	1.00	0.00	0.0024	0.0170	0.0657	27.44	1.83
5.25 m	11.00	50.00	25.00	5.00	3.00	6.00	0.00	-	0.0161	0.0724	-	-
7.50 m	6.00	49.00	35.00	4.00	2.00	4.00	0.00	0.0044	0.0252	0.0920	20.71	1.56
8.25 m	7.00	45.00	38.00	6.00	1.00	3.00	0.00	0.0037	0.0265	0.1051	28.52	1.82

GRAIN SIZE DISTRIBUTION CURVES

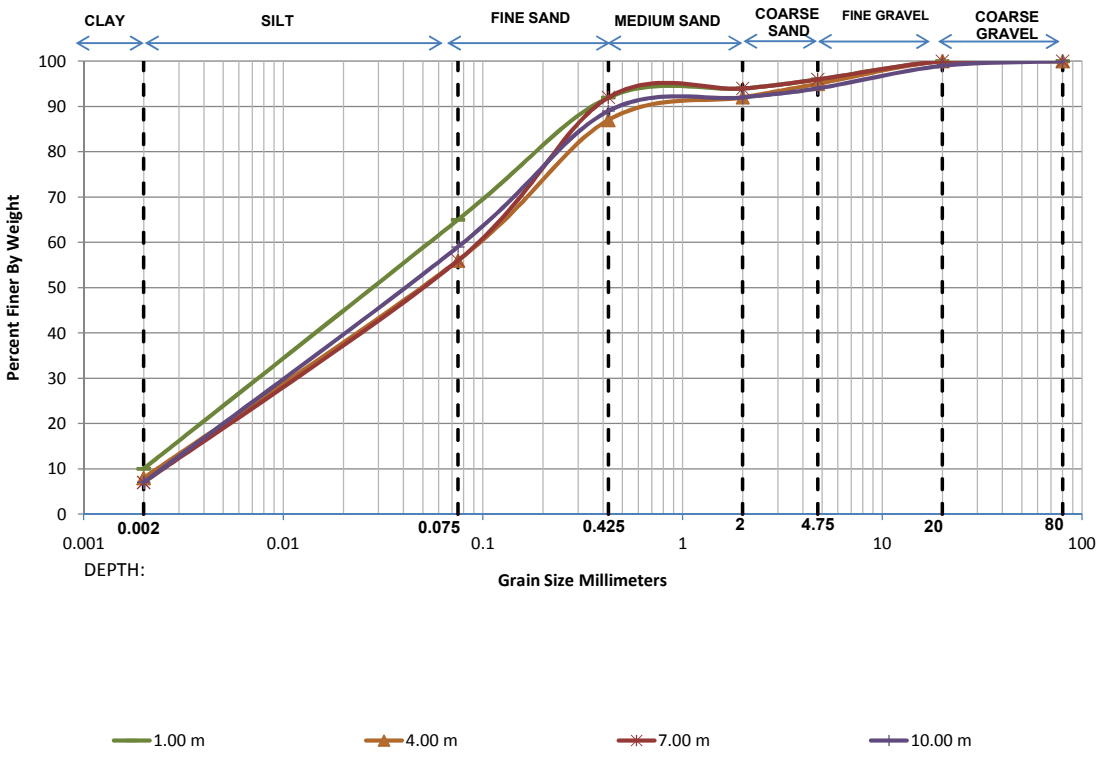
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	30+176 Minor Bridge
B.H. No.	BH-CL



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
0.50 m	6.00	45.00	43.00	3.00	2.00	1.00	0.00	0.0046	0.0289	0.1059	23.09	1.72
2.25 m	7.00	46.00	39.00	5.00	1.00	2.00	0.00	0.0037	0.0258	0.0995	27.13	1.82
5.25 m	11.00	48.00	30.00	4.00	2.00	5.00	0.00	-	0.0173	0.0779	-	-
8.25 m	10.00	49.00	27.00	4.00	3.00	7.00	0.00	0.0020	0.0181	0.0780	38.99	2.10
11.25 m	12.00	51.00	23.00	3.00	2.00	9.00	0.00	-	0.0144	0.0674	-	-
14.25 m	11.00	50.00	25.00	5.00	1.00	8.00	0.00	-	0.0161	0.0724	-	-
17.25 m	12.00	49.00	22.00	4.00	3.00	10.00	0.00	-	0.0151	0.0723	-	-

GRAIN SIZE DISTRIBUTION CURVES

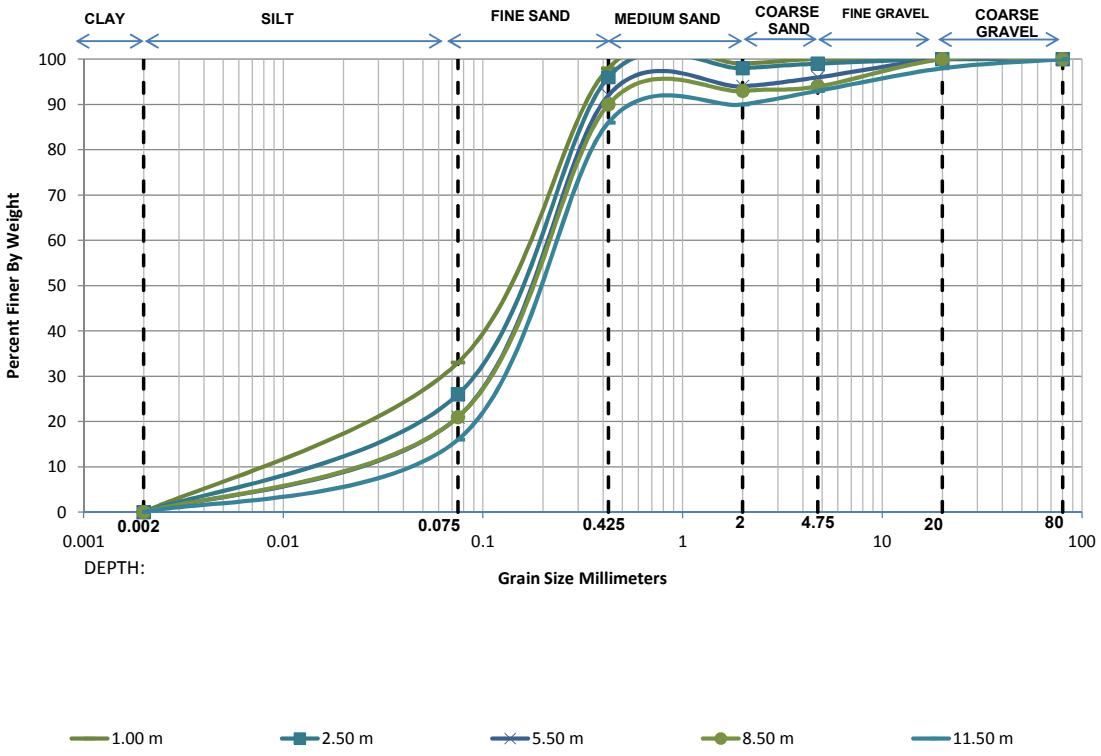
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	30+478 Minor Bridge
B.H. No.	BH-CL



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
1.00 m	10.00	55.00	27.00	2.00	2.00	4.00	0.00	0.0020	0.0156	0.0635	31.75	1.92
4.00 m	8.00	48.00	31.00	5.00	3.00	5.00	0.00	0.0029	0.0221	0.0893	30.33	1.85
7.00 m	7.00	49.00	36.00	2.00	2.00	4.00	0.00	0.0036	0.0235	0.0876	24.26	1.74
10.00 m	7.00	52.00	30.00	3.00	2.00	5.00	1.00	0.0036	0.0214	0.0777	21.86	1.65

GRAIN SIZE DISTRIBUTION CURVES

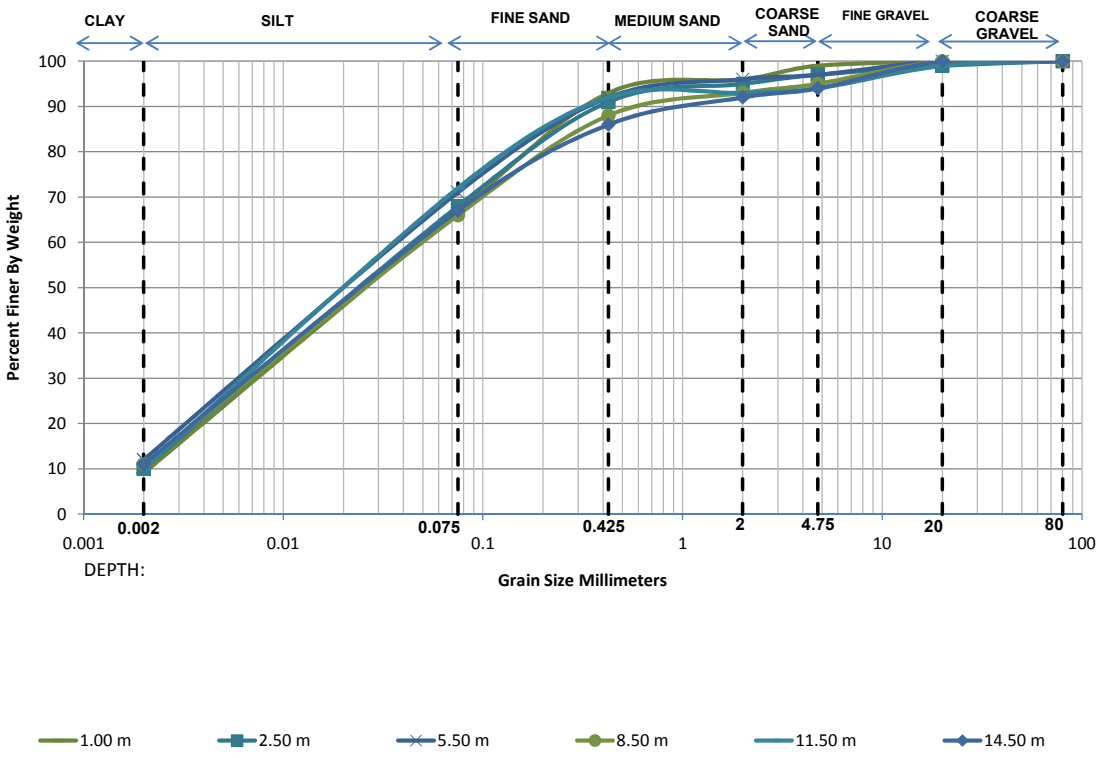
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	30+697 Minor Bridge
B.H. No.	BH-CL



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
1.00 m	0.00	33.00	65.00	1.00	1.00	0.00	0.00	0.0114	0.0655	0.1646	14.41	2.28
2.50 m	0.00	26.00	70.00	2.00	1.00	1.00	0.00	0.0176	0.0889	0.1904	10.83	2.36
5.50 m	0.00	21.00	71.00	2.00	2.00	4.00	0.00	0.0257	0.1087	0.2135	8.30	2.15
8.50 m	0.00	21.00	69.00	3.00	1.00	6.00	0.00	0.0256	0.1091	0.2182	8.52	2.13
11.50 m	0.00	16.00	70.00	4.00	3.00	5.00	2.00	0.0407	0.1320	0.2435	5.98	1.76

GRAIN SIZE DISTRIBUTION CURVES

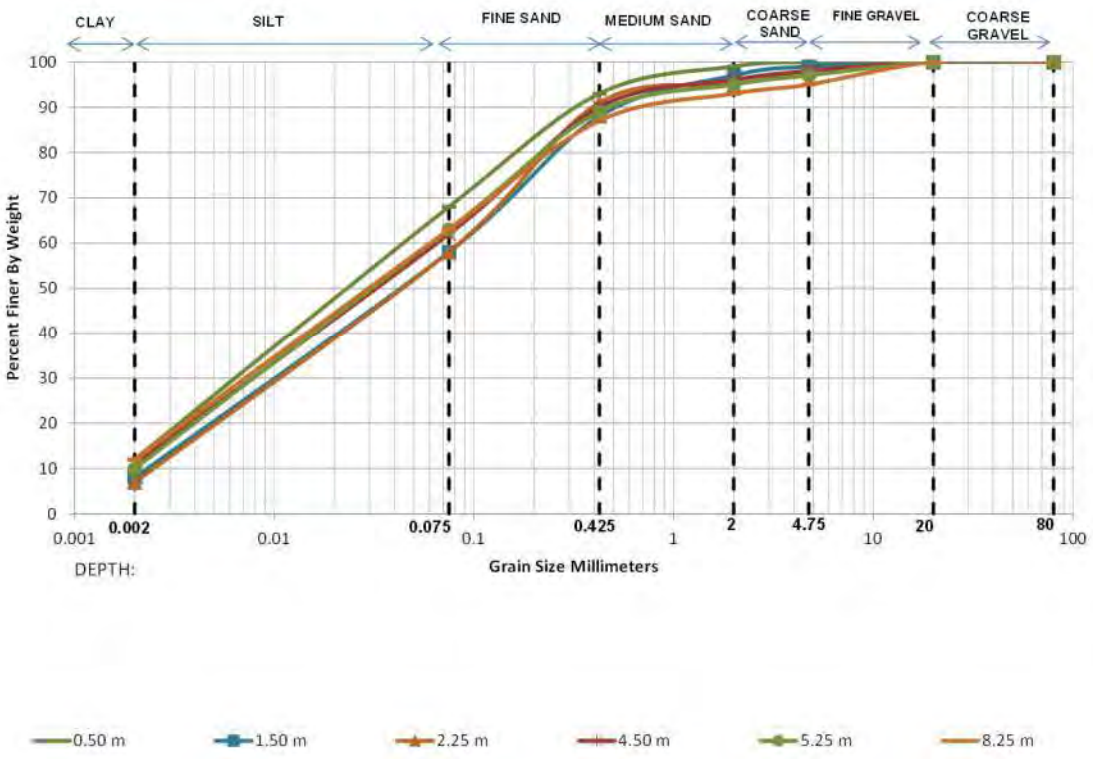
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	31+354 Minor Bridge
B.H. No.	BH-CL



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
1.00 m	9.00	58.00	26.00	3.00	3.00	1.00	0.00	0.0024	0.0158	0.0599	25.06	1.75
2.50 m	10.00	58.00	23.00	4.00	2.00	2.00	1.00	0.0020	0.0145	0.0577	28.86	1.82
5.50 m	12.00	59.00	21.00	4.00	1.00	3.00	0.00	-	0.0120	0.0521	-	-
8.50 m	11.00	55.00	22.00	5.00	2.00	5.00	0.00	-	0.0142	0.0611	-	-
11.50 m	10.00	62.00	20.00	1.00	1.00	5.00	1.00	0.0020	0.0134	0.0513	25.64	1.75
14.50 m	11.00	56.00	19.00	6.00	2.00	6.00	0.00	-	0.0138	0.0591	-	-

GRAIN SIZE DISTRIBUTION CURVES

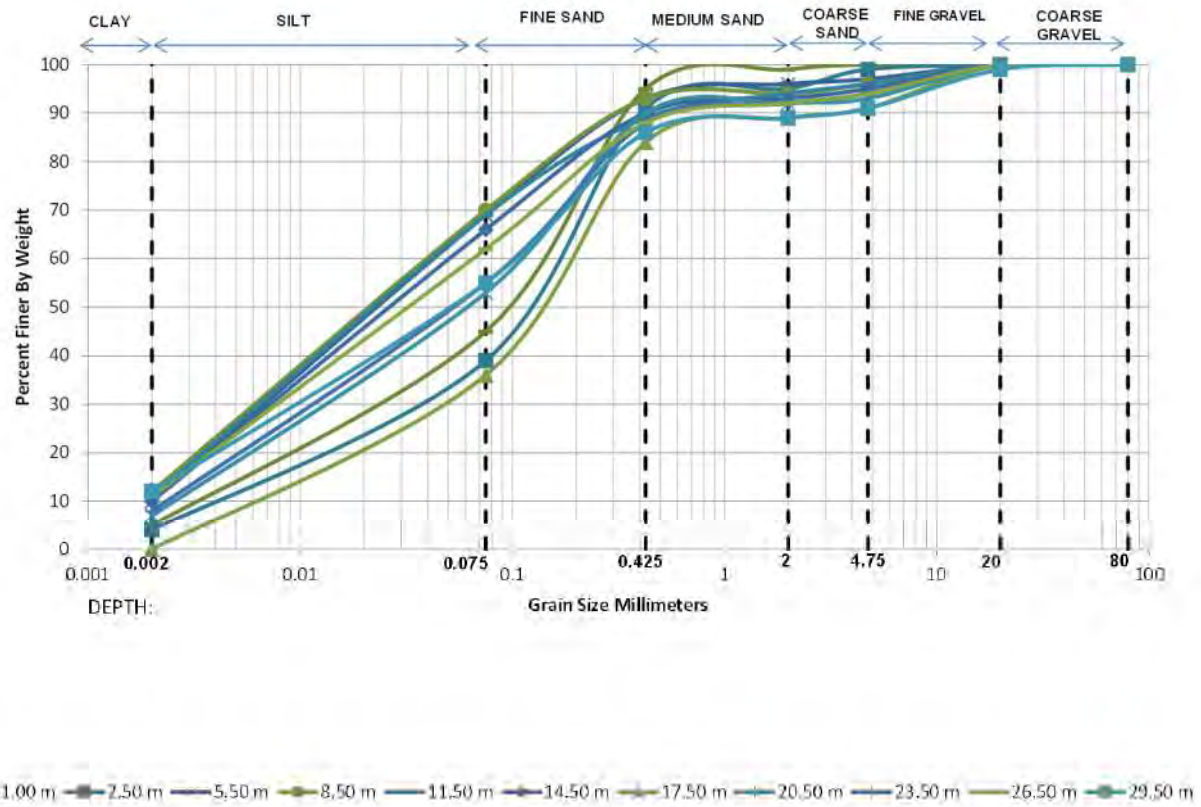
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	32+160
B.H. No.	BH-CL



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
1.00 m	10.00	58.00	24.00	4.00	2.00	2.00	0.00	0.0020	0.0145	0.0578	28.88	1.83
4.00 m	9.00	53.00	26.00	6.00	2.00	4.00	0.00	0.0024	0.0177	0.0701	29.22	1.86
7.00 m	12.00	52.00	19.00	9.00	2.00	6.00	0.00	-	0.0138	0.0650	-	-
10.00 m	11.00	54.00	20.00	7.00	3.00	5.00	0.00	-	0.0144	0.0630	-	-

GRAIN SIZE DISTRIBUTION CURVES

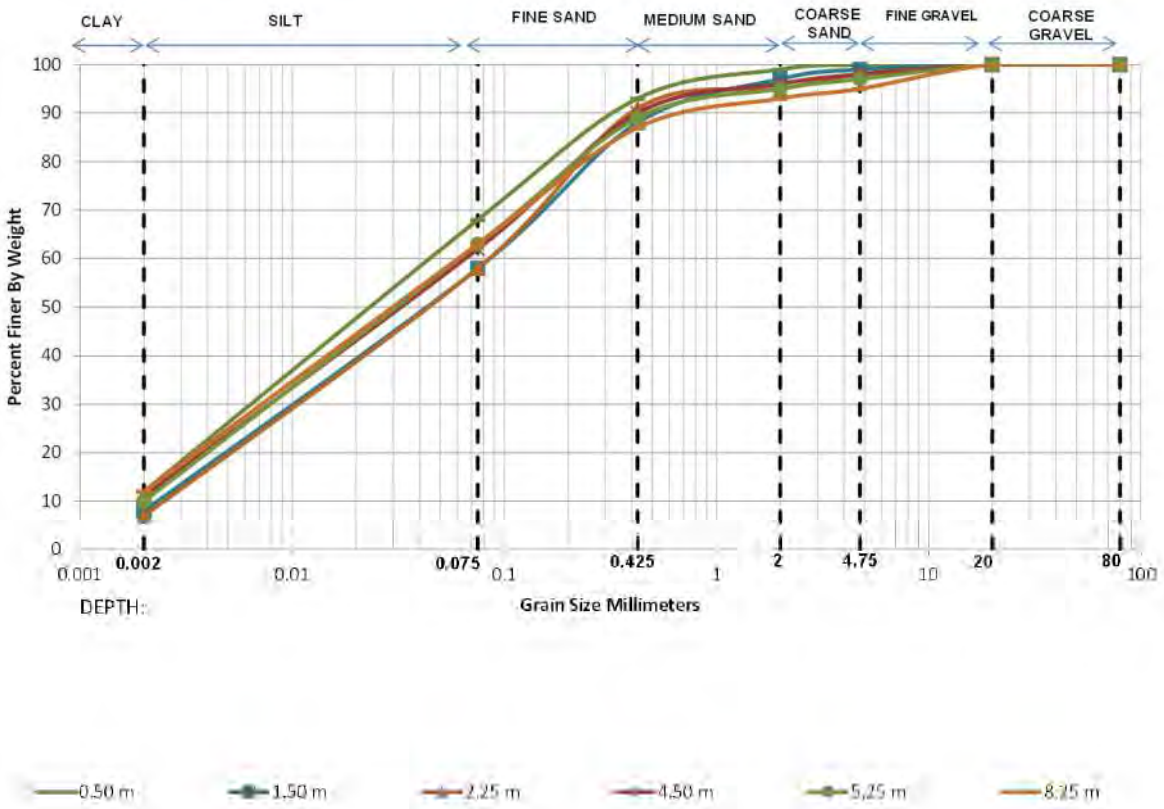
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	32+487
B.H. No.	BH-CL



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
0.50 m	6.00	47.00	33.00	12.00	0.00	2.00	0.00	0.0045	0.0266	0.1044	23.25	1.51
2.25 m	7.00	48.00	33.00	8.00	1.00	3.00	0.00	0.0036	0.0240	0.0933	25.77	1.70
5.25 m	11.00	58.00	18.00	6.00	2.00	5.00	0.00	-	0.0132	0.0555	-	-
8.25 m	6.00	29.00	50.00	9.00	1.00	5.00	0.00	0.0058	0.0570	0.1890	32.74	2.98
11.25 m	7.00	23.00	51.00	11.00	1.00	7.00	0.00	0.0051	0.0750	0.2227	43.55	4.94

GRAIN SIZE DISTRIBUTION CURVES

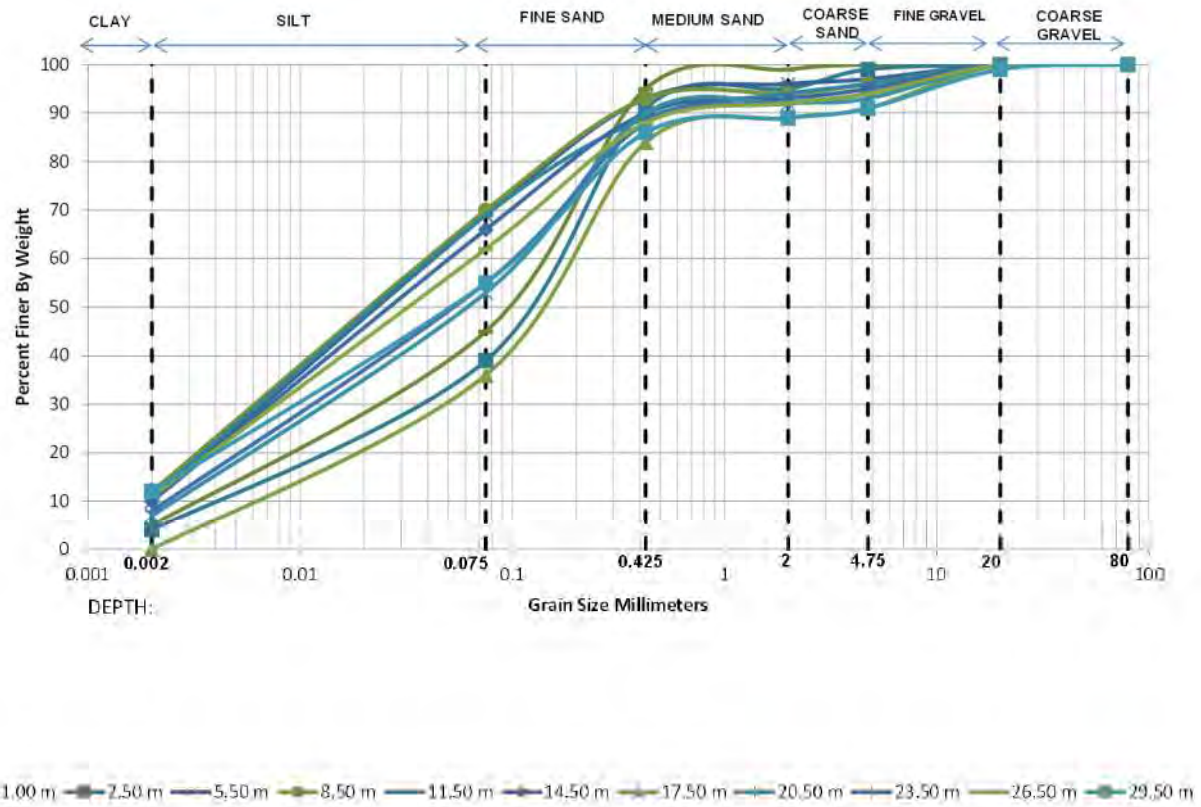
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	30+083
B.H. No.	BH-CL



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
0.50 m	12.00	56.00	25.00	6.00	1.00	0.00	0.00	-	0.0129	0.0572	-	-
1.50 m	8.00	50.00	30.00	9.00	2.00	1.00	0.00	0.0029	0.0208	0.0813	27.75	1.82
2.25 m	7.00	51.00	33.00	4.00	3.00	2.00	0.00	0.0036	0.0221	0.0808	22.60	1.69
4.50 m	11.00	51.00	28.00	6.00	2.00	2.00	0.00	-	0.0159	0.0700	-	-
5.25 m	10.00	53.00	26.00	6.00	2.00	3.00	0.00	0.0020	0.0163	0.0677	33.85	1.96
8.25 m	12.00	51.00	24.00	6.00	2.00	5.00	0.00	-	0.0144	0.0674	-	-

GRAIN SIZE DISTRIBUTION CURVES

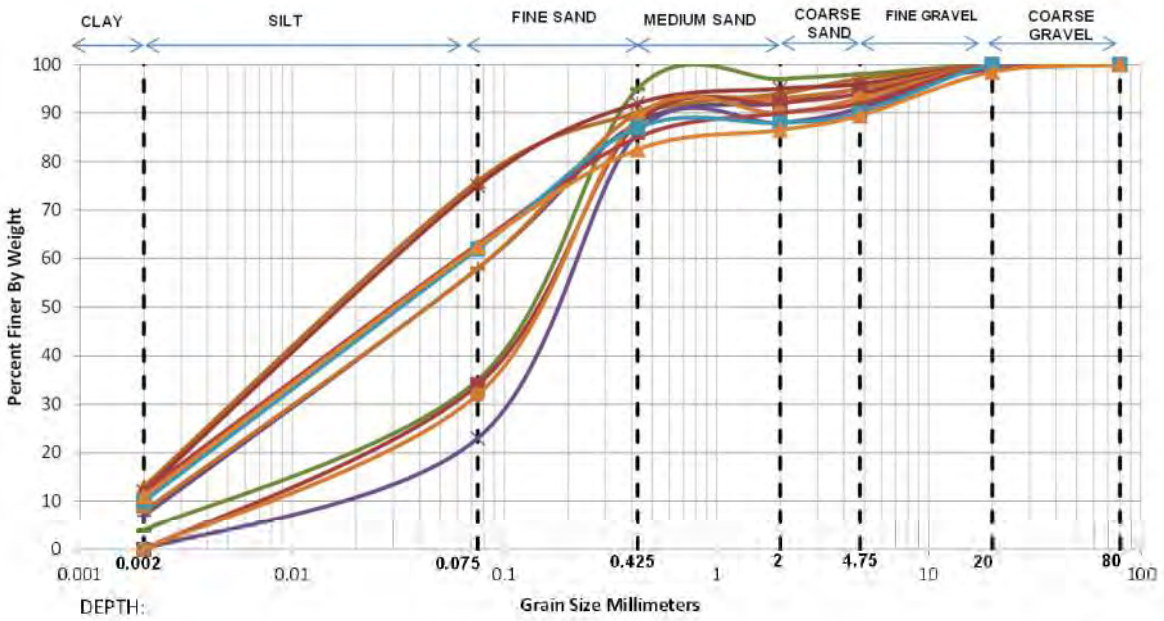
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	30+488 km
B.H. No.	BH-A1



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
1.00 m	5.00	40.00	50.00	4.00	1.00	0.00	0.00	0.0061	0.0372	0.1285	21.19	1.78
2.50 m	4.00	35.00	52.00	4.00	4.00	1.00	0.00	0.0083	0.0486	0.1570	18.89	1.81
5.50 m	10.00	59.00	24.00	3.00	1.00	3.00	0.00	0.0020	0.0143	0.0561	28.04	1.81
8.50 m	12.00	58.00	23.00	1.00	2.00	4.00	0.00	-	0.0123	0.0537	-	-
11.50 m	11.00	58.00	20.00	5.00	2.00	4.00	0.00	-	0.0133	0.0556	-	-
14.50 m	10.00	56.00	24.00	3.00	2.00	5.00	0.00	0.0020	0.0152	0.0614	30.71	1.87
17.50 m	0.00	36.00	48.00	5.00	2.00	9.00	0.00	0.0094	0.0564	0.1835	19.52	1.84
20.50 m	7.00	46.00	37.00	2.00	1.00	7.00	0.00	0.0037	0.0257	0.1003	27.37	1.79
23.50 m	8.00	47.00	33.00	4.00	2.00	6.00	0.00	0.0030	0.0228	0.0931	31.53	1.90
26.50 m	11.00	51.00	26.00	4.00	2.00	6.00	0.00	-	0.0158	0.0699	-	-
29.50 m	12.00	43.00	31.00	3.00	2.00	8.00	1.00	-	0.0186	0.0948	-	-

GRAIN SIZE DISTRIBUTION CURVES

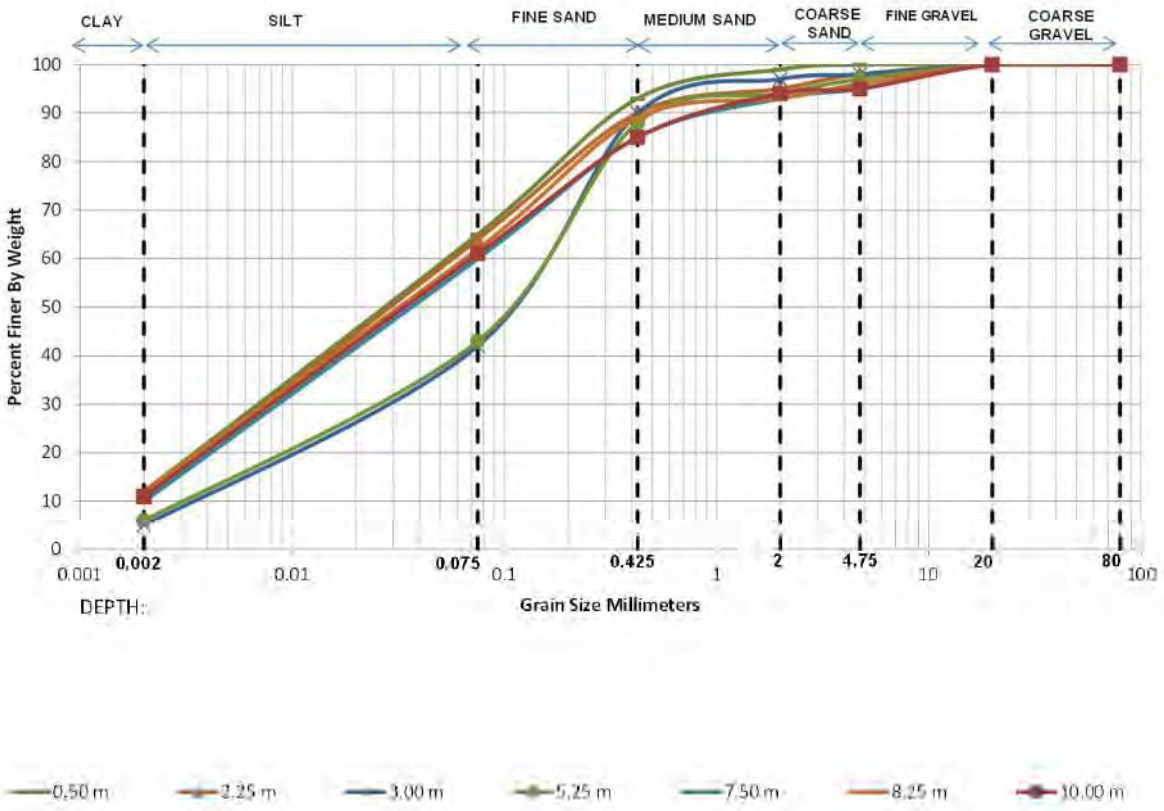
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	30+488 km
B.H. No.	BH-A2



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
1.00 m	4.00	31.00	60.00	2.00	1.00	2.00	0.00	0.0092	0.0587	0.1648	17.87	2.26
4.00 m	13.00	63.00	14.00	4.00	3.00	3.00	0.00	-	0.0101	0.0444	-	-
7.00 m	12.00	63.00	17.00	3.00	1.00	4.00	0.00	-	0.0111	0.0462	-	-
10.00 m	7.00	51.00	30.00	4.00	3.00	4.00	1.00	0.0036	0.0219	0.0811	22.71	1.66
13.00 m	8.00	50.00	32.00	3.00	2.00	5.00	0.00	0.0029	0.0209	0.0809	27.63	1.85
16.00 m	0.00	34.00	54.00	4.00	2.00	6.00	0.00	0.0105	0.0622	0.1800	17.09	2.04
19.00 m	0.00	23.00	63.00	2.00	3.00	9.00	0.00	0.0215	0.1017	0.2219	10.33	2.17
22.00 m	0.00	32.00	57.00	1.00	3.00	7.00	0.00	0.0118	0.0683	0.1839	15.61	2.15
25.00 m	12.00	51.00	22.00	5.00	2.00	8.00	0.00	-	0.0143	0.0673	-	-
28.50 m	10.00	52.00	25.00	1.00	2.00	10.00	0.00	0.0020	0.0167	0.0700	35.00	1.98
29.50 m	11.00	51.50	20.00	4.00	3.00	9.00	1.50	-	0.0153	0.0686	-	-

GRAIN SIZE DISTRIBUTION CURVES

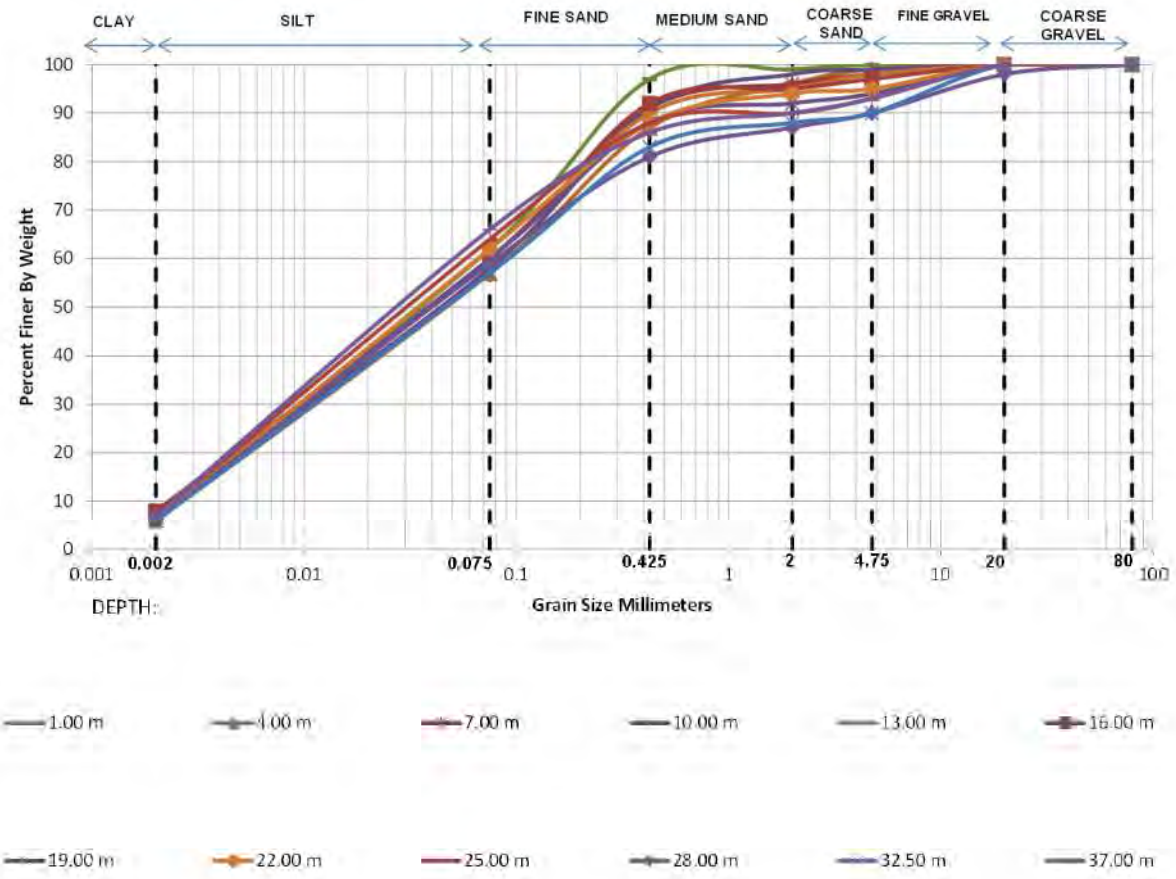
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	31+095
B.H. No.	BH-CL



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
0.50 m	12.00	53.00	28.00	6.00	1.00	0.00	0.00	-	0.0139	0.0631	-	-
2.25 m	11.00	53.00	26.00	5.00	3.00	2.00	0.00	-	0.0150	0.0654	-	-
3.00 m	5.00	37.00	48.00	7.00	1.00	2.00	0.00	0.0063	0.0417	0.1480	23.45	1.86
5.25 m	6.00	37.00	45.00	6.00	3.00	3.00	0.00	0.0050	0.0388	0.1475	29.63	2.05
7.50 m	10.00	50.00	25.00	8.00	2.00	5.00	0.00	0.0020	0.0175	0.0750	37.50	2.05
8.25 m	12.00	50.00	27.00	4.00	3.00	4.00	0.00	-	0.0149	0.0698	-	-
10.00 m	11.00	50.00	24.00	9.00	1.00	5.00	0.00	-	0.0161	0.0724	-	-

GRAIN SIZE DISTRIBUTION CURVES

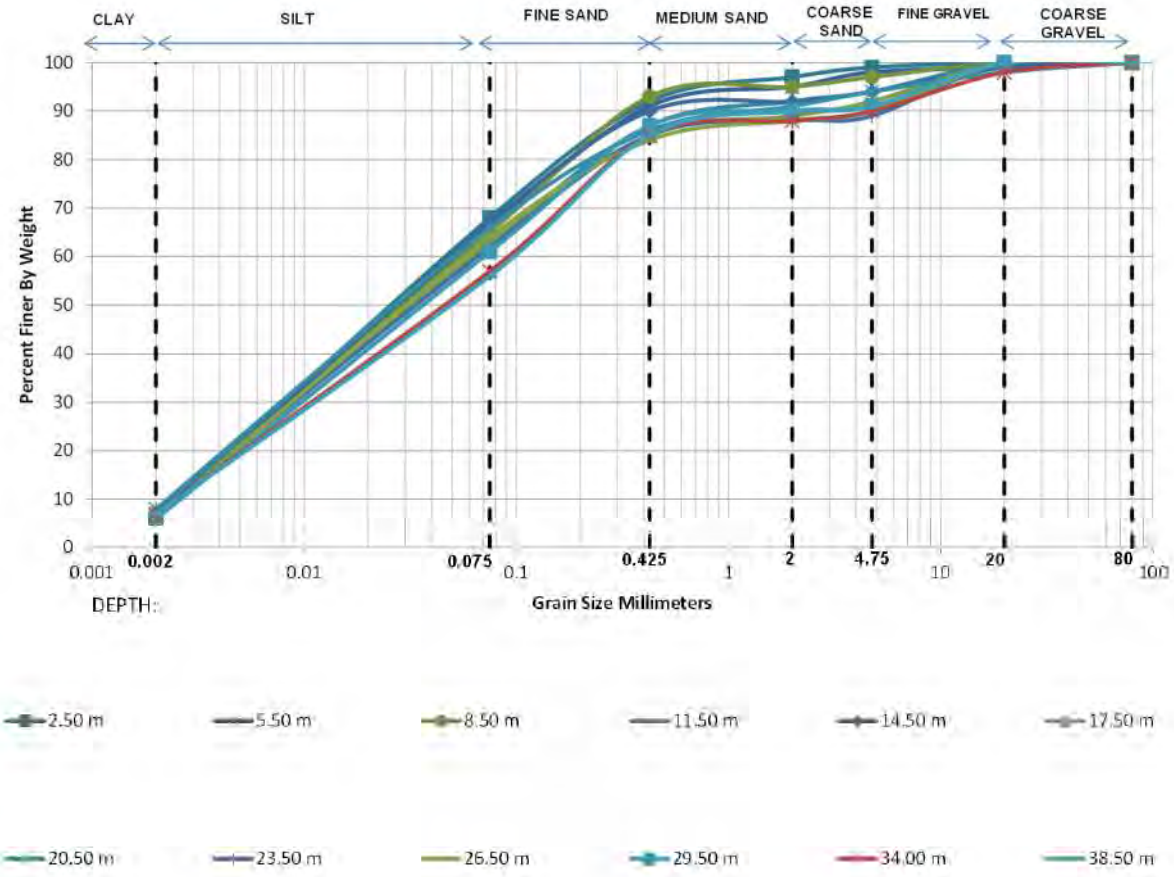
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	31+714 km
B.H. No.	BH-A1



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
1.00 m	7.00	55.00	35.00	2.00	1.00	0.00	0.00	0.0035	0.0202	0.0704	19.96	1.64
4.00 m	6.00	51.00	30.00	9.00	3.00	1.00	0.00	0.0044	0.0237	0.0851	19.44	1.51
7.00 m	6.00	54.00	31.00	5.00	2.00	2.00	0.00	0.0043	0.0221	0.0750	17.39	1.51
10.00 m	7.00	51.00	33.00	7.00	1.00	1.00	0.00	0.0036	0.0221	0.0808	22.61	1.69
13.00 m	7.00	53.00	30.00	5.00	3.00	2.00	0.00	0.0035	0.0209	0.0750	21.16	1.64
16.00 m	8.00	52.00	32.00	3.00	2.00	3.00	0.00	0.0029	0.0199	0.0750	25.72	1.81
19.00 m	7.00	53.00	28.00	4.00	2.00	6.00	0.00	0.0035	0.0208	0.0750	21.18	1.63
22.00 m	6.00	56.00	26.00	6.00	1.00	5.00	0.00	0.0043	0.0209	0.0703	16.49	1.46
25.00 m	7.00	57.00	24.00	2.00	3.00	7.00	0.00	0.0035	0.0189	0.0660	18.89	1.54
28.00 m	6.00	53.00	22.00	6.00	3.00	8.00	2.00	0.0043	0.0221	0.0781	18.11	1.45
32.50 m	6.00	51.00	26.00	5.00	2.00	10.00	0.00	0.0044	0.0234	0.0861	19.72	1.46
37.00 m	7.00	59.00	20.00	4.00	3.00	7.00	0.00	0.0035	0.0180	0.0620	17.87	1.50

GRAIN SIZE DISTRIBUTION CURVES

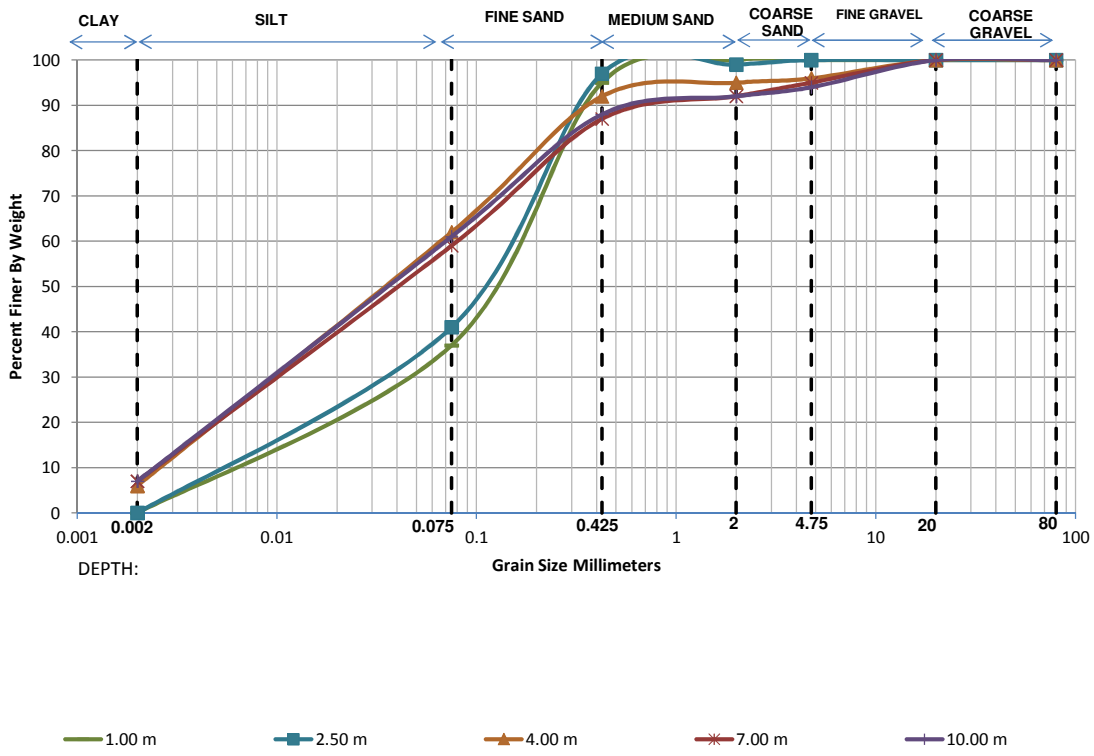
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	31+714 km
B.H. No.	BH-A2



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
2.50 m	6.00	62.00	24.00	5.00	2.00	1.00	0.00	0.0042	0.0186	0.0589	14.14	1.41
5.50 m	7.00	59.00	25.00	4.00	3.00	1.00	1.00	0.0035	0.0182	0.0621	17.89	1.53
8.50 m	7.00	58.00	28.00	2.00	2.00	3.00	0.00	0.0035	0.0186	0.0641	18.39	1.56
11.50 m	8.00	55.00	24.00	5.00	2.00	6.00	0.00	0.0029	0.0182	0.0679	23.47	1.68
14.50 m	6.00	61.00	23.00	2.00	2.00	5.00	1.00	0.0042	0.0189	0.0605	14.49	1.41
17.50 m	7.00	56.00	22.00	4.00	3.00	8.00	0.00	0.0035	0.0192	0.0680	19.43	1.54
20.50 m	8.00	58.00	20.00	5.00	3.00	4.00	2.00	0.0029	0.0169	0.0617	21.46	1.61
23.50 m	7.00	55.00	23.00	3.00	1.00	11.00	0.00	0.0035	0.0196	0.0702	20.00	1.56
26.50 m	6.00	58.00	20.00	4.00	2.00	10.00	0.00	0.0042	0.0198	0.0660	15.65	1.41
29.50 m	6.00	55.00	26.00	3.00	1.00	9.00	0.00	0.0043	0.0214	0.0726	16.95	1.47
34.00 m	7.00	50.00	28.00	3.00	2.00	8.00	2.00	0.0036	0.0224	0.0854	23.86	1.64
38.50 m	7.00	49.00	29.00	5.00	1.00	9.00	0.00	0.0036	0.0231	0.0900	25.01	1.64

GRAIN SIZE DISTRIBUTION CURVES

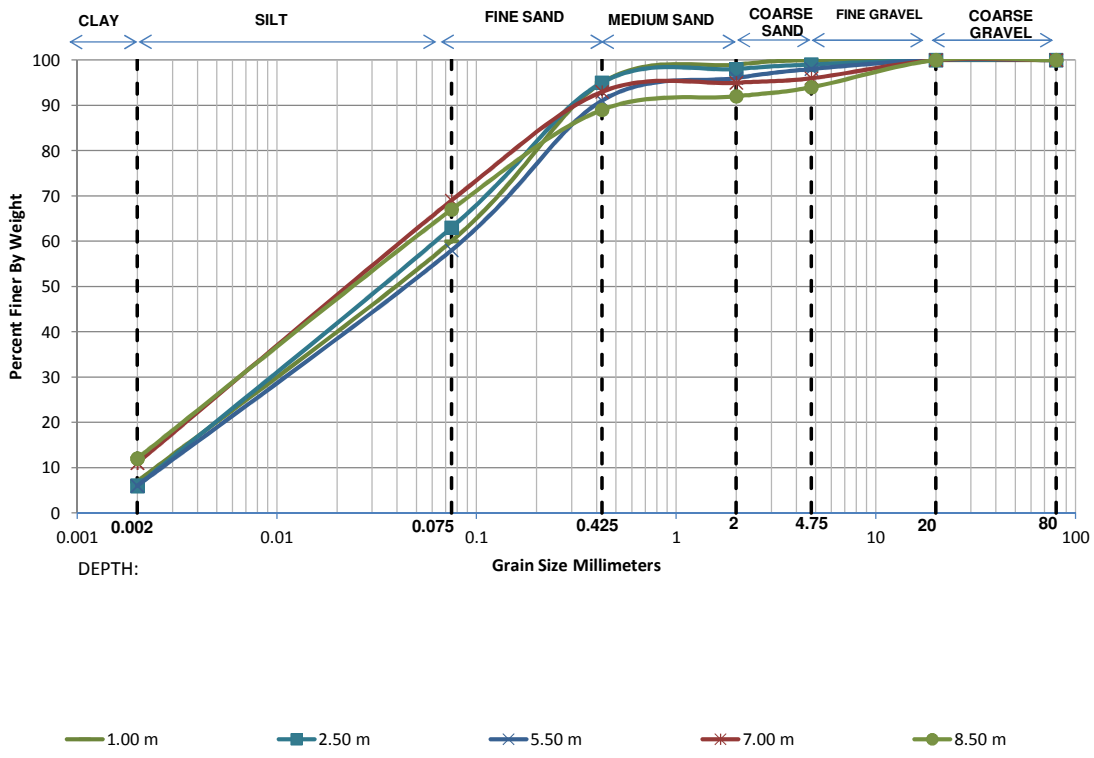
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	32+191
B.H. No.	BH-CL



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
1.00 m	0.00	37.00	58.00	5.00	0.00	0.00	0.00	0.0092	0.0545	0.1562	16.89	2.05
2.50 m	0.00	41.00	56.00	2.00	1.00	0.00	0.00	0.0078	0.0457	0.1387	17.78	1.93
4.00 m	6.00	56.00	30.00	3.00	1.00	4.00	0.00	0.0043	0.0211	0.0704	16.48	1.48
7.00 m	7.00	52.00	28.00	5.00	3.00	5.00	0.00	0.0036	0.0213	0.0778	21.90	1.64
10.00 m	7.00	54.00	27.00	4.00	2.00	6.00	0.00	0.0035	0.0203	0.0726	20.57	1.60

GRAIN SIZE DISTRIBUTION CURVES

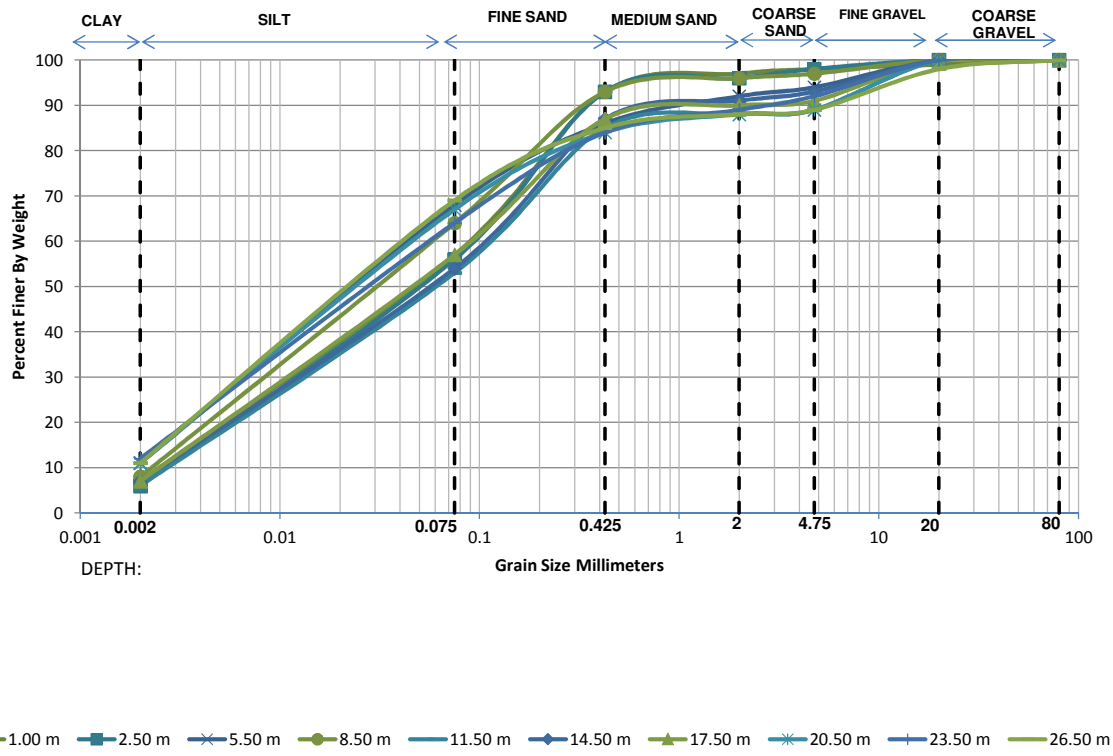
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	32+738 km
B.H. No.	BH-C/L



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
1.00 m	7.00	53.00	35.00	4.00	1.00	0.00	0.00	0.0036	0.0211	0.0750	21.12	1.67
2.50 m	6.00	57.00	32.00	3.00	1.00	1.00	0.00	0.0043	0.0208	0.0683	16.04	1.48
5.50 m	6.00	52.00	33.00	5.00	2.00	2.00	0.00	0.0044	0.0233	0.0807	18.51	1.54
7.00 m	11.00	58.00	24.00	2.00	1.00	4.00	0.00	-	0.0134	0.0558	-	-
8.50 m	12.00	55.00	22.00	3.00	2.00	6.00	0.00	-	0.0130	0.0589	-	-

GRAIN SIZE DISTRIBUTION CURVES

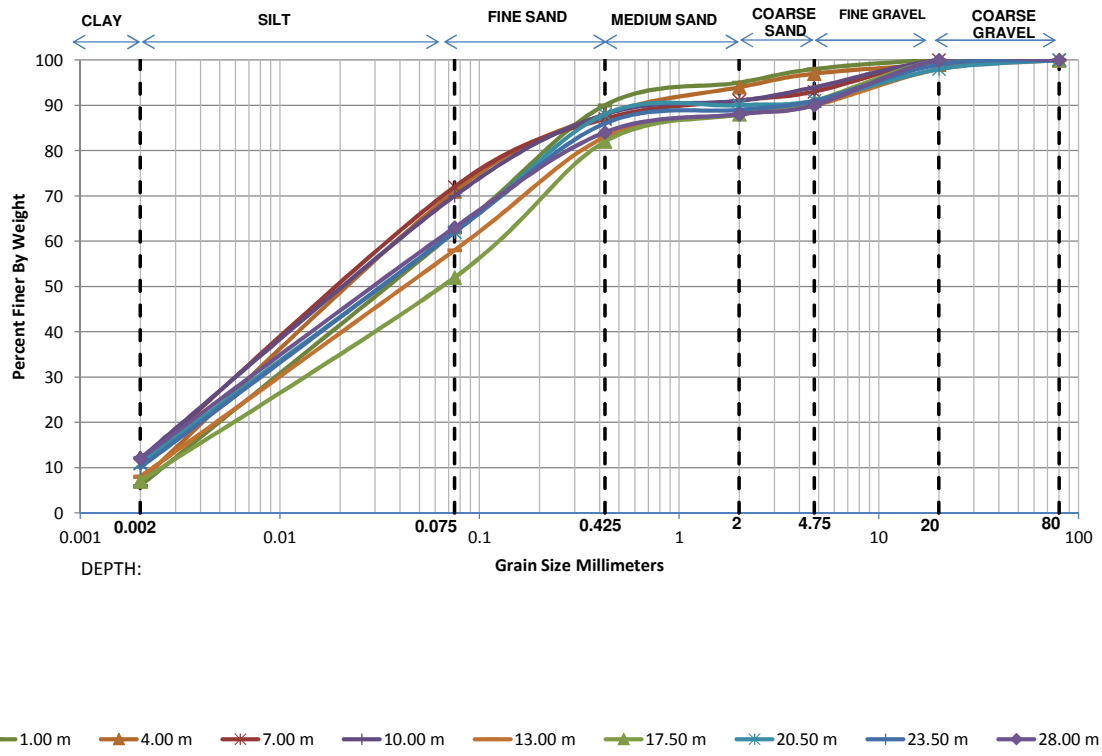
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	33+713 km
B.H. No.	BH-A1



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
1.00 m	7.00	50.00	36.00	4.00	1.00	1.00	1.00	0.0036	0.0228	0.0839	23.35	1.73
2.50 m	6.00	50.00	37.00	3.00	2.00	2.00	0.00	0.0044	0.0247	0.0873	19.75	1.58
5.50 m	11.00	57.00	18.00	6.00	2.00	6.00	0.00	-	0.0135	0.0572	-	-
8.50 m	8.00	56.00	29.00	3.00	1.00	3.00	0.00	0.0029	0.0180	0.0659	22.81	1.70
11.50 m	6.00	47.00	32.00	3.00	1.00	11.00	0.00	0.0045	0.0265	0.1039	23.16	1.51
14.50 m	7.00	47.00	33.00	4.00	2.00	7.00	0.00	0.0036	0.0247	0.0979	26.93	1.71
17.50 m	7.00	50.00	30.00	3.00	1.00	9.00	0.00	0.0036	0.0225	0.0849	23.70	1.66
20.50 m	11.00	56.00	17.00	4.00	1.00	11.00	0.00	-	0.0137	0.0590	-	-
23.50 m	12.00	52.00	20.00	5.00	3.00	8.00	0.00	-	0.0139	0.0650	-	-
26.50 m	11.00	58.00	16.00	3.00	1.00	9.00	2.00	-	0.0131	0.0554	-	-

GRAIN SIZE DISTRIBUTION CURVES

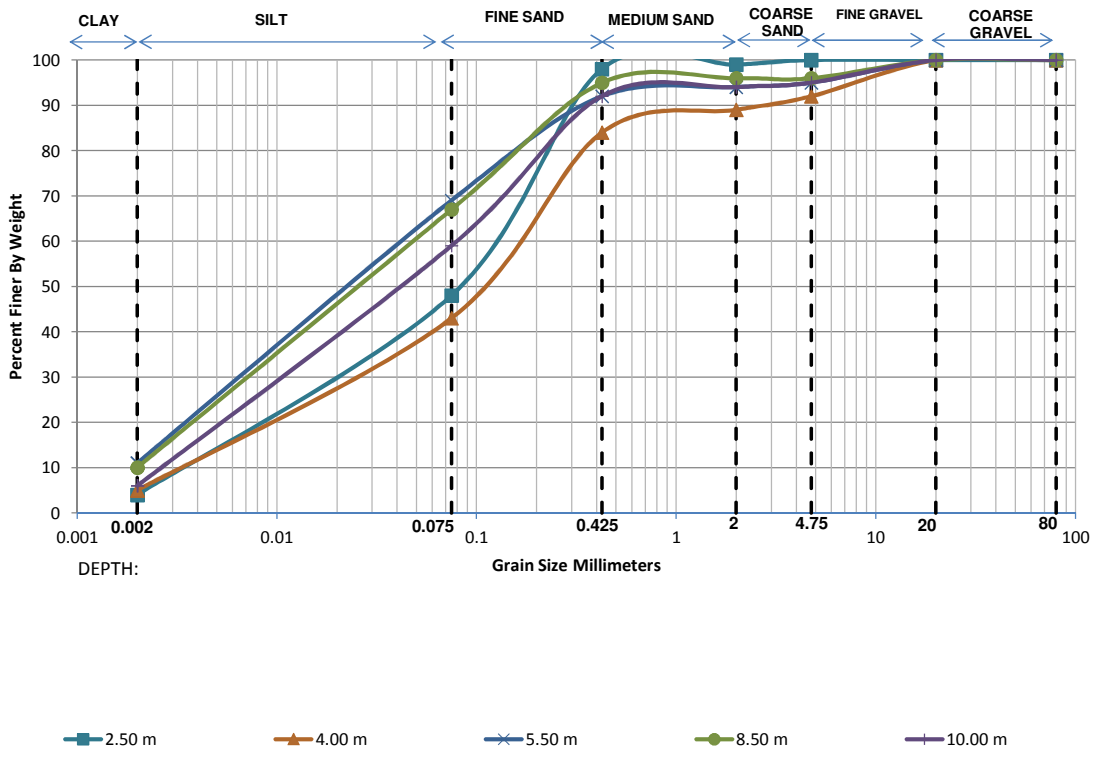
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	33+713 km
B.H. No.	BH-A2



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
1.00 m	6.00	56.00	28.00	5.00	3.00	2.00	0.00	0.0043	0.0210	0.0704	16.49	1.47
4.00 m	7.00	64.00	17.00	6.00	3.00	2.00	1.00	0.0034	0.0164	0.0537	15.69	1.46
7.00 m	11.00	61.00	15.00	4.00	2.00	7.00	0.00	-	0.0124	0.0506	-	-
10.00 m	12.00	58.00	18.00	3.00	3.00	6.00	0.00	-	0.0121	0.0535	-	-
13.00 m	8.00	50.00	25.00	5.00	2.00	8.00	2.00	0.0029	0.0206	0.0819	28.00	1.77
17.50 m	7.00	45.00	30.00	6.00	3.00	9.00	0.00	0.0037	0.0260	0.1137	31.00	1.62
20.50 m	11.00	51.00	26.00	2.00	1.00	7.00	2.00	-	0.0158	0.0699	-	-
23.50 m	10.00	52.00	24.00	3.00	2.00	8.00	1.00	0.0020	0.0166	0.0700	34.99	1.97
28.00 m	12.00	51.00	21.00	4.00	2.00	10.00	0.00	-	0.0143	0.0673	-	-

GRAIN SIZE DISTRIBUTION CURVES

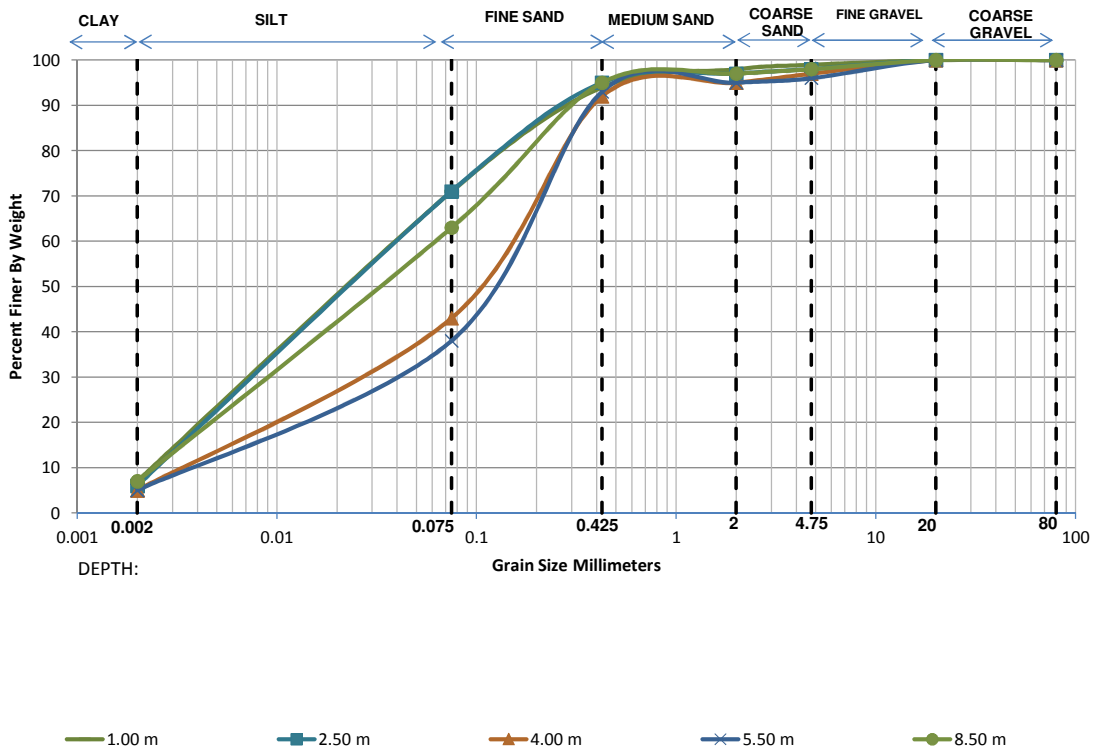
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	34+019 km
B.H. No.	BH-CL



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
2.50 m	4.00	44.00	50.00	1.00	1.00	0.00	0.00	0.0072	0.0348	0.1139	15.72	1.47
4.00 m	5.00	38.00	41.00	5.00	3.00	8.00	0.00	0.0062	0.0395	0.1553	25.20	1.63
5.50 m	11.00	58.00	23.00	2.00	1.00	5.00	0.00	-	0.0134	0.0557	-	-
8.50 m	10.00	57.00	28.00	1.00	0.00	4.00	0.00	0.0020	0.0150	0.0597	29.86	1.88
10.00 m	6.00	53.00	33.00	2.00	1.00	5.00	0.00	0.0043	0.0227	0.0776	17.89	1.53

GRAIN SIZE DISTRIBUTION CURVES

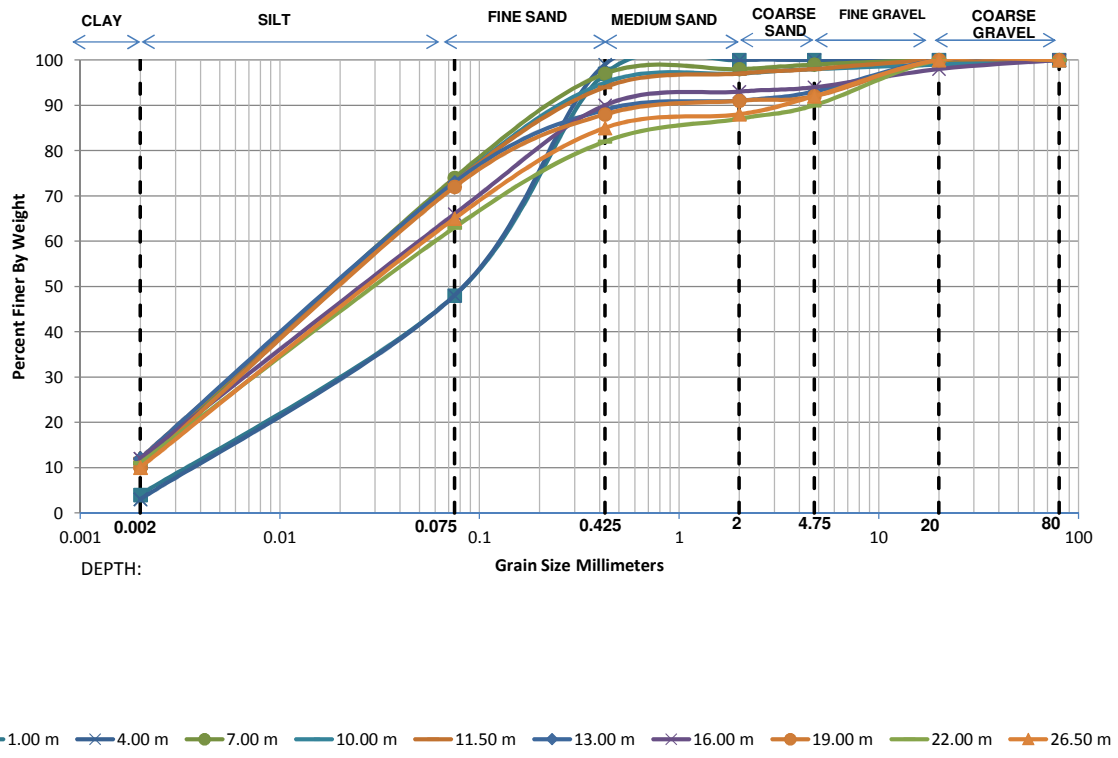
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	34+619 km
B.H. No.	BH-CL



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
1.00 m	7.00	64.00	23.00	4.00	1.00	1.00	0.00	0.0034	0.0166	0.0540	15.75	1.49
2.50 m	6.00	65.00	24.00	2.00	1.00	2.00	0.00	0.0041	0.0178	0.0544	13.19	1.41
4.00 m	5.00	38.00	49.00	3.00	2.00	3.00	0.00	0.0062	0.0401	0.1398	22.46	1.85
5.50 m	5.00	33.00	55.00	2.00	1.00	4.00	0.00	0.0068	0.0501	0.1575	23.00	2.33
8.50 m	7.00	56.00	32.00	2.00	1.00	2.00	0.00	0.0035	0.0196	0.0682	19.43	1.60

GRAIN SIZE DISTRIBUTION CURVES

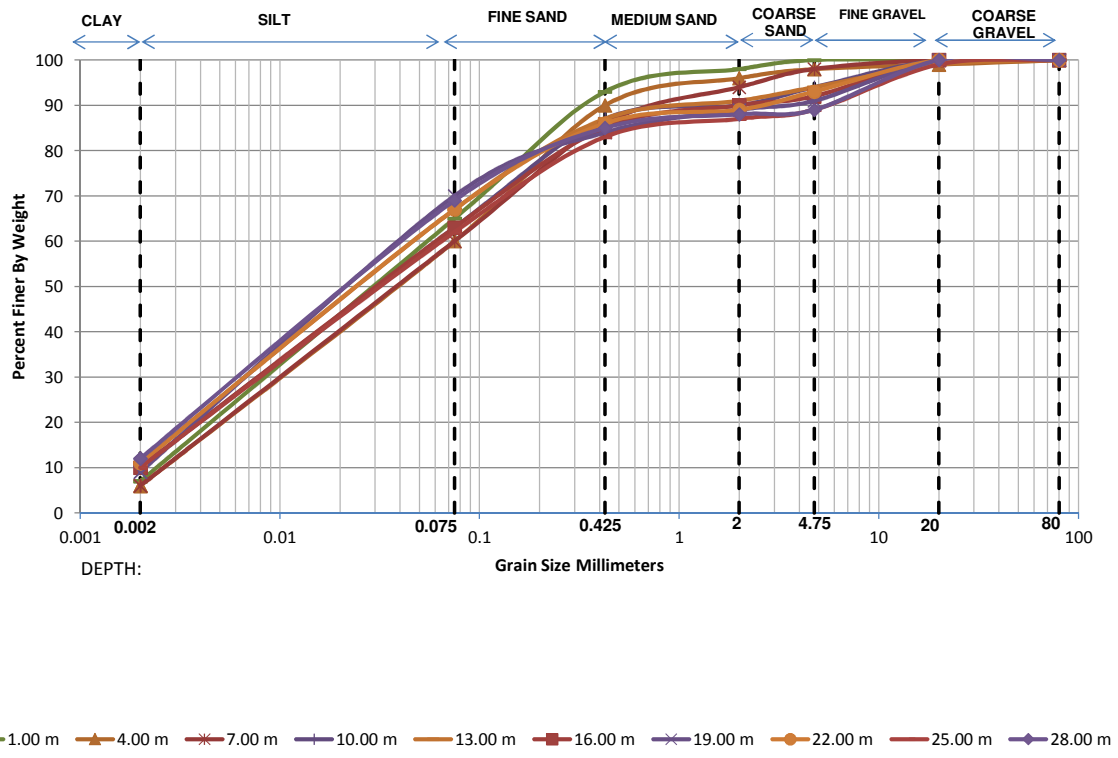
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	35+273 km
B.H. No.	BH-A1



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
1.00 m	4.00	44.00	49.00	3.00	0.00	0.00	0.00	0.0072	0.0348	0.1148	15.87	1.45
4.00 m	3.00	45.00	51.00	1.00	0.00	0.00	0.00	0.0091	0.0364	0.1129	12.47	1.29
7.00 m	11.00	63.00	23.00	1.00	1.00	1.00	0.00	-	0.0122	0.0483	-	-
10.00 m	10.00	63.00	22.00	2.00	1.00	1.00	1.00	0.0020	0.0132	0.0500	25.00	1.75
11.50 m	12.00	61.00	21.00	3.00	1.00	2.00	0.00	-	0.0116	0.0491	-	-
13.00 m	12.00	61.00	16.00	2.00	2.00	7.00	0.00	-	0.0114	0.0488	-	-
16.00 m	12.00	54.00	24.00	3.00	1.00	4.00	2.00	-	0.0134	0.0609	-	-
19.00 m	10.00	62.00	16.00	3.00	1.00	8.00	0.00	0.0020	0.0133	0.0511	25.53	1.72
22.00 m	11.00	52.00	19.00	5.00	3.00	10.00	0.00	-	0.0151	0.0674	-	-
26.50 m	10.00	55.00	20.00	3.00	4.00	8.00	0.00	0.0020	0.0153	0.0632	31.62	1.86

GRAIN SIZE DISTRIBUTION CURVES

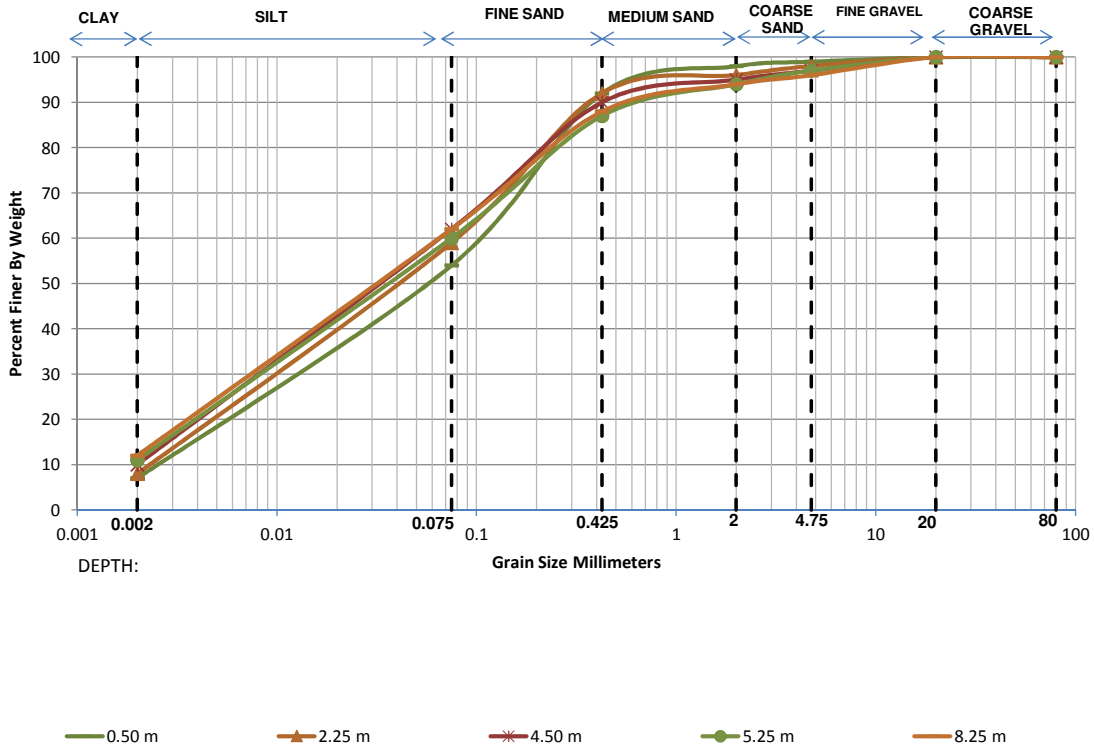
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	35+273 km
B.H. No.	BH-A2



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
1.00 m	7.00	58.00	28.00	5.00	2.00	0.00	0.00	0.0035	0.0186	0.0641	18.39	1.56
4.00 m	6.00	54.00	30.00	6.00	2.00	1.00	1.00	0.0043	0.0220	0.0750	17.39	1.50
7.00 m	6.00	54.00	26.00	8.00	4.00	2.00	0.00	0.0043	0.0218	0.0750	17.43	1.48
10.00 m	10.00	53.00	24.00	3.00	4.00	6.00	0.00	0.0020	0.0162	0.0677	33.83	1.94
13.00 m	11.00	56.00	20.00	4.00	3.00	5.00	1.00	-	0.0138	0.0591	-	-
16.00 m	10.00	53.00	22.00	5.00	2.00	8.00	0.00	0.0020	0.0161	0.0676	33.81	1.93
19.00 m	9.00	61.00	14.00	5.00	2.00	9.00	0.00	0.0024	0.0146	0.0543	22.78	1.64
22.00 m	11.00	56.00	19.00	3.00	4.00	7.00	0.00	-	0.0138	0.0591	-	-
25.00 m	10.00	52.00	21.00	4.00	2.00	10.00	1.00	0.0020	0.0165	0.0699	34.96	1.94
28.00 m	12.00	57.00	16.00	3.00	1.00	11.00	0.00	-	0.0123	0.0550	-	-

GRAIN SIZE DISTRIBUTION CURVES

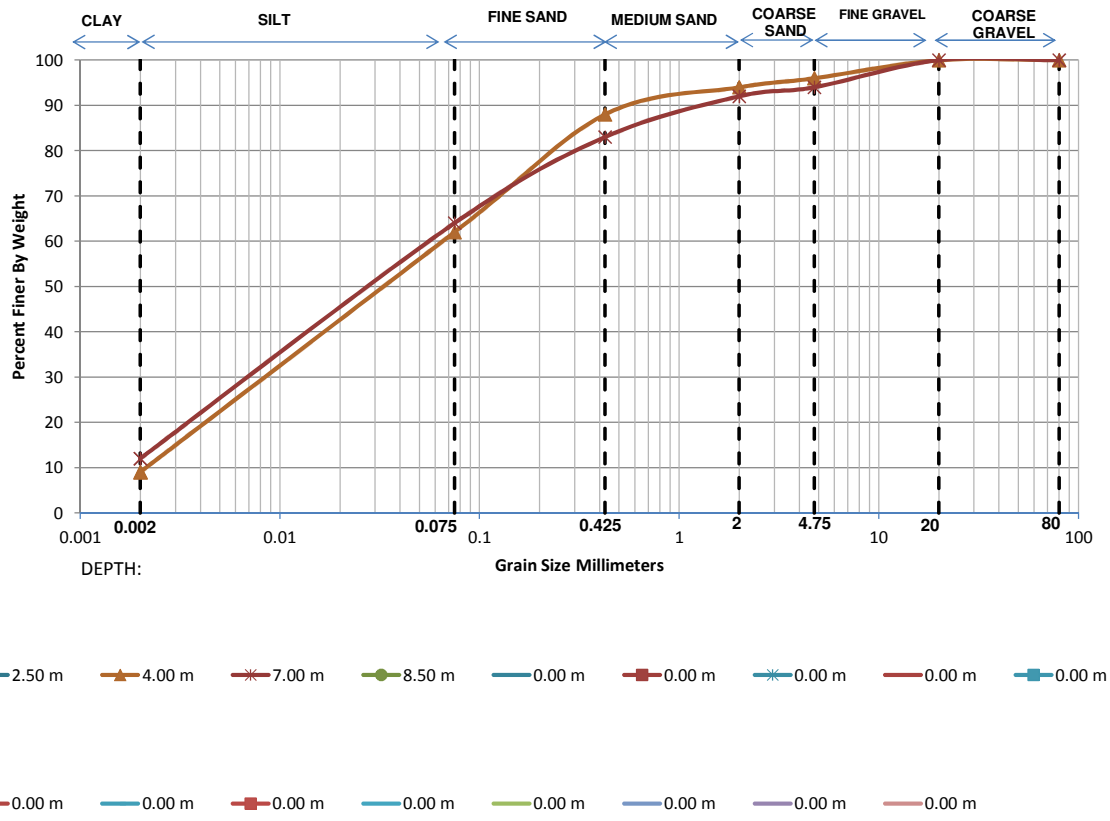
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	36+367
B.H. No.	BH-CL



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
0.50 m	7.00	47.00	38.00	6.00	1.00	1.00	0.00	0.0036	0.0250	0.0955	26.20	1.79
2.25 m	8.00	51.00	33.00	4.00	2.00	2.00	0.00	0.0029	0.0204	0.0777	26.58	1.84
4.50 m	10.00	52.00	28.00	5.00	2.00	3.00	0.00	0.0020	0.0168	0.0700	35.02	2.01
5.25 m	11.00	49.00	27.00	7.00	3.00	3.00	0.00	-	0.0167	0.0750	-	-
8.25 m	12.00	50.00	26.00	6.00	2.00	4.00	0.00	-	0.0149	0.0698	-	-

GRAIN SIZE DISTRIBUTION CURVES

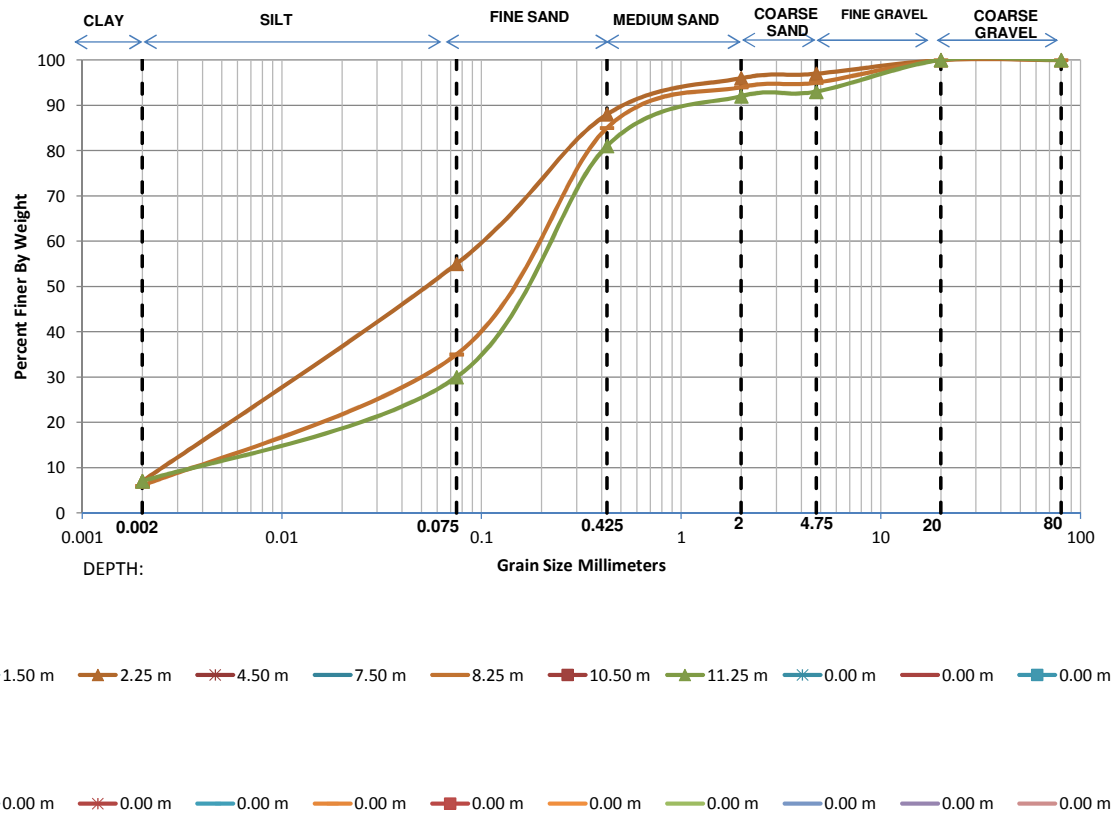
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	36+816 km
B.H. No.	BH-A1



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
1.00 m	6.00	59.00	29.00	2.00	3.00	1.00	0.00	0.0042	0.0198	0.0643	15.24	1.45
2.50 m	7.00	51.00	31.00	7.00	3.00	1.00	0.00	0.0036	0.0220	0.0810	22.69	1.67
5.50 m	10.00	60.00	23.00	3.00	1.00	3.00	0.00	0.0020	0.0140	0.0544	27.21	1.79
8.50 m	12.00	64.00	16.00	2.00	2.00	4.00	0.00	-	0.0109	0.0450	-	-
11.50 m	10.00	54.00	24.00	6.00	2.00	3.00	1.00	0.0020	0.0158	0.0655	32.73	1.92
14.50 m	11.00	60.00	18.00	6.00	2.00	3.00	0.00	-	0.0127	0.0523	-	-
17.50 m	7.00	49.00	31.00	4.00	3.00	6.00	0.00	0.0036	0.0232	0.0891	24.74	1.67
21.00 m	8.00	46.00	29.00	8.00	1.00	8.00	0.00	0.0030	0.0233	0.1019	34.45	1.80
23.50 m	12.00	59.00	17.00	4.00	2.00	6.00	0.00	-	0.0119	0.0518	-	-
26.50 m	11.00	63.00	16.00	4.00	3.00	3.00	0.00	-	0.0120	0.0479	-	-
30.00 m	11.00	58.00	20.00	5.00	2.00	4.00	0.00	-	0.0133	0.0556	-	-

GRAIN SIZE DISTRIBUTION CURVES

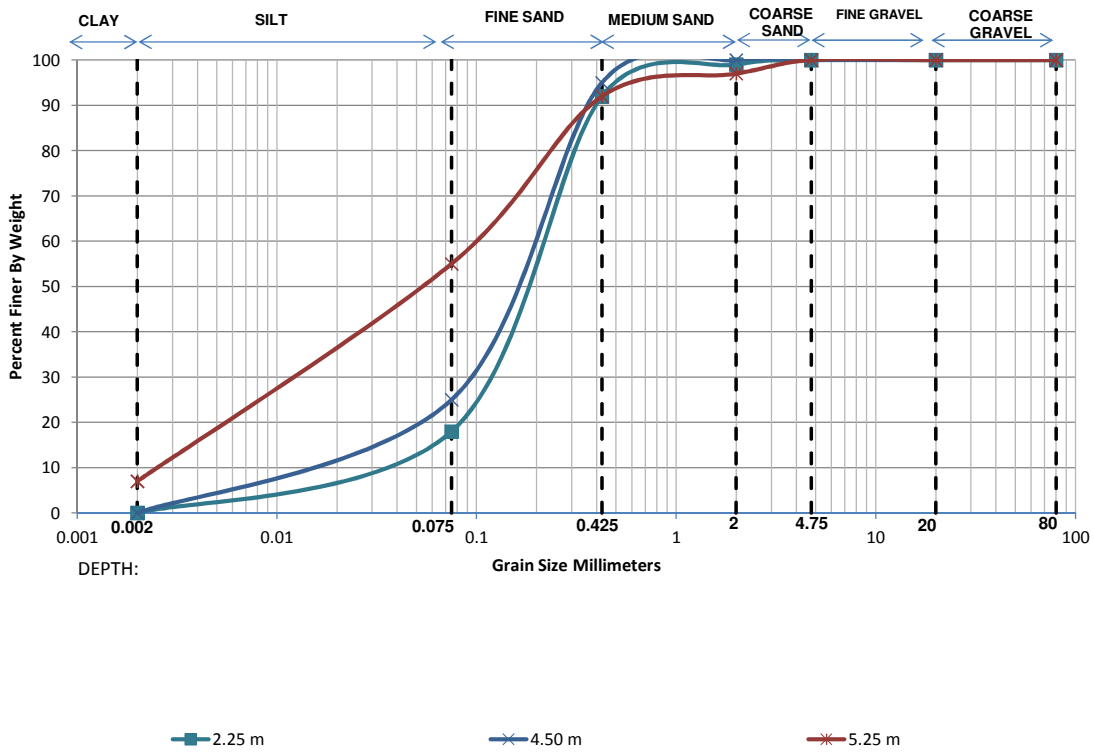
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	36+816 km
B.H. No.	BH-A2



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
1.00 m	5.00	44.00	44.00	4.00	2.00	1.00	0.00	0.0058	0.0321	0.1145	19.87	1.56
4.00 m	4.00	40.00	51.00	2.00	1.00	2.00	0.00	0.0076	0.0399	0.1316	17.24	1.58
7.00 m	6.00	55.00	33.00	4.00	2.00	0.00	0.00	0.0043	0.0217	0.0727	16.90	1.51
10.00 m	11.00	61.00	16.00	5.00	2.00	5.00	0.00	-	0.0124	0.0507	-	-
13.00 m	10.00	56.00	21.00	4.00	3.00	6.00	0.00	0.0020	0.0150	0.0613	30.65	1.85
16.00 m	7.00	54.00	26.00	4.00	3.00	6.00	0.00	0.0035	0.0202	0.0726	20.58	1.60
19.50 m	6.00	55.00	23.00	6.00	2.00	8.00	0.00	0.0043	0.0212	0.0726	16.97	1.45
22.00 m	8.00	49.00	27.00	5.00	4.00	6.00	1.00	0.0029	0.0212	0.0860	29.30	1.79
23.50 m	13.00	58.00	18.00	4.00	1.00	5.00	1.00	-	0.0111	0.0515	-	-
26.50 m	11.00	56.00	22.00	3.00	2.00	6.00	0.00	-	0.0139	0.0592	-	-
29.50 m	12.00	58.00	17.00	4.00	3.00	5.00	1.00	-	0.0121	0.0534	-	-

GRAIN SIZE DISTRIBUTION CURVES

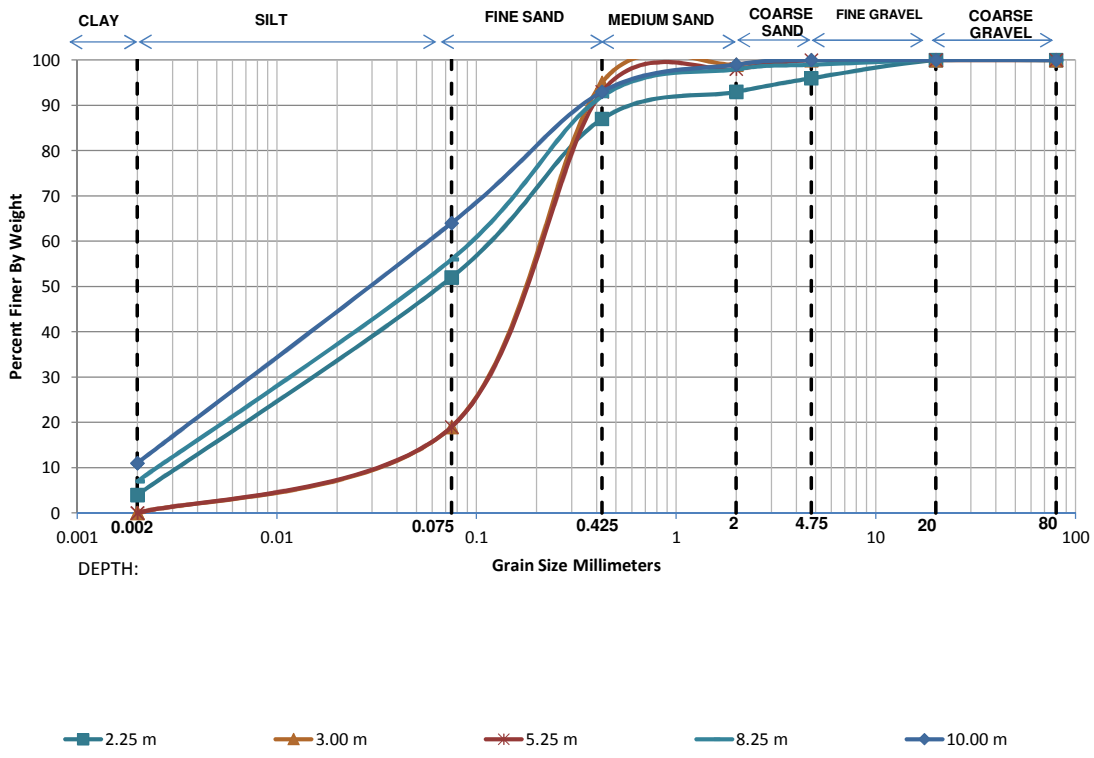
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	37+174 Minor Bridge
B.H. No.	BH-CL



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
2.25 m	0.00	18.00	74.00	7.00	1.00	0.00	0.00	0.0338	0.1213	0.2241	6.63	1.94
4.50 m	0.00	25.00	70.00	5.00	0.00	0.00	0.00	0.0188	0.0927	0.1961	10.41	2.33
5.25 m	7.00	48.00	37.00	5.00	3.00	0.00	0.00	0.0036	0.0242	0.0915	25.23	1.76

GRAIN SIZE DISTRIBUTION CURVES

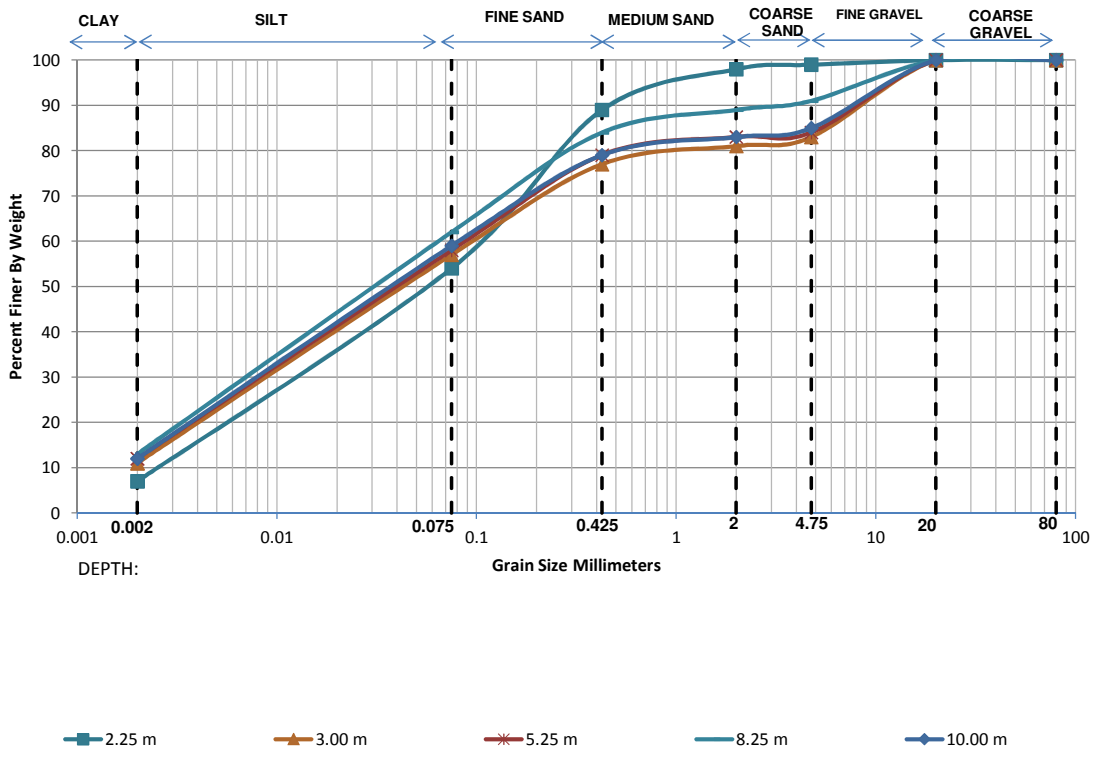
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	37+487 Minor Bridge
B.H. No.	BH-CL



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
2.25 m	4.00	48.00	35.00	6.00	3.00	4.00	0.00	0.0069	0.0301	0.1069	15.58	1.24
3.00 m	0.00	19.00	76.00	4.00	1.00	0.00	0.00	0.0309	0.1162	0.2144	6.93	2.04
5.25 m	0.00	19.00	74.00	5.00	2.00	0.00	0.00	0.0308	0.1167	0.2184	7.09	2.02
8.25 m	7.00	49.00	36.00	6.00	1.00	1.00	0.00	0.0036	0.0235	0.0878	24.31	1.74
10.00 m	11.00	53.00	29.00	6.00	1.00	0.00	0.00	-	0.0151	0.0655	-	-

GRAIN SIZE DISTRIBUTION CURVES

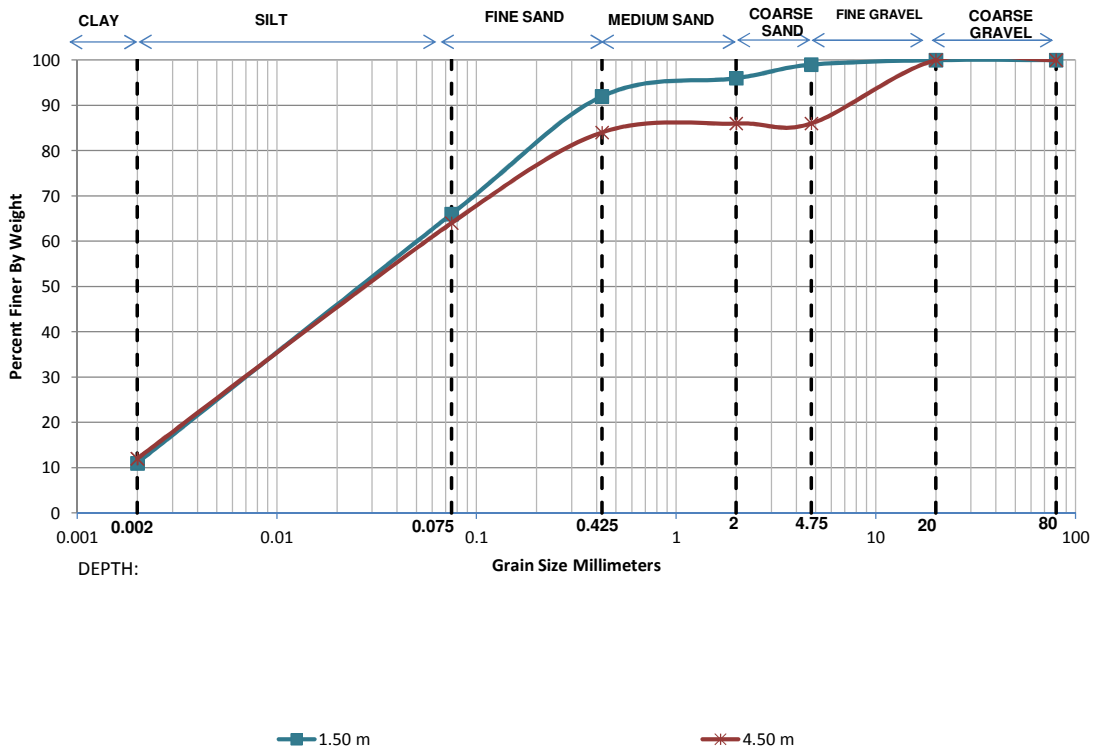
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	38+127 Minor Bridge
B.H. No.	BH-CL



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
2.25 m	7.00	47.00	35.00	9.00	1.00	1.00	0.00	0.0036	0.0248	0.0973	26.72	1.73
3.00 m	11.00	46.00	20.00	4.00	2.00	17.00	0.00	-	0.0178	0.0898	-	-
5.25 m	12.00	46.00	21.00	4.00	1.00	16.00	0.00	-	0.0164	0.0832	-	-
8.25 m	13.00	49.00	22.00	5.00	2.00	9.00	0.00	-	0.0138	0.0697	-	-
10.00 m	12.00	47.00	20.00	4.00	2.00	15.00	0.00	-	0.0158	0.0785	-	-

GRAIN SIZE DISTRIBUTION CURVES

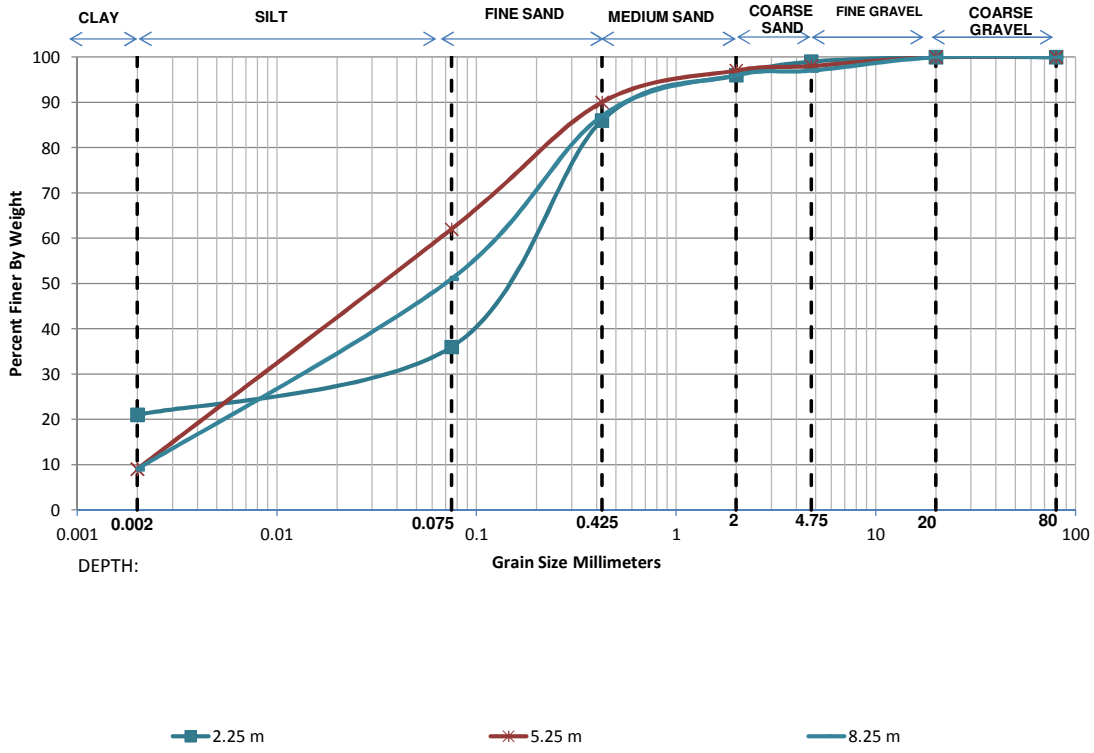
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	38+482 Minor Bridge
B.H. No.	BH-CL



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
1.50 m	11.00	55.00	26.00	4.00	3.00	1.00	0.00	-	0.0143	0.0613	-	-
4.50 m	12.00	52.00	20.00	2.00	0.00	14.00	0.00	-	0.0139	0.0650	-	-

GRAIN SIZE DISTRIBUTION CURVES

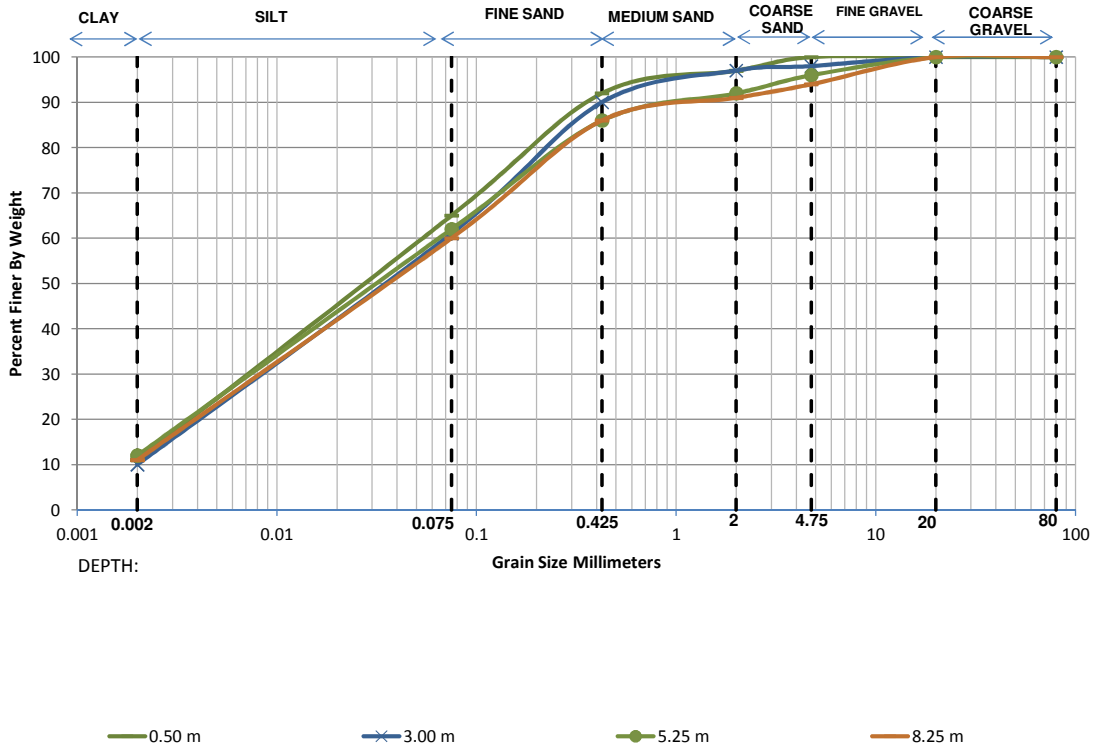
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	52+934 Minor Bridge
B.H. No.	BH-CL



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
2.25 m	21.00	15.00	50.00	10.00	3.00	1.00	0.00	-	0.0372	0.1965	-	-
5.25 m	9.00	53.00	28.00	7.00	1.00	2.00	0.00	0.0024	0.0178	0.0701	29.23	1.88
8.25 m	9.00	42.00	36.00	9.00	1.00	3.00	0.00	0.0024	0.0251	0.1135	46.74	2.28

GRAIN SIZE DISTRIBUTION CURVES

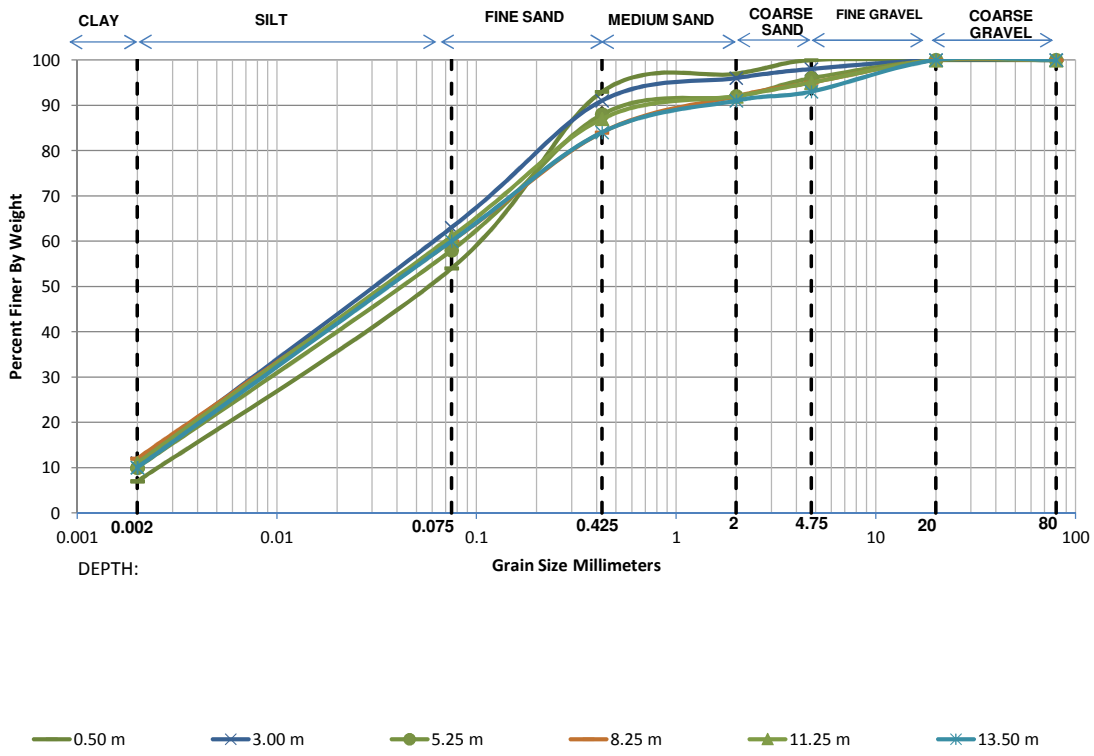
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	38+701
B.H. No.	BH-CL



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
0.50 m	11.00	54.00	27.00	5.00	3.00	0.00	0.00	-	0.0147	0.0633	-	-
3.00 m	10.00	51.00	29.00	7.00	1.00	2.00	0.00	0.0020	0.0173	0.0725	36.23	2.06
5.25 m	12.00	50.00	24.00	6.00	4.00	4.00	0.00	-	0.0148	0.0698	-	-
8.25 m	11.00	49.00	26.00	5.00	3.00	6.00	0.00	-	0.0166	0.0750	-	-

GRAIN SIZE DISTRIBUTION CURVES

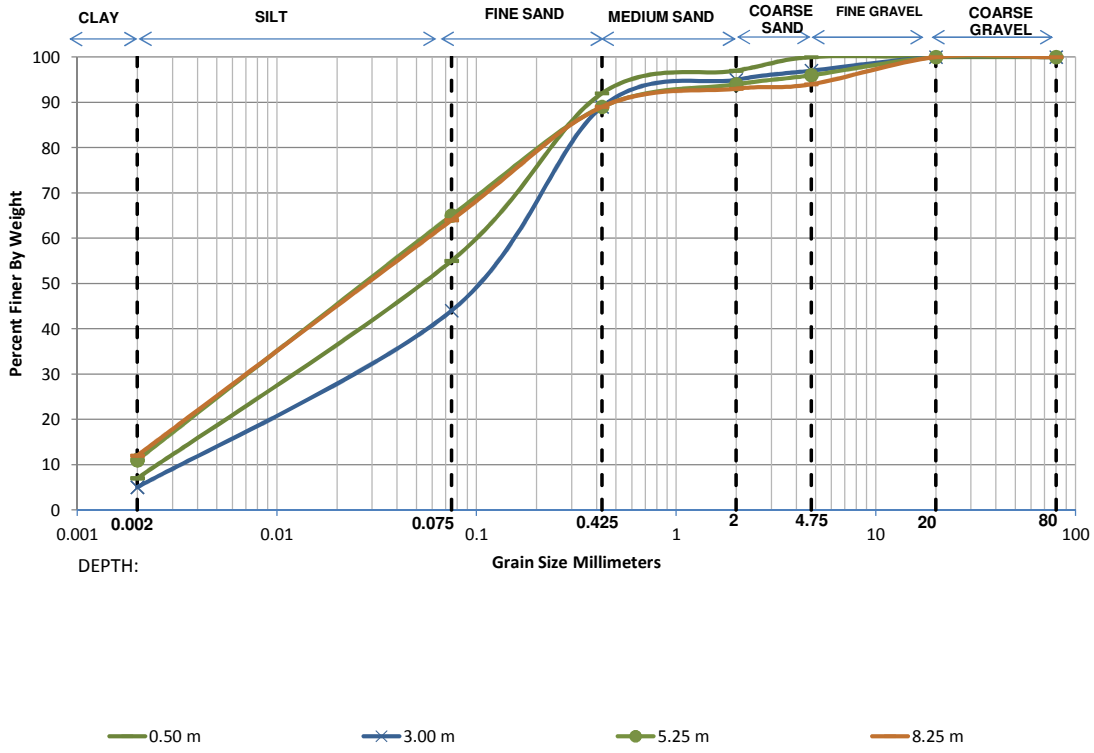
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	38+778
B.H. No.	BH-CL



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
0.50 m	7.00	47.00	39.00	4.00	3.00	0.00	0.00	0.0036	0.0250	0.0950	26.03	1.81
3.00 m	11.00	52.00	28.00	5.00	2.00	2.00	0.00	-	0.0155	0.0676	-	-
5.25 m	10.00	48.00	30.00	4.00	4.00	4.00	0.00	0.0020	0.0188	0.0813	40.66	2.17
8.25 m	12.00	48.00	24.00	8.00	3.00	5.00	0.00	-	0.0156	0.0750	-	-
11.25 m	11.00	50.00	26.00	5.00	3.00	5.00	0.00	-	0.0162	0.0724	-	-
13.50 m	10.00	50.00	24.00	7.00	2.00	7.00	0.00	0.0020	0.0175	0.0750	37.50	2.04

GRAIN SIZE DISTRIBUTION CURVES

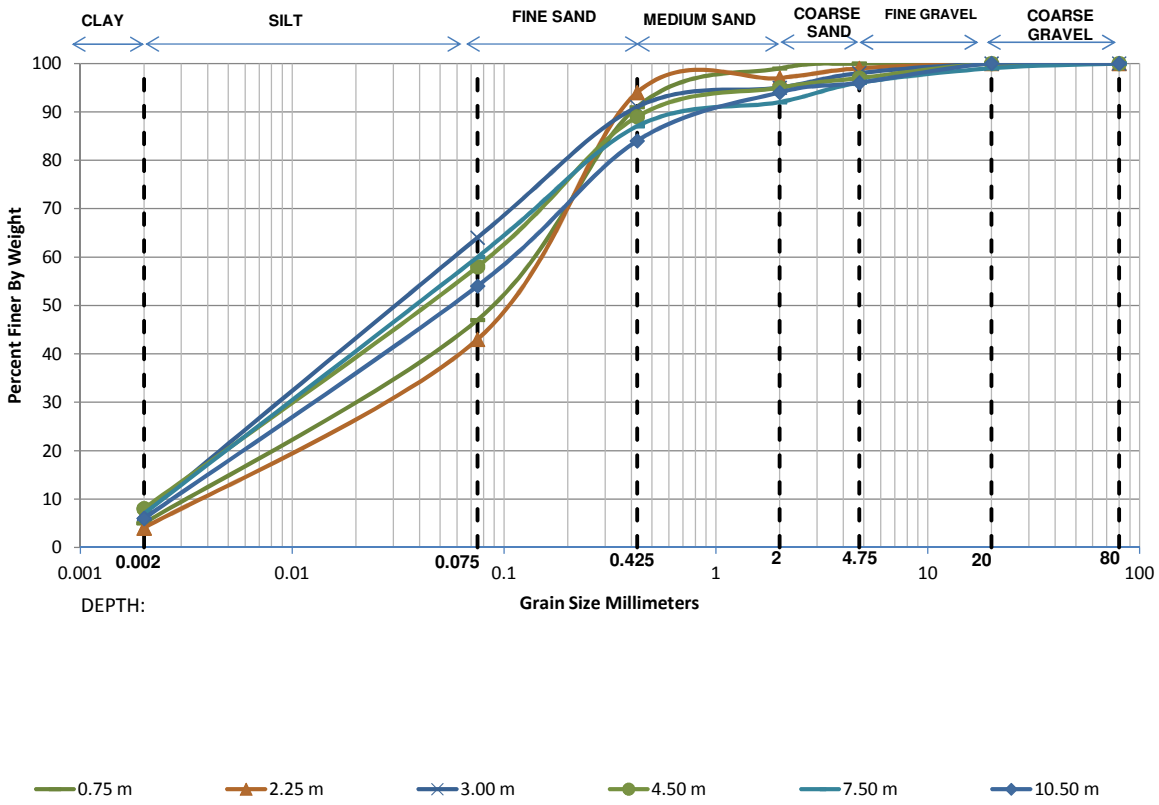
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	39+060
B.H. No.	BH-CL



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
0.50 m	7.00	48.00	37.00	5.00	3.00	0.00	0.00	0.0036	0.0242	0.0915	25.23	1.76
3.00 m	5.00	39.00	45.00	6.00	2.00	3.00	0.00	0.0061	0.0383	0.1409	23.06	1.70
5.25 m	11.00	54.00	24.00	5.00	2.00	4.00	0.00	-	0.0146	0.0632	-	-
8.25 m	12.00	52.00	25.00	4.00	1.00	6.00	0.00	-	0.0141	0.0652	-	-

GRAIN SIZE DISTRIBUTION CURVES

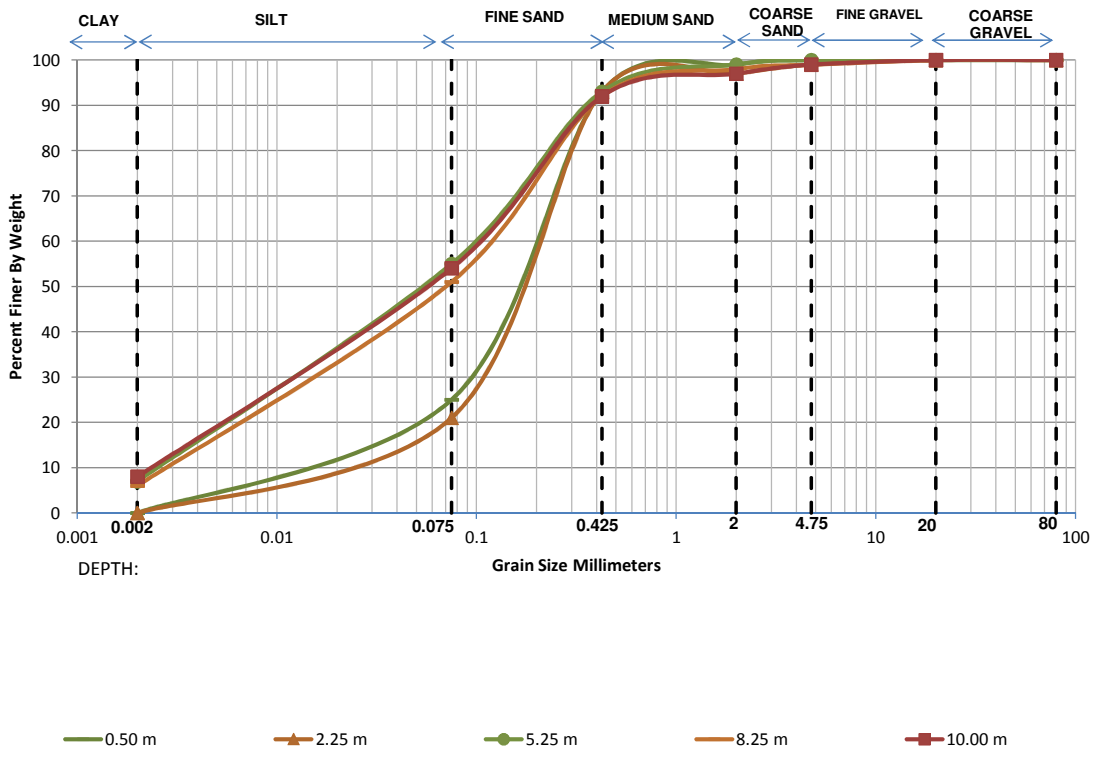
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	39+149
B.H. No.	BH-PLT-03



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
0.75 m	5.00	42.00	44.00	8.00	1.00	0.00	0.00	0.0059	0.0343	0.1256	21.35	1.59
2.25 m	4.00	39.00	51.00	3.00	2.00	1.00	0.00	0.0077	0.0414	0.1368	17.66	1.61
3.00 m	7.00	57.00	27.00	4.00	3.00	2.00	0.00	0.0035	0.0190	0.0660	18.90	1.56
4.50 m	8.00	50.00	31.00	6.00	2.00	3.00	0.00	0.0029	0.0209	0.0811	27.68	1.84
7.50 m	7.00	53.00	27.00	5.00	4.00	3.00	1.00	0.0035	0.0207	0.0750	21.19	1.62
10.50 m	6.00	48.00	30.00	10.00	2.00	4.00	0.00	0.0045	0.0256	0.1009	22.66	1.46

GRAIN SIZE DISTRIBUTION CURVES

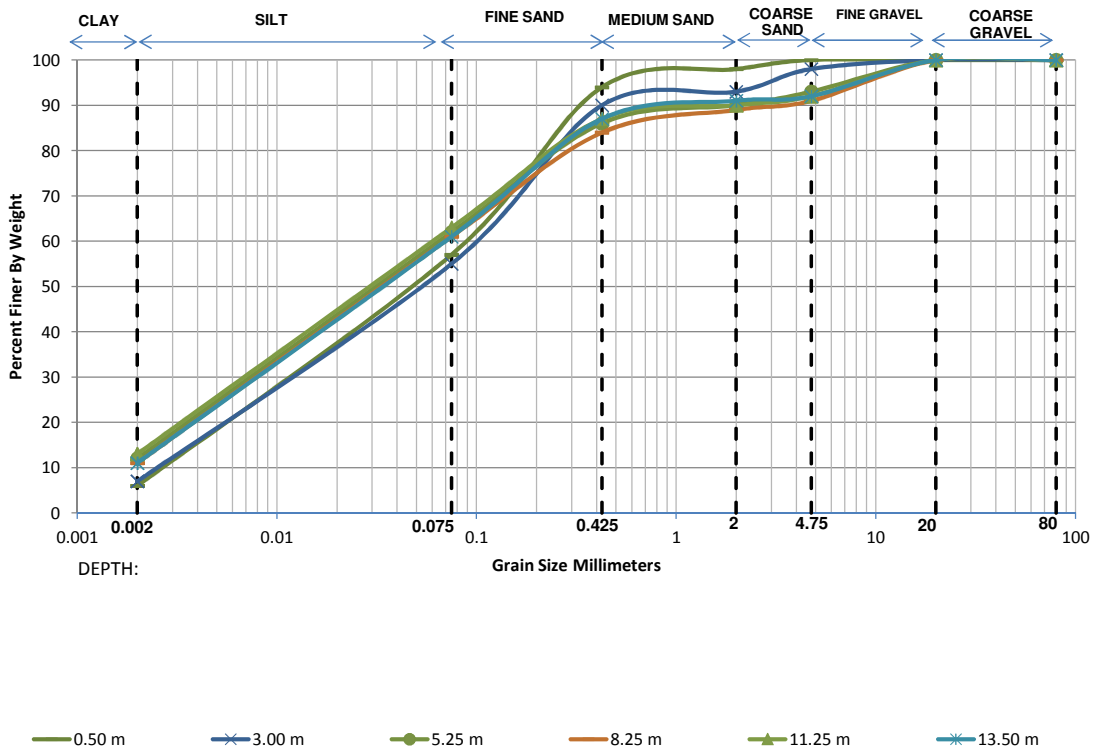
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	39+400
B.H. No.	BH-CL



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
0.50 m	0.00	25.00	68.00	6.00	1.00	0.00	0.00	0.0188	0.0930	0.2002	10.67	2.30
2.25 m	0.00	21.00	72.00	4.00	2.00	1.00	0.00	0.0258	0.1085	0.2120	8.22	2.15
5.25 m	7.00	48.00	38.00	6.00	1.00	0.00	0.00	0.0036	0.0242	0.0913	25.15	1.77
8.25 m	6.00	45.00	41.00	6.00	1.00	1.00	0.00	0.0046	0.0287	0.1076	23.50	1.68
10.00 m	8.00	46.00	38.00	5.00	2.00	1.00	0.00	0.0030	0.0238	0.0957	32.24	2.00

GRAIN SIZE DISTRIBUTION CURVES

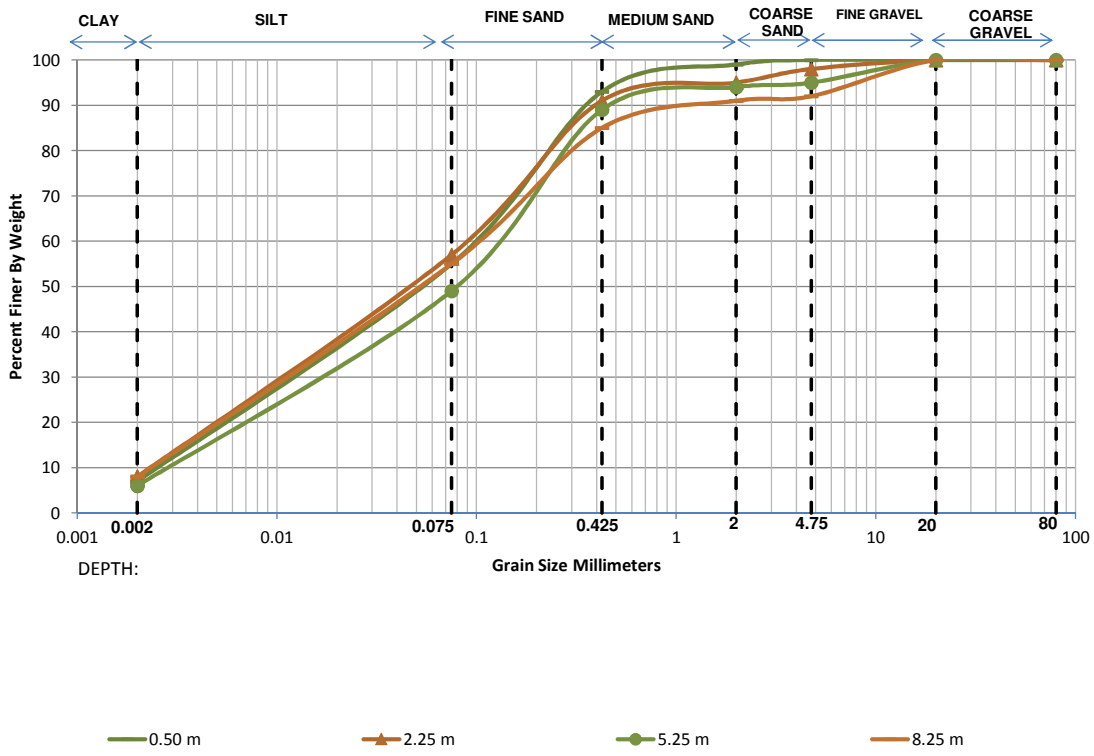
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	40+325
B.H. No.	BH-CL



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
0.50 m	6.00	51.00	37.00	4.00	2.00	0.00	0.00	0.0044	0.0241	0.0837	19.04	1.57
3.00 m	7.00	48.00	35.00	3.00	5.00	2.00	0.00	0.0036	0.0241	0.0921	25.40	1.74
5.25 m	12.00	50.00	24.00	4.00	3.00	7.00	0.00	-	0.0148	0.0698	-	-
8.25 m	11.00	50.00	23.00	5.00	2.00	9.00	0.00	-	0.0160	0.0724	-	-
11.25 m	13.00	50.00	24.00	3.00	2.00	8.00	0.00	-	0.0135	0.0673	-	-
13.50 m	11.00	50.00	26.00	4.00	1.00	8.00	0.00	-	0.0162	0.0724	-	-

GRAIN SIZE DISTRIBUTION CURVES

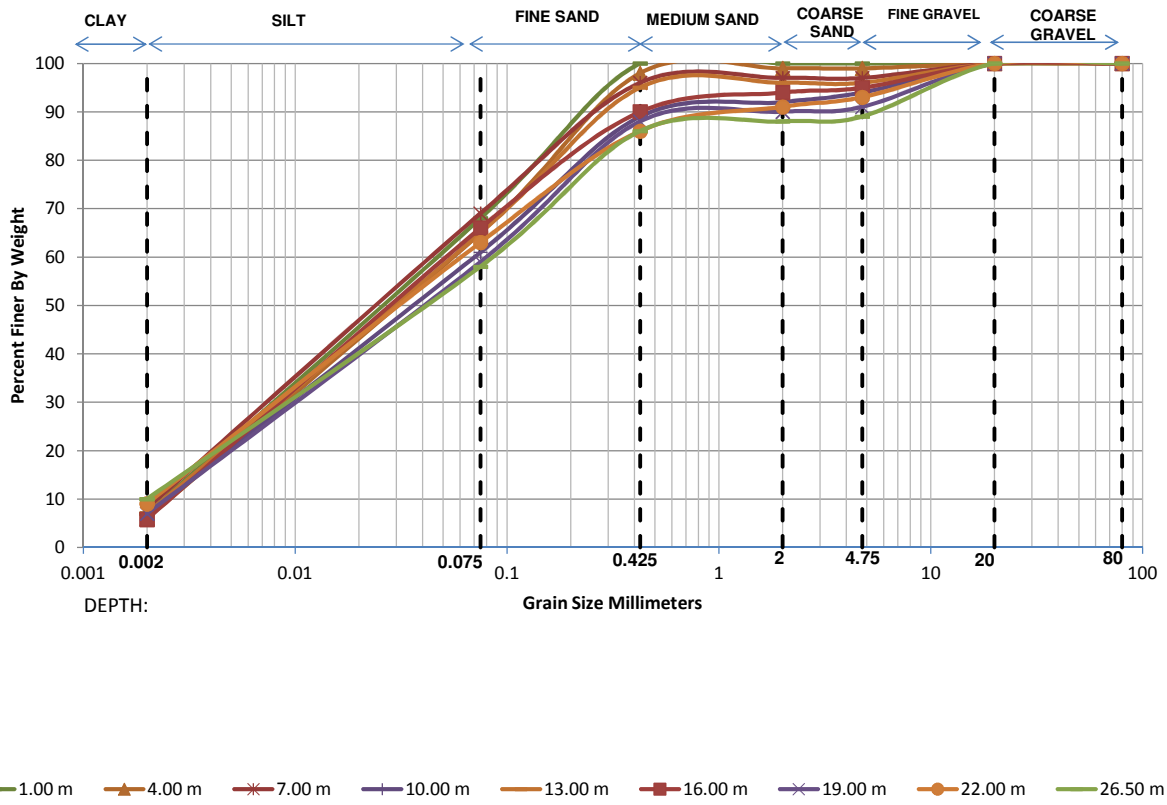
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	40+573
B.H. No.	BH-CL



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
0.50 m	7.00	48.00	38.00	6.00	1.00	0.00	0.00	0.0036	0.0242	0.0913	25.15	1.77
2.25 m	8.00	49.00	34.00	4.00	3.00	2.00	0.00	0.0029	0.0216	0.0843	28.70	1.89
5.25 m	6.00	43.00	40.00	5.00	1.00	5.00	0.00	0.0047	0.0306	0.1189	25.57	1.69
8.25 m	8.00	47.00	30.00	6.00	1.00	8.00	0.00	0.0030	0.0227	0.0949	32.16	1.83

GRAIN SIZE DISTRIBUTION CURVES

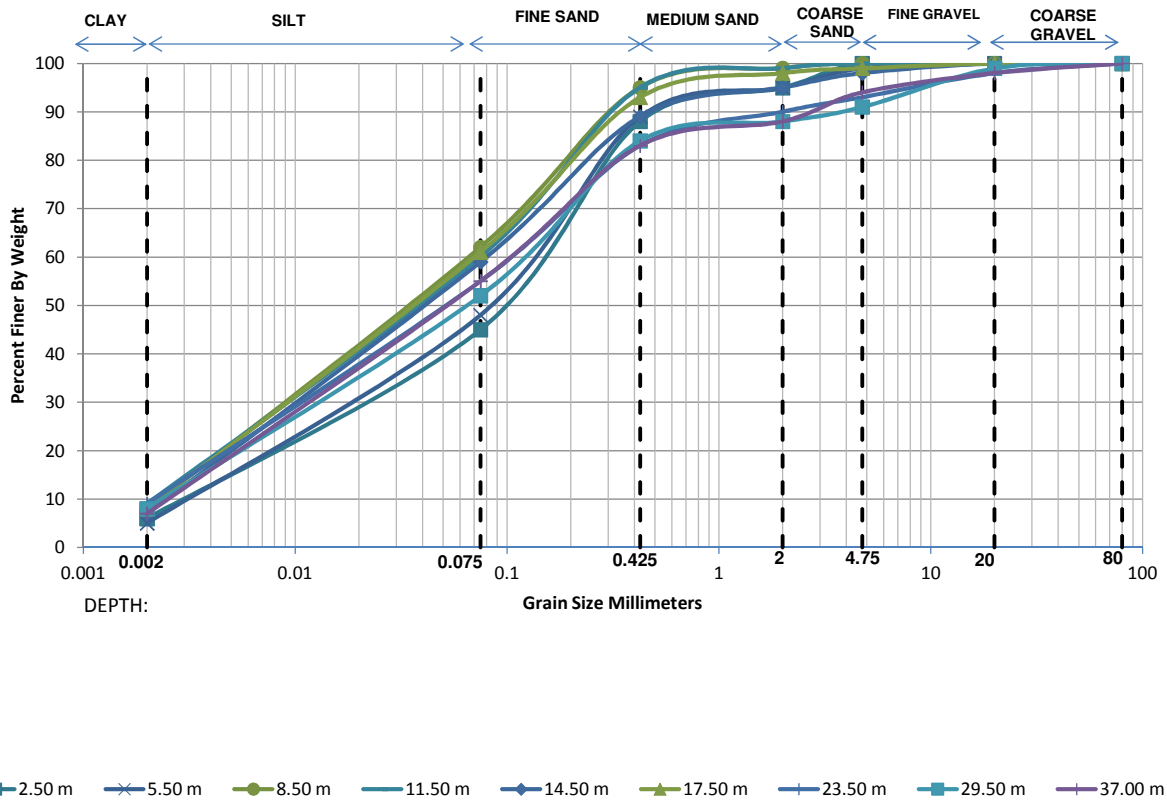
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	41+056 Major Bridge
B.H. No.	BH-A1



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
1.00 m	7.00	61.00	32.00	0.00	0.00	0.00	0.00	0.0035	0.0178	0.0590	17.03	1.55
4.00 m	6.00	59.00	33.00	1.00	0.00	1.00	0.00	0.0042	0.0200	0.0644	15.25	1.47
7.00 m	8.00	61.00	27.00	1.00	0.00	3.00	0.00	0.0029	0.0162	0.0568	19.84	1.62
10.00 m	7.00	54.00	28.00	3.00	2.00	6.00	0.00	0.0035	0.0203	0.0726	20.57	1.61
13.00 m	7.00	58.00	30.00	1.00	0.00	4.00	0.00	0.0035	0.0187	0.0642	18.40	1.57
16.00 m	5.80	60.20	24.00	4.00	1.00	5.00	0.00	0.0044	0.0195	0.0624	14.31	1.40
19.00 m	7.00	52.00	29.00	2.00	1.00	9.00	0.00	0.0036	0.0213	0.0778	21.87	1.65
22.00 m	9.00	54.00	23.00	5.00	2.00	7.00	0.00	0.0024	0.0171	0.0678	28.27	1.81
26.50 m	10.00	48.00	28.00	2.00	1.00	11.00	0.00	0.0020	0.0187	0.0815	40.76	2.14

GRAIN SIZE DISTRIBUTION CURVES

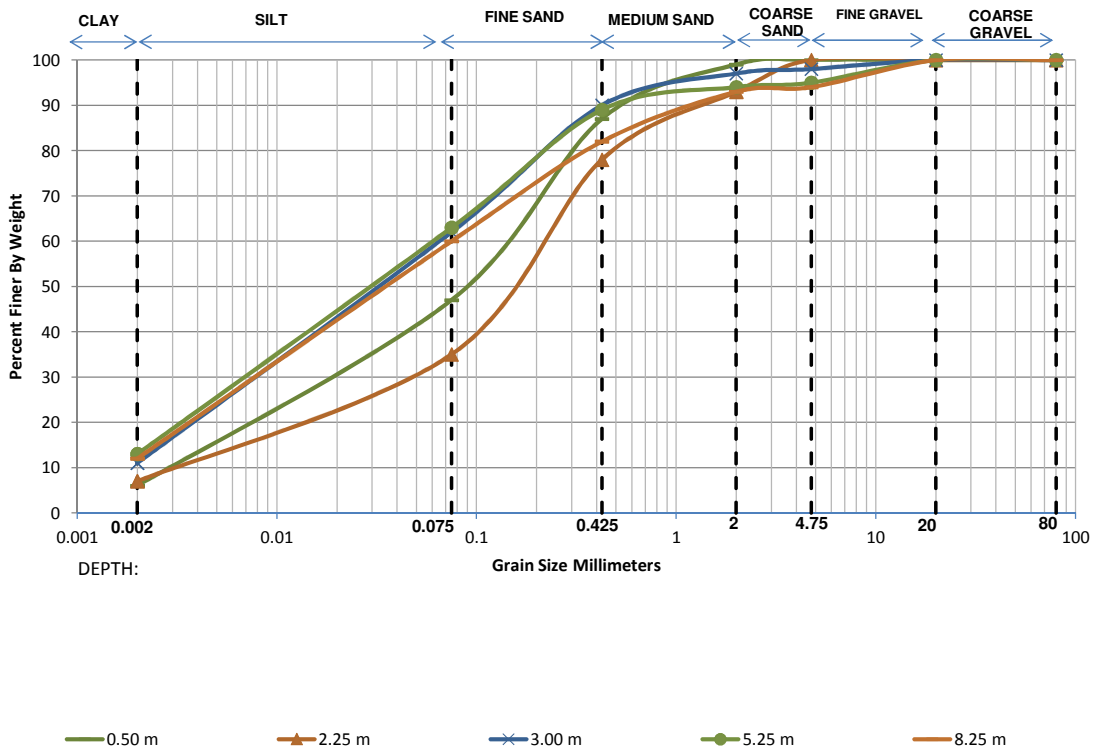
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	41+056 Major Bridge
B.H. No.	BH-A2



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
2.50 m	6.00	39.00	43.00	7.00	5.00	0.00	0.00	0.0048	0.0356	0.1389	28.64	1.89
5.50 m	5.00	43.00	41.00	6.00	4.00	1.00	0.00	0.0058	0.0329	0.1233	21.25	1.52
8.50 m	8.00	54.00	33.00	4.00	1.00	0.00	0.00	0.0029	0.0190	0.0703	24.20	1.77
11.50 m	9.00	51.00	35.00	4.00	1.00	0.00	0.00	0.0024	0.0190	0.0750	31.19	2.00
14.50 m	7.00	52.00	30.00	6.00	3.00	2.00	0.00	0.0036	0.0214	0.0778	21.86	1.65
17.50 m	8.00	53.00	32.00	5.00	1.00	1.00	0.00	0.0029	0.0194	0.0726	24.94	1.78
23.50 m	9.00	46.00	28.00	7.00	3.00	5.00	2.00	0.0024	0.0215	0.0966	40.01	1.98
29.50 m	8.00	44.00	32.00	4.00	3.00	8.00	1.00	0.0030	0.0250	0.1107	37.15	1.90
37.00 m	7.00	48.00	28.00	5.00	6.00	4.00	2.00	0.0036	0.0237	0.0960	26.58	1.61

GRAIN SIZE DISTRIBUTION CURVES

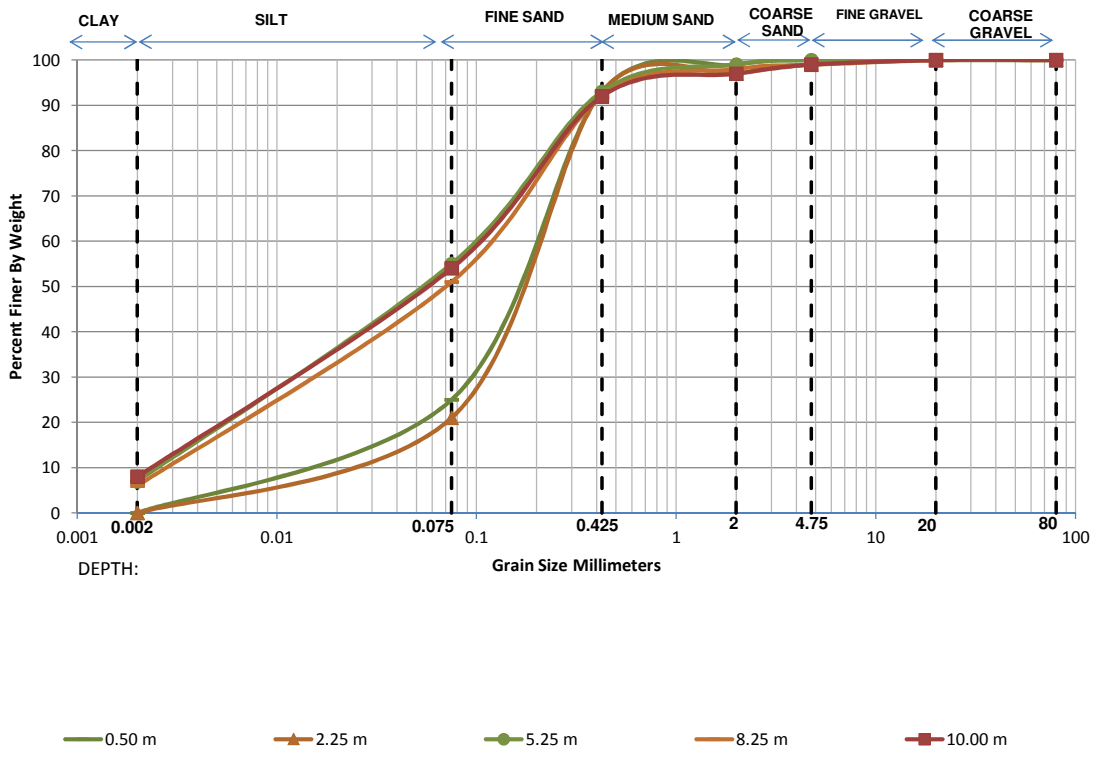
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	41+100 Minor Bridge
B.H. No.	BH-CL



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
0.50 m	6.00	41.00	40.00	12.00	1.00	0.00	0.00	0.0047	0.0328	0.1326	28.00	1.72
2.25 m	7.00	28.00	43.00	15.00	7.00	0.00	0.00	0.0044	0.0559	0.2177	49.12	3.24
3.00 m	11.00	51.00	28.00	7.00	1.00	2.00	0.00	-	0.0159	0.0700	-	-
5.25 m	13.00	50.00	26.00	5.00	1.00	5.00	0.00	-	0.0136	0.0673	-	-
8.25 m	12.00	48.00	22.00	11.00	1.00	6.00	0.00	-	0.0155	0.0750	-	-

GRAIN SIZE DISTRIBUTION CURVES

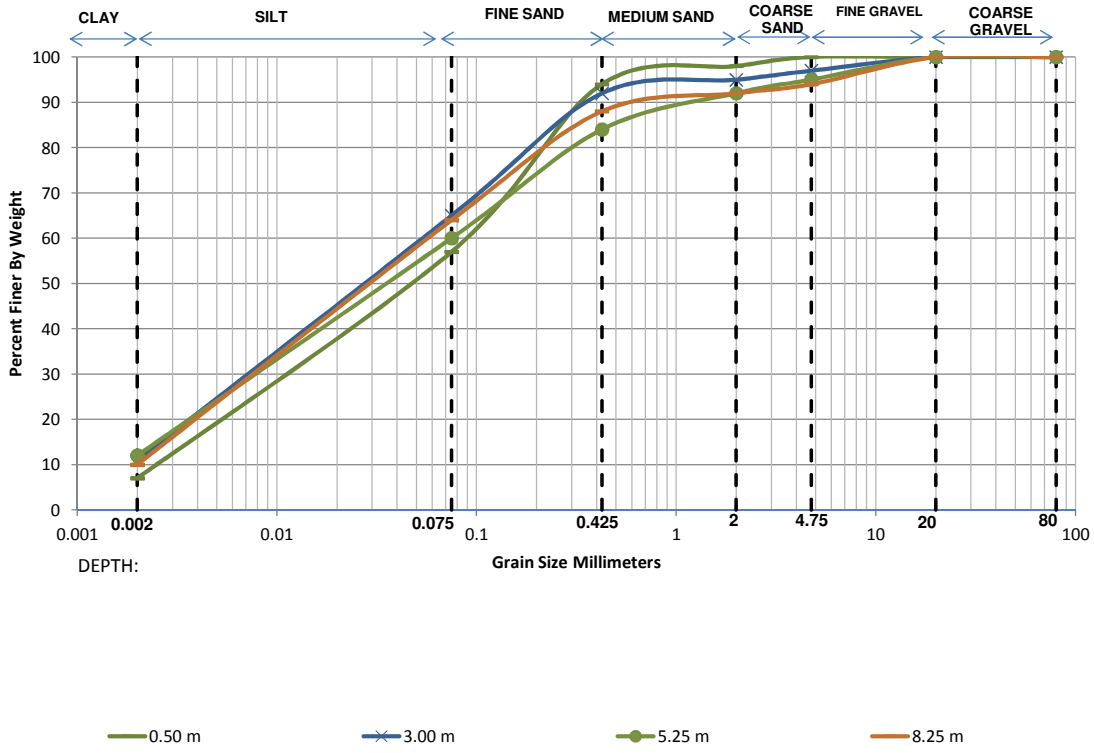
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	41+217
B.H. No.	BH-CL



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
0.50 m	0.00	25.00	68.00	6.00	1.00	0.00	0.00	0.0188	0.0930	0.2002	10.67	2.30
2.25 m	0.00	19.00	72.00	4.00	3.00	2.00	0.00	0.0307	0.1172	0.2223	7.25	2.01
3.00 m	7.00	49.00	34.00	6.00	1.00	3.00	0.00	0.0036	0.0233	0.0883	24.48	1.71
5.25 m	10.00	51.00	28.00	6.00	1.00	4.00	0.00	0.0020	0.0172	0.0725	36.23	2.05
8.25 m	12.00	50.00	28.00	6.00	1.00	3.00	0.00	-	0.0149	0.0699	-	-

GRAIN SIZE DISTRIBUTION CURVES

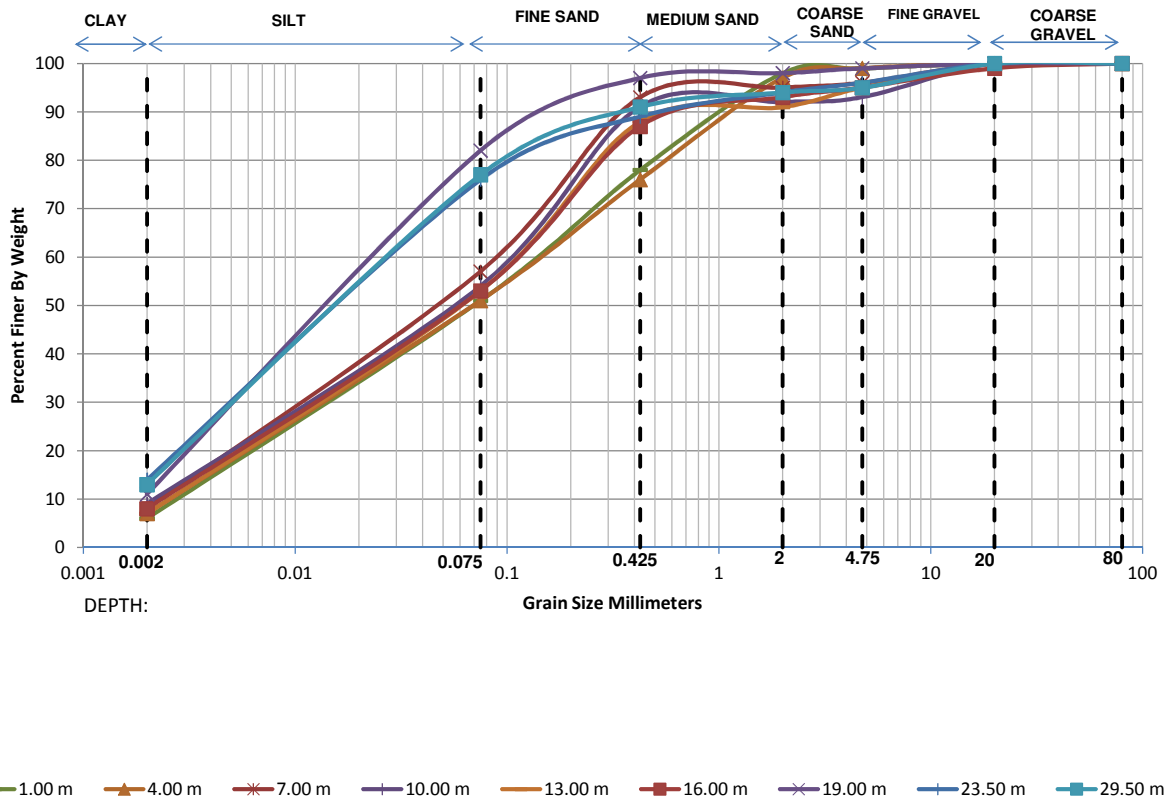
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	41+235
B.H. No.	BH-CL



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
0.50 m	7.00	50.00	37.00	4.00	2.00	0.00	0.00	0.0036	0.0229	0.0838	23.31	1.74
3.00 m	11.00	54.00	27.00	3.00	2.00	3.00	0.00	-	0.0147	0.0633	-	-
5.25 m	12.00	48.00	24.00	8.00	3.00	5.00	0.00	-	0.0156	0.0750	-	-
8.25 m	10.00	54.00	24.00	4.00	2.00	6.00	0.00	0.0020	0.0158	0.0655	32.73	1.92

GRAIN SIZE DISTRIBUTION CURVES

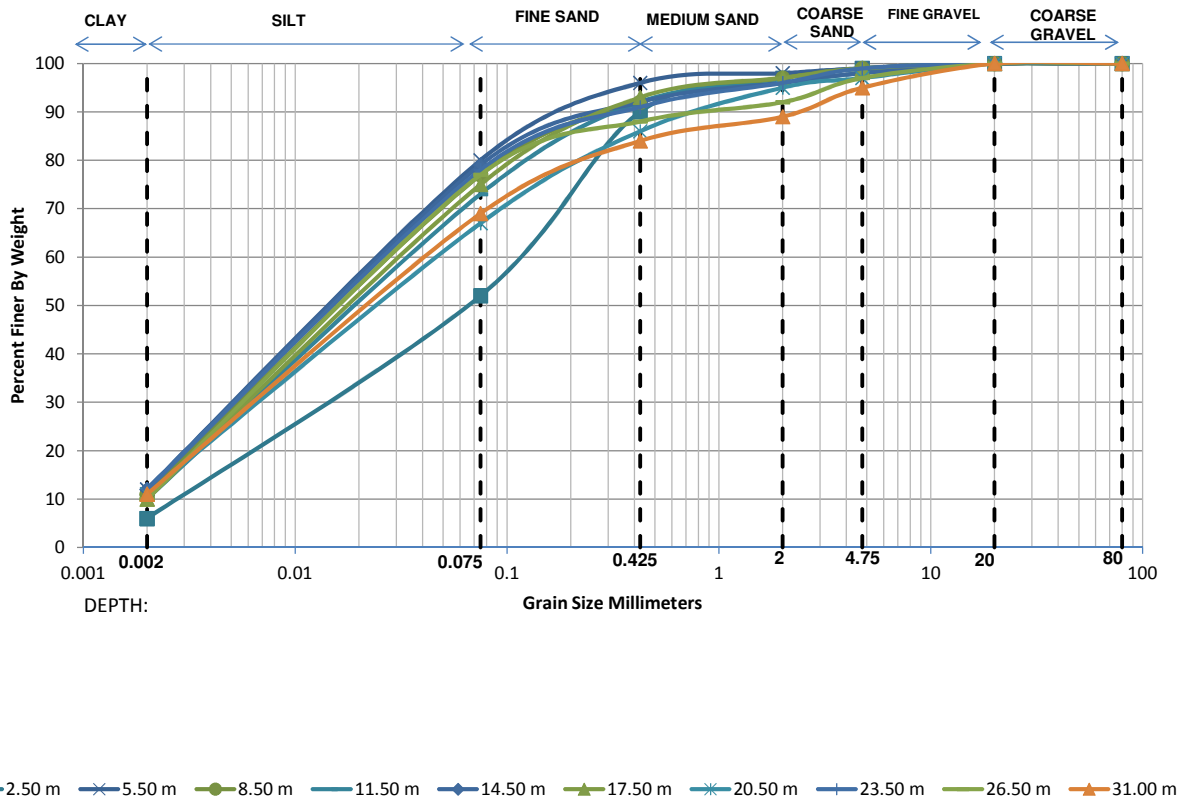
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	41+390 Major Bridge
B.H. No.	BH-A1



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
1.00 m	6.00	45.00	27.00	20.00	1.00	1.00	0.00	0.0045	0.0278	0.1328	29.30	1.29
4.00 m	7.00	44.00	25.00	21.00	2.00	1.00	0.00	0.0037	0.0265	0.1404	38.20	1.36
7.00 m	8.00	49.00	36.00	2.00	1.00	4.00	0.00	0.0029	0.0217	0.0840	28.57	1.91
10.00 m	9.00	45.00	37.00	1.00	1.00	7.00	0.00	0.0024	0.0227	0.0960	39.65	2.22
13.00 m	7.00	46.00	35.00	3.00	4.00	5.00	0.00	0.0037	0.0255	0.1017	27.79	1.75
16.00 m	8.00	45.00	34.00	6.00	2.00	4.00	1.00	0.0030	0.0244	0.1031	34.68	1.94
19.00 m	11.00	71.00	15.00	1.00	1.00	1.00	0.00	-	0.0107	0.0391	-	-
23.50 m	14.00	62.00	13.00	5.00	2.00	4.00	0.00	-	0.0094	0.0438	-	-
29.50 m	13.00	64.00	14.00	3.00	1.00	5.00	0.00	-	0.0100	0.0432	-	-

GRAIN SIZE DISTRIBUTION CURVES

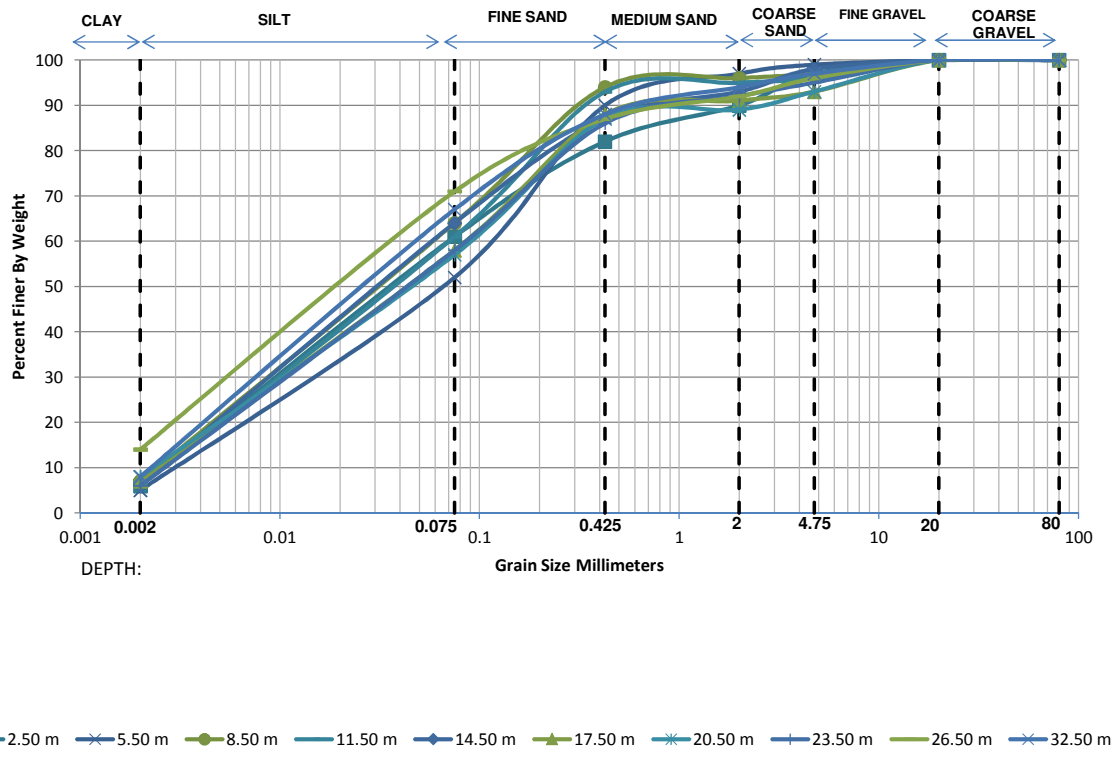
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	41+390 Major Bridge
B.H. No.	BH-A2



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
2.50 m	6.00	46.00	38.00	7.00	2.00	1.00	0.00	0.0045	0.0277	0.1050	23.14	1.61
5.50 m	12.00	68.00	16.00	2.00	1.00	1.00	0.00	-	0.0103	0.0406	-	-
8.50 m	11.00	66.00	15.00	5.00	2.00	1.00	0.00	-	0.0114	0.0442	-	-
11.50 m	10.00	63.00	19.00	4.00	2.00	2.00	0.00	0.0020	0.0131	0.0498	24.92	1.73
14.50 m	12.00	67.00	13.00	4.00	2.00	2.00	0.00	-	0.0104	0.0414	-	-
17.50 m	10.00	65.00	18.00	4.00	2.00	1.00	0.00	0.0020	0.0127	0.0472	23.59	1.71
20.50 m	11.00	56.00	19.00	9.00	2.00	3.00	0.00	-	0.0138	0.0591	-	-
23.50 m	12.00	66.00	13.00	5.00	3.00	1.00	0.00	-	0.0105	0.0425	-	-
26.50 m	10.00	67.00	11.00	4.00	5.00	3.00	0.00	0.0020	0.0121	0.0444	22.21	1.66
31.00 m	11.00	58.00	15.00	5.00	6.00	5.00	0.00	-	0.0131	0.0553	-	-

GRAIN SIZE DISTRIBUTION CURVES

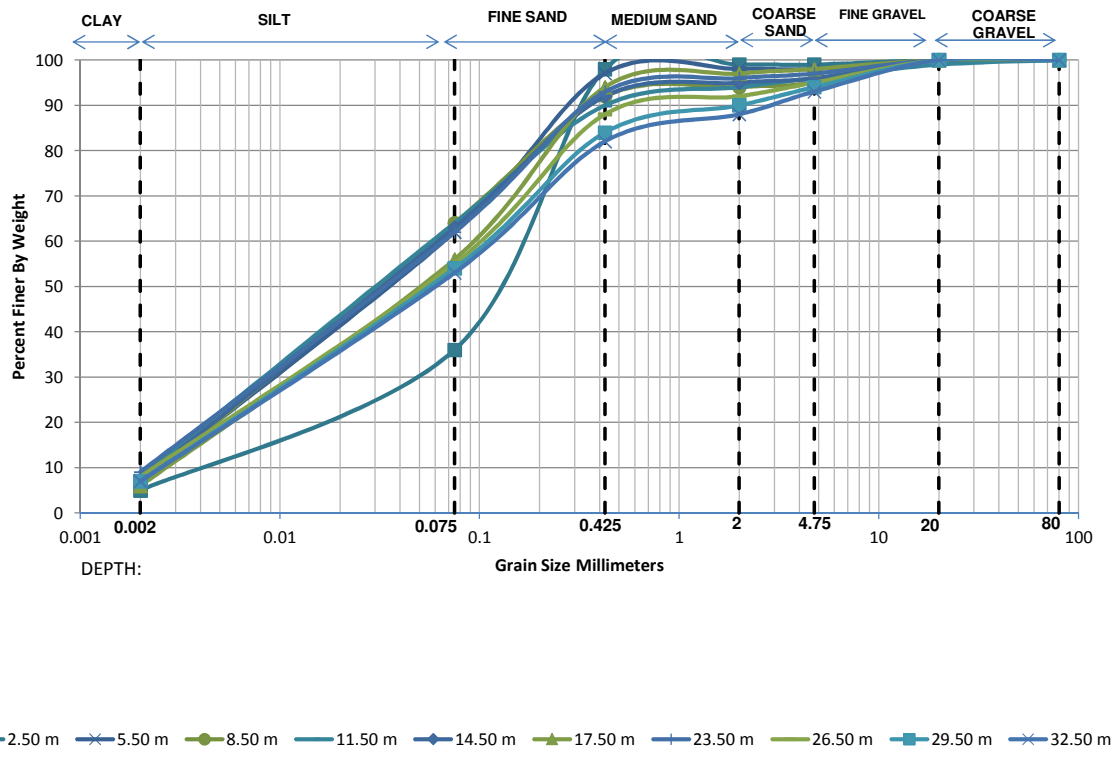
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	42+256 Major Bridge
B.H. No.	BH-A1



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
2.50 m	6.00	55.00	21.00	8.00	7.00	3.00	0.00	0.0043	0.0211	0.0726	16.99	1.44
5.50 m	5.00	47.00	38.00	7.00	2.00	1.00	0.00	0.0056	0.0289	0.1047	18.77	1.43
8.50 m	7.00	57.00	30.00	2.00	1.00	3.00	0.00	0.0035	0.0191	0.0661	18.90	1.58
11.50 m	6.00	55.00	32.00	2.00	1.00	4.00	0.00	0.0043	0.0217	0.0727	16.91	1.50
14.50 m	6.00	58.00	23.00	6.00	5.00	2.00	0.00	0.0042	0.0200	0.0661	15.64	1.43
17.50 m	7.00	51.00	30.00	3.00	2.00	7.00	0.00	0.0036	0.0219	0.0811	22.70	1.66
20.50 m	8.00	49.00	30.00	2.00	4.00	7.00	0.00	0.0029	0.0214	0.0850	28.96	1.84
23.50 m	6.00	52.00	28.00	6.00	3.00	5.00	0.00	0.0043	0.0230	0.0813	18.69	1.50
26.50 m	14.00	57.00	16.00	5.00	4.00	4.00	0.00	-	0.0103	0.0510	-	-
32.50 m	8.00	59.00	21.00	6.00	3.00	3.00	0.00	0.0029	0.0166	0.0599	20.87	1.61

GRAIN SIZE DISTRIBUTION CURVES

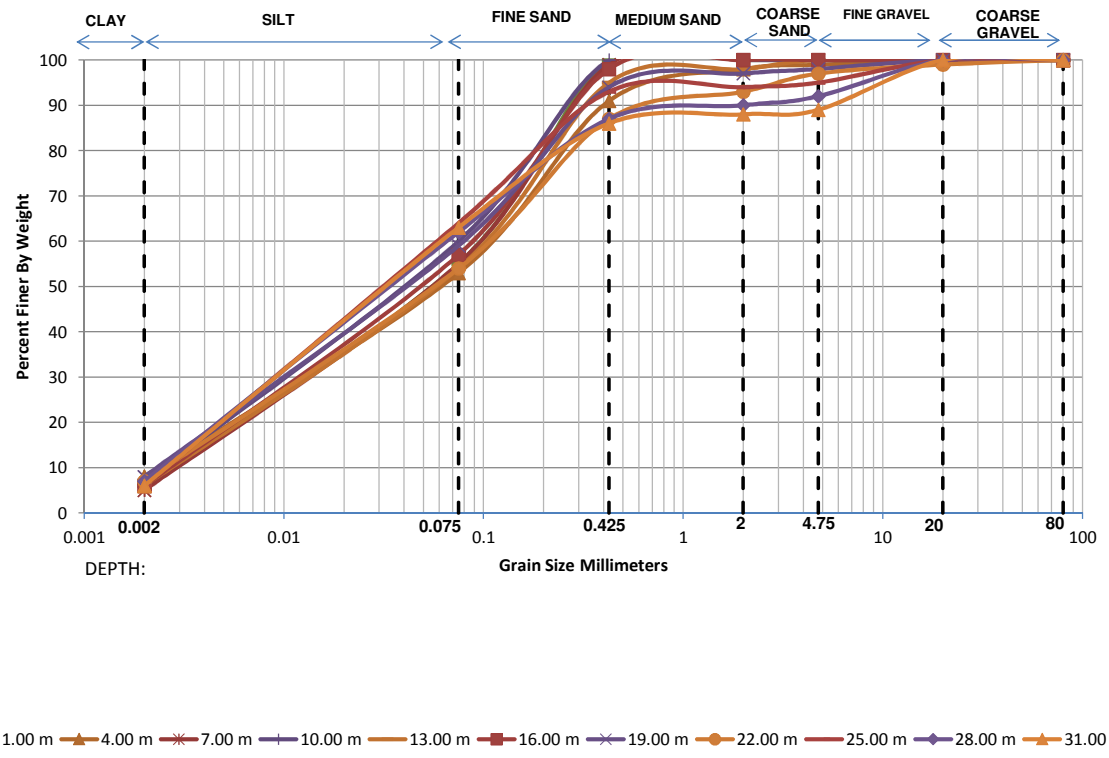
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	42+256 Major Bridge
B.H. No.	BH-P2



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
2.50 m	5.00	31.00	62.00	1.00	0.00	1.00	0.00	0.0072	0.0555	0.1576	21.77	2.70
5.50 m	7.00	55.00	35.00	1.00	0.00	2.00	0.00	0.0035	0.0202	0.0704	19.96	1.64
8.50 m	6.00	58.00	28.00	2.00	1.00	5.00	0.00	0.0042	0.0202	0.0662	15.64	1.45
11.50 m	8.00	56.00	26.00	4.00	2.00	3.00	1.00	0.0029	0.0179	0.0658	22.79	1.68
14.50 m	7.00	56.00	29.00	3.00	1.00	4.00	0.00	0.0035	0.0195	0.0681	19.43	1.59
17.50 m	6.00	50.00	38.00	3.00	1.00	2.00	0.00	0.0044	0.0247	0.0871	19.69	1.59
23.50 m	9.00	53.00	31.00	3.00	1.00	3.00	0.00	0.0024	0.0179	0.0702	29.24	1.90
26.50 m	8.00	47.00	33.00	4.00	3.00	5.00	0.00	0.0030	0.0228	0.0931	31.53	1.90
29.50 m	7.00	47.00	30.00	6.00	4.00	6.00	0.00	0.0036	0.0245	0.1005	27.67	1.64
32.50 m	7.00	46.00	29.00	6.00	5.00	7.00	0.00	0.0036	0.0252	0.1081	29.62	1.61

GRAIN SIZE DISTRIBUTION CURVES

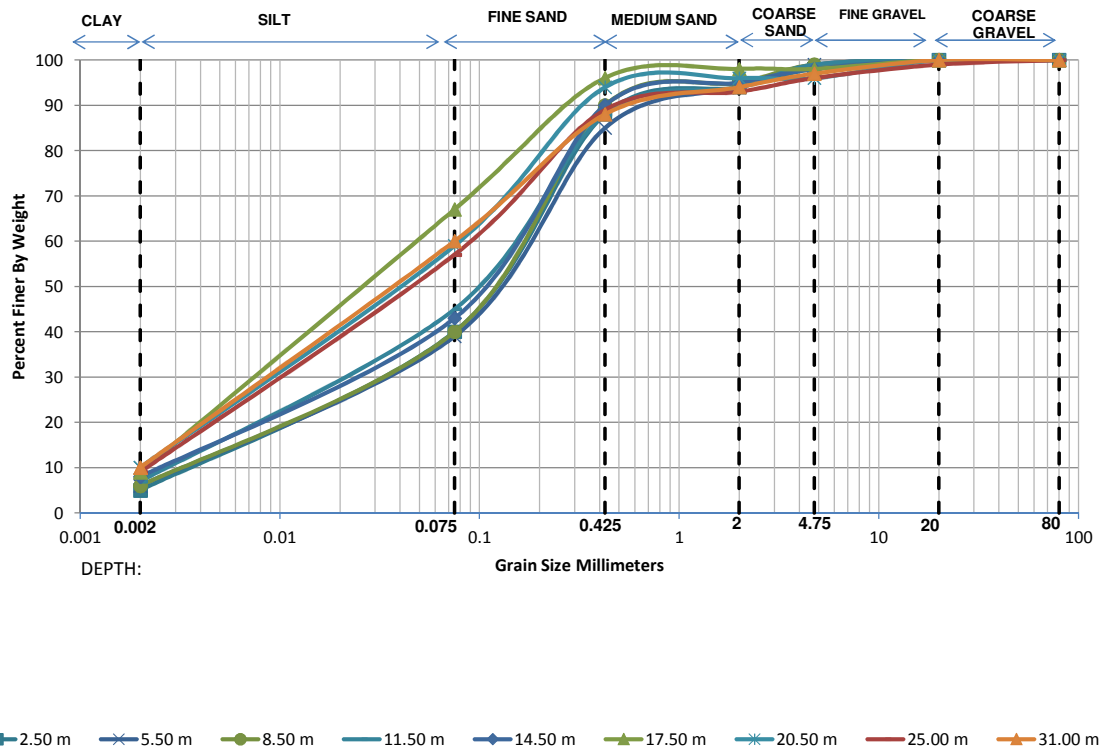
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	42+256 Major Bridge
B.H. No.	BH-P3



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
1.00 m	6.00	49.00	45.00	0.00	0.00	0.00	0.00	0.0045	0.0258	0.0969	21.68	1.54
4.00 m	8.00	45.00	38.00	7.00	1.00	1.00	0.00	0.0030	0.0246	0.1005	33.76	2.02
7.00 m	5.00	50.00	44.00	1.00	0.00	0.00	0.00	0.0055	0.0270	0.0893	16.30	1.49
10.00 m	7.00	53.00	40.00	0.00	0.00	0.00	0.00	0.0036	0.0214	0.0750	21.08	1.71
13.00 m	6.00	48.00	41.00	3.00	2.00	0.00	0.00	0.0045	0.0263	0.0940	20.95	1.64
16.00 m	6.00	51.00	41.00	2.00	0.00	0.00	0.00	0.0044	0.0243	0.0832	18.89	1.61
19.00 m	8.00	51.00	35.00	3.00	1.00	2.00	0.00	0.0029	0.0205	0.0777	26.55	1.86
22.00 m	7.00	47.00	33.00	6.00	4.00	2.00	1.00	0.0036	0.0247	0.0982	26.99	1.70
25.00 m	6.00	58.00	29.00	1.00	1.00	5.00	0.00	0.0042	0.0202	0.0662	15.64	1.46
28.00 m	7.00	55.00	25.00	3.00	2.00	8.00	0.00	0.0035	0.0197	0.0702	19.99	1.57
31.00 m	6.00	57.00	23.00	2.00	1.00	11.00	0.00	0.0042	0.0204	0.0681	16.07	1.43

GRAIN SIZE DISTRIBUTION CURVES

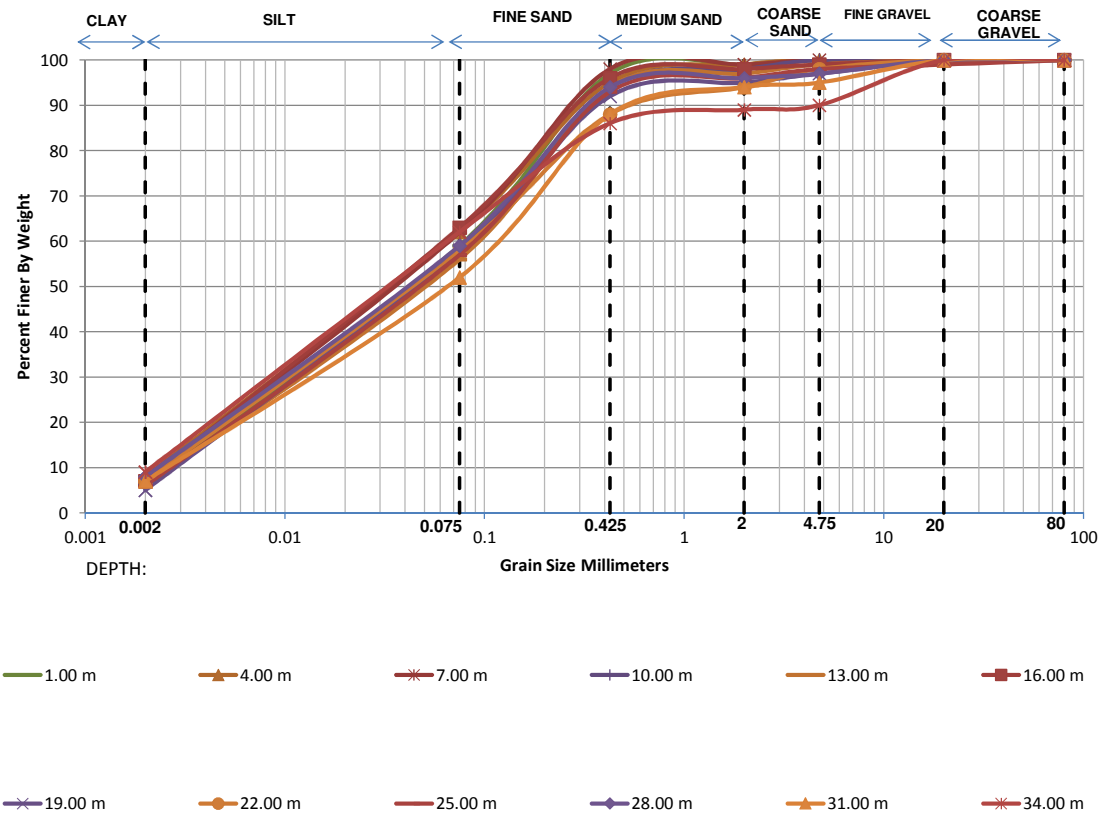
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	42+256 Major Bridge
B.H. No.	BH-P4



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
2.50 m	5.00	35.00	48.00	6.00	4.00	2.00	0.00	0.0065	0.0453	0.1598	24.49	1.97
5.50 m	6.00	33.00	46.00	9.00	5.00	1.00	0.00	0.0053	0.0464	0.1725	32.63	2.36
8.50 m	6.00	34.00	50.00	5.00	4.00	1.00	0.00	0.0052	0.0446	0.1561	29.87	2.44
11.50 m	7.00	38.00	43.00	6.00	5.00	1.00	0.00	0.0039	0.0346	0.1390	35.82	2.21
14.50 m	8.00	35.00	47.00	5.00	3.00	2.00	0.00	0.0031	0.0369	0.1447	46.23	3.00
17.50 m	9.00	58.00	29.00	2.00	0.00	2.00	0.00	0.0024	0.0160	0.0600	25.10	1.77
20.50 m	10.00	49.00	35.00	2.00	0.00	4.00	0.00	0.0020	0.0185	0.0777	38.87	2.20
25.00 m	9.00	48.00	32.00	4.00	3.00	3.00	1.00	0.0024	0.0205	0.0848	35.17	2.05
31.00 m	10.00	50.00	28.00	6.00	3.00	3.00	0.00	0.0020	0.0177	0.0750	37.50	2.08

GRAIN SIZE DISTRIBUTION CURVES

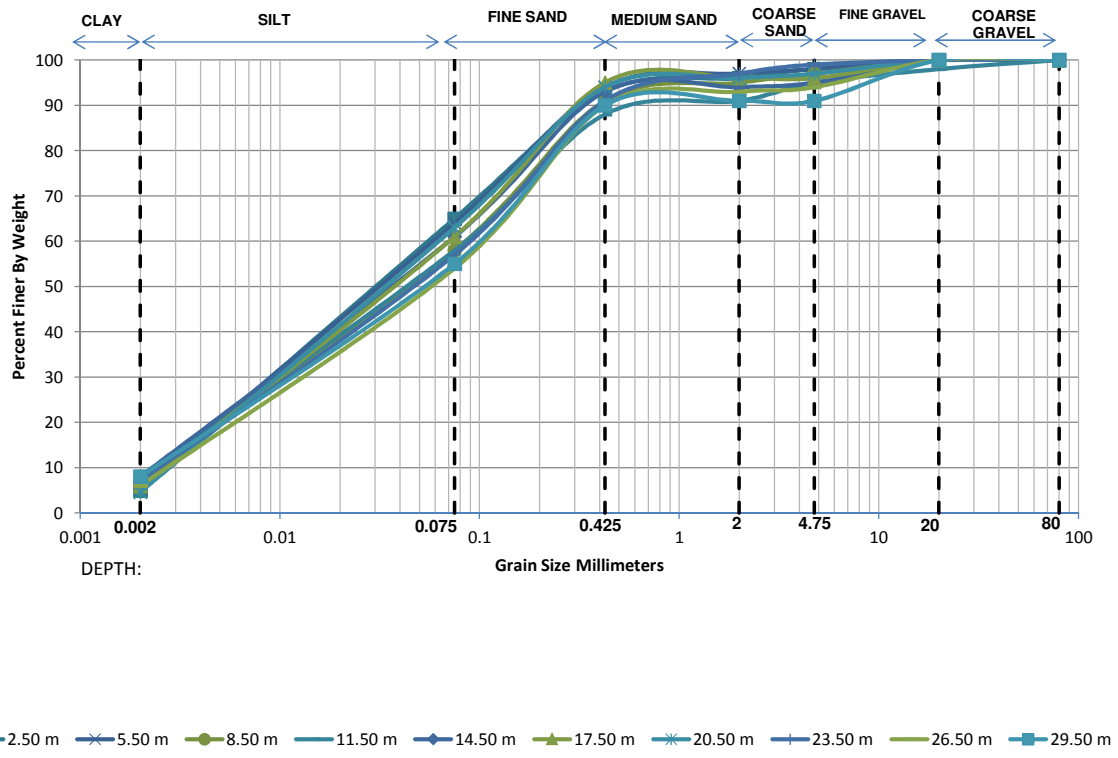
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	42+256 Major Bridge
B.H. No.	BH-P5



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
1.00 m	6.00	53.00	38.00	2.00	1.00	0.00	0.00	0.0044	0.0230	0.0775	17.82	1.56
4.00 m	8.00	54.00	33.00	4.00	1.00	0.00	0.00	0.0029	0.0190	0.0703	24.20	1.77
7.00 m	7.00	55.00	36.00	1.00	1.00	0.00	0.00	0.0035	0.0202	0.0704	19.96	1.64
10.00 m	8.00	50.00	36.00	4.00	2.00	0.00	0.00	0.0029	0.0211	0.0807	27.50	1.89
13.00 m	6.00	50.00	38.00	3.00	2.00	1.00	0.00	0.0044	0.0247	0.0871	19.69	1.59
16.00 m	7.00	56.00	33.00	2.00	1.00	1.00	0.00	0.0035	0.0196	0.0682	19.42	1.61
19.00 m	5.00	53.00	34.00	3.00	2.00	3.00	0.00	0.0053	0.0246	0.0806	15.11	1.41
22.00 m	7.00	51.00	30.00	6.00	4.00	2.00	0.00	0.0036	0.0219	0.0811	22.72	1.66
25.00 m	6.00	51.00	36.00	3.00	2.00	1.00	1.00	0.0044	0.0240	0.0838	19.08	1.56
28.00 m	8.00	51.00	35.00	2.00	1.00	3.00	0.00	0.0029	0.0205	0.0777	26.55	1.86
31.00 m	7.00	45.00	36.00	6.00	1.00	5.00	0.00	0.0037	0.0264	0.1067	28.99	1.78
34.00 m	9.00	53.00	24.00	3.00	1.00	10.00	0.00	0.0024	0.0176	0.0701	29.21	1.84

GRAIN SIZE DISTRIBUTION CURVES

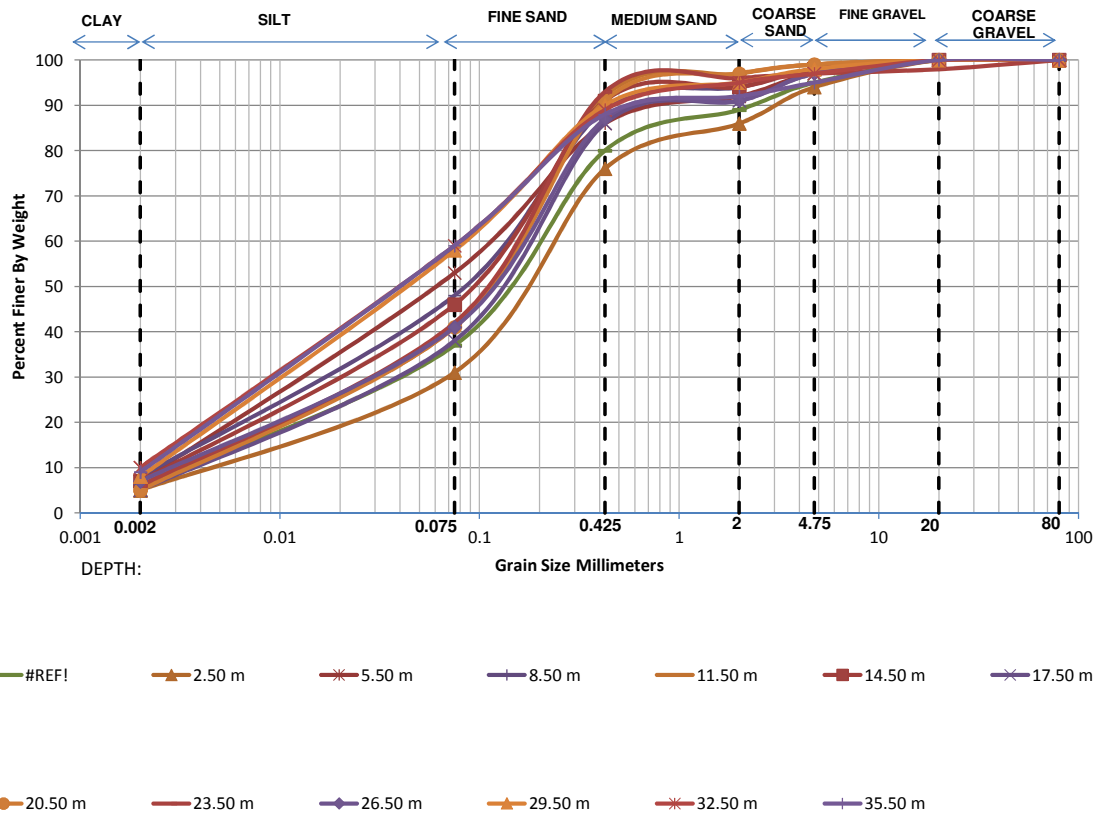
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	42+256 Major Bridge
B.H. No.	BH-P6



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
2.50 m	5.00	60.00	28.00	3.00	2.00	2.00	0.00	0.0051	0.0211	0.0645	12.60	1.35
5.50 m	6.00	58.00	30.00	3.00	1.00	2.00	0.00	0.0042	0.0203	0.0663	15.64	1.46
8.50 m	7.00	51.00	33.00	4.00	2.00	3.00	0.00	0.0036	0.0221	0.0808	22.60	1.69
11.50 m	8.00	50.00	30.00	3.00	4.00	3.00	2.00	0.0029	0.0208	0.0811	27.71	1.83
14.50 m	8.00	53.00	32.00	1.00	1.00	5.00	0.00	0.0029	0.0194	0.0726	24.94	1.78
17.50 m	6.00	55.00	34.00	1.00	0.00	4.00	0.00	0.0043	0.0218	0.0727	16.90	1.51
20.50 m	4.60	58.40	31.00	2.00	1.00	3.00	0.00	0.0056	0.0226	0.0685	12.21	1.33
23.50 m	7.00	50.00	34.00	6.00	2.00	1.00	0.00	0.0036	0.0227	0.0843	23.47	1.71
26.50 m	6.00	48.00	36.00	3.00	1.00	6.00	0.00	0.0045	0.0260	0.0960	21.47	1.58
29.50 m	8.00	47.00	35.00	1.00	0.00	9.00	0.00	0.0030	0.0230	0.0921	31.16	1.94

GRAIN SIZE DISTRIBUTION CURVES

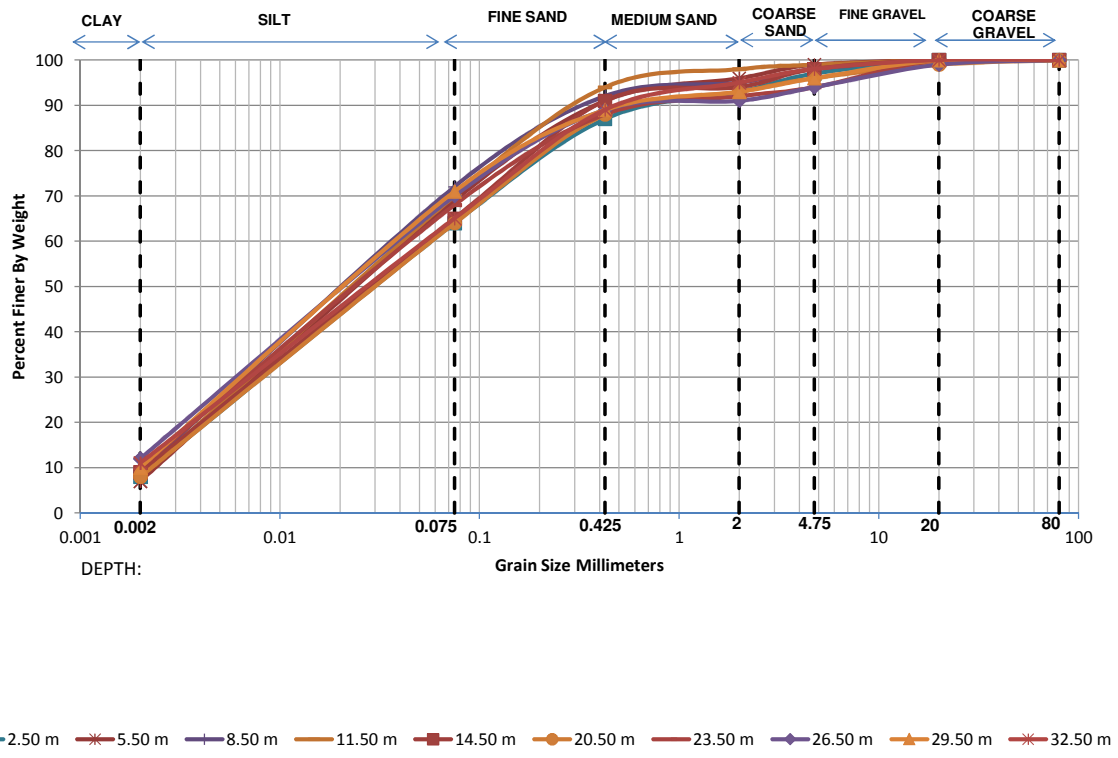
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	42+256 Major Bridge
B.H. No.	BH-P13



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
#REF!	6.00	31.00	43.00	9.00	6.00	5.00	0.00	0.0055	0.0509	0.1975	36.15	2.40
2.50 m	5.00	26.00	45.00	10.00	8.00	6.00	0.00	0.0081	0.0709	0.2403	29.53	2.57
5.50 m	7.00	46.00	33.00	6.00	5.00	3.00	0.00	0.0037	0.0254	0.1037	28.37	1.70
8.50 m	8.00	40.00	41.00	5.00	4.00	2.00	0.00	0.0030	0.0295	0.1242	40.88	2.31
11.50 m	6.00	35.00	51.00	5.00	2.00	1.00	0.00	0.0052	0.0427	0.1488	28.89	2.38
14.50 m	7.00	39.00	45.00	3.00	4.00	2.00	0.00	0.0039	0.0333	0.1296	33.63	2.23
17.50 m	5.00	33.00	48.00	5.00	6.00	3.00	0.00	0.0068	0.0496	0.1722	25.42	2.11
20.50 m	5.00	36.00	50.00	6.00	2.00	1.00	0.00	0.0064	0.0436	0.1501	23.35	1.97
23.50 m	6.00	36.00	51.00	3.00	1.00	1.00	2.00	0.0051	0.0409	0.1429	28.15	2.31
26.50 m	7.00	34.00	46.00	4.00	6.00	3.00	0.00	0.0041	0.0414	0.1580	38.96	2.67
29.50 m	8.00	50.00	32.00	5.00	3.00	2.00	0.00	0.0029	0.0209	0.0810	27.64	1.85
32.50 m	10.00	49.00	30.00	6.00	2.00	3.00	0.00	0.0020	0.0183	0.0779	38.94	2.14
35.50 m	9.00	50.00	29.00	4.00	3.00	5.00	0.00	0.0024	0.0192	0.0779	32.37	1.97

GRAIN SIZE DISTRIBUTION CURVES

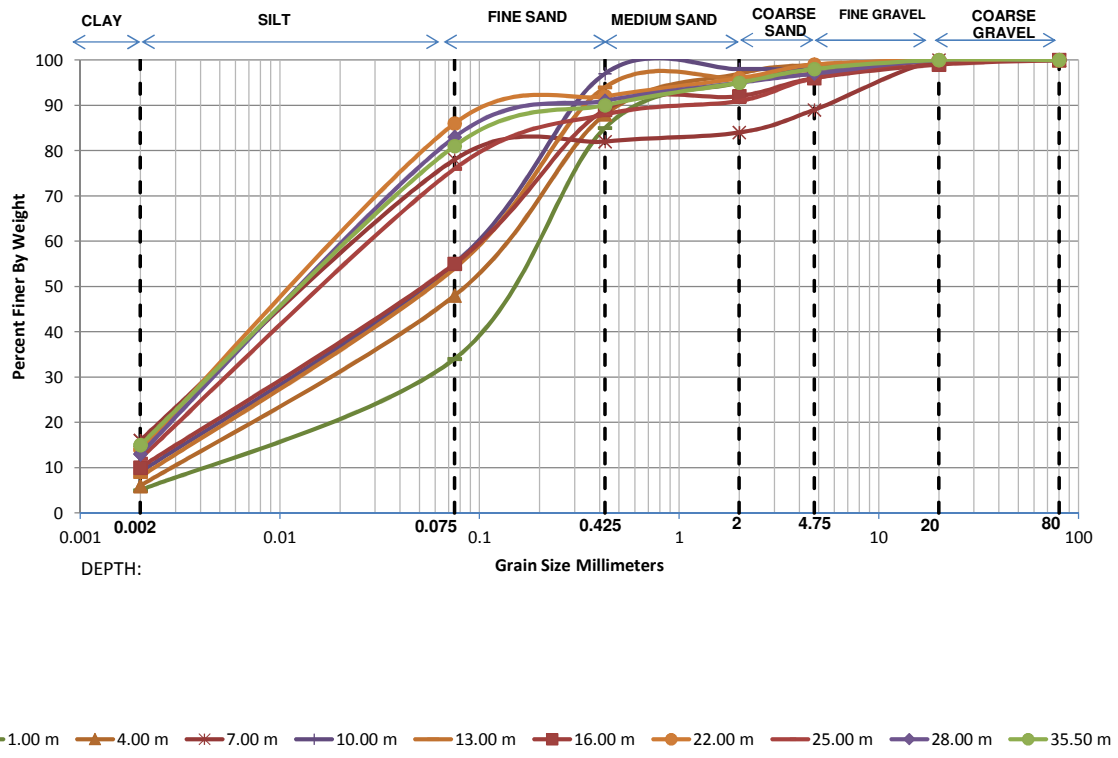
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	42+256 Major Bridge
B.H. No.	BH-P14



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
2.50 m	8.00	56.00	23.00	6.00	4.00	3.00	0.00	0.0029	0.0177	0.0658	22.78	1.66
5.50 m	7.00	62.00	22.00	5.00	3.00	1.00	0.00	0.0034	0.0171	0.0569	16.54	1.49
8.50 m	9.00	63.00	20.00	3.00	3.00	2.00	0.00	0.0024	0.0143	0.0517	21.69	1.65
11.50 m	8.00	62.00	24.00	4.00	1.00	1.00	0.00	0.0029	0.0159	0.0551	19.29	1.59
14.50 m	9.00	56.00	26.00	3.00	4.00	2.00	0.00	0.0024	0.0165	0.0637	26.59	1.79
20.50 m	8.00	56.00	24.00	5.00	3.00	3.00	1.00	0.0029	0.0178	0.0658	22.78	1.67
23.50 m	10.00	58.00	20.00	4.00	2.00	6.00	0.00	0.0020	0.0144	0.0576	28.79	1.80
26.50 m	12.00	58.00	19.00	2.00	3.00	5.00	1.00	-	0.0122	0.0535	-	-
29.50 m	10.00	61.00	18.00	4.00	3.00	4.00	0.00	0.0020	0.0136	0.0526	26.31	1.75
32.50 m	11.00	54.00	24.00	6.00	3.00	2.00	0.00	-	0.0146	0.0632	-	-

GRAIN SIZE DISTRIBUTION CURVES

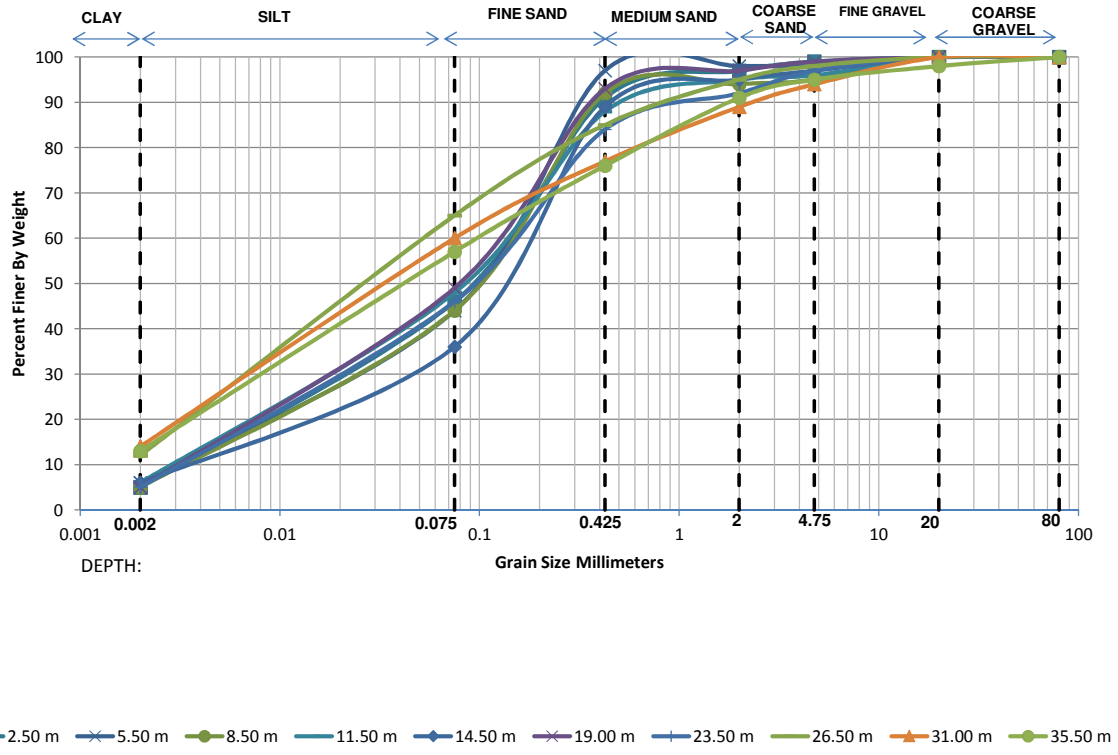
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	42+256 Major Bridge
B.H. No.	BH-P15



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
1.00 m	5.00	29.00	51.00	10.00	3.00	2.00	0.00	0.0075	0.0606	0.1927	25.70	2.54
4.00 m	6.00	42.00	40.00	9.00	2.00	1.00	0.00	0.0047	0.0317	0.1257	26.78	1.70
7.00 m	16.00	62.00	4.00	2.00	5.00	11.00	0.00	-	0.0077	0.0399	-	-
10.00 m	9.00	46.00	42.00	1.00	0.00	2.00	0.00	0.0024	0.0223	0.0904	37.36	2.27
13.00 m	8.00	46.00	40.00	2.00	1.00	3.00	0.00	0.0030	0.0240	0.0947	31.89	2.04
16.00 m	10.00	45.00	34.00	3.00	4.00	3.00	1.00	0.0020	0.0208	0.0930	46.51	2.33
22.00 m	14.00	72.00	6.00	4.00	3.00	1.00	0.00	-	0.0081	0.0337	-	-
25.00 m	12.00	64.00	12.00	3.00	5.00	4.00	0.00	-	0.0108	0.0447	-	-
28.00 m	13.00	70.00	8.00	4.00	2.00	3.00	0.00	-	0.0091	0.0368	-	-
35.50 m	15.00	66.00	9.00	5.00	3.00	2.00	0.00	-	0.0081	0.0376	-	-

GRAIN SIZE DISTRIBUTION CURVES

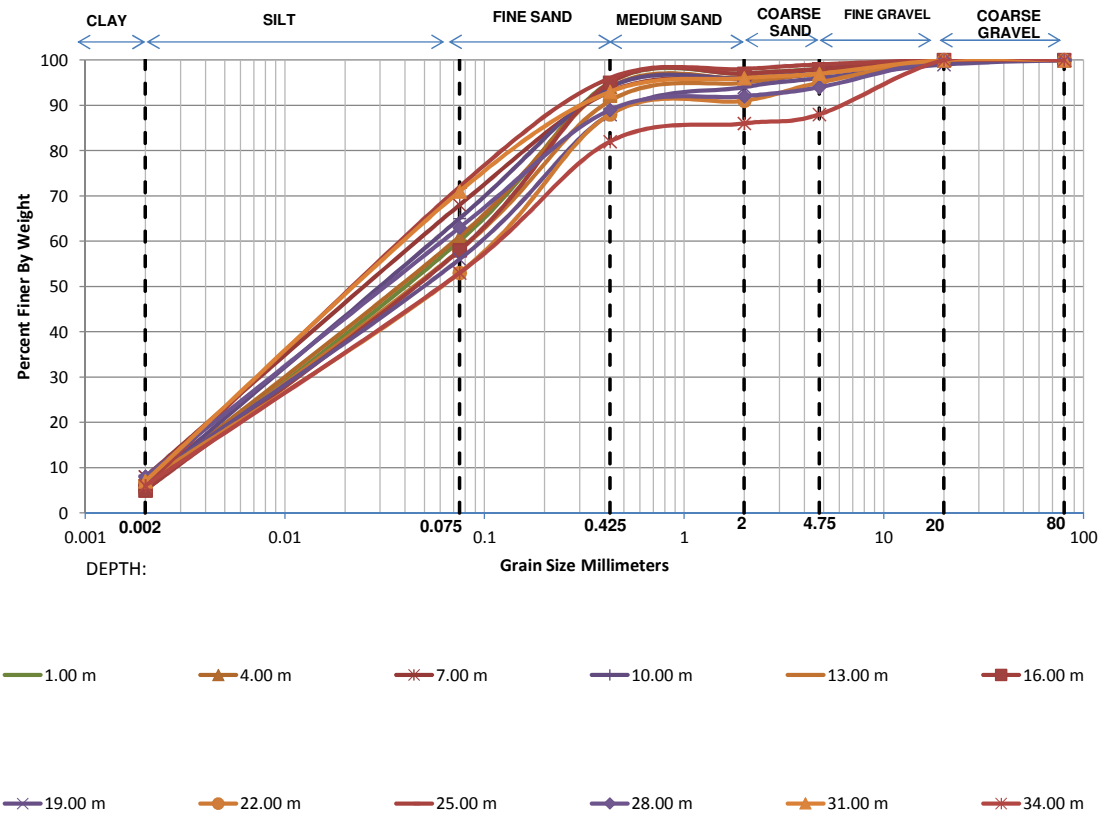
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	42+256 Major Bridge
B.H. No.	BH-P16



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
2.50 m	5.00	41.00	45.00	6.00	2.00	1.00	0.00	0.0060	0.0356	0.1295	21.73	1.64
5.50 m	6.00	38.00	53.00	1.00	0.00	2.00	0.00	0.0050	0.0378	0.1303	26.30	2.21
8.50 m	5.00	39.00	48.00	2.00	1.00	5.00	0.00	0.0061	0.0385	0.1355	22.10	1.79
11.50 m	6.00	42.00	40.00	7.00	1.00	4.00	0.00	0.0047	0.0317	0.1252	26.68	1.71
14.50 m	6.00	30.00	53.00	6.00	2.00	3.00	0.00	0.0057	0.0543	0.1743	30.76	2.99
19.00 m	5.00	44.00	44.00	4.00	2.00	1.00	0.00	0.0058	0.0321	0.1145	19.87	1.56
23.50 m	5.00	41.00	38.00	8.00	5.00	3.00	0.00	0.0059	0.0351	0.1419	23.99	1.47
26.50 m	12.00	53.00	20.00	10.00	3.00	2.00	0.00	-	0.0136	0.0628	-	-
31.00 m	14.00	46.00	17.00	12.00	5.00	6.00	0.00	-	0.0134	0.0750	-	-
35.50 m	13.00	44.00	19.00	15.00	4.00	3.00	2.00	-	0.0158	0.0924	-	-

GRAIN SIZE DISTRIBUTION CURVES

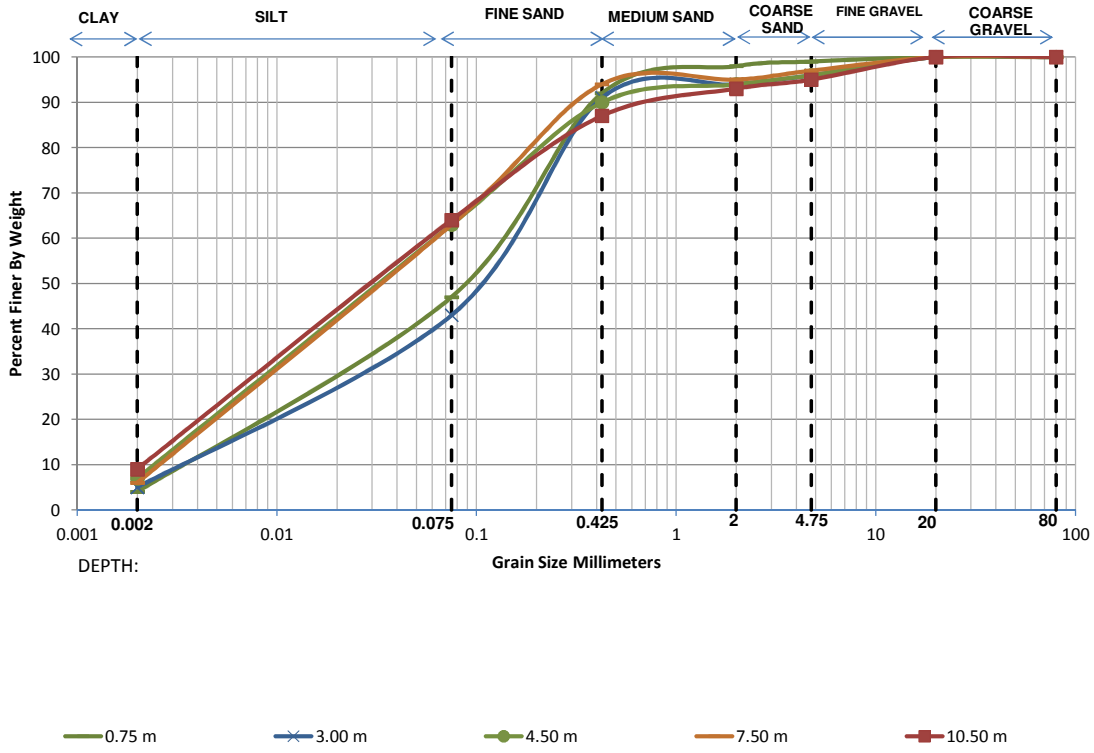
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	42+256 Major Bridge
B.H. No.	BH-A2



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
1.00 m	5.00	55.00	35.00	2.00	1.00	2.00	0.00	0.0053	0.0236	0.0750	14.23	1.41
4.00 m	6.00	55.00	33.00	2.00	1.00	3.00	0.00	0.0043	0.0217	0.0727	16.90	1.51
7.00 m	8.00	60.00	25.00	3.00	2.00	2.00	0.00	0.0029	0.0165	0.0584	20.35	1.62
10.00 m	6.00	59.00	29.00	2.00	2.00	2.00	0.00	0.0042	0.0198	0.0643	15.24	1.45
13.00 m	6.00	52.00	33.00	4.00	2.00	3.00	0.00	0.0044	0.0233	0.0807	18.51	1.54
16.00 m	5.00	53.00	37.00	2.00	1.00	2.00	0.00	0.0053	0.0247	0.0803	15.04	1.43
19.00 m	7.00	49.00	32.00	6.00	2.00	3.00	1.00	0.0036	0.0232	0.0889	24.67	1.69
22.00 m	7.00	46.00	35.00	3.00	4.00	5.00	0.00	0.0037	0.0255	0.1017	27.79	1.75
25.00 m	6.00	66.00	24.00	2.00	1.00	1.00	0.00	0.0041	0.0175	0.0530	12.90	1.40
28.00 m	8.00	55.00	26.00	3.00	2.00	6.00	0.00	0.0029	0.0183	0.0680	23.48	1.70
31.00 m	7.00	64.00	22.00	3.00	1.00	3.00	0.00	0.0034	0.0165	0.0539	15.74	1.48
34.00 m	6.00	47.00	29.00	4.00	2.00	12.00	0.00	0.0045	0.0263	0.1074	23.99	1.44

GRAIN SIZE DISTRIBUTION CURVES

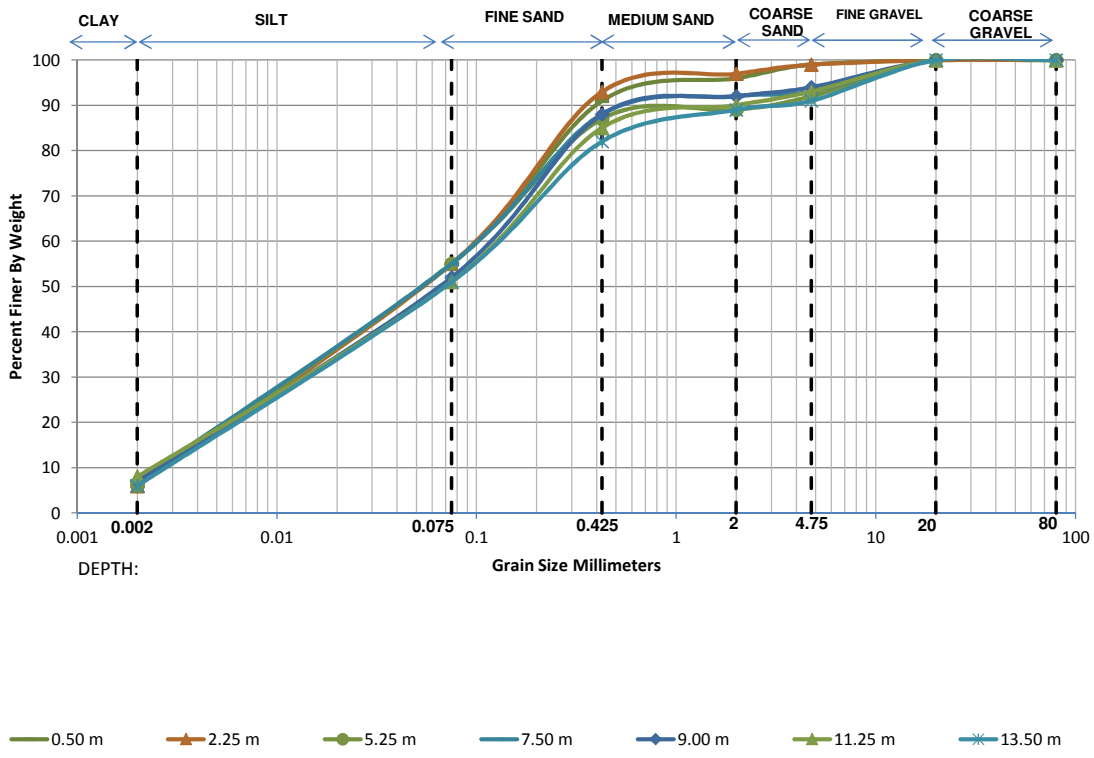
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	43+100
B.H. No.	BH-PLT-02



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
0.75 m	4.00	43.00	45.00	6.00	1.00	1.00	0.00	0.0073	0.0356	0.1237	16.97	1.41
3.00 m	5.00	38.00	48.00	3.00	2.00	4.00	0.00	0.0062	0.0400	0.1412	22.71	1.83
4.50 m	7.00	56.00	27.00	4.00	2.00	4.00	0.00	0.0035	0.0194	0.0681	19.43	1.57
7.50 m	6.00	57.00	31.00	1.00	2.00	3.00	0.00	0.0043	0.0207	0.0683	16.04	1.48
10.50 m	9.00	55.00	23.00	6.00	2.00	5.00	0.00	0.0024	0.0168	0.0656	27.39	1.79

GRAIN SIZE DISTRIBUTION CURVES

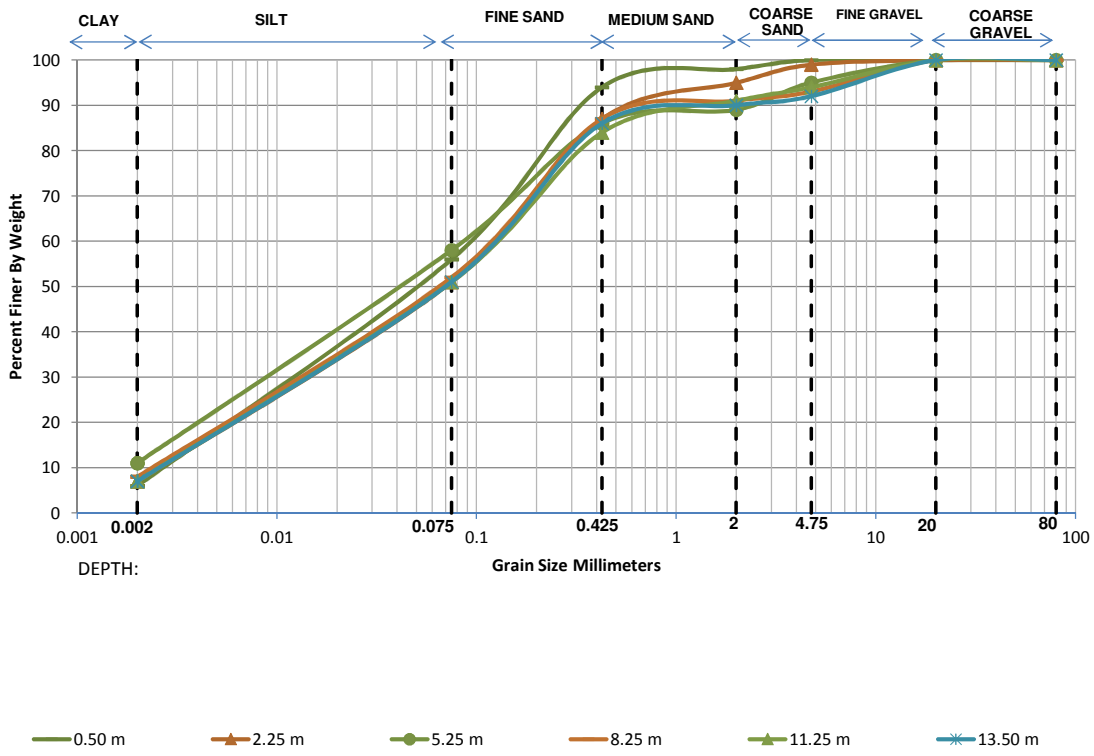
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	43+452
B.H. No.	BH-CL



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
0.50 m	7.00	48.00	36.00	5.00	3.00	1.00	0.00	0.0036	0.0241	0.0919	25.33	1.75
2.25 m	6.00	49.00	38.00	4.00	2.00	1.00	0.00	0.0044	0.0254	0.0910	20.45	1.59
5.25 m	6.00	49.00	32.00	2.00	3.00	8.00	0.00	0.0044	0.0251	0.0931	21.00	1.52
7.50 m	7.00	48.00	33.00	4.00	1.00	7.00	0.00	0.0036	0.0240	0.0930	25.68	1.70
9.00 m	7.00	45.00	36.00	4.00	2.00	6.00	0.00	0.0037	0.0264	0.1064	28.90	1.78
11.25 m	8.00	43.00	34.00	5.00	3.00	7.00	0.00	0.0030	0.0260	0.1148	38.37	1.97
13.50 m	6.00	45.00	31.00	7.00	2.00	9.00	0.00	0.0045	0.0281	0.1194	26.26	1.45

GRAIN SIZE DISTRIBUTION CURVES

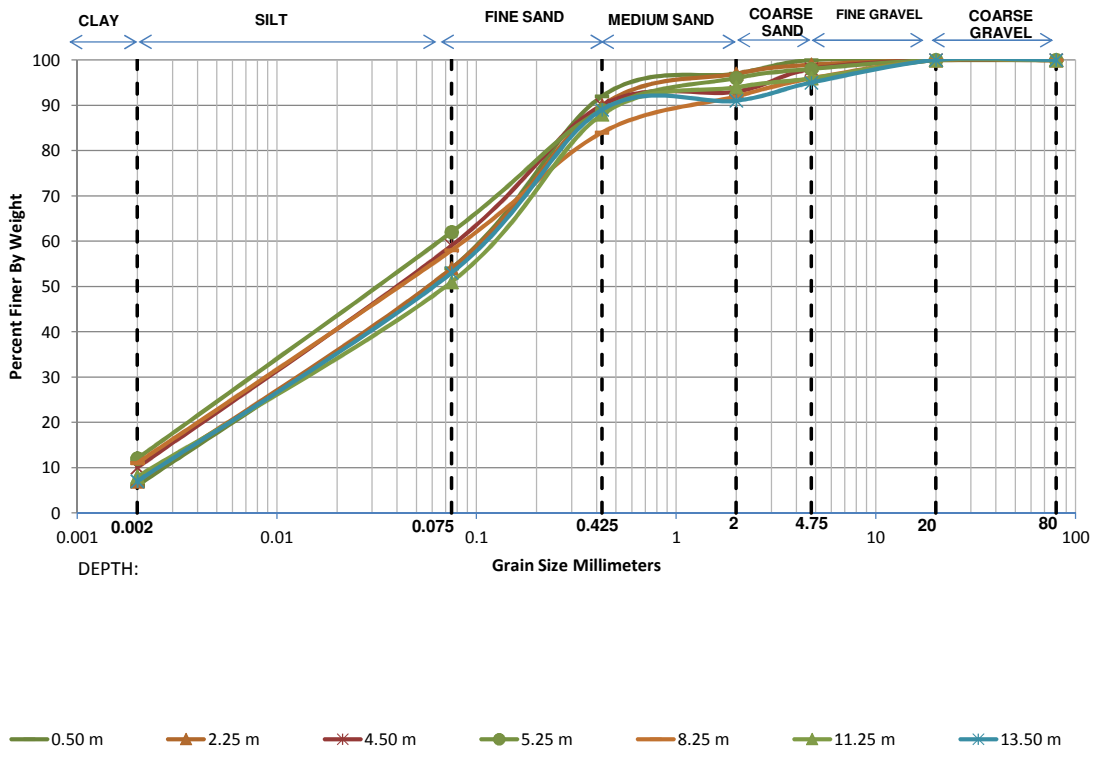
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	43+585
B.H. No.	BH-CL



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
0.50 m	6.00	50.00	38.00	4.00	2.00	0.00	0.00	0.0044	0.0247	0.0871	19.70	1.59
2.25 m	7.00	44.00	36.00	8.00	4.00	1.00	0.00	0.0037	0.0273	0.1128	30.47	1.78
5.25 m	11.00	47.00	28.00	3.00	6.00	5.00	0.00	-	0.0177	0.0816	-	-
8.25 m	8.00	44.00	35.00	4.00	2.00	7.00	0.00	0.0030	0.0252	0.1075	36.04	1.99
11.25 m	7.00	44.00	33.00	7.00	3.00	6.00	0.00	0.0037	0.0271	0.1164	31.50	1.70
13.50 m	7.00	44.00	35.00	4.00	2.00	8.00	0.00	0.0037	0.0272	0.1131	30.58	1.77

GRAIN SIZE DISTRIBUTION CURVES

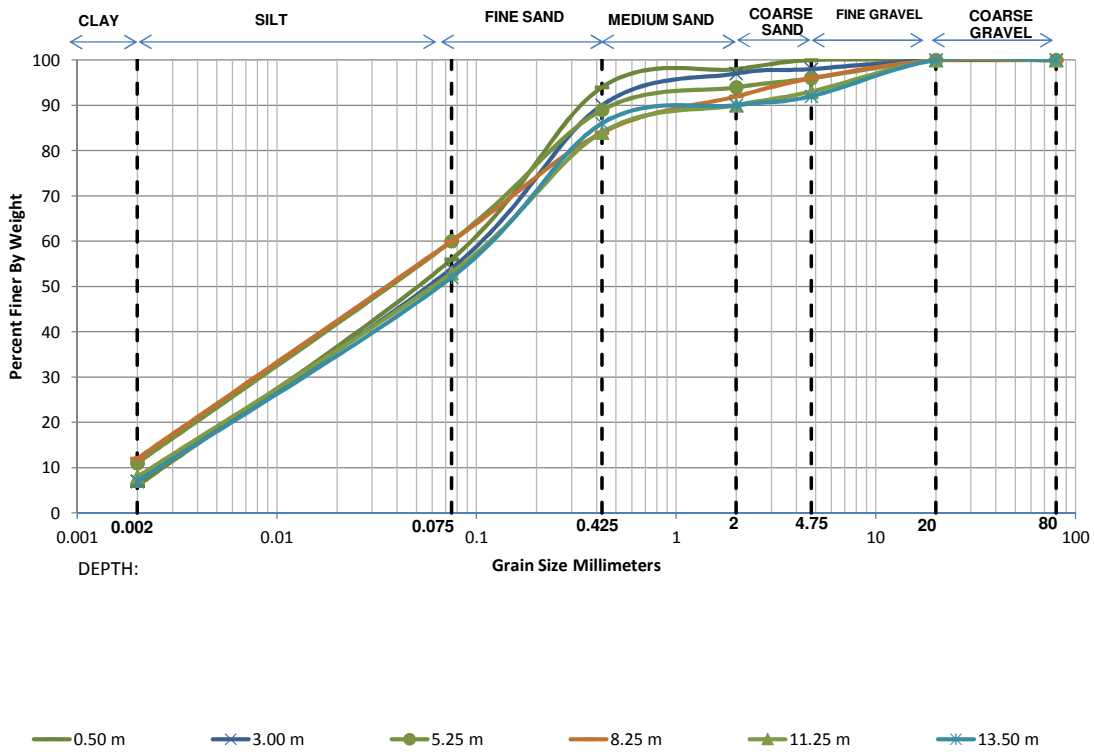
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	43+732
B.H. No.	BH-CL



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
0.50 m	6.00	48.00	38.00	5.00	3.00	0.00	0.00	0.0045	0.0261	0.0953	21.28	1.60
2.25 m	7.00	47.00	36.00	7.00	2.00	1.00	0.00	0.0036	0.0248	0.0966	26.50	1.75
4.50 m	10.00	49.00	31.00	3.00	5.00	2.00	0.00	0.0020	0.0183	0.0778	38.92	2.15
5.25 m	12.00	50.00	27.00	7.00	2.00	2.00	0.00	-	0.0149	0.0698	-	-
8.25 m	11.00	47.00	26.00	8.00	4.00	4.00	0.00	-	0.0176	0.0821	-	-
11.25 m	8.00	43.00	37.00	6.00	2.00	4.00	0.00	0.0030	0.0262	0.1116	37.26	2.06
13.50 m	7.00	46.00	36.00	2.00	4.00	5.00	0.00	0.0037	0.0256	0.1009	27.55	1.77

GRAIN SIZE DISTRIBUTION CURVES

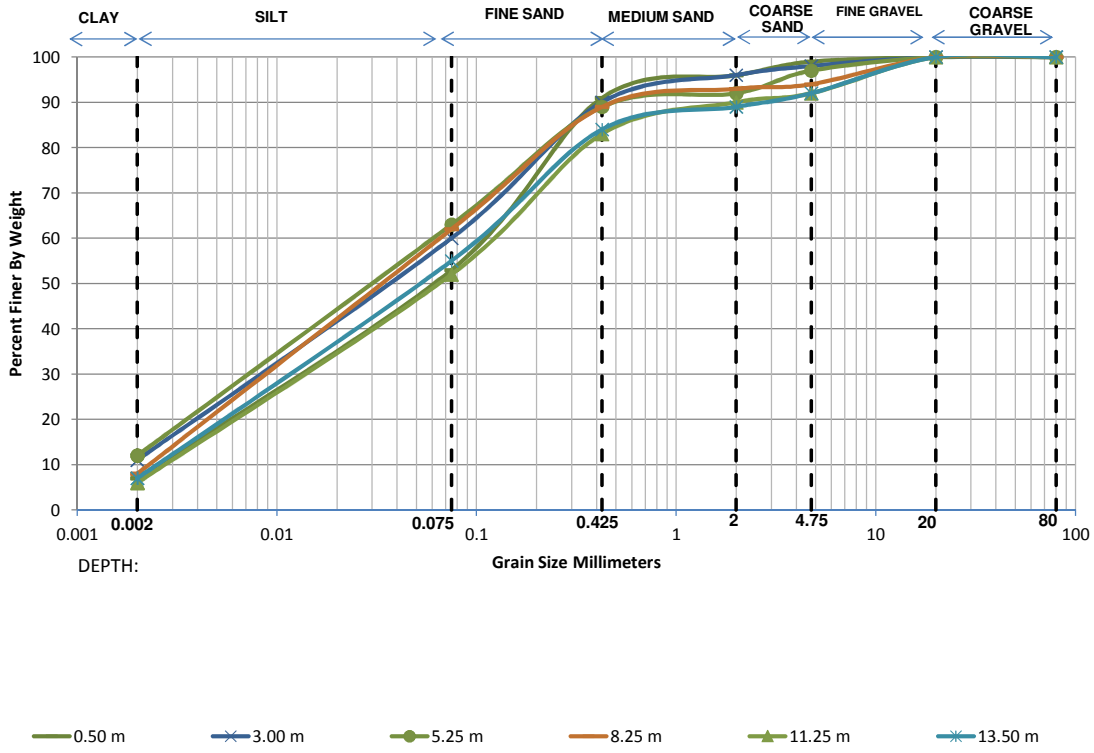
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	44+050
B.H. No.	BH-CL



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
0.50 m	6.00	50.00	38.00	4.00	2.00	0.00	0.00	0.0044	0.0247	0.0871	19.70	1.59
3.00 m	7.00	47.00	36.00	7.00	1.00	2.00	0.00	0.0036	0.0248	0.0966	26.50	1.75
5.25 m	11.00	49.00	29.00	5.00	2.00	4.00	0.00	-	0.0168	0.0750	-	-
8.25 m	12.00	48.00	24.00	8.00	4.00	4.00	0.00	-	0.0156	0.0750	-	-
11.25 m	8.00	45.00	31.00	6.00	3.00	7.00	0.00	0.0030	0.0242	0.1059	35.65	1.86
13.50 m	7.00	45.00	34.00	4.00	2.00	8.00	0.00	0.0037	0.0263	0.1082	29.44	1.74

GRAIN SIZE DISTRIBUTION CURVES

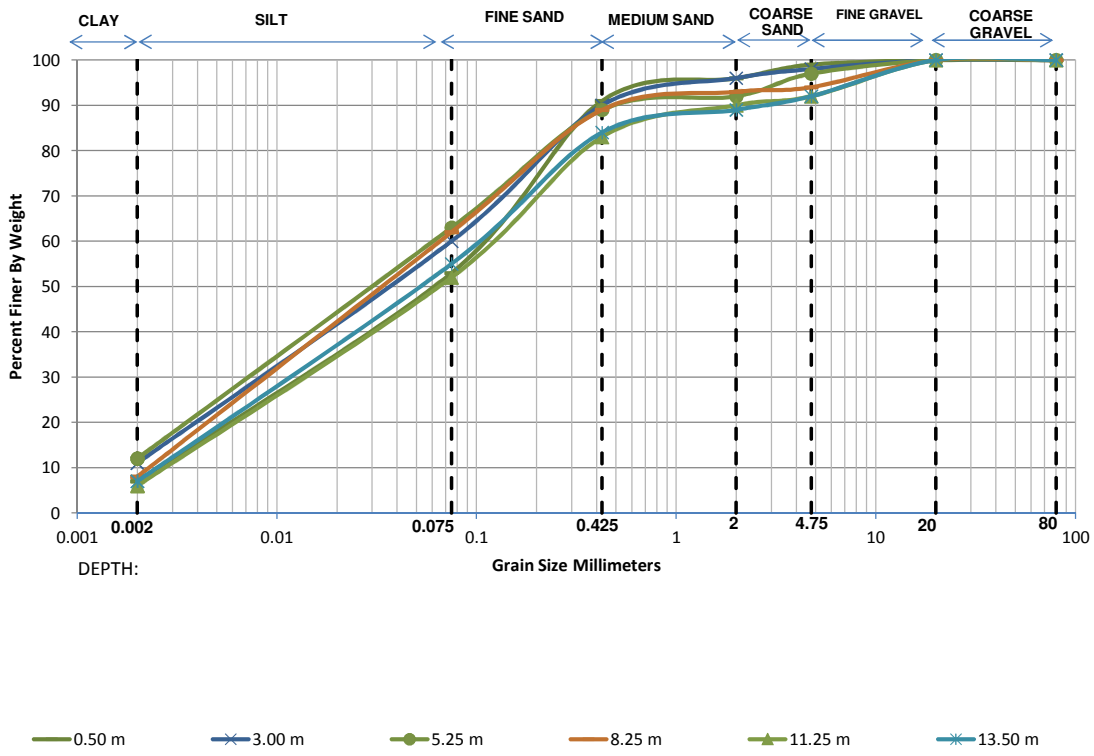
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	44+116
B.H. No.	BH-CL



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
0.50 m	7.00	46.00	38.00	5.00	3.00	1.00	0.00	0.0037	0.0257	0.1000	27.29	1.80
3.00 m	11.00	49.00	30.00	6.00	2.00	2.00	0.00	-	0.0168	0.0750	-	-
5.25 m	12.00	51.00	26.00	3.00	5.00	3.00	0.00	-	0.0145	0.0674	-	-
8.25 m	8.00	54.00	27.00	4.00	1.00	6.00	0.00	0.0029	0.0187	0.0702	24.20	1.72
11.25 m	6.00	46.00	31.00	7.00	2.00	8.00	0.00	0.0045	0.0272	0.1122	24.86	1.46
13.50 m	7.00	48.00	29.00	5.00	3.00	8.00	0.00	0.0036	0.0237	0.0953	26.37	1.63

GRAIN SIZE DISTRIBUTION CURVES

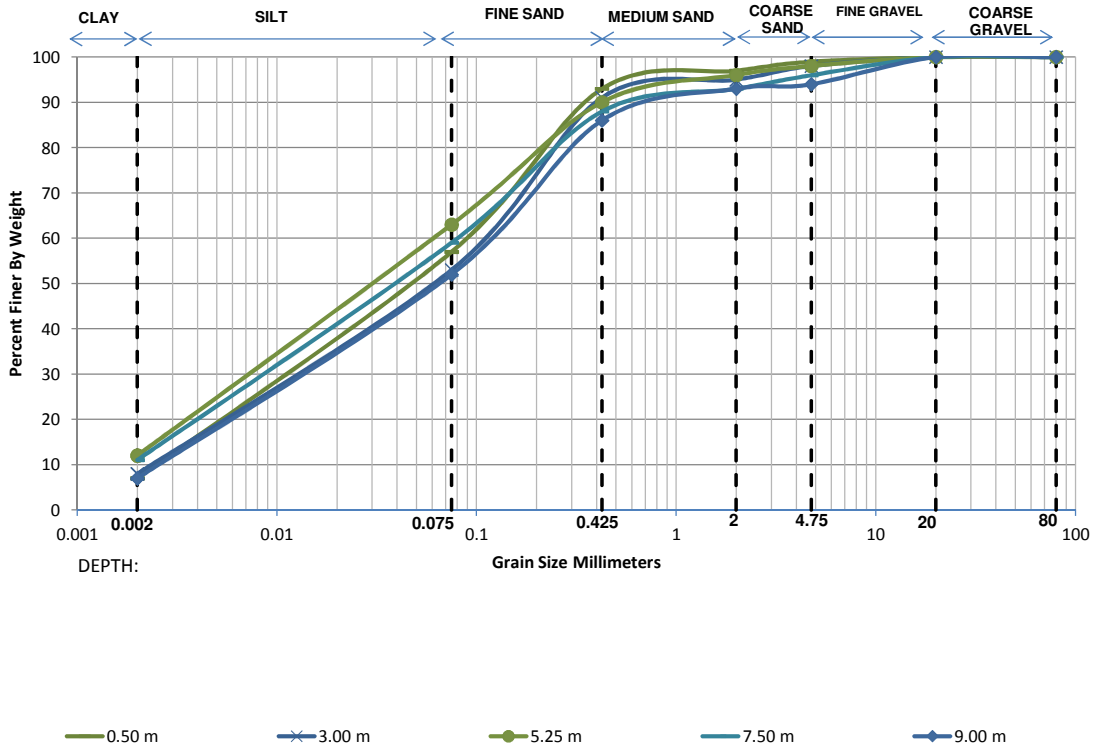
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	44+317 Minor Bridge
B.H. No.	BH-CL



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
0.50 m	0.00	14.00	76.00	8.00	2.00	0.00	0.00	0.0505	0.1398	0.2406	4.76	1.61
3.00 m	6.00	53.00	31.00	5.00	3.00	2.00	0.00	0.0043	0.0226	0.0777	17.92	1.52
5.25 m	7.00	56.00	26.00	7.00	1.00	3.00	0.00	0.0035	0.0193	0.0681	19.43	1.57
6.00 m	11.00	49.00	31.00	4.00	2.00	3.00	0.00	-	0.0169	0.0750	-	-
8.25 m	12.00	48.00	26.00	6.00	3.00	5.00	0.00	-	0.0157	0.0750	-	-

GRAIN SIZE DISTRIBUTION CURVES

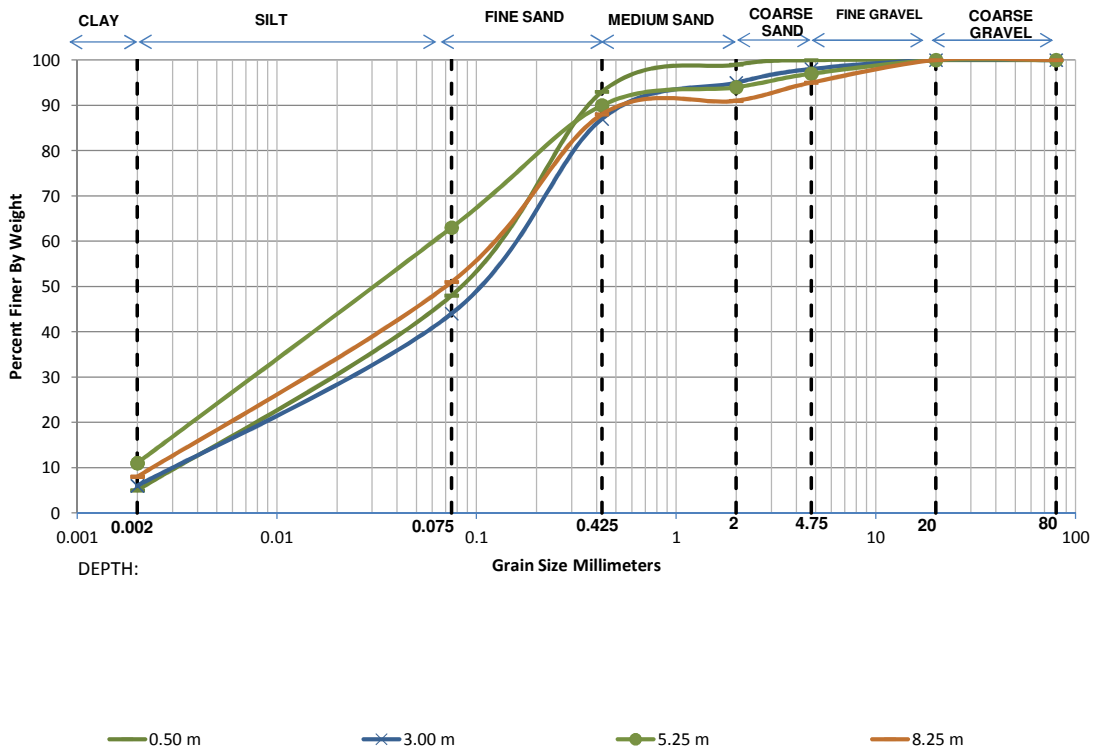
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	44+641
B.H. No.	BH-CL



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
0.50 m	7.00	50.00	36.00	4.00	2.00	1.00	0.00	0.0036	0.0228	0.0839	23.35	1.73
3.00 m	8.00	45.00	38.00	4.00	3.00	2.00	0.00	0.0030	0.0246	0.1002	33.65	2.03
5.25 m	12.00	51.00	27.00	6.00	2.00	2.00	0.00	-	0.0145	0.0675	-	-
7.50 m	11.00	48.00	29.00	5.00	3.00	4.00	0.00	-	0.0172	0.0780	-	-
9.00 m	7.00	45.00	34.00	7.00	1.00	6.00	0.00	0.0037	0.0263	0.1088	29.59	1.73

GRAIN SIZE DISTRIBUTION CURVES

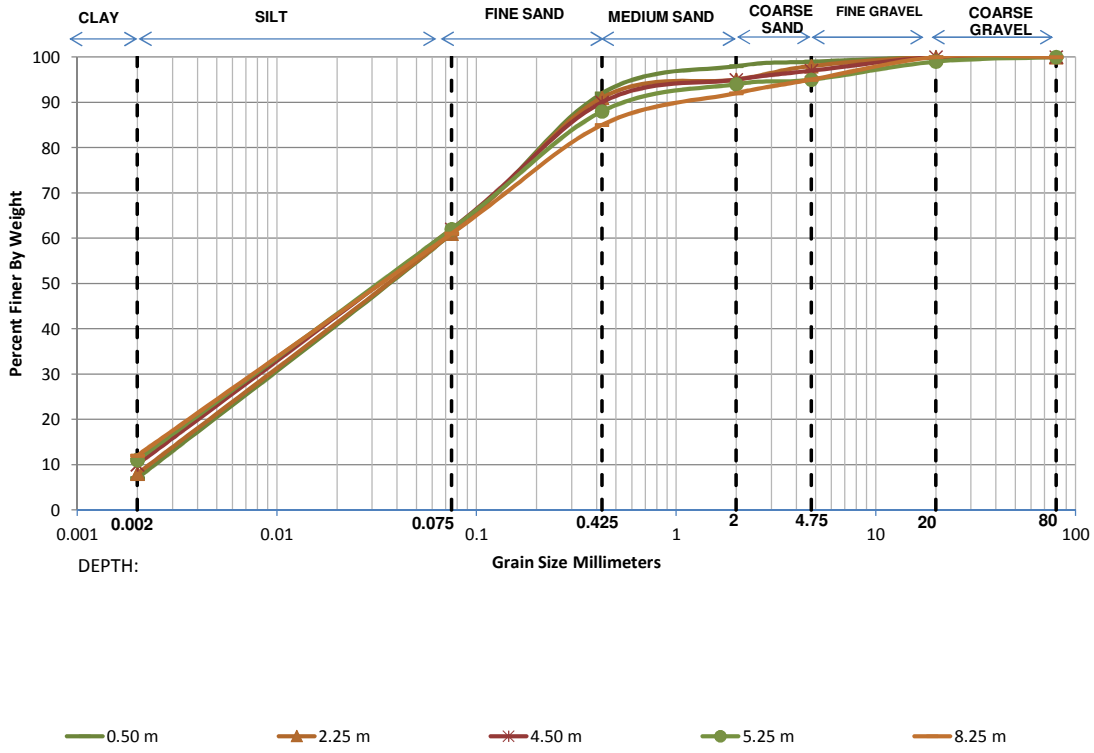
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	44+910
B.H. No.	BH-CL



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
0.50 m	5.00	43.00	45.00	6.00	1.00	0.00	0.00	0.0058	0.0332	0.1189	20.41	1.59
3.00 m	6.00	38.00	43.00	8.00	3.00	2.00	0.00	0.0049	0.0371	0.1455	29.66	1.93
5.25 m	11.00	52.00	27.00	4.00	3.00	3.00	0.00	-	0.0154	0.0676	-	-
8.25 m	8.00	43.00	37.00	3.00	4.00	5.00	0.00	0.0030	0.0262	0.1111	37.08	2.07

GRAIN SIZE DISTRIBUTION CURVES

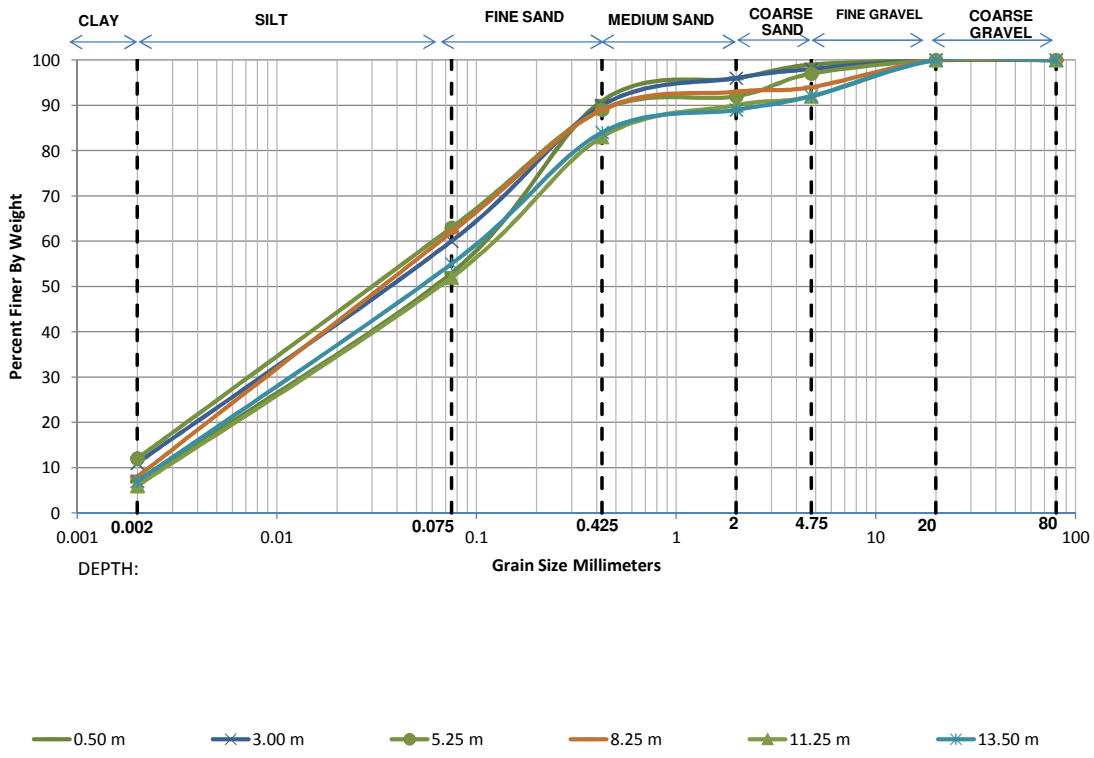
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	45+048
B.H. No.	BH-CL



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
0.50 m	7.00	54.00	31.00	6.00	1.00	1.00	0.00	0.0035	0.0204	0.0726	20.55	1.63
2.25 m	8.00	53.00	30.00	4.00	3.00	2.00	0.00	0.0029	0.0193	0.0726	24.94	1.77
4.50 m	10.00	52.00	28.00	5.00	2.00	3.00	0.00	0.0020	0.0168	0.0700	35.02	2.01
5.25 m	11.00	51.00	26.00	6.00	1.00	4.00	1.00	-	0.0158	0.0699	-	-
8.25 m	12.00	49.00	24.00	7.00	3.00	5.00	0.00	-	0.0152	0.0723	-	-

GRAIN SIZE DISTRIBUTION CURVES

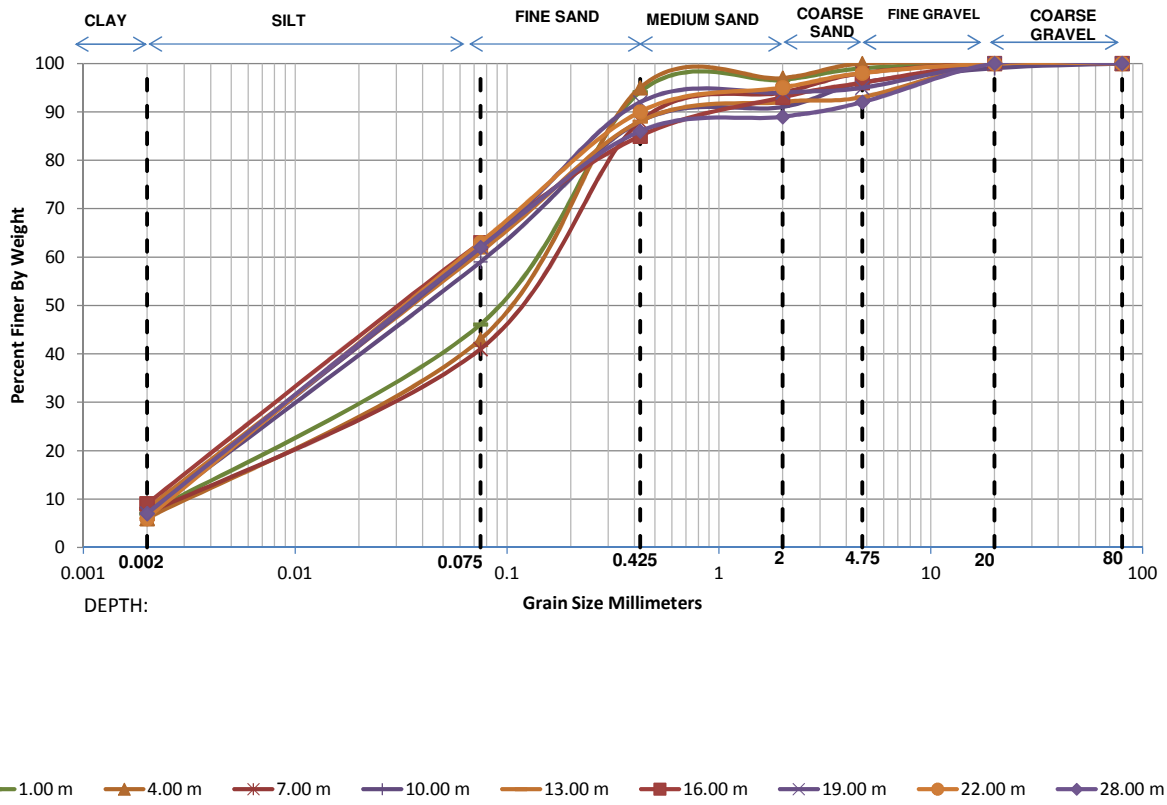
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	45+411 Minor Bridge
B.H. No.	BH-CL



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
0.50 m	0.00	20.00	67.00	11.00	2.00	0.00	0.00	0.0278	0.1144	0.2312	8.33	2.04
3.00 m	7.00	46.00	38.00	4.00	3.00	2.00	0.00	0.0037	0.0257	0.0999	27.26	1.81
5.25 m	6.00	45.00	33.00	12.00	1.00	3.00	0.00	0.0046	0.0282	0.1173	25.76	1.49
7.50 m	11.00	47.00	31.00	5.00	2.00	4.00	0.00	-	0.0178	0.0813	-	-
8.25 m	12.00	50.00	26.00	4.00	3.00	5.00	0.00	-	0.0149	0.0698	-	-

GRAIN SIZE DISTRIBUTION CURVES

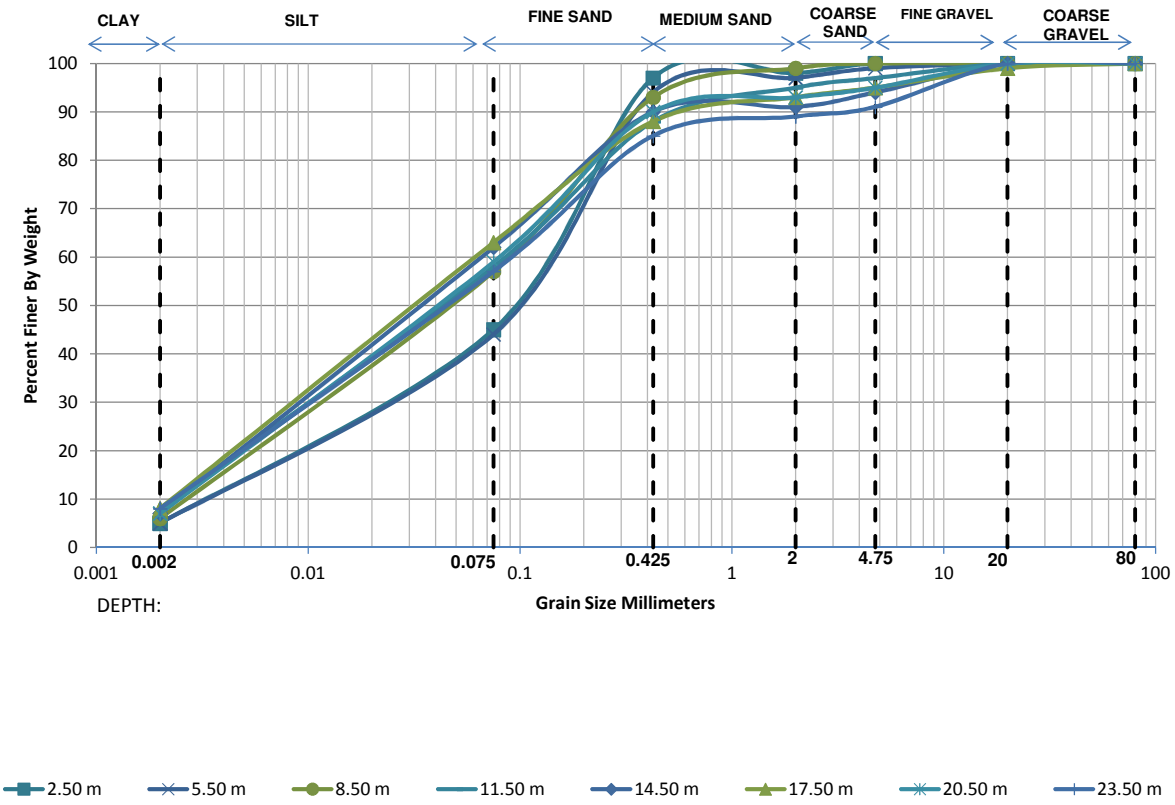
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	45+480 Major Bridge
B.H. No.	BH-A1



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
1.00 m	7.00	39.10	48.00	2.50	2.40	1.00	0.00	0.0039	0.0334	0.1257	32.57	2.30
4.00 m	6.00	37.00	52.00	2.00	3.00	0.00	0.00	0.0050	0.0393	0.1363	27.20	2.26
7.00 m	7.00	34.00	47.00	6.00	4.00	2.00	0.00	0.0041	0.0415	0.1566	38.58	2.71
10.00 m	7.00	52.00	29.00	3.00	5.00	3.00	1.00	0.0036	0.0213	0.0778	21.88	1.65
13.00 m	8.00	53.00	27.00	4.00	1.00	7.00	0.00	0.0029	0.0192	0.0725	24.95	1.74
16.00 m	9.00	54.00	22.00	8.00	3.00	4.00	0.00	0.0024	0.0171	0.0677	28.27	1.80
19.00 m	7.00	55.00	30.00	2.00	1.00	5.00	0.00	0.0035	0.0199	0.0703	19.98	1.61
22.00 m	6.00	57.00	27.00	5.00	3.00	2.00	0.00	0.0042	0.0205	0.0682	16.05	1.46
28.00 m	7.00	55.00	24.00	3.00	3.00	8.00	0.00	0.0035	0.0197	0.0702	20.00	1.57

GRAIN SIZE DISTRIBUTION CURVES

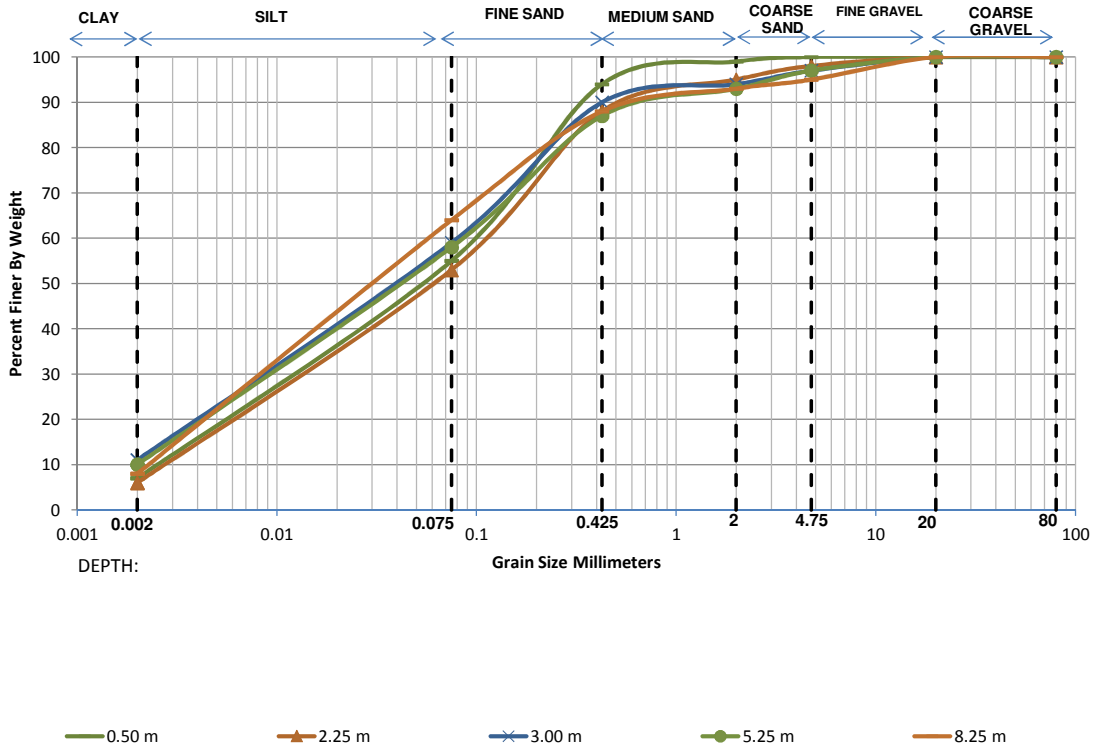
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	45+480 Major Bridge
B.H. No.	BH-A2



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
2.50 m	5.00	40.00	52.00	1.00	2.00	0.00	0.00	0.0061	0.0374	0.1261	20.75	1.82
5.50 m	5.00	39.00	50.00	3.00	2.00	1.00	0.00	0.0061	0.0387	0.1333	21.69	1.82
8.50 m	6.00	51.00	36.00	6.00	1.00	0.00	0.00	0.0044	0.0240	0.0839	19.10	1.56
11.50 m	8.00	50.00	30.00	7.00	2.00	3.00	0.00	0.0029	0.0208	0.0812	27.73	1.83
14.50 m	7.00	55.00	28.00	1.00	3.00	6.00	0.00	0.0035	0.0199	0.0703	19.98	1.59
17.50 m	8.00	55.00	25.00	5.00	2.00	4.00	1.00	0.0029	0.0182	0.0679	23.47	1.69
20.50 m	7.00	52.00	31.00	3.00	2.00	5.00	0.00	0.0036	0.0214	0.0777	21.84	1.66
23.50 m	8.00	49.00	28.00	4.00	2.00	9.00	0.00	0.0029	0.0213	0.0856	29.17	1.81

GRAIN SIZE DISTRIBUTION CURVES

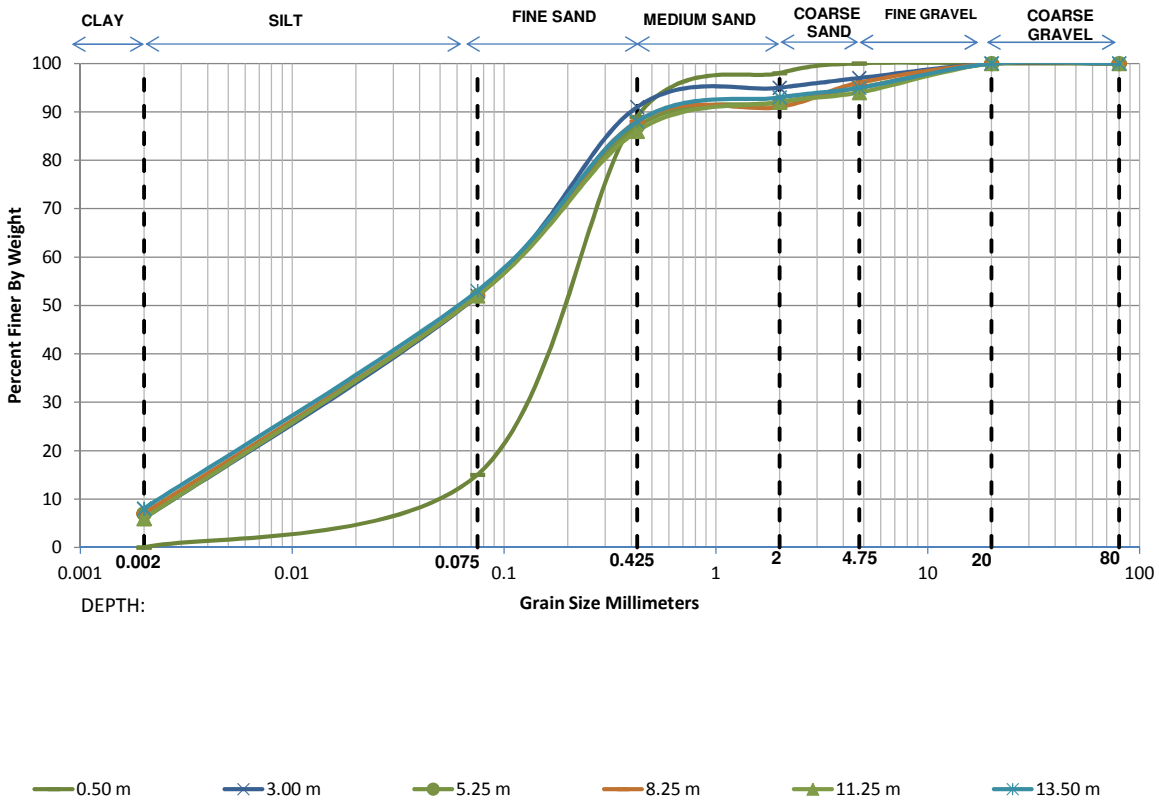
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	45+612 Minor Bridge
B.H. No.	BH-CL



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
0.50 m	7.00	48.00	39.00	5.00	1.00	0.00	0.00	0.0036	0.0243	0.0909	25.04	1.79
2.25 m	6.00	47.00	35.00	7.00	3.00	2.00	0.00	0.0045	0.0267	0.1020	22.68	1.55
3.00 m	11.00	48.00	31.00	4.00	3.00	3.00	0.00	-	0.0173	0.0779	-	-
5.25 m	10.00	48.00	29.00	6.00	4.00	3.00	0.00	0.0020	0.0187	0.0815	40.74	2.15
8.25 m	8.00	56.00	24.00	5.00	2.00	5.00	0.00	0.0029	0.0178	0.0658	22.78	1.67

GRAIN SIZE DISTRIBUTION CURVES

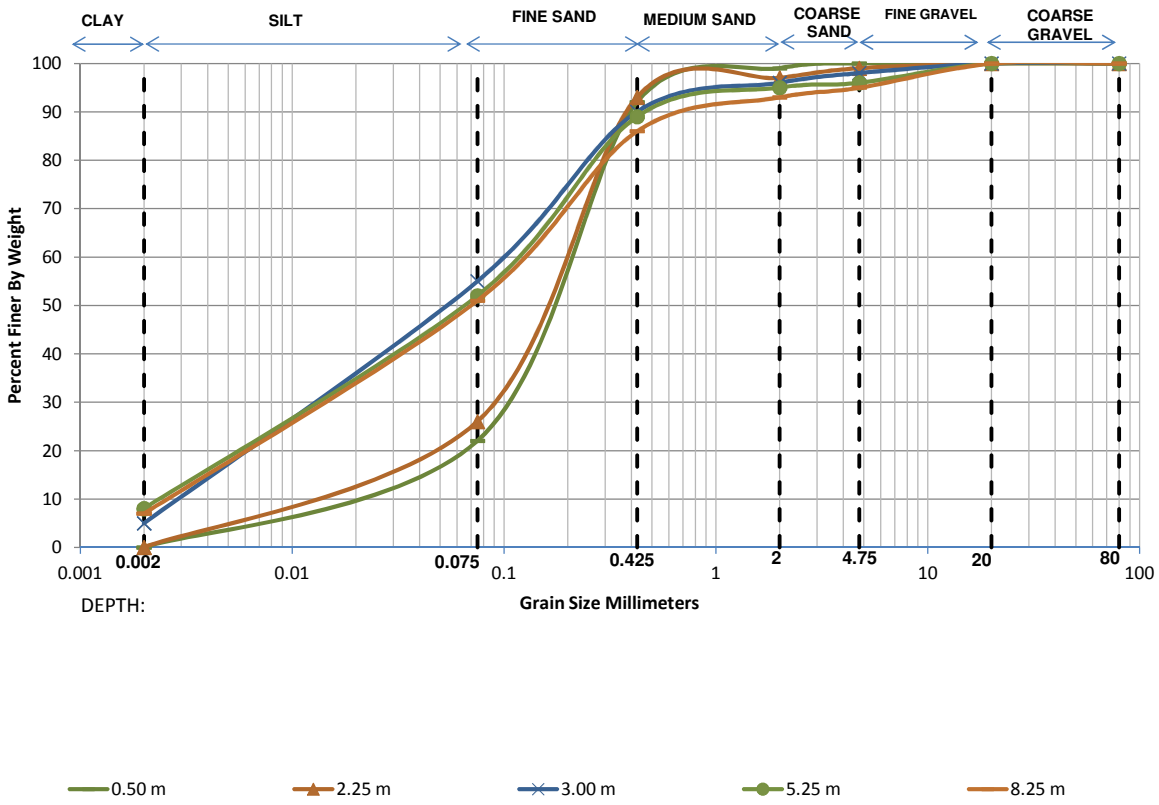
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	45+984
B.H. No.	BH-CL



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
0.50 m	0.00	15.00	74.00	9.00	2.00	0.00	0.00	0.0454	0.1357	0.2403	5.29	1.69
3.00 m	6.00	46.00	39.00	4.00	2.00	3.00	0.00	0.0045	0.0278	0.1039	22.88	1.63
5.25 m	7.00	45.00	35.00	5.00	3.00	5.00	0.00	0.0037	0.0263	0.1074	29.21	1.76
8.25 m	7.00	45.00	36.00	3.00	5.00	4.00	0.00	0.0037	0.0264	0.1062	28.86	1.78
11.25 m	6.00	46.00	34.00	6.00	2.00	6.00	0.00	0.0045	0.0274	0.1084	23.95	1.54
13.50 m	8.00	45.00	35.00	5.00	2.00	5.00	0.00	0.0030	0.0244	0.1022	34.37	1.96

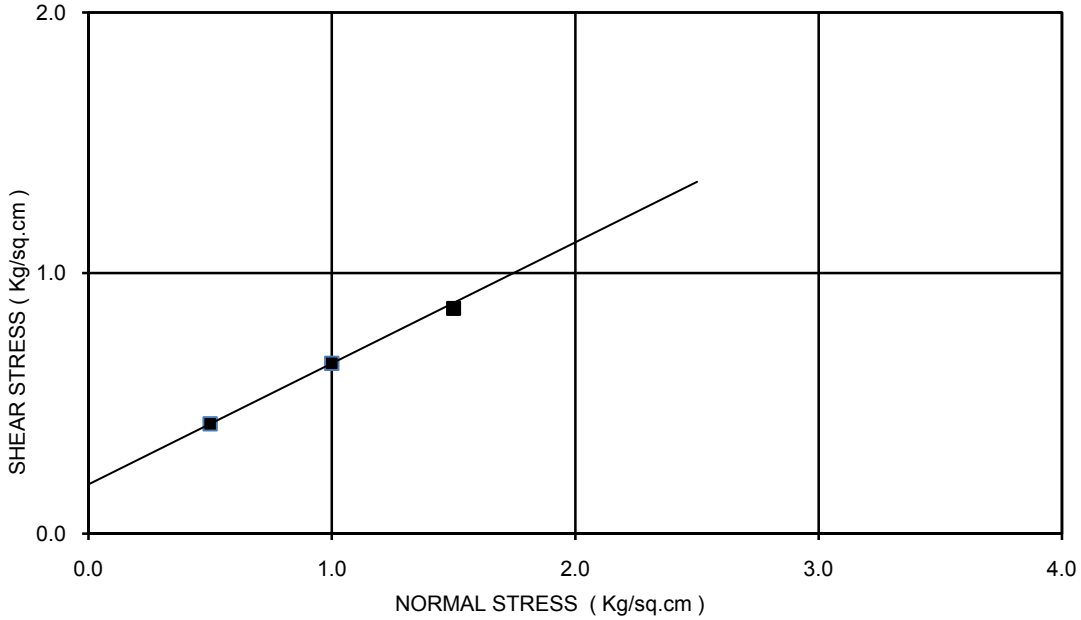
GRAIN SIZE DISTRIBUTION CURVES

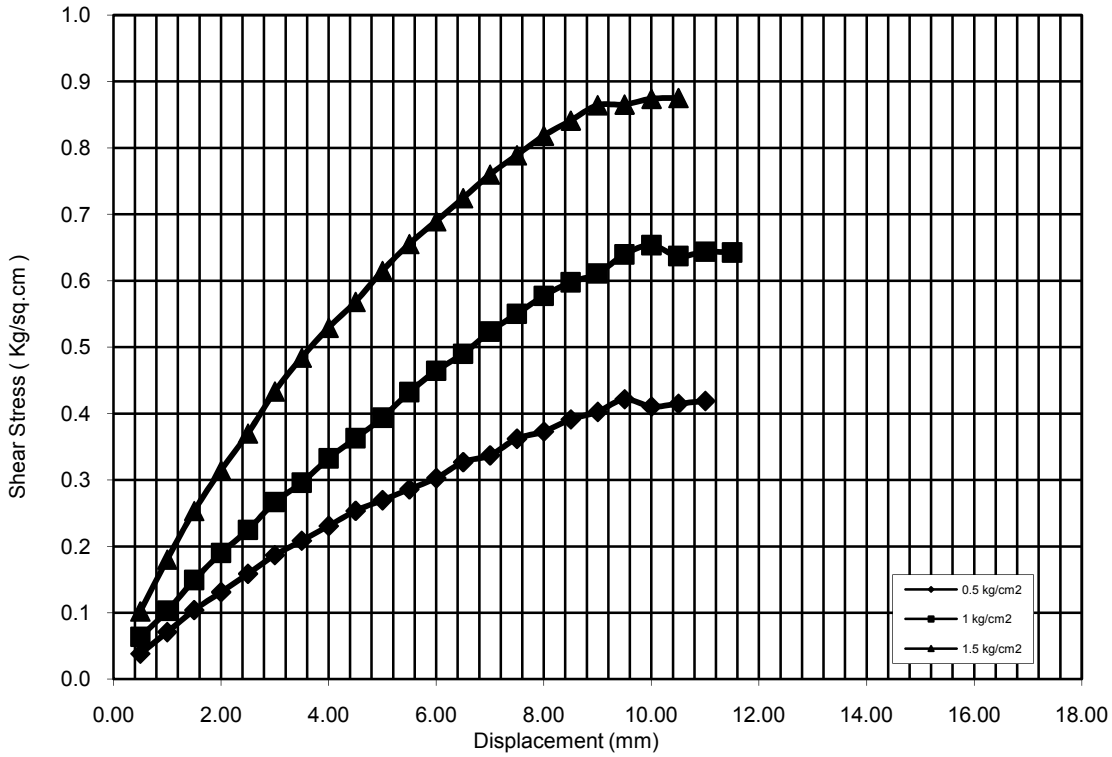
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	46+400
B.H. No.	BH-CL



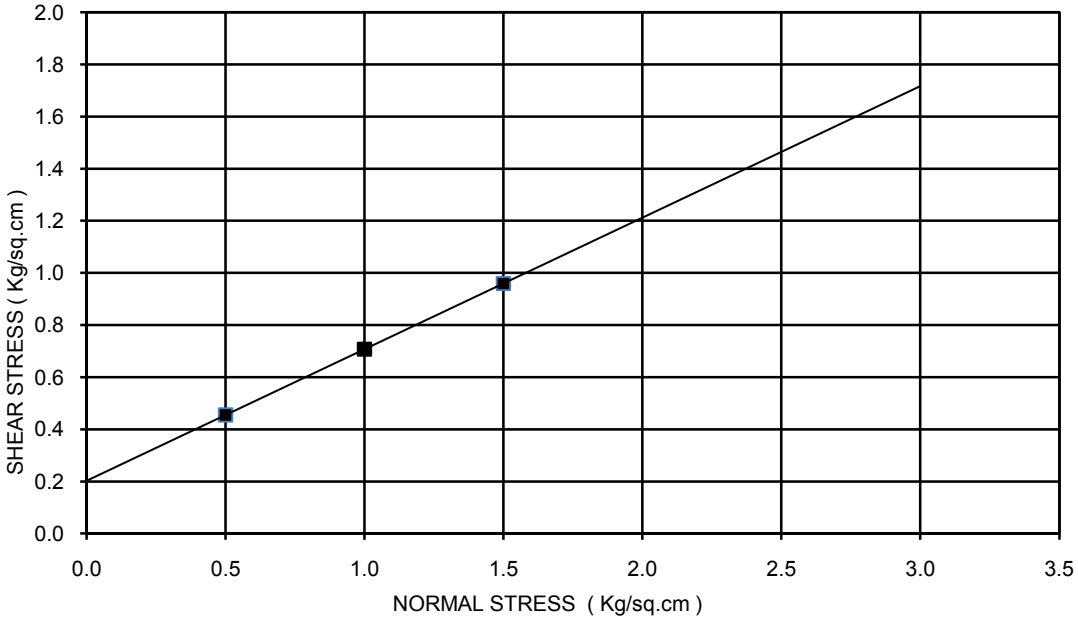
Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
0.50 m	0.00	22.00	70.00	7.00	1.00	0.00	0.00	0.0236	0.1048	0.2119	8.96	2.19
2.25 m	0.00	26.00	67.00	4.00	2.00	1.00	0.00	0.0174	0.0892	0.1964	11.26	2.32
3.00 m	5.00	50.00	35.00	6.00	2.00	2.00	0.00	0.0054	0.0265	0.0920	16.90	1.40
5.25 m	8.00	44.00	37.00	6.00	1.00	4.00	0.00	0.0030	0.0254	0.1061	35.55	2.03
8.25 m	7.00	44.00	35.00	7.00	2.00	5.00	0.00	0.0037	0.0272	0.1137	30.75	1.76

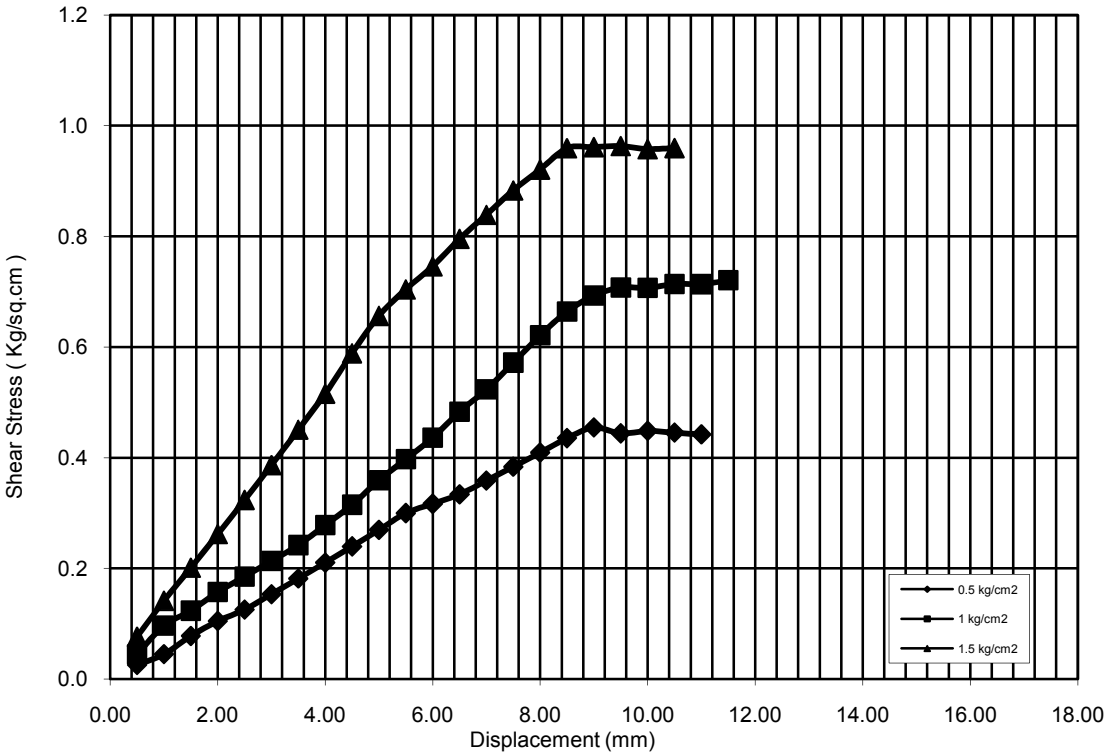
BORE HOLE NO: BH-A1
CHAINAGE : -29+487
SAMPLE NO.: UDS-1
DEPTH: 2.50 m
COHESION(C)= 0.19 kg/sq.cm
ANGLE OF FRICTION(Phi): 25 deg
TYPE OF THE TEST: DST



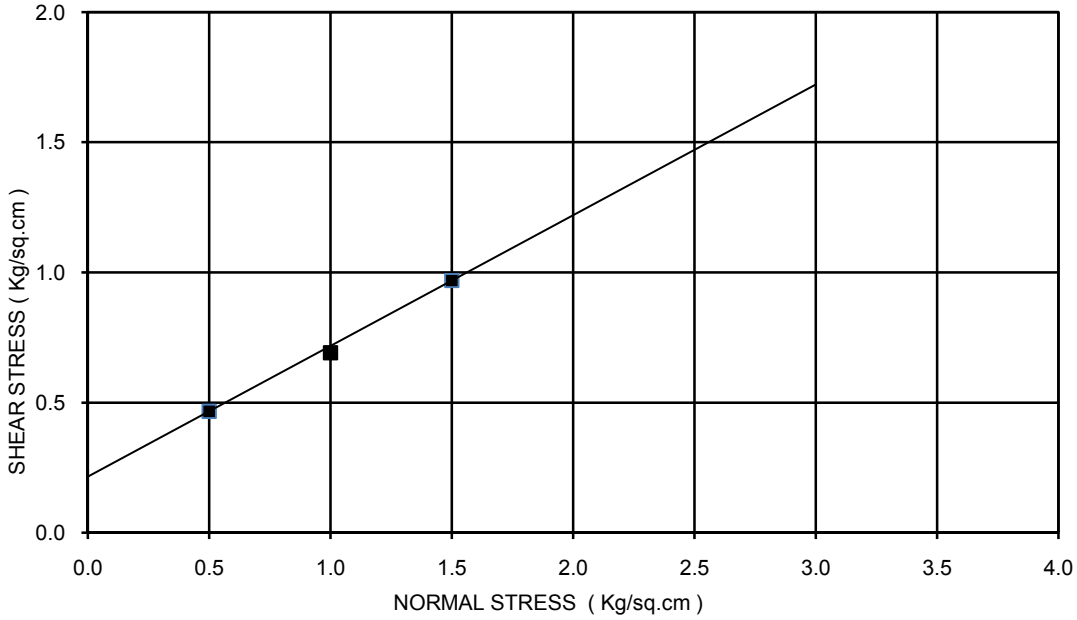


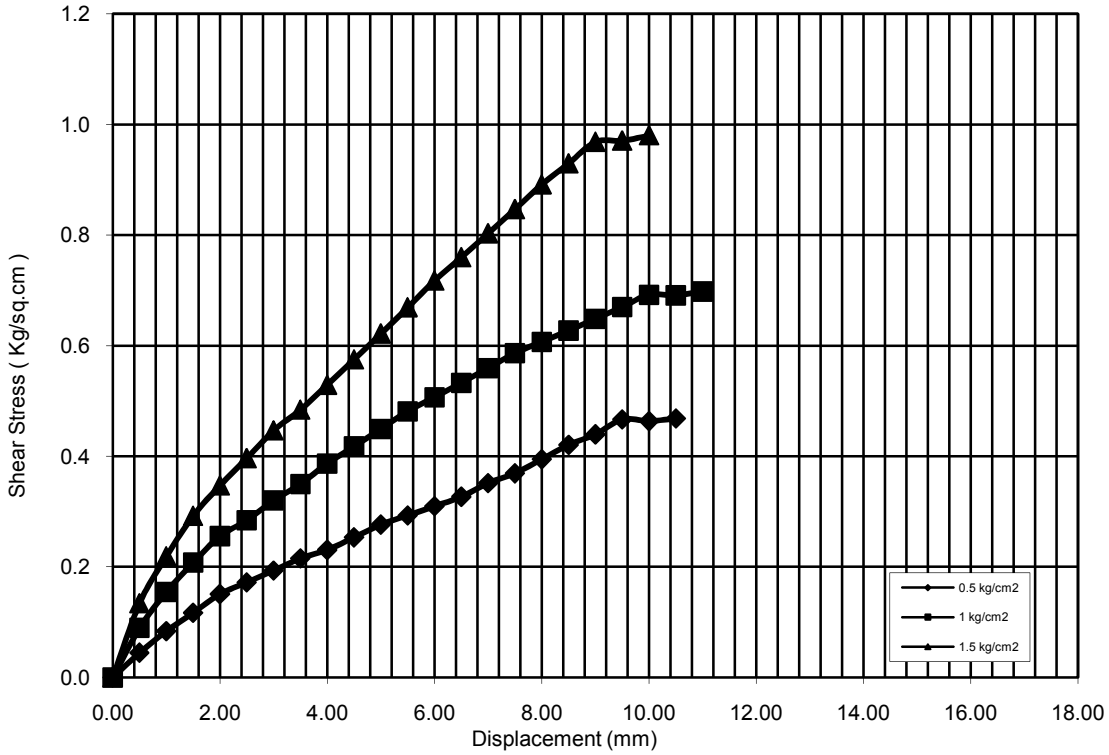
BORE HOLE NO: BH-A1
CHAINAGE : - 29+487
SAMPLE NO.: UDS-2
DEPTH: 5.50 m
COHESION(C)= 0.20 kg/sq.cm
ANGLE OF FRICTION(Phi): 27 deg
TYPE OF THE TEST: DST



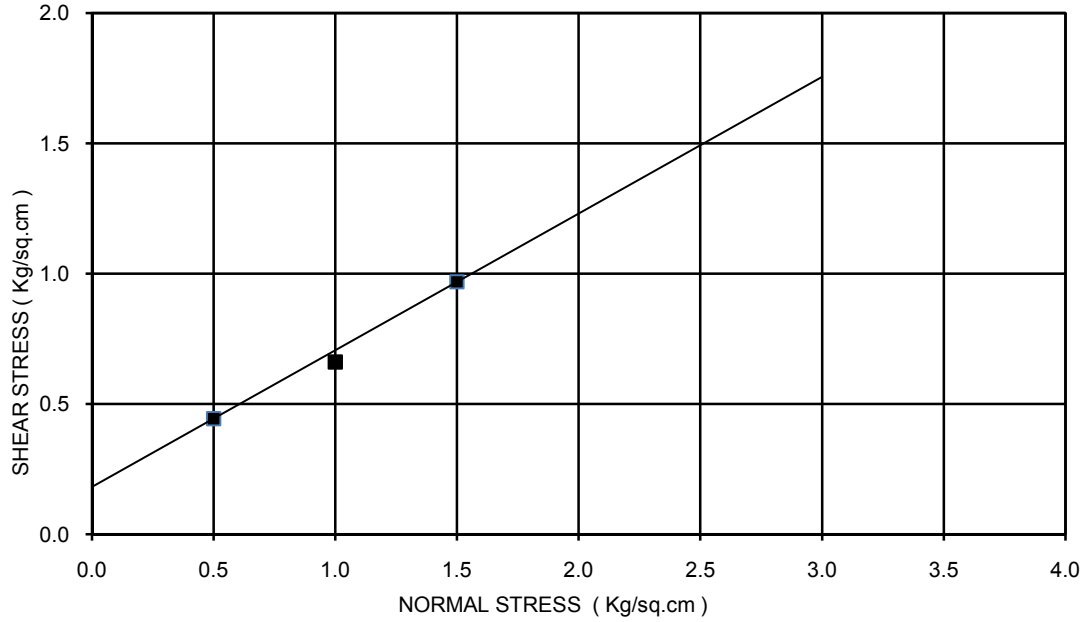


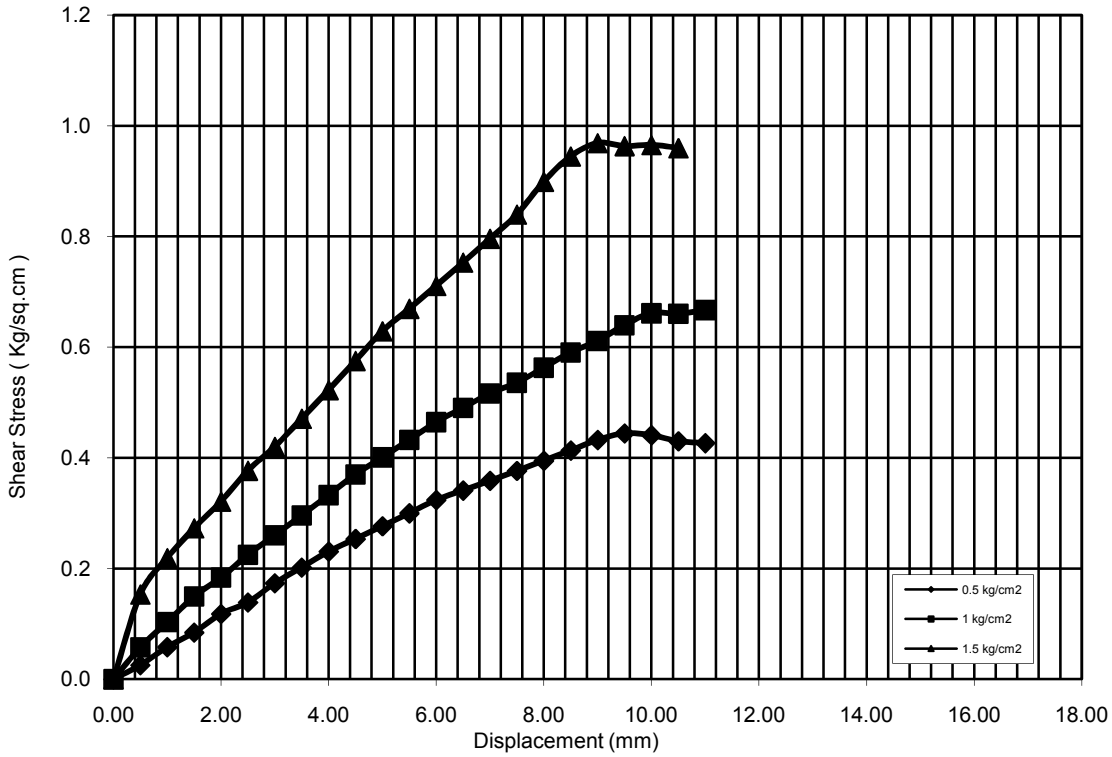
BORE HOLE NO: BH-A2
CHAINAGE :- 29+487
SAMPLE NO.: UDS-2
DEPTH: 4.00 m
COHESION(C)= 0.22 kg/sq.cm
ANGLE OF FRICTION(Phi): 27 deg
TYPE OF THE TEST: DST



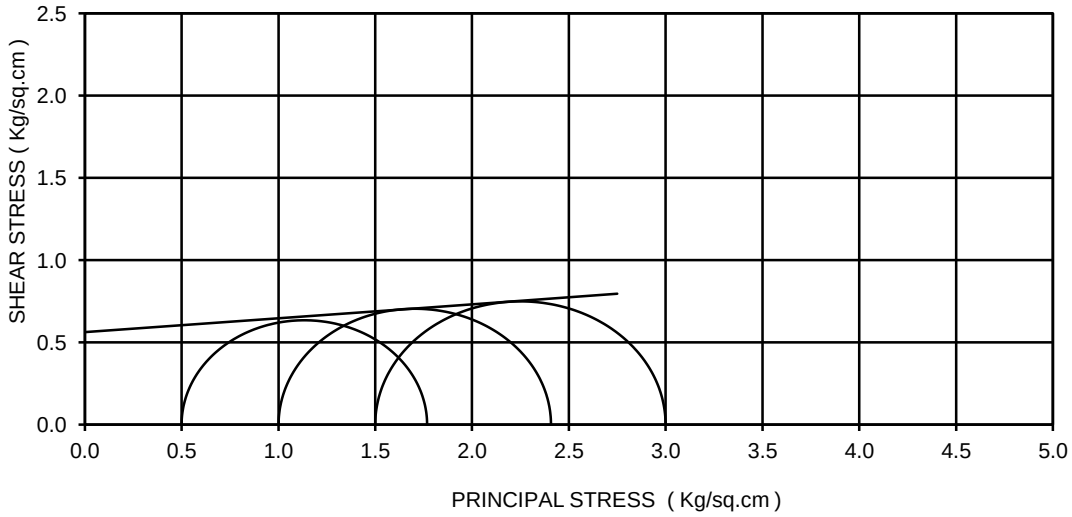


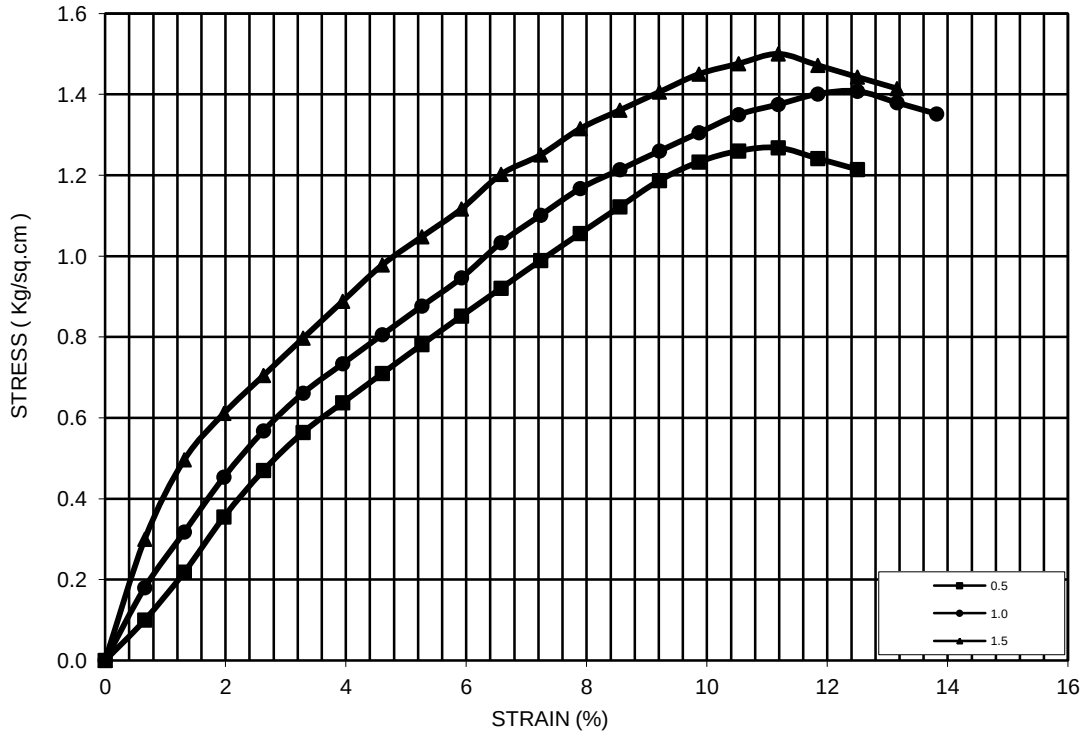
BORE HOLE NO: BH-A2
CHAINAGE:- 29+487
SAMPLE NO.: UDS-3
DEPTH: 7.00 m
COHESION(C)= 0.18 kg/sq.cm
ANGLE OF FRICTION(Phi): 28deg
TYPE OF THE TEST: DST



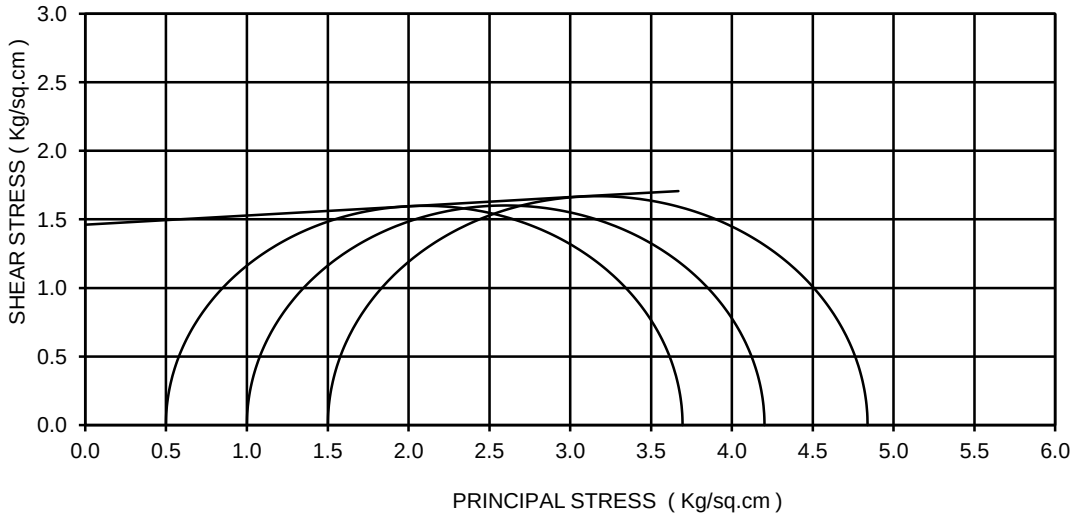


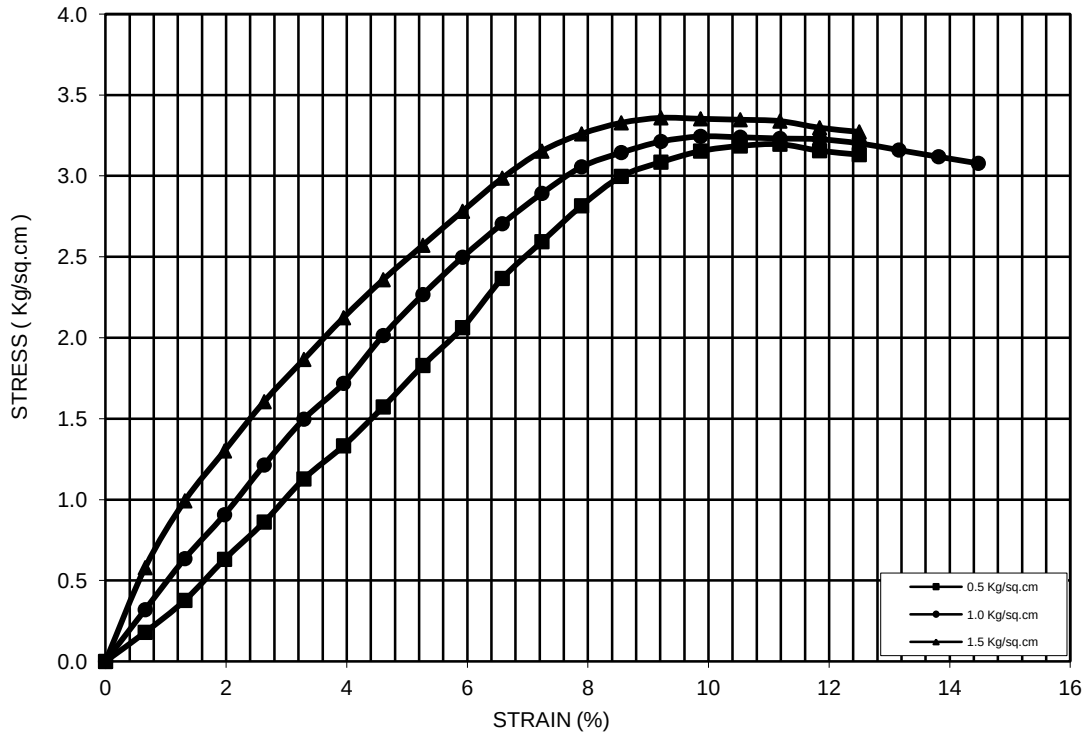
BORE HOLE NO: BH-CL
CHAINAGE: 32+160
SAMPLE NO.: UDS-1
DEPTH: 1.00 m
COHESION(C)= 0.56 kg/sq.cm
ANGLE OF FRICTION(Phi): 5 deg
TYPE OF THE TEST: UUT



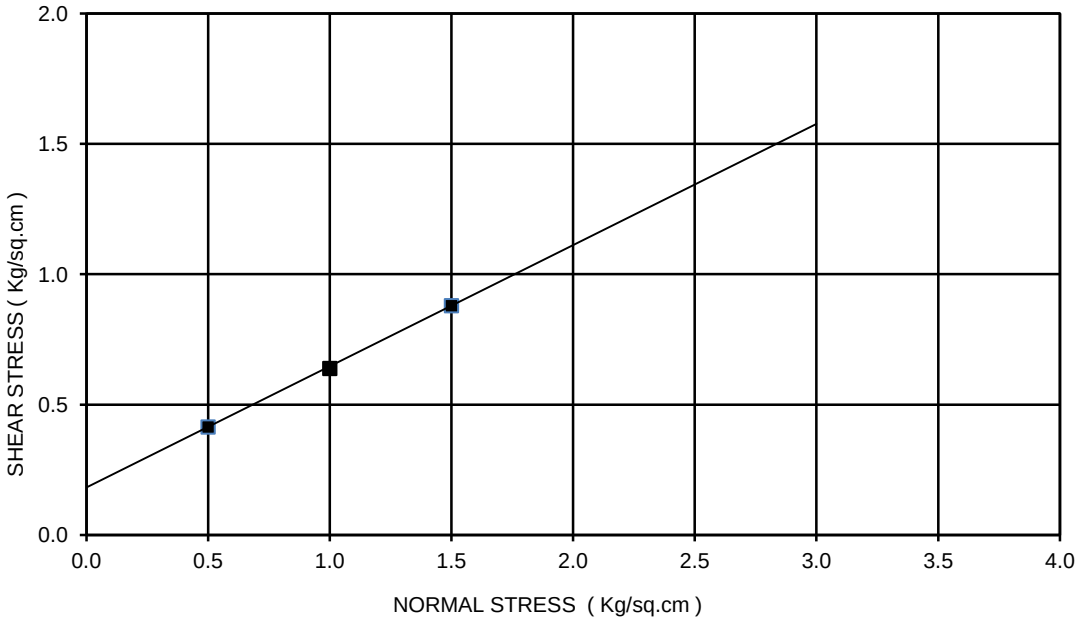


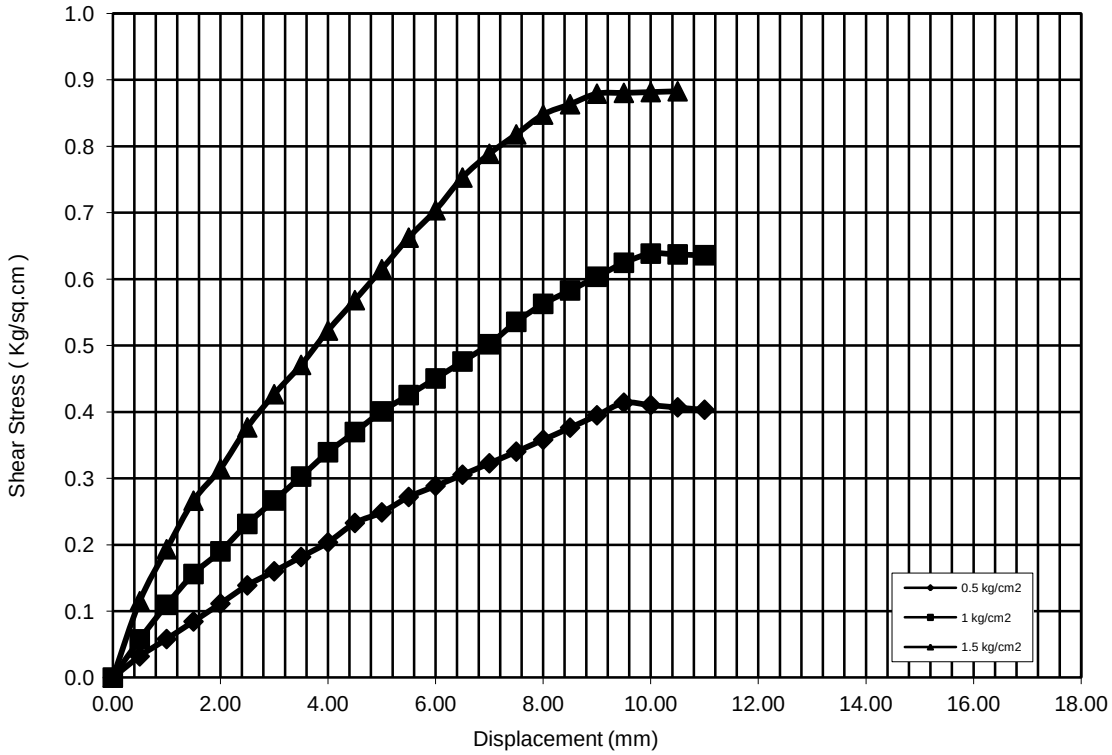
BORE HOLE NO: BH-CL
CHAINAGE: 32+487
SAMPLE NO.: UDS-2
DEPTH: 5.25 m
COHESION(C)= 1.46 kg/sq.cm
ANGLE OF FRICTION(Phi): 4 deg
TYPE OF THE TEST: UUT



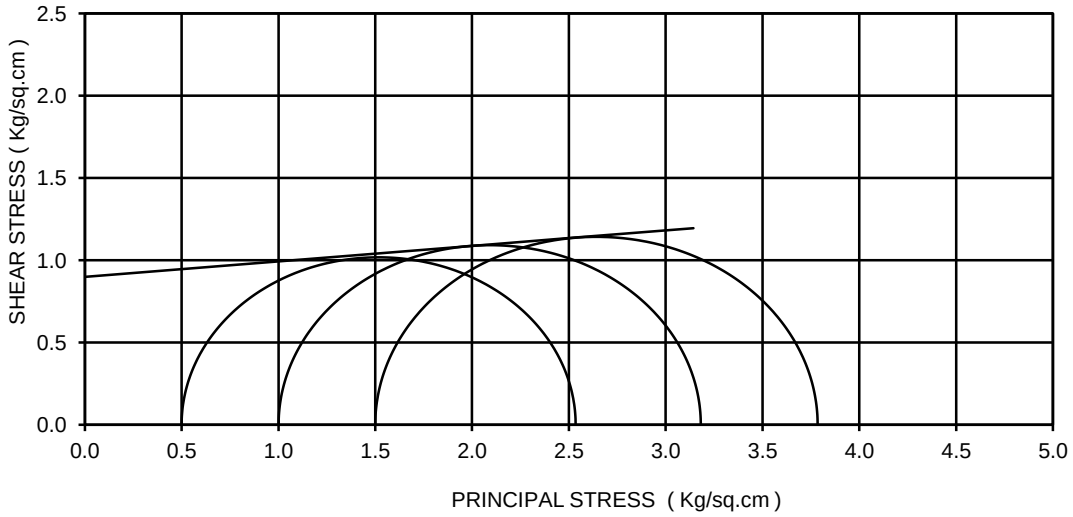


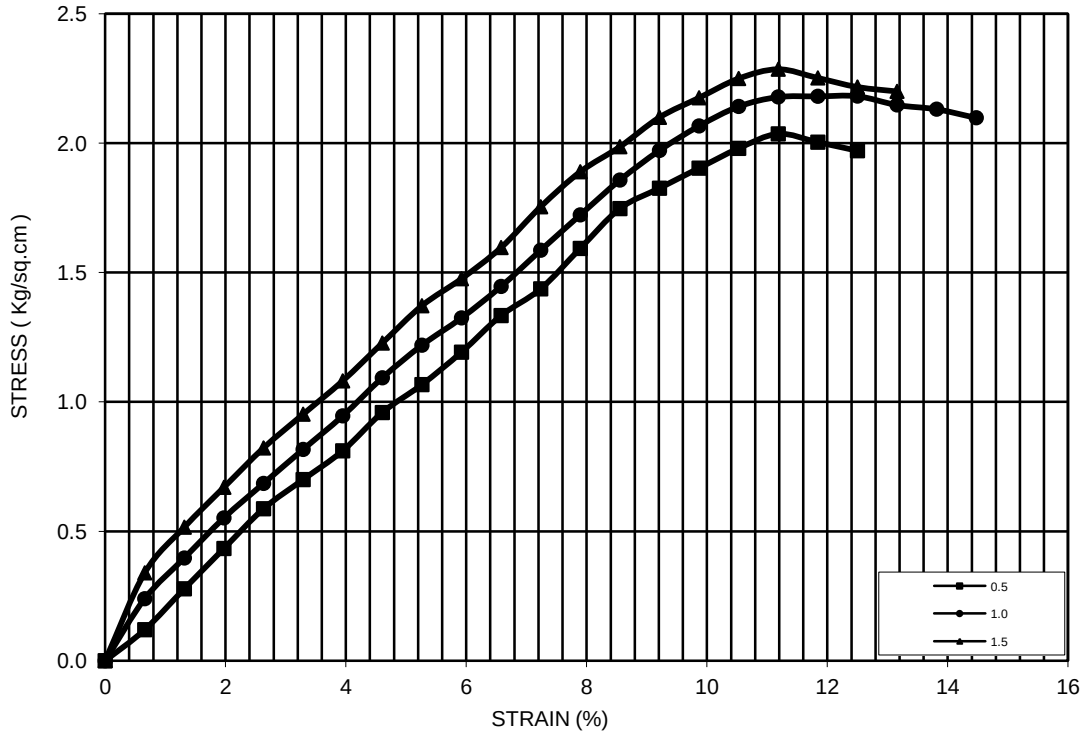
BORE HOLE NO: BH-CL
CHAINAGE:30+083
SAMPLE NO.: UDS-1
DEPTH: 2.25 m
COHESION(C)= 0.18 kg/sq.cm
ANGLE OF FRICTION(Phi): 25 deg
TYPE OF THE TEST: DST



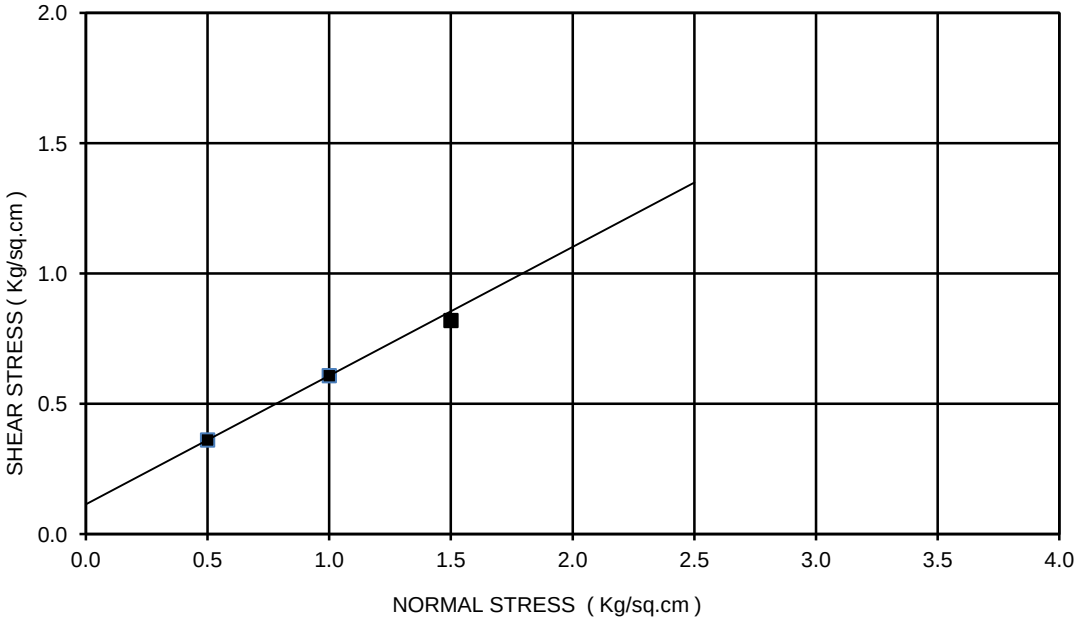


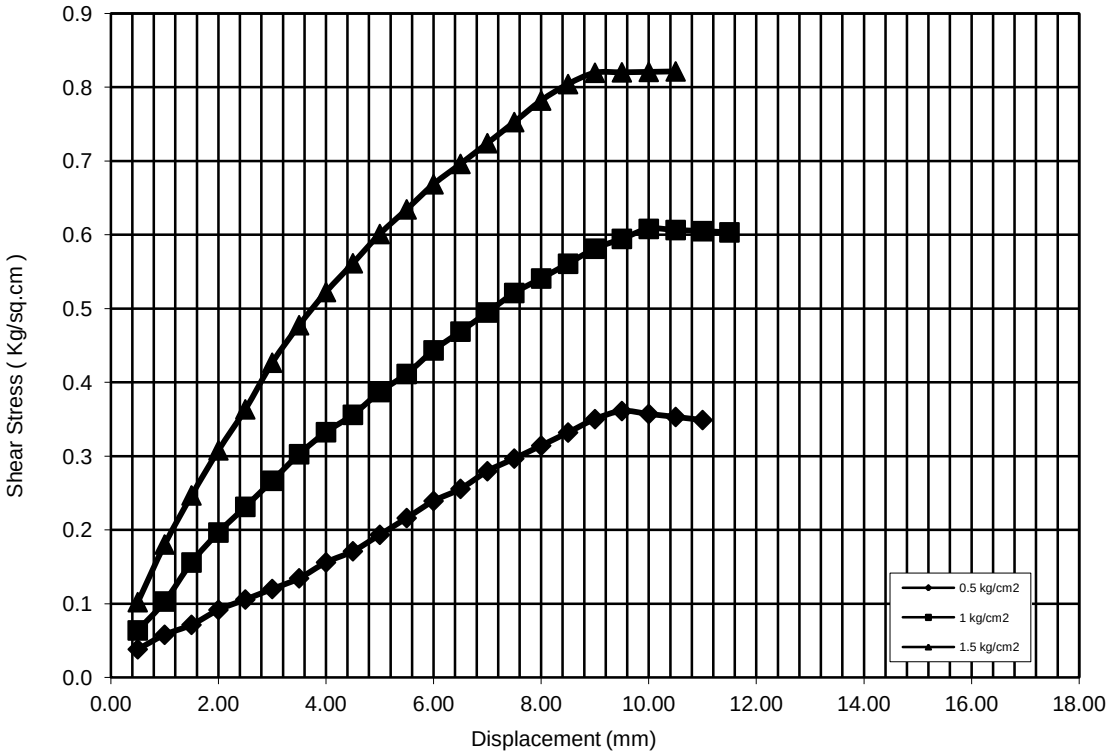
BORE HOLE NO: BH-A1
CHAINAGE: 30+488
SAMPLE NO.: UDS-2
DEPTH: 5.50 m
COHESION(C)= 0.90 kg/sq.cm
ANGLE OF FRICTION(Phi): 5 deg
TYPE OF THE TEST: UUT



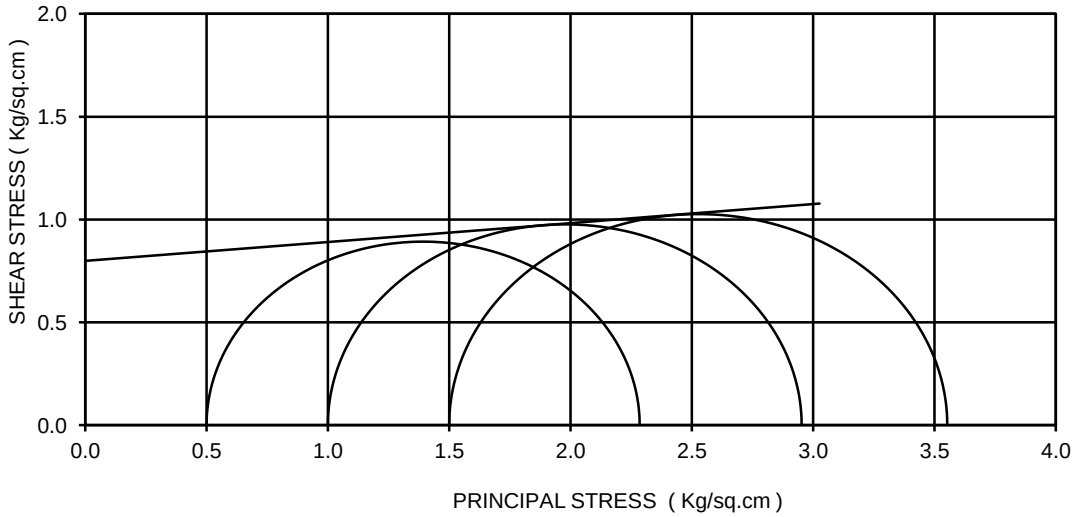


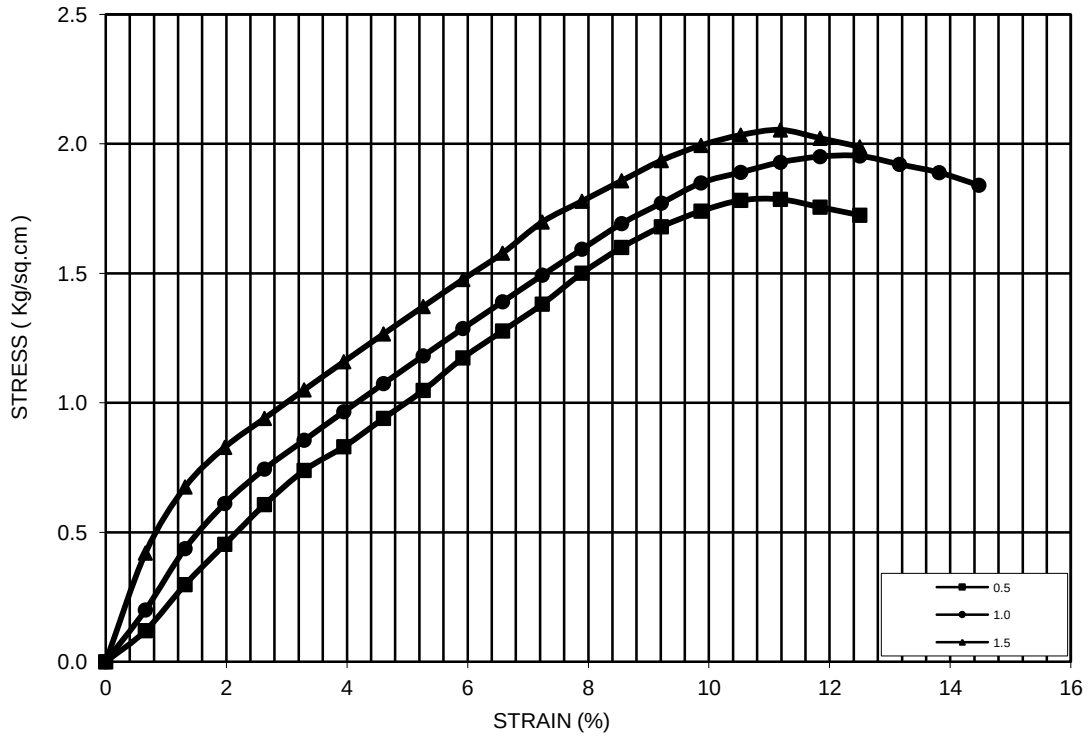
BORE HOLE NO: BH-A1
CHAINAGE:30+488
SAMPLE NO.: UDS-1
DEPTH: 2.50 m
COHESION(C)= 0.11 kg/sq.cm
ANGLE OF FRICTION(Phi): 26 deg
TYPE OF THE TEST: DST



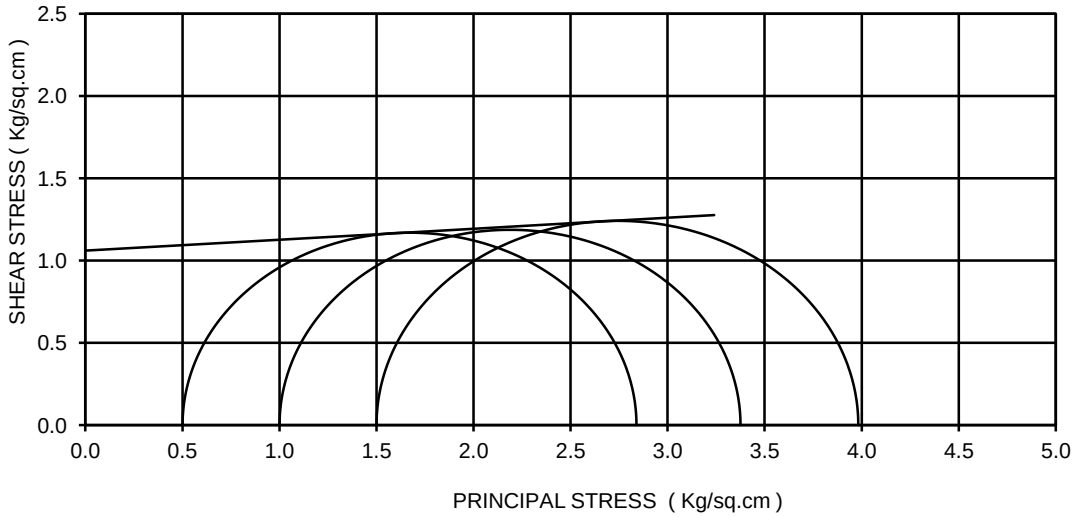


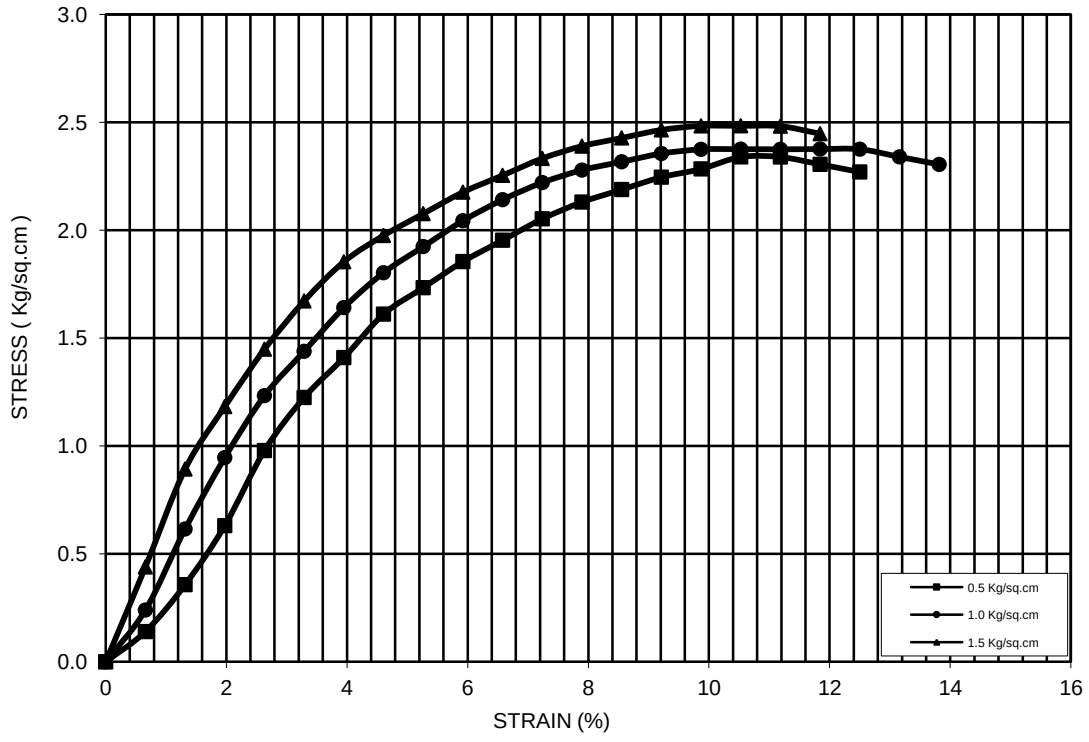
BORE HOLE NO: BH-A2
CHAINAGE: 30+488
SAMPLE NO.: UDS-2
DEPTH: 4.00 m
COHESION(C)= 0.8 kg/sq.cm
ANGLE OF FRICTION(Phi): 5 deg
TYPE OF THE TEST: UUT



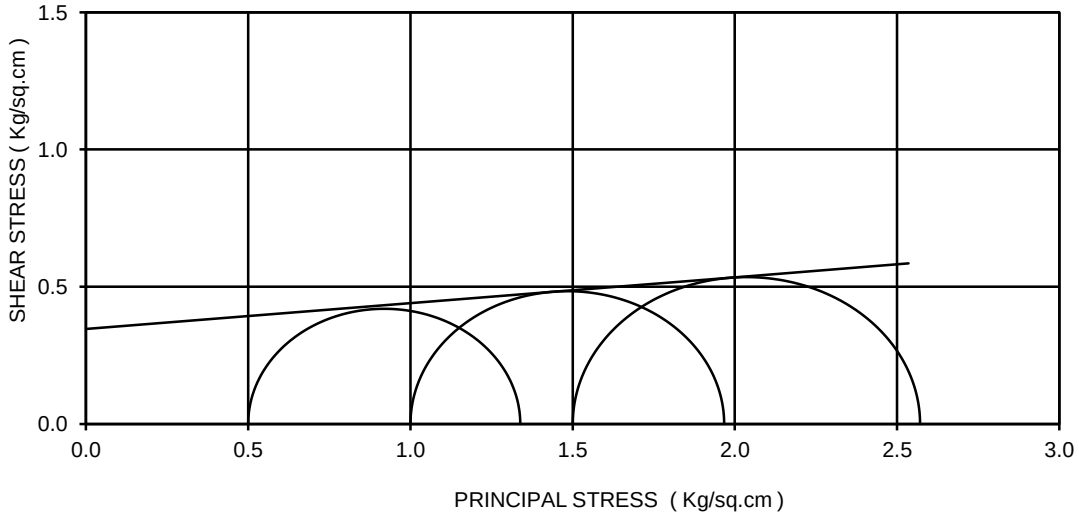


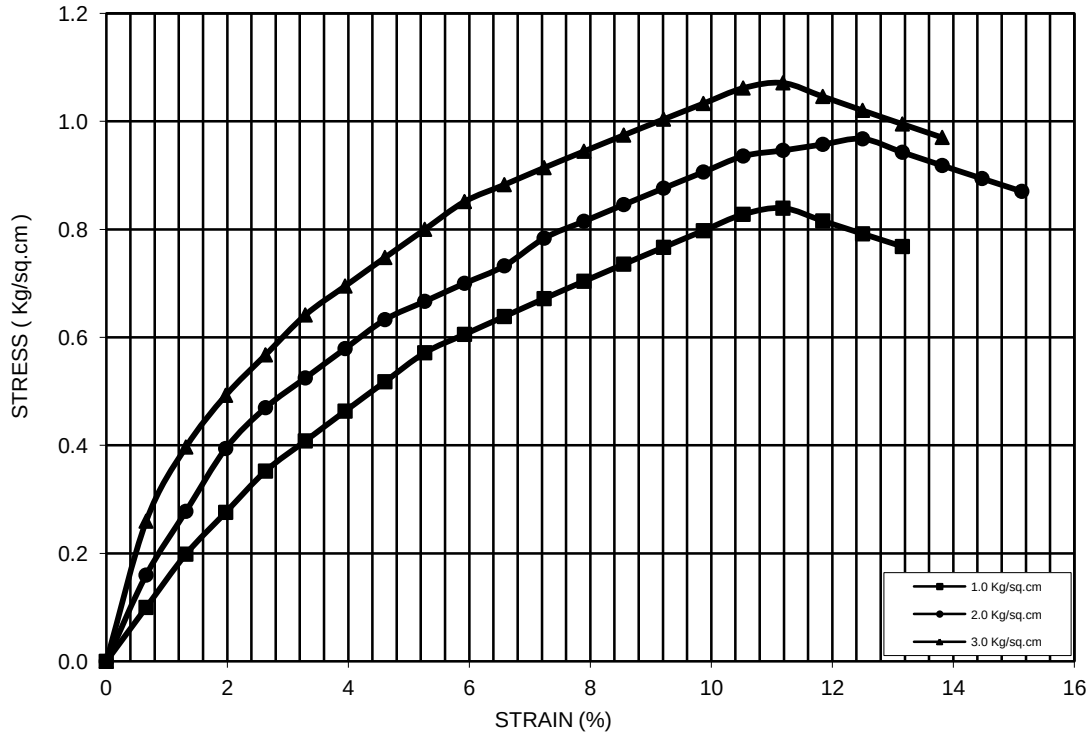
BORE HOLE NO: BH-A2
CHAINAGE:30+488
SAMPLE NO.: UDS-3
DEPTH: 7.50 m
COHESION(C)= 1.06 kg/sq.cm
ANGLE OF FRICTION(Phi): 4 deg
TYPE OF THE TEST: UUT



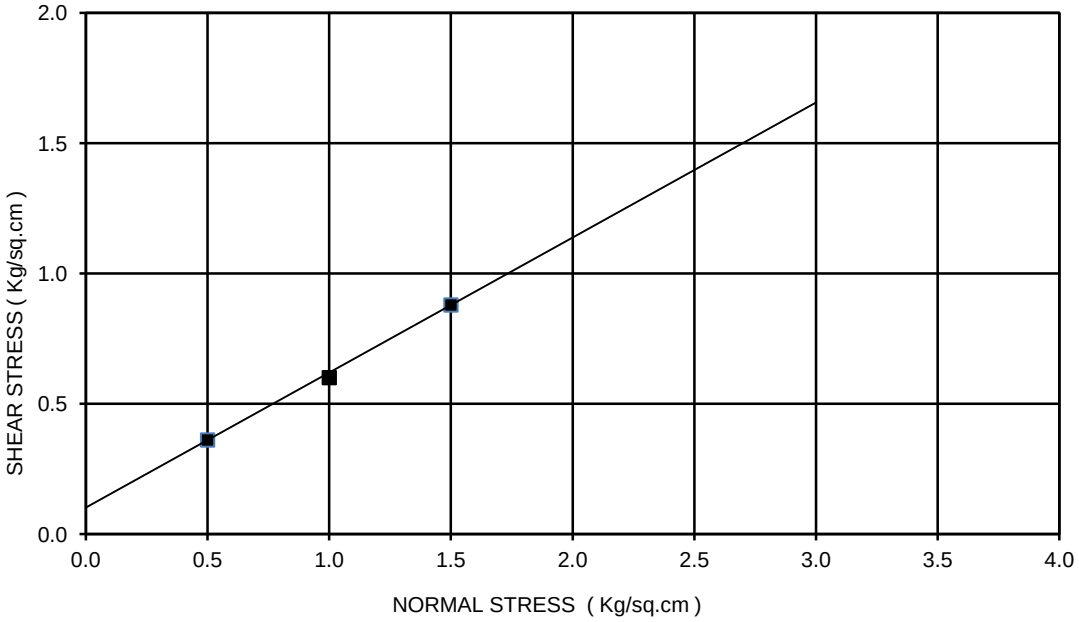


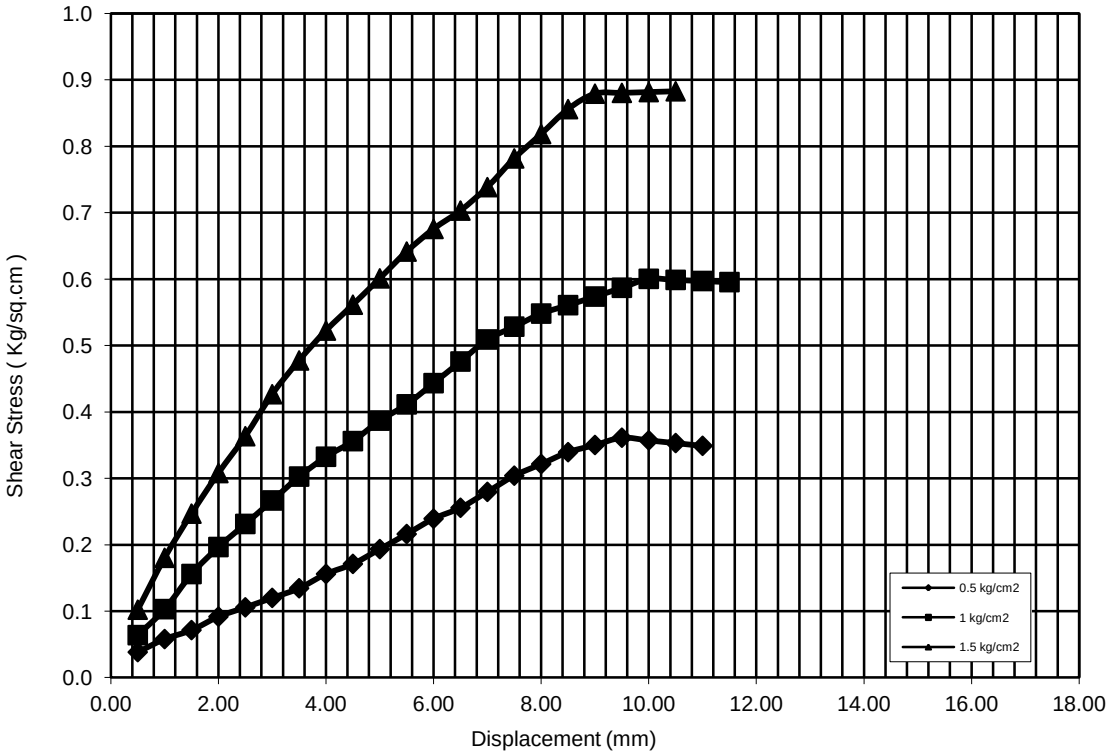
BORE HOLE NO: BH-CL
CHAINAGE:31+095
SAMPLE NO.: UDS-1
DEPTH: 2.25 m
COHESION(C)= 0.35 kg/sq.cm
ANGLE OF FRICTION(Phi):5deg
TYPE OF THE TEST: UUT



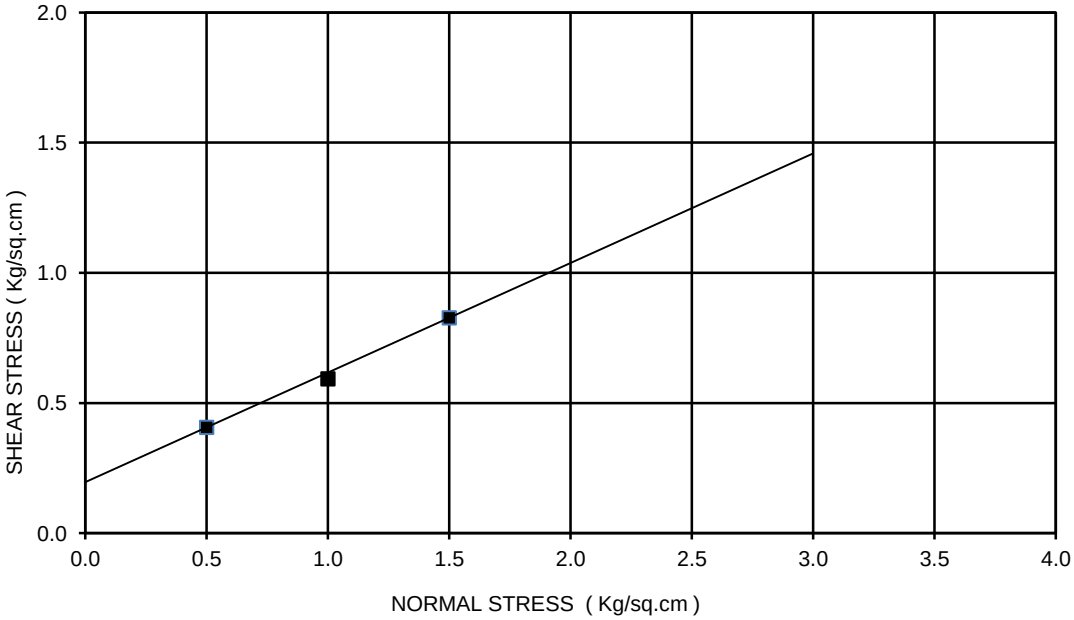


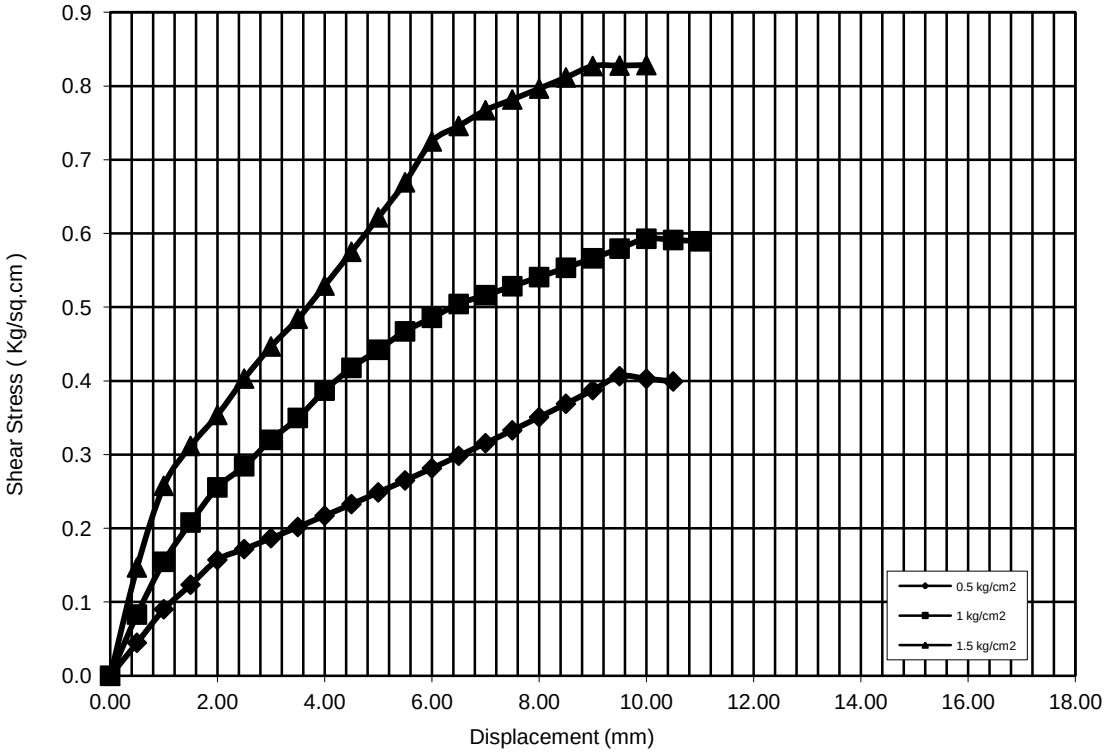
BORE HOLE NO: BH-CL
CHAINAGE:31+095
SAMPLE NO.: UDS-2
DEPTH: 5.25 m
COHESION(C)= 0.11 kg/sq.cm
ANGLE OF FRICTION(Phi): 27 deg
TYPE OF THE TEST: DST



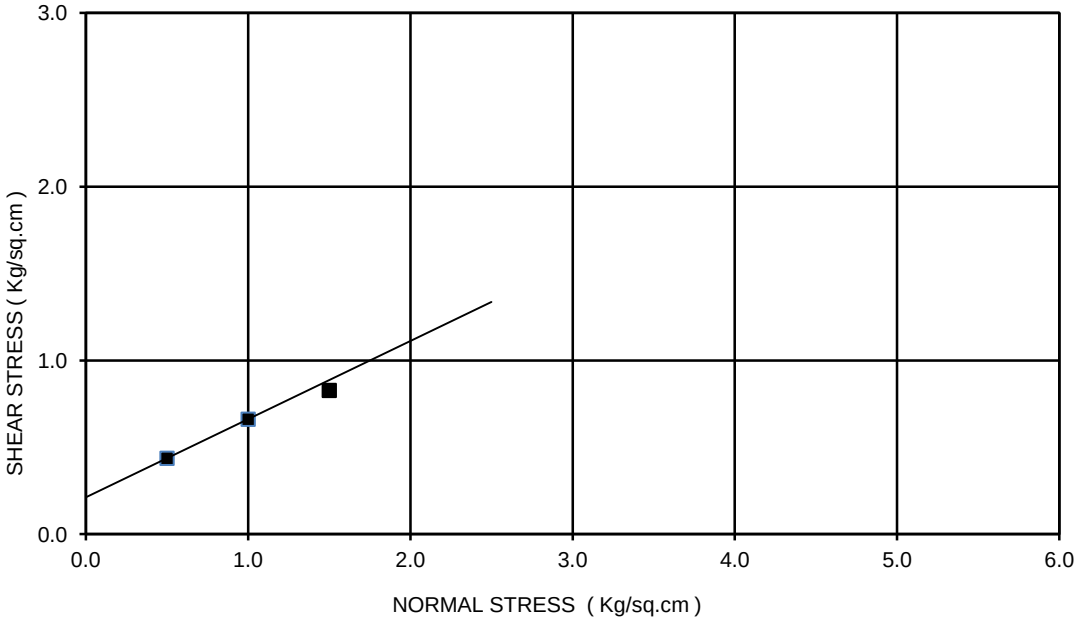


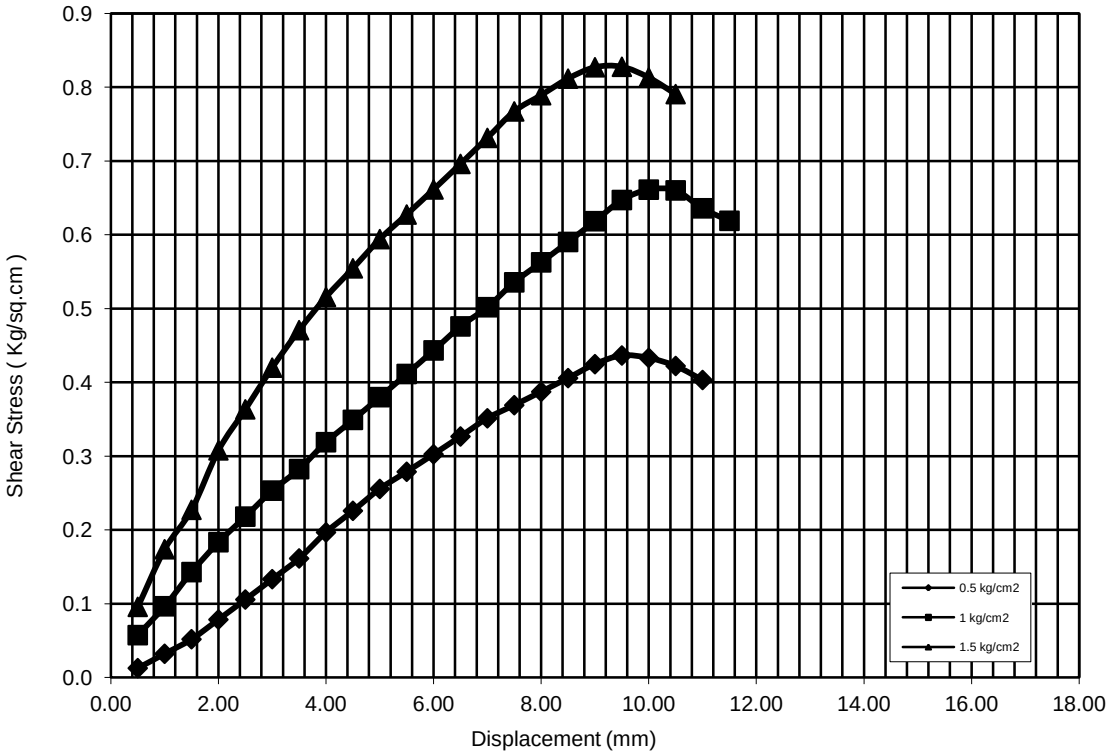
BORE HOLE NO: BH-A1
CHAINAGE:31+714
SAMPLE NO.: UDS-1
DEPTH: 1.00 m
COHESION(C)= 0.20 kg/sq.cm
ANGLE OF FRICTION(Phi): 23 deg
TYPE OF THE TEST: DST



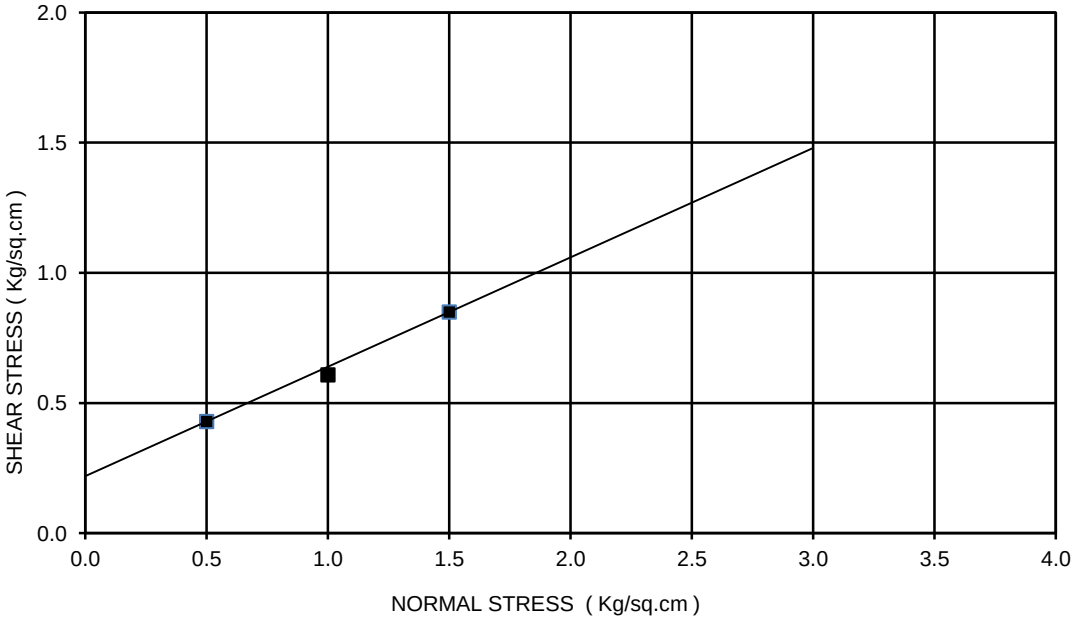


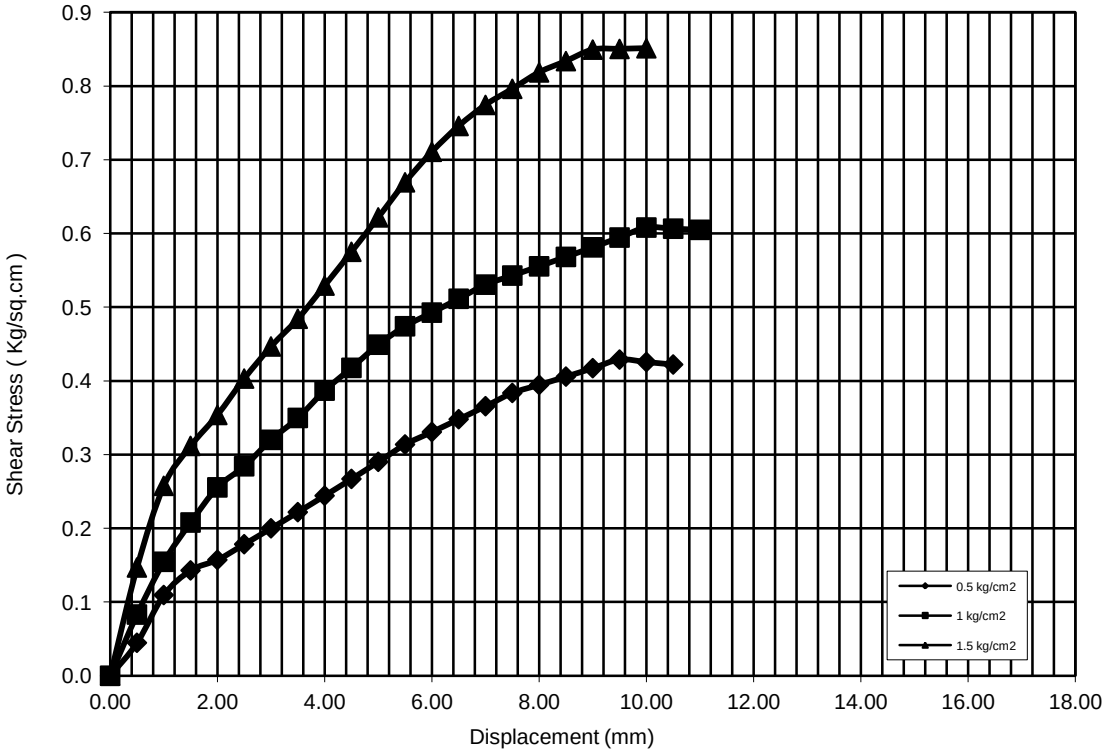
BORE HOLE NO: BH-A1
CHAINAGE: 31+714
SAMPLE NO.: UDS-3
DEPTH: 7.00 m
COHESION(C)= 0.21 kg/sq.cm
ANGLE OF FRICTION(Phi): 24 deg
TYPE OF THE TEST: DST



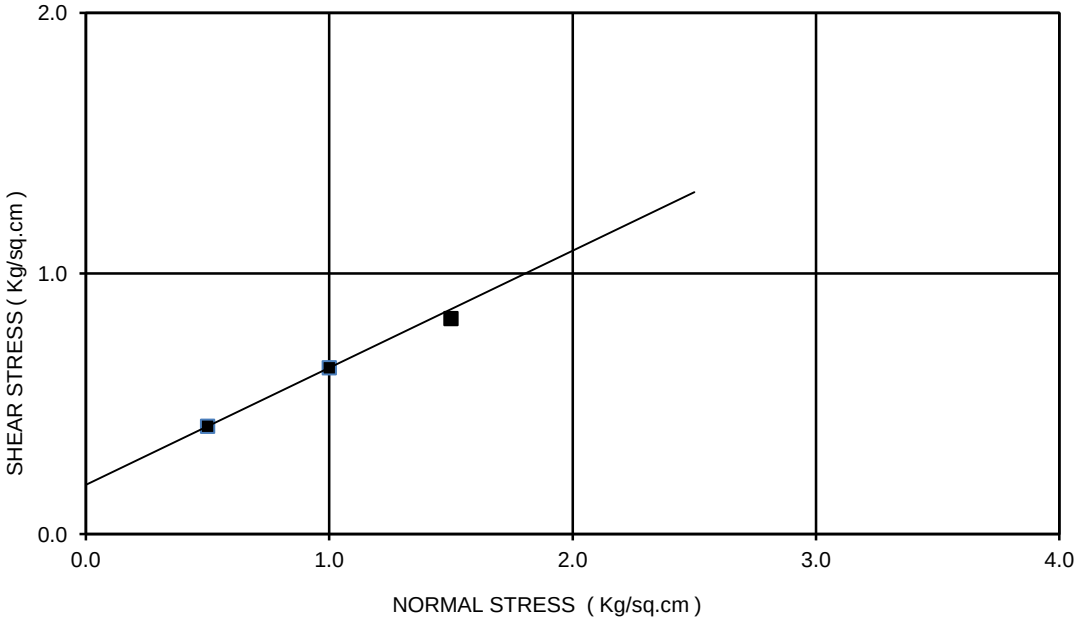


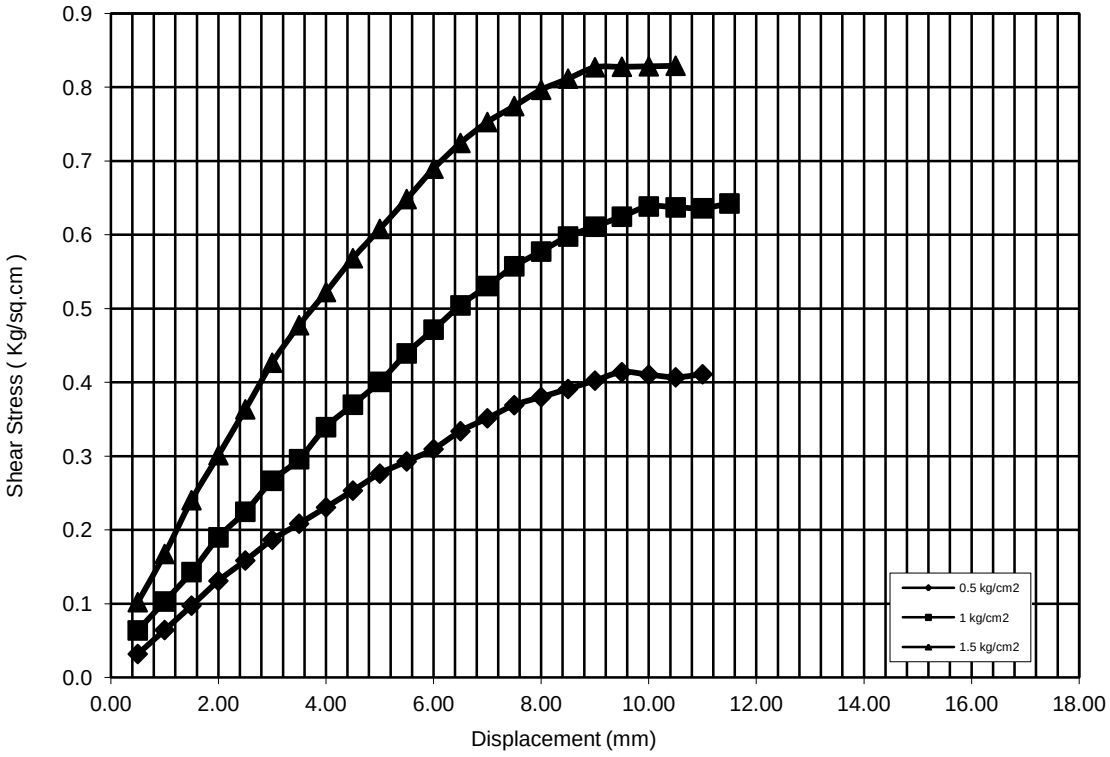
BORE HOLE NO: BH-A2
CHAINAGE:31+714
SAMPLE NO.: UDS-1
DEPTH: 2.50 m
COHESION(C)= 0.22 kg/sq.cm
ANGLE OF FRICTION(Phi): 23 deg
TYPE OF THE TEST: DST



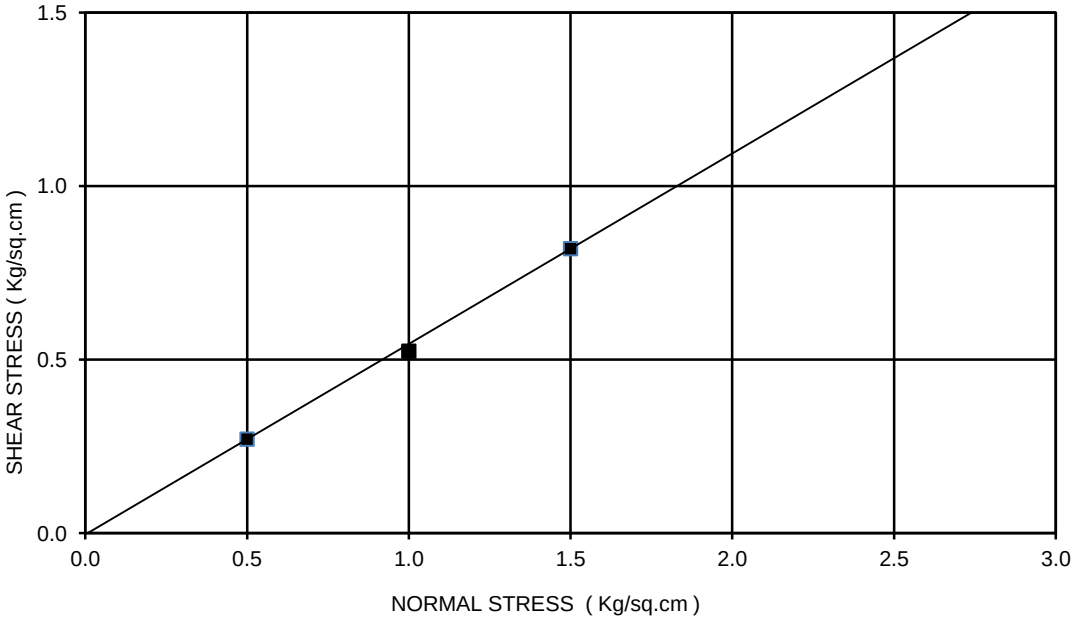


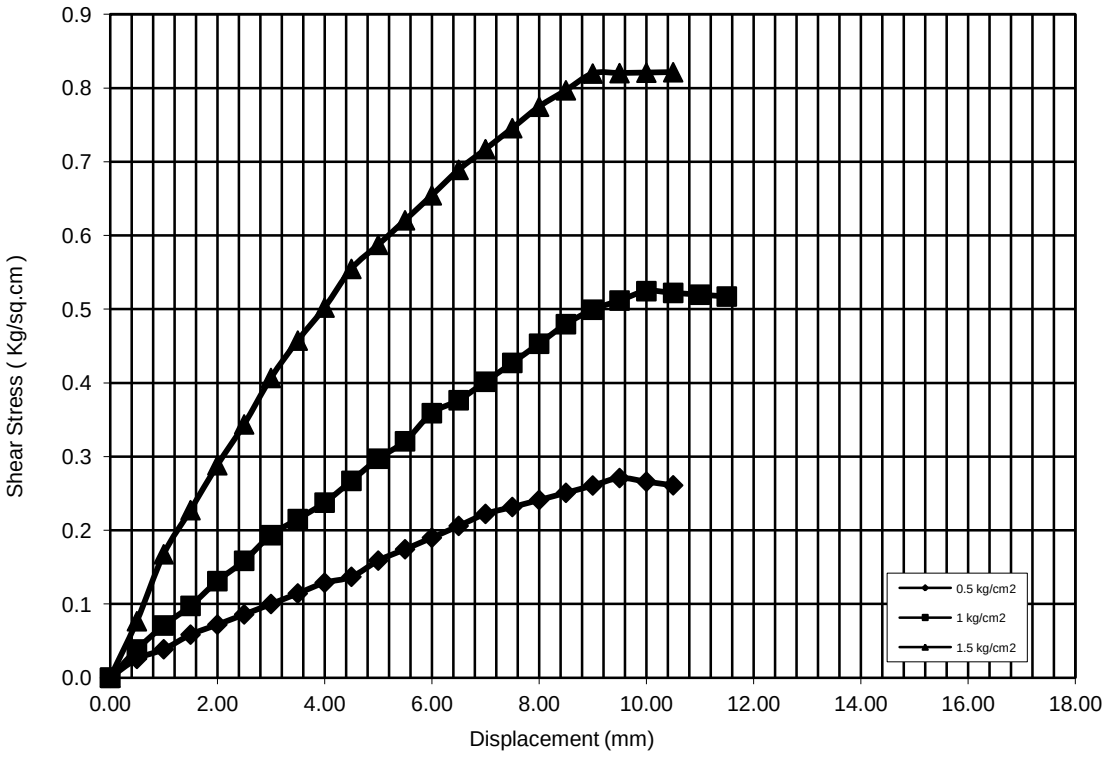
BORE HOLE NO: BH-A2
CHAINAGE:31+714
SAMPLE NO.: UDS-2
DEPTH: 5.50 m
COHESION(C)= 0.19 kg/sq.cm
ANGLE OF FRICTION(Phi): 24 deg
TYPE OF THE TEST: DST



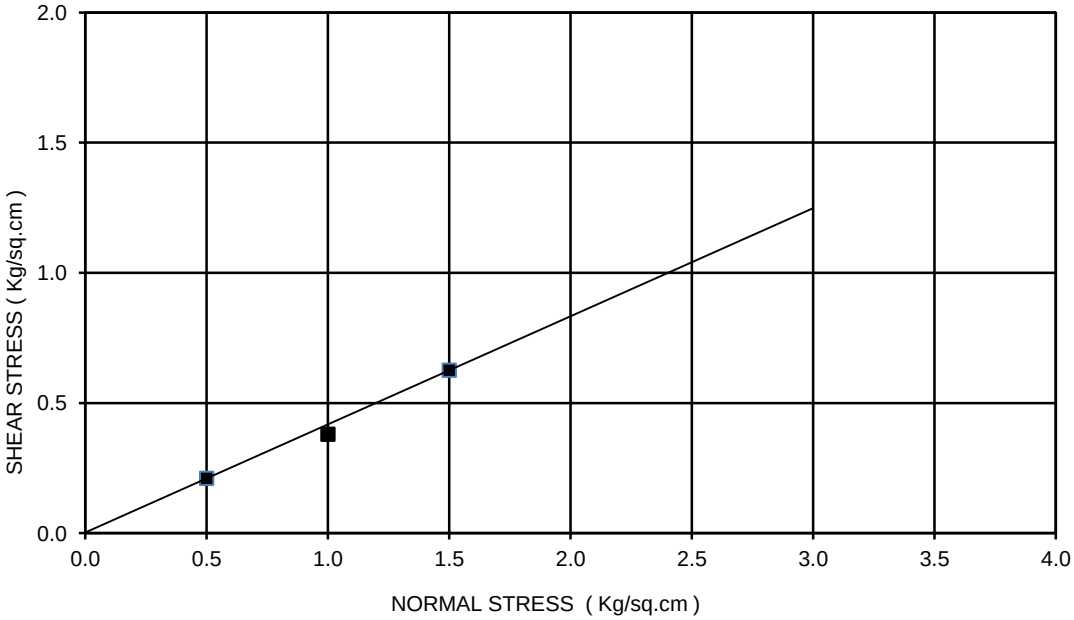


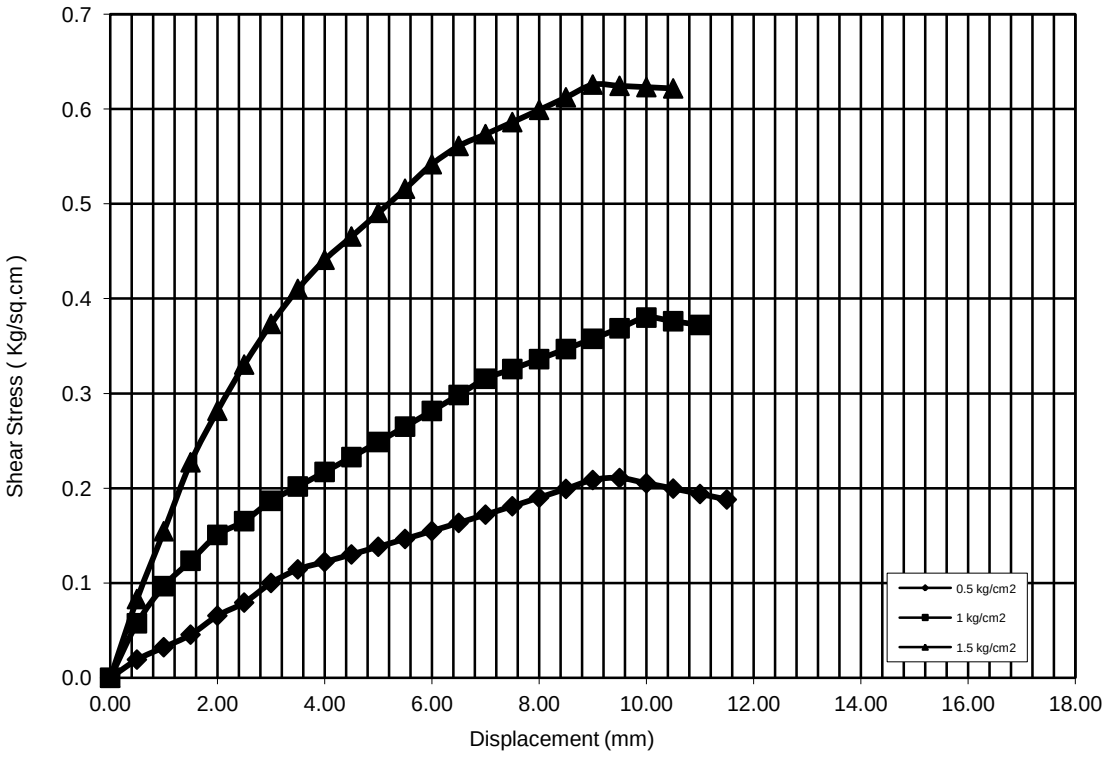
BORE HOLE NO: BH-CL
CHAINAGE : 32+191
SAMPLE NO.: UDS-1
DEPTH: 1.00 m
COHESION(C)= 0.00 kg/sq.cm
ANGLE OF FRICTION(Phi): 29 deg
TYPE OF THE TEST: DST



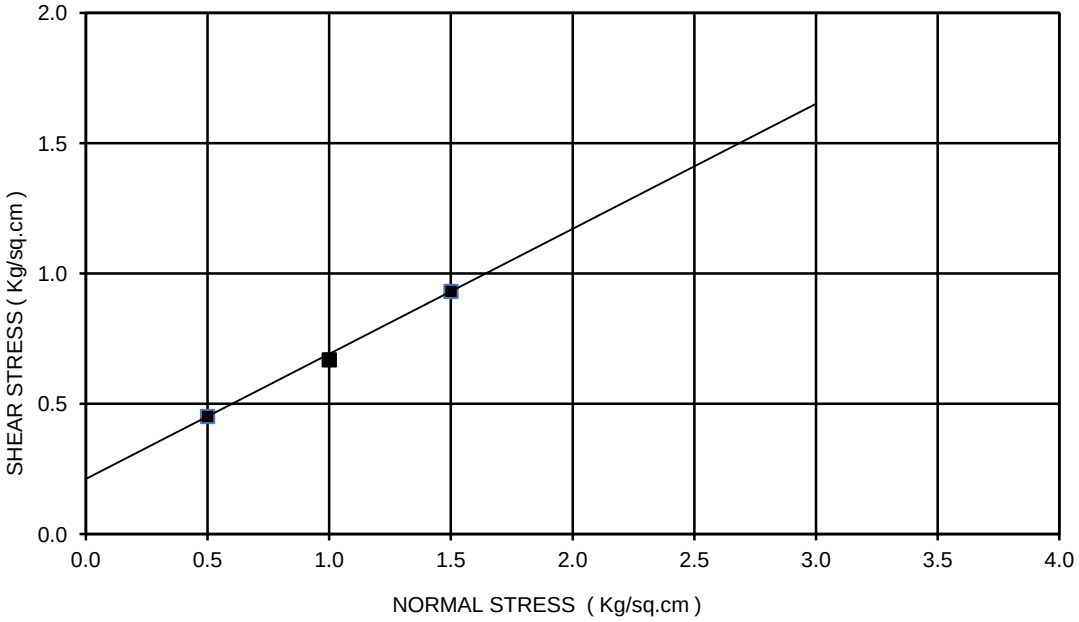


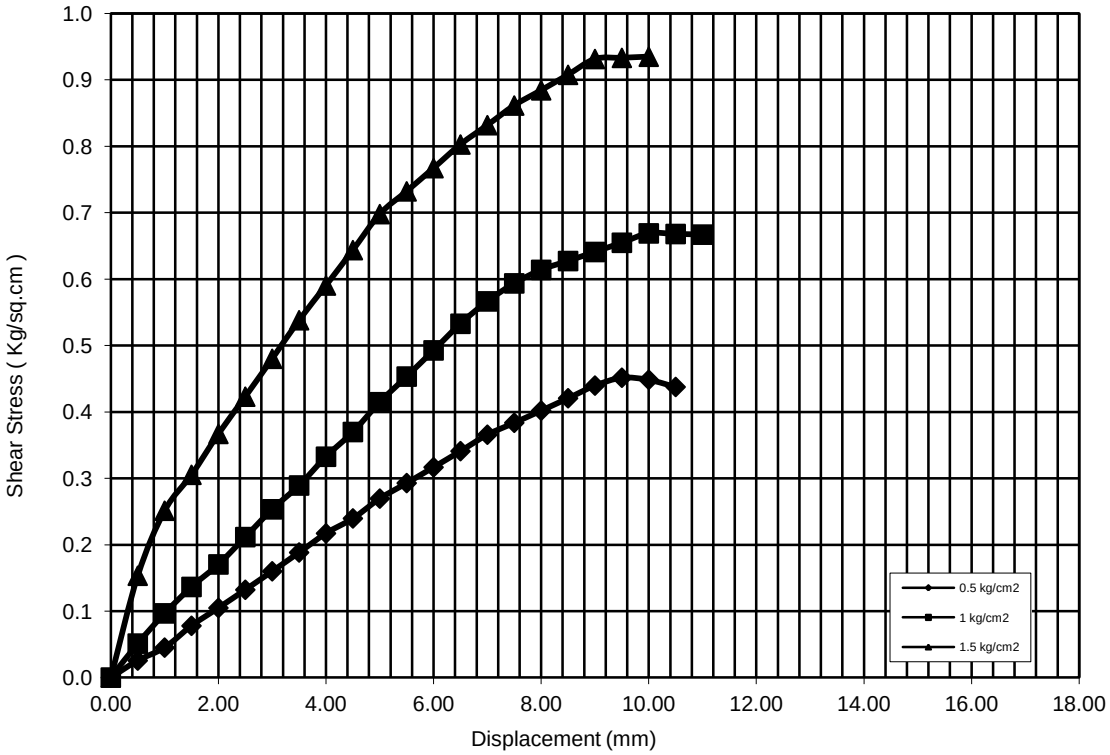
BORE HOLE NO: BH-CL
CHAINAGE:32+738
SAMPLE NO.: UDS-1
DEPTH: 2.50 m
COHESION(C)= 0.00 kg/sq.cm
ANGLE OF FRICTION(Phi): 23 deg
TYPE OF THE TEST: DST



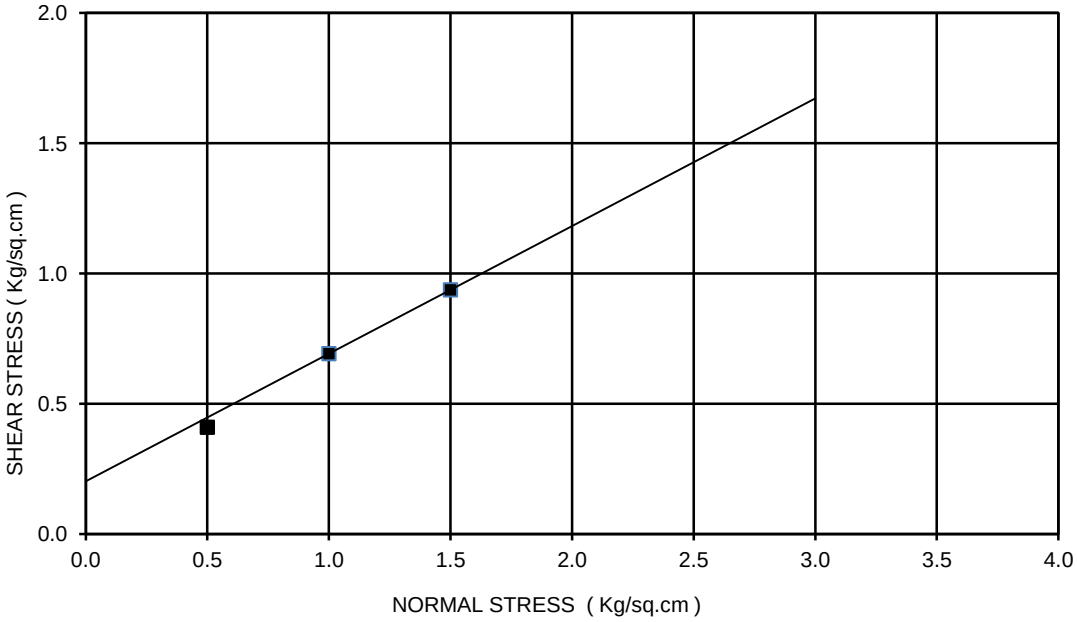


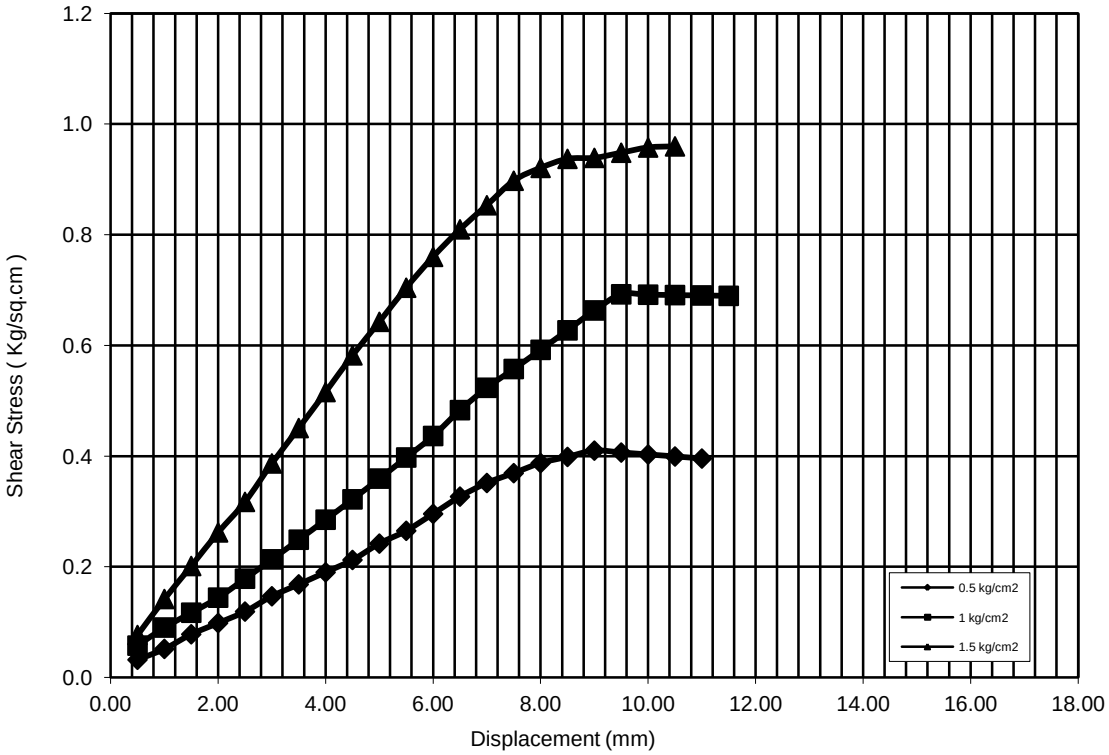
BORE HOLE NO: BH-A1
CHAINAGE: 33+713
SAMPLE NO.: UDS-1
DEPTH: 2.50 m
COHESION(C)= 0.21 kg/sq.cm
ANGLE OF FRICTION(Phi): 26 deg
TYPE OF THE TEST: DST



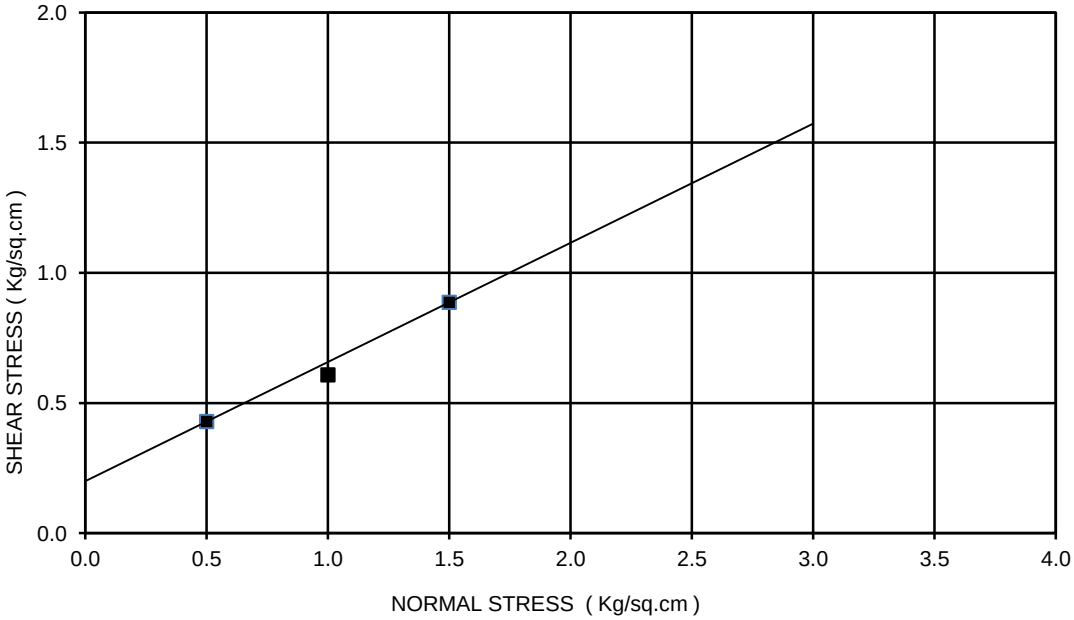


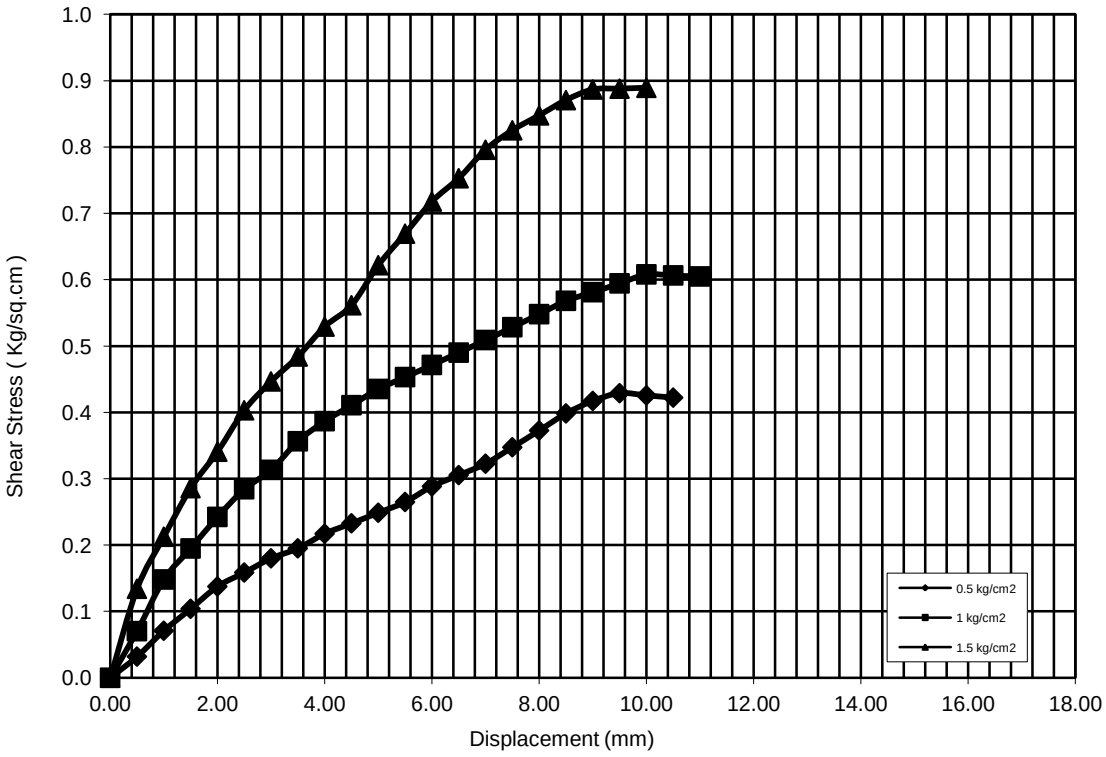
BORE HOLE NO: BH-A1
CHAINAGE: 33+713
SAMPLE NO.: UDS-2
DEPTH: 8.50 m
COHESION(C)= 0.2 kg/sq.cm
ANGLE OF FRICTION(Phi): 26 deg
TYPE OF THE TEST: DST



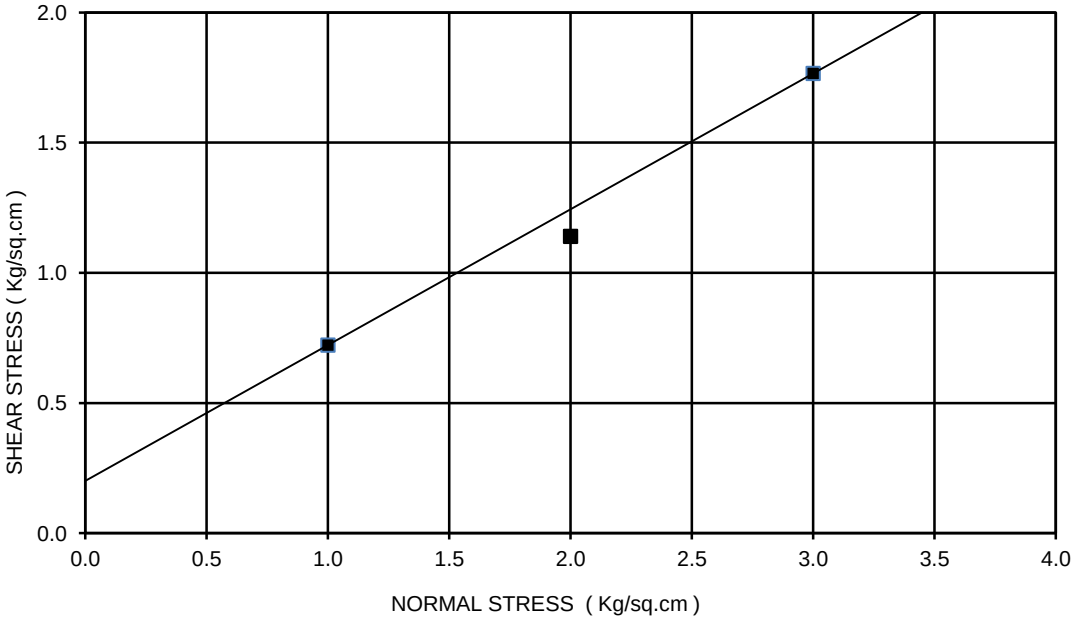


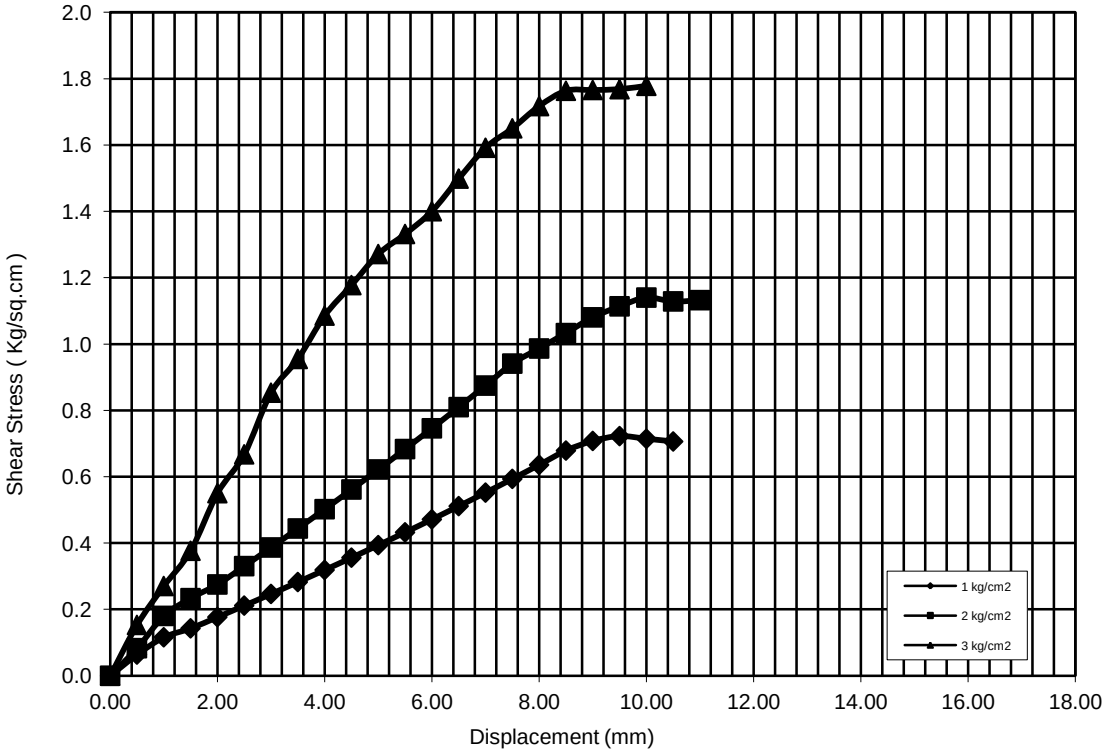
BORE HOLE NO: BH-A2
CHAINAGE:33+713
SAMPLE NO.: UDS-1
DEPTH: 1.00 m
COHESION(C)= 0.20 kg/sq.cm
ANGLE OF FRICTION(Phi): 25 deg
TYPE OF THE TEST: DST



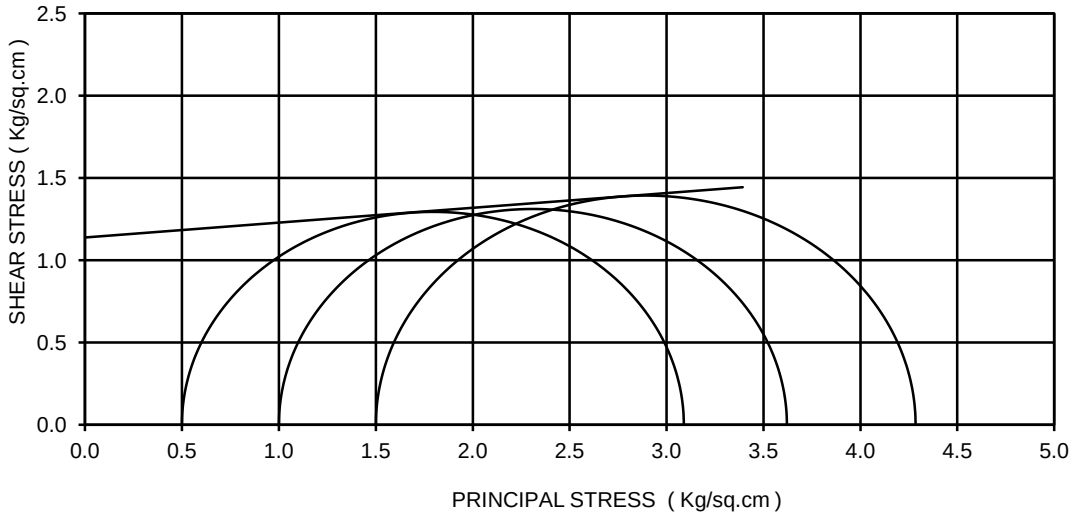


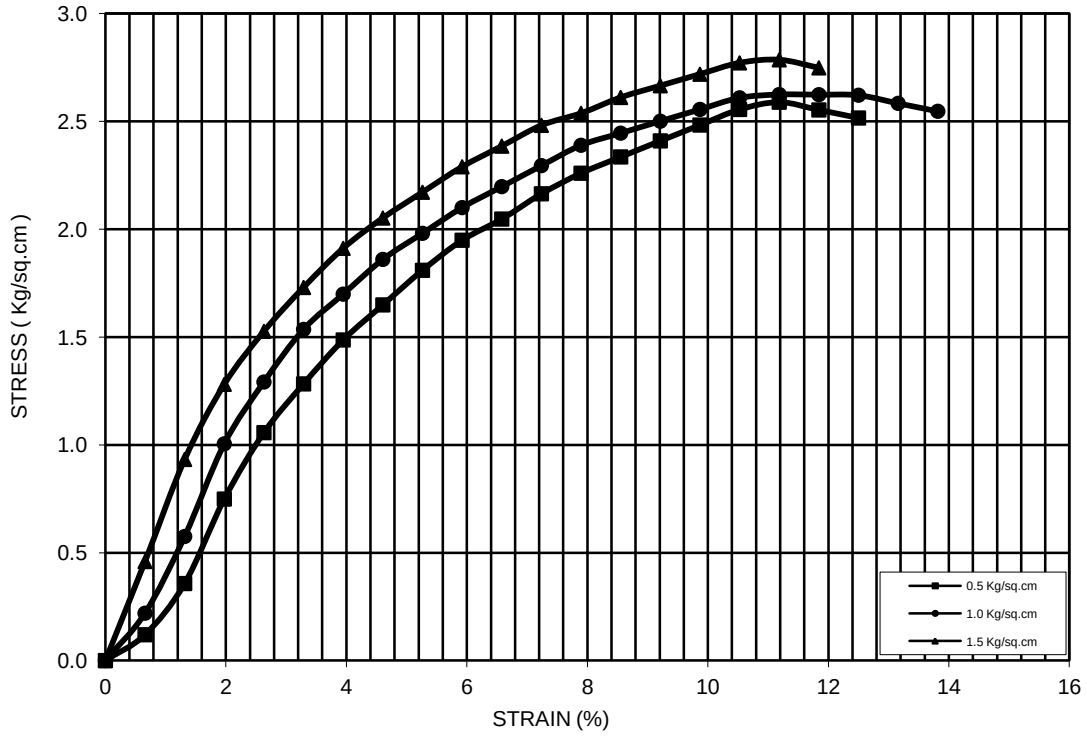
BORE HOLE NO: BH-A2
CHAINAGE:33+713
SAMPLE NO.: UDS-5
DEPTH: 13.00 m
COHESION(C)= 0.08 kg/sq.cm
ANGLE OF FRICTION(Phi): 26 deg
TYPE OF THE TEST: DST



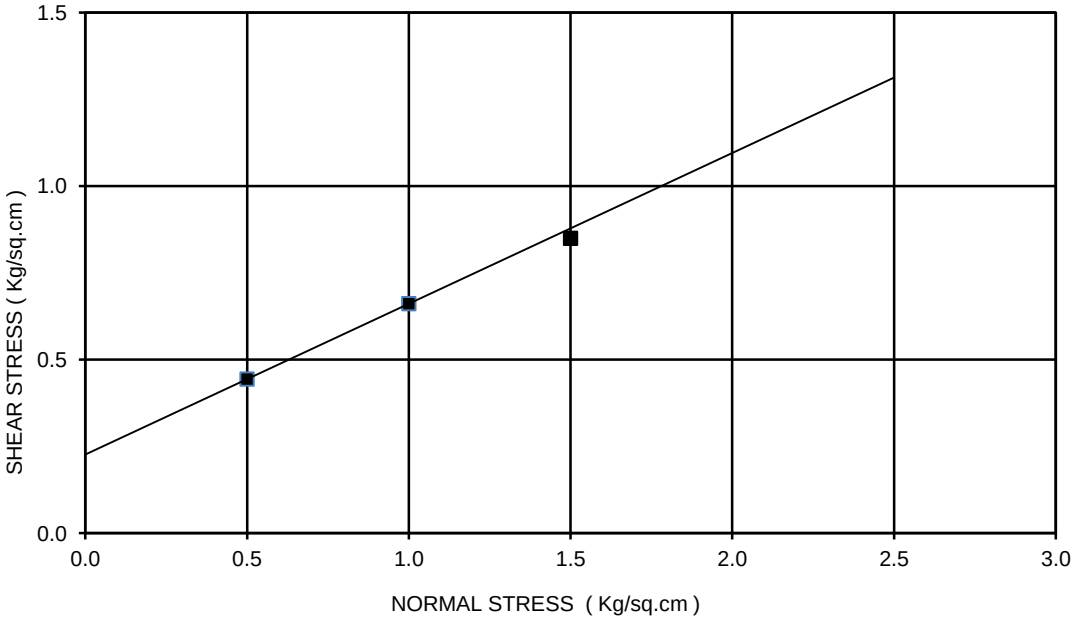


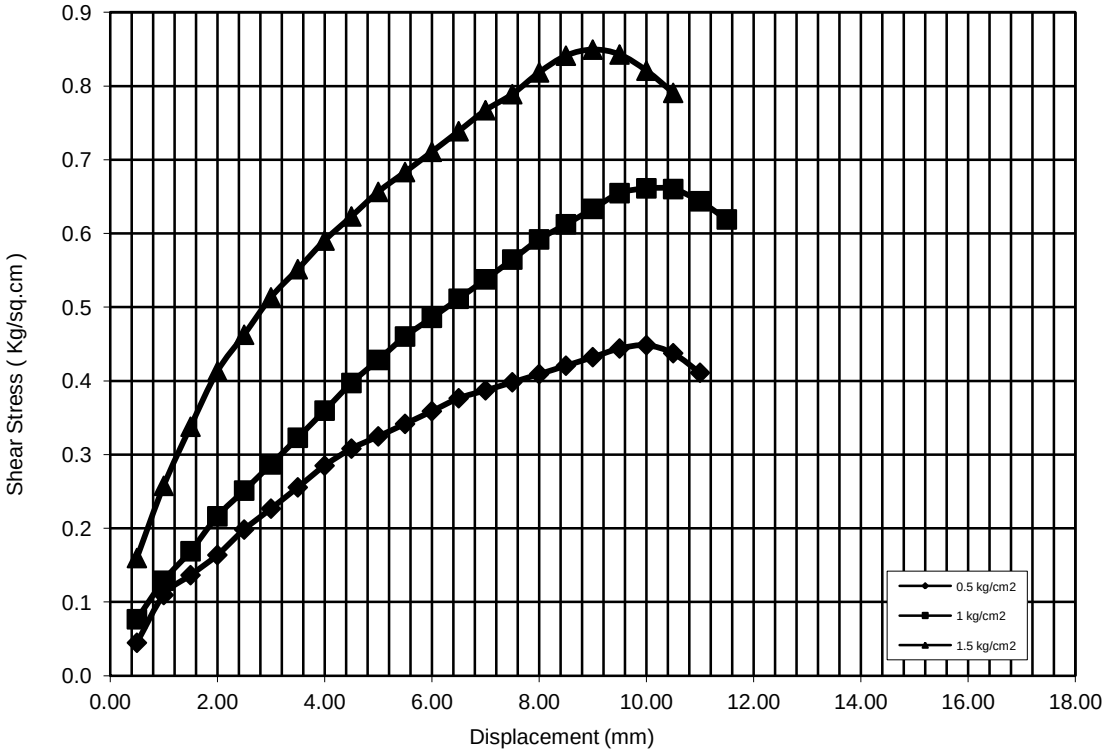
BORE HOLE NO: BH-CL
CHAINAGE:34+019
SAMPLE NO.: UDS-2
DEPTH: 4.00m
COHESION(C)= 1.14 kg/sq.cm
ANGLE OF FRICTION(Phi): 5 deg
TYPE OF THE TEST: UUT



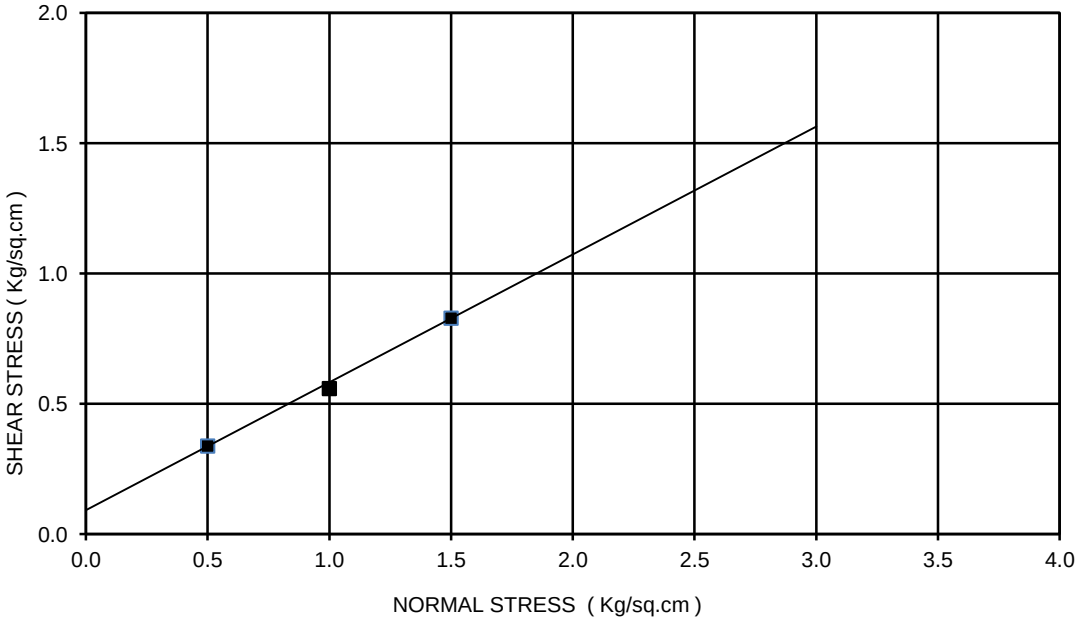


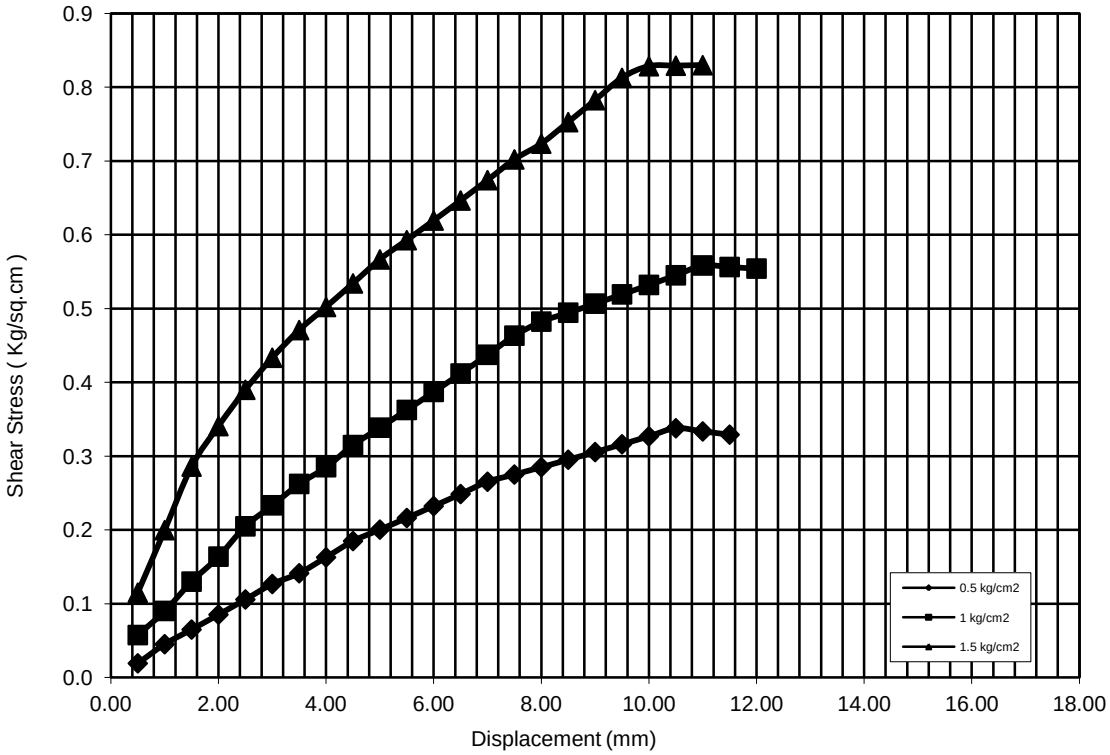
BORE HOLE NO: BH-CL
CHAINAGE:34+619
SAMPLE NO.: UDS-1
DEPTH: 2.50 m
COHESION(C)= 0.23 kg/sq.cm
ANGLE OF FRICTION(Phi): 23 deg
TYPE OF THE TEST: DST



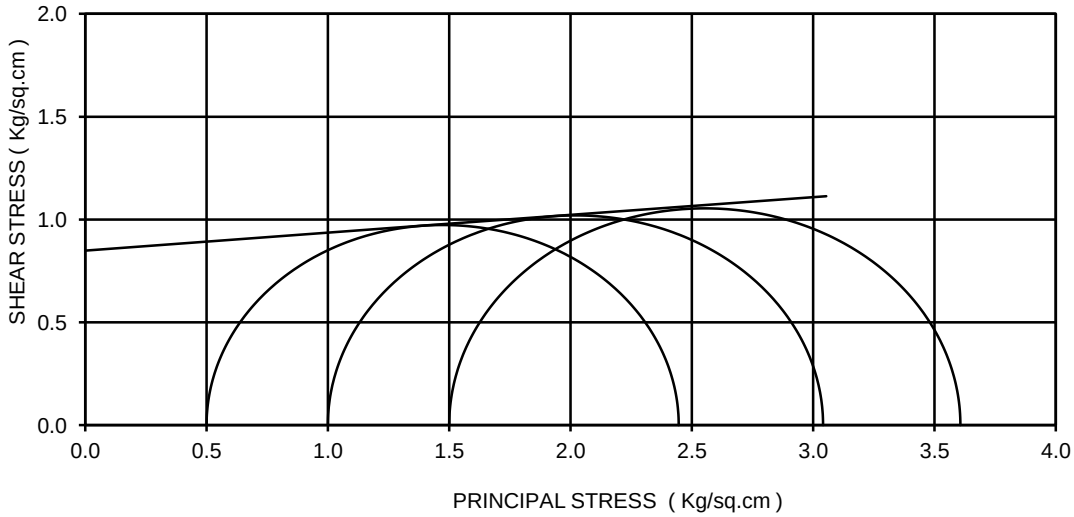


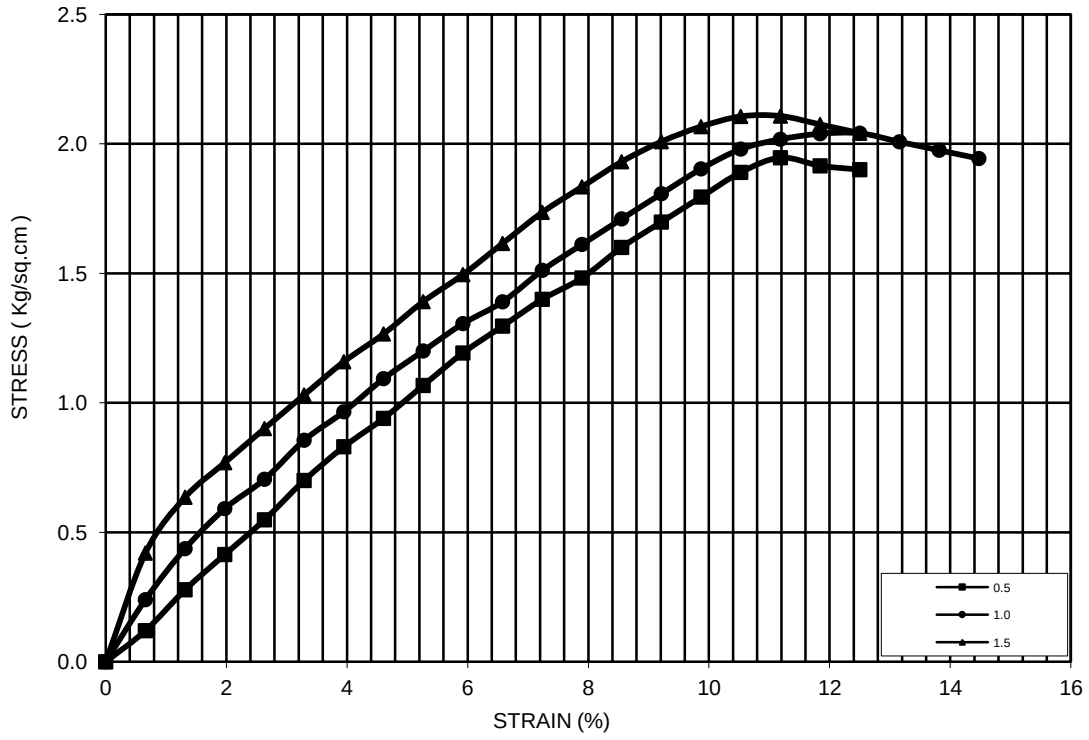
BORE HOLE NO: BH-A1
CHAINAGE:35+273
SAMPLE NO.: UDS-1
DEPTH: 2.50 m
COHESION(C)= 0.09 kg/sq.cm
ANGLE OF FRICTION(Phi): 26 deg
TYPE OF THE TEST: DST



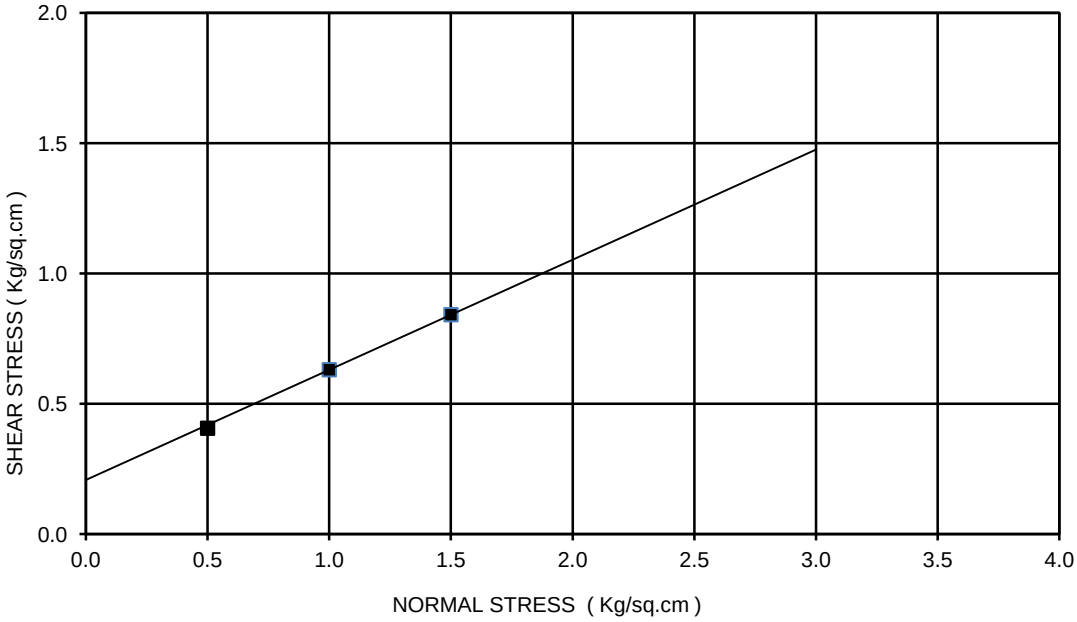


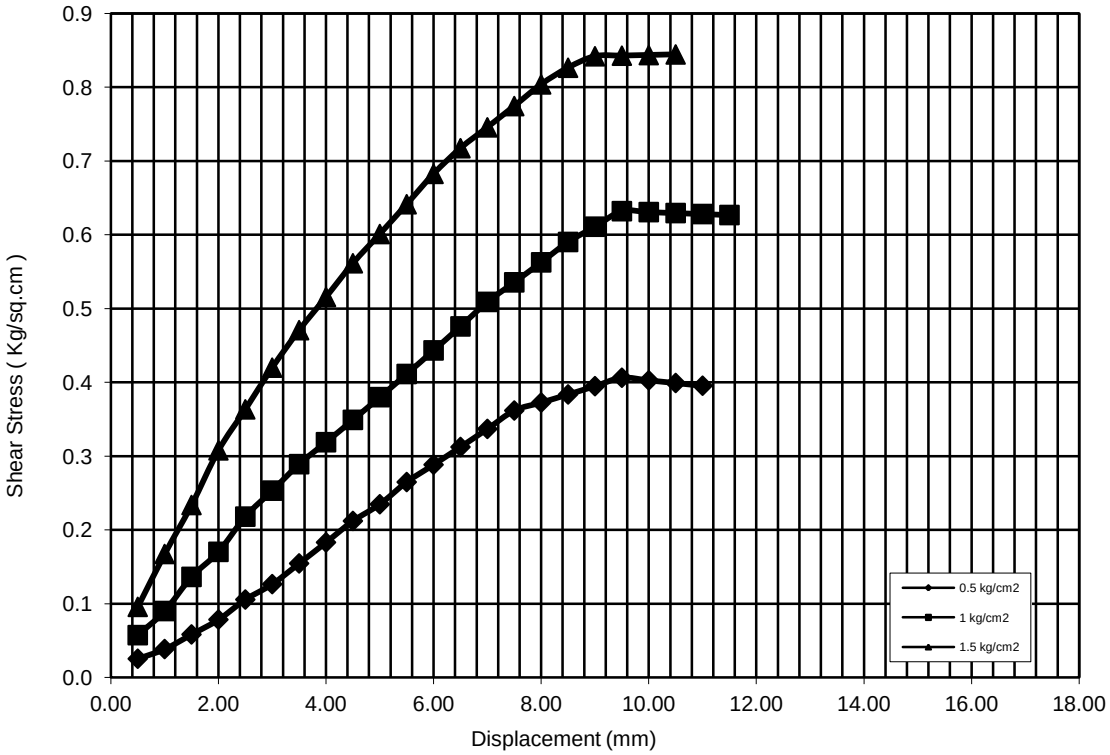
BORE HOLE NO: BH-A1
CHAINAGE : 35+273
SAMPLE NO.: UDS-2
DEPTH: 8.50 m
COHESION(C)= 0.85 kg/sq.cm
ANGLE OF FRICTION(Phi): 5 deg
TYPE OF THE TEST: UUT



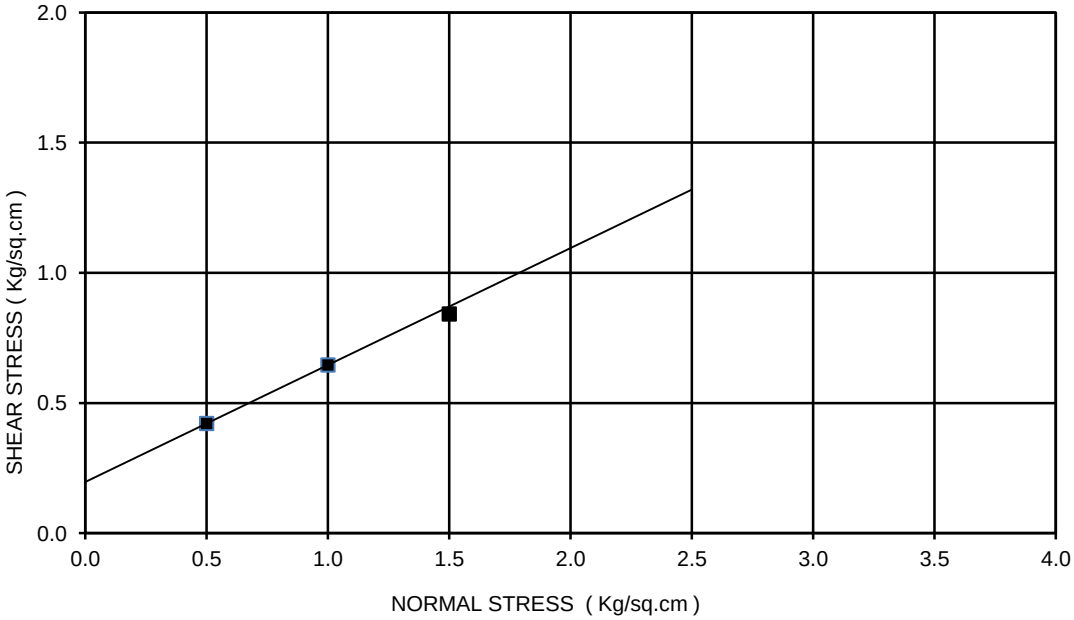


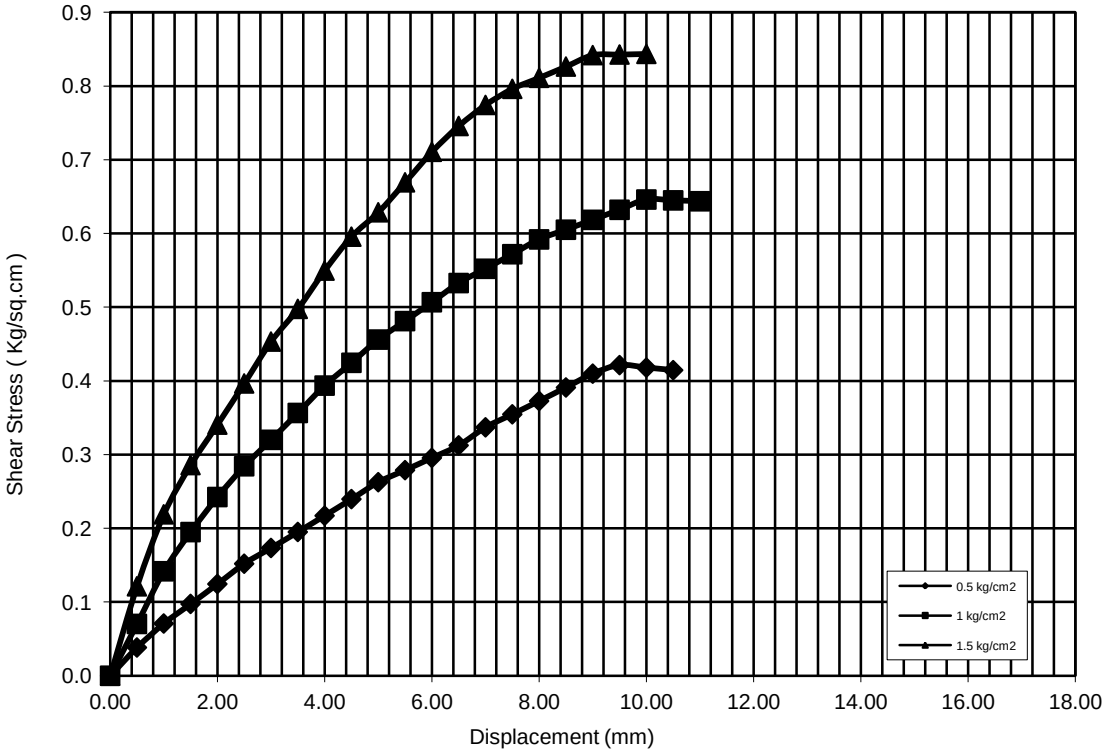
BORE HOLE NO: BH-A2
CHAINAGE: 35+273
SAMPLE NO.: UDS-1
DEPTH: 1.00 m
COHESION(C)= 0.21 kg/sq.cm
ANGLE OF FRICTION(Phi): 23 deg
TYPE OF THE TEST: DST



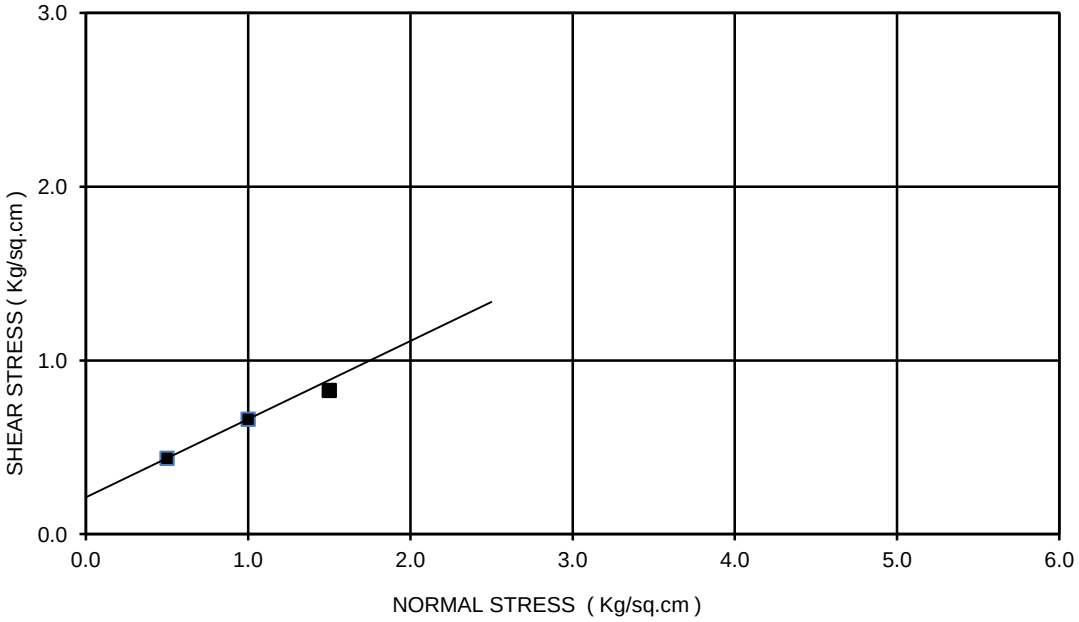


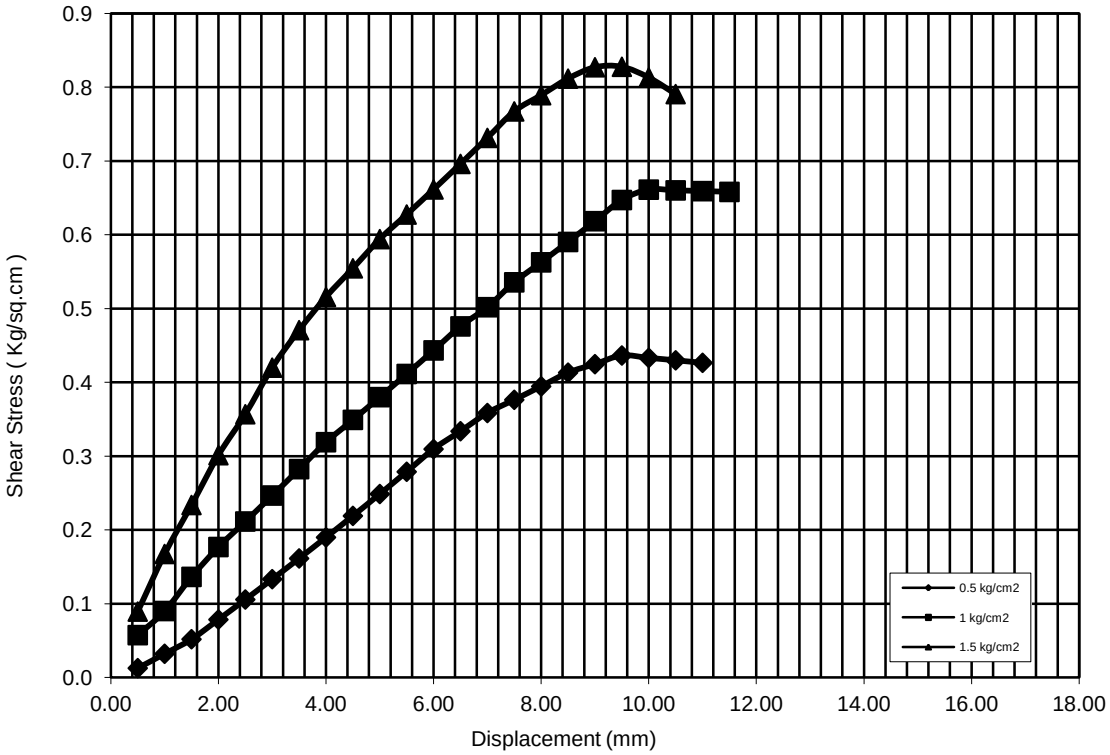
BORE HOLE NO: BH-A2
CHAINAGE: 35+273
SAMPLE NO.: UDS-2
DEPTH: 4.00 m
COHESION(C)= 0.20 kg/sq.cm
ANGLE OF FRICTION(Phi): 24 deg
TYPE OF THE TEST: DST



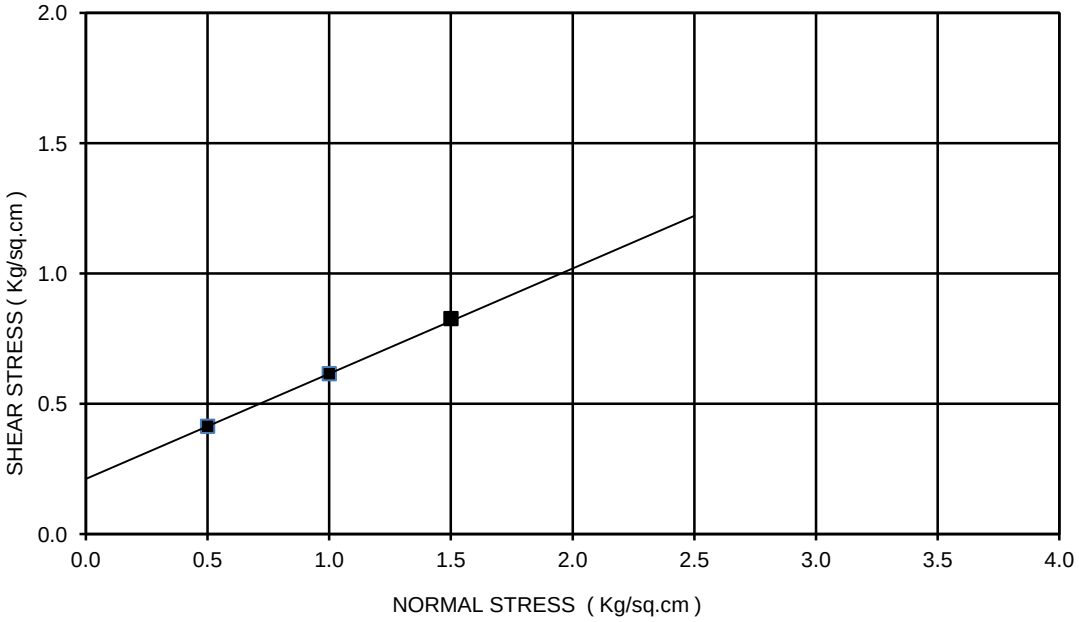


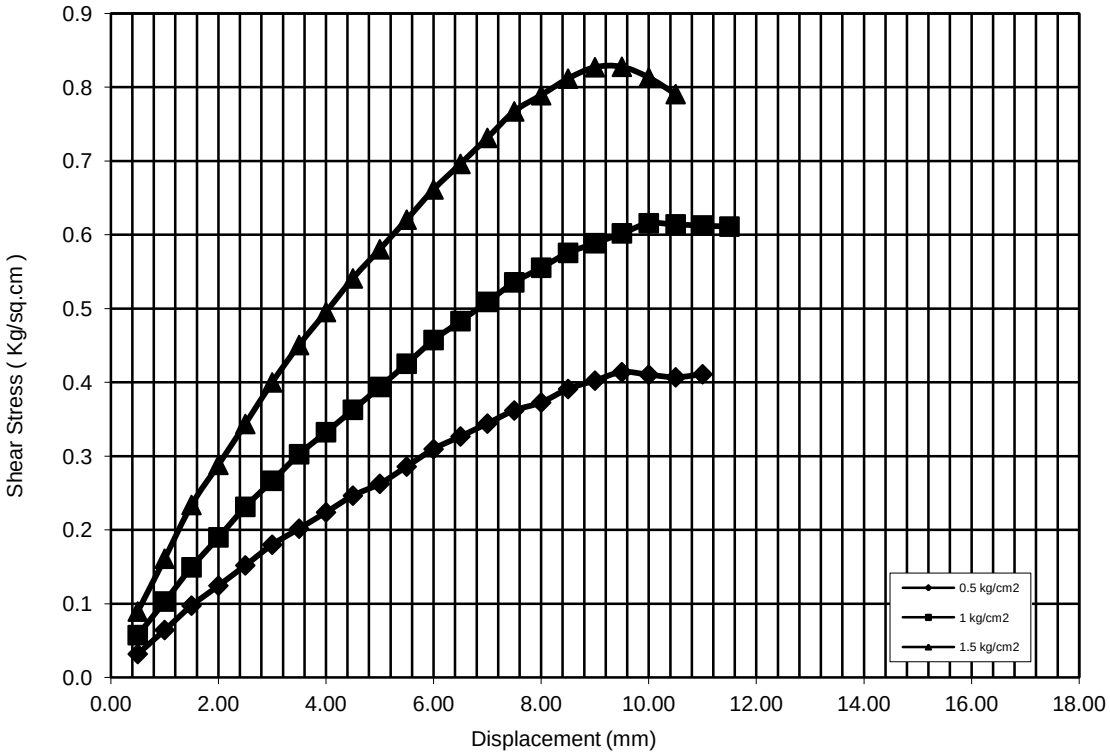
BORE HOLE NO: BH-CL
CHAINAGE: 36+367
SAMPLE NO.: UDS-1
DEPTH: 2.25 m
COHESION(C)= 0.21 kg/sq.cm
ANGLE OF FRICTION(Phi): 24 deg
TYPE OF THE TEST: DST



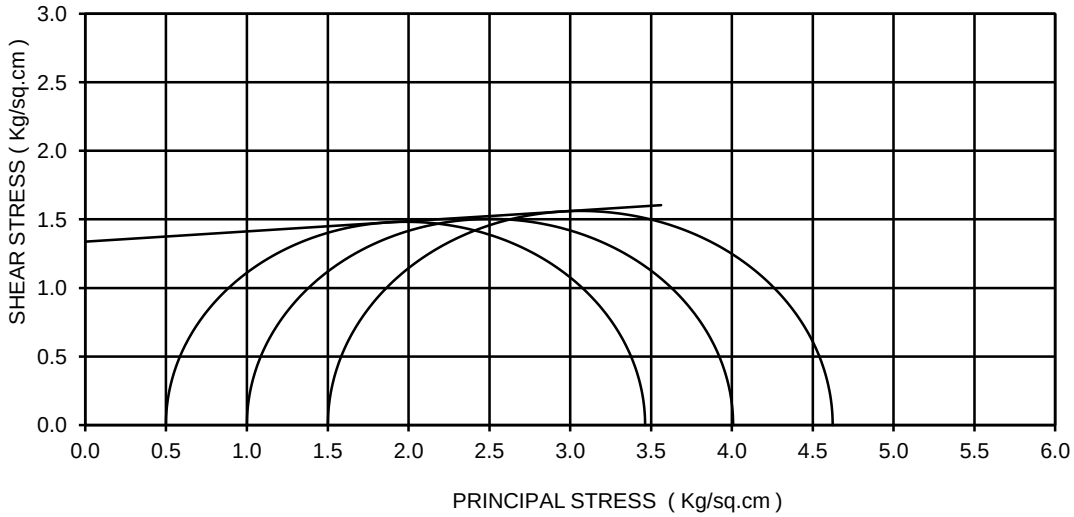


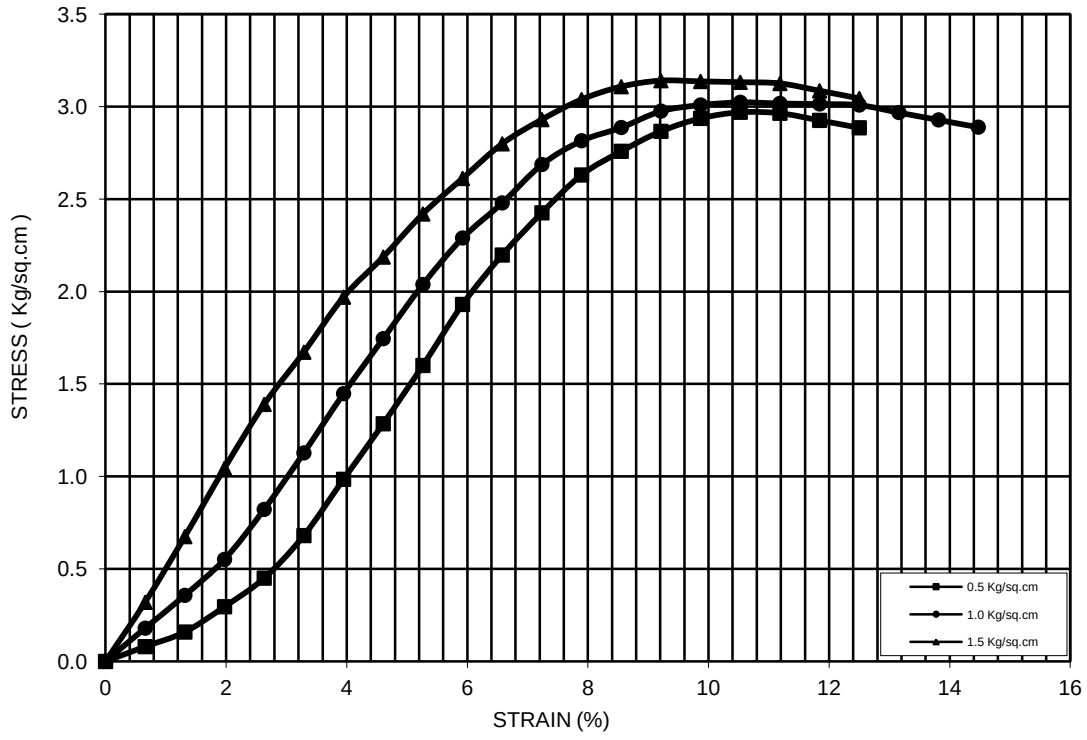
BORE HOLE NO: BH-A-1
CHAINAGE: 36+816
SAMPLE NO.: UDS-1
DEPTH: 2.50 m
COHESION(C)= 0.21 kg/sq.cm
ANGLE OF FRICTION(Phi): 22 deg
TYPE OF THE TEST: DST



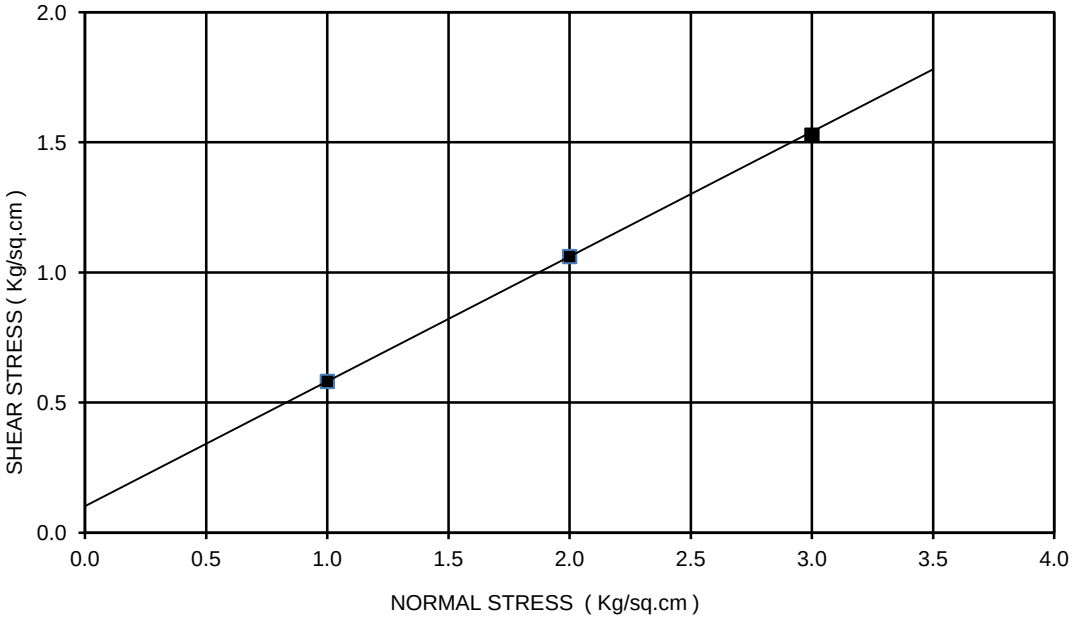


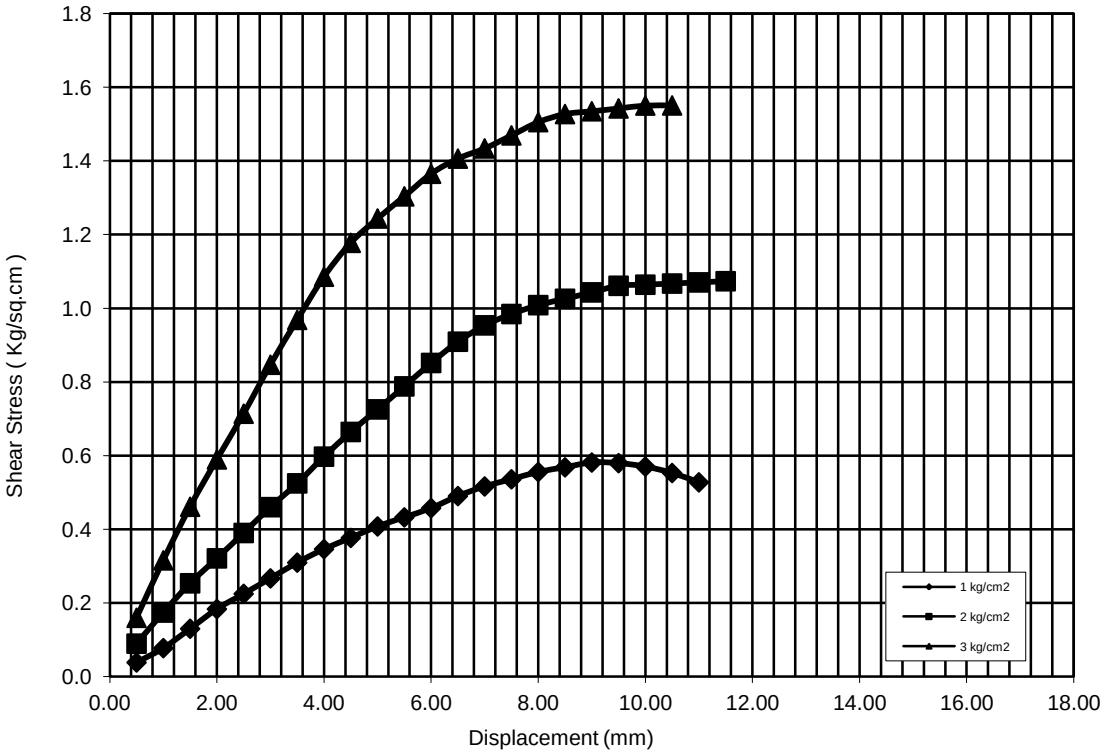
BORE HOLE NO: BH-A1
CHAINAGE:36+816
SAMPLE NO.: UDS-2
DEPTH: 5.50 m
COHESION(C)= 1.34 kg/sq.cm
ANGLE OF FRICTION(Phi): 4 deg
TYPE OF THE TEST: UUT



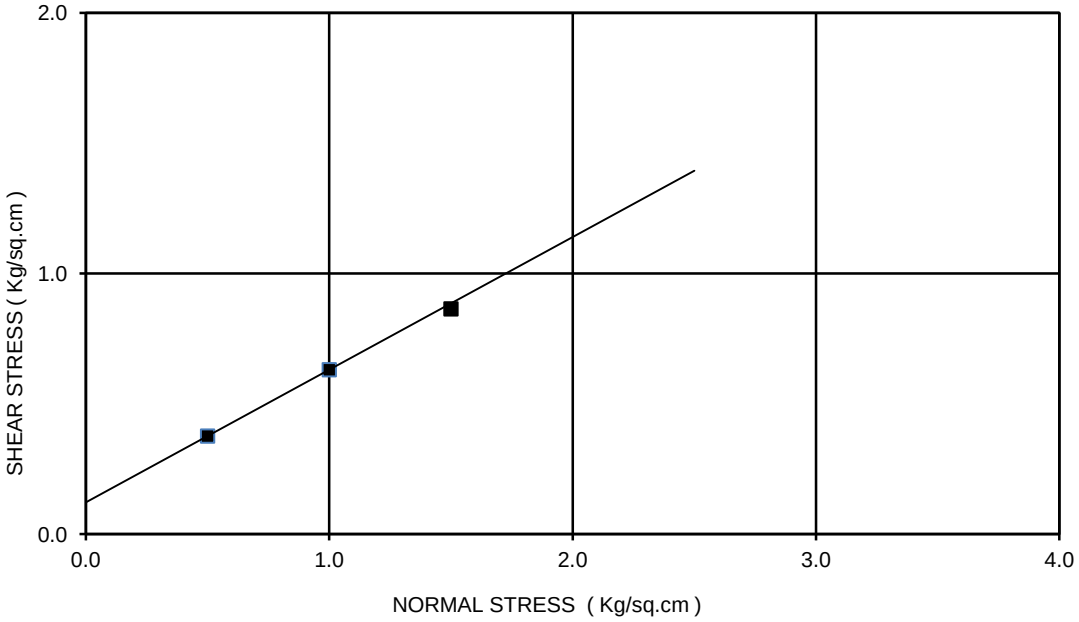


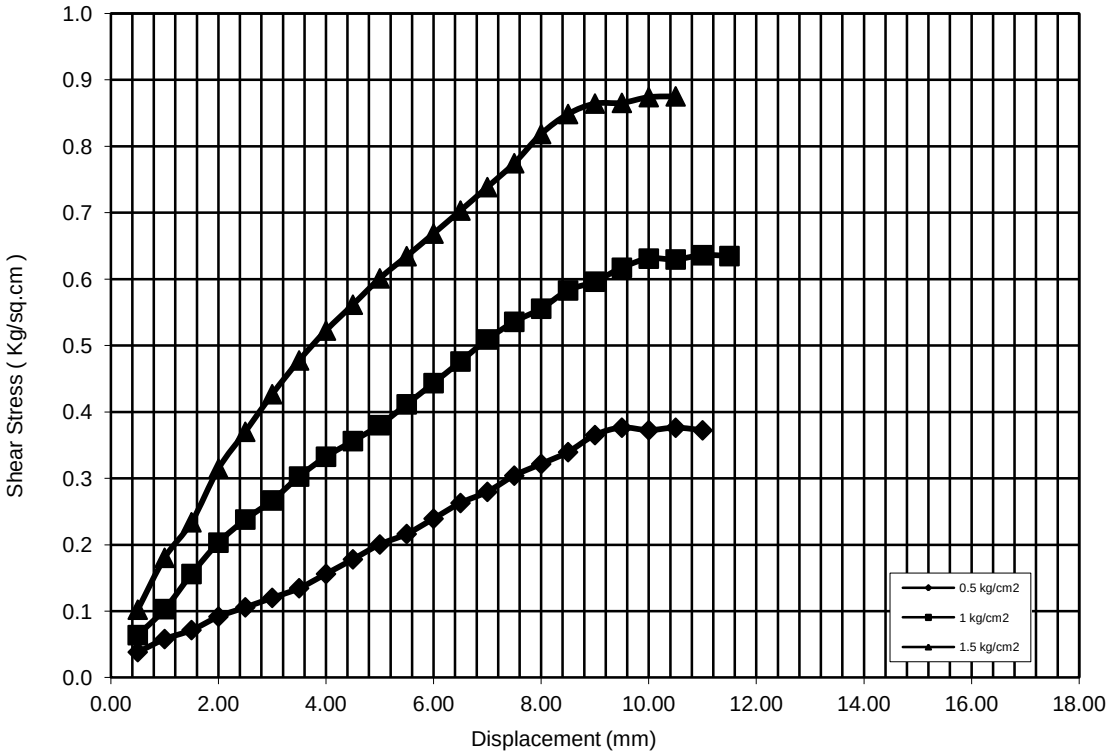
BORE HOLE NO: BH-A-2
CHAINAGE:36+816
SAMPLE NO.: UDS-1
DEPTH: 1.00 m
COHESION(C)= 0.10 kg/sq.cm
ANGLE OF FRICTION(Phi): 26 deg
TYPE OF THE TEST: DST



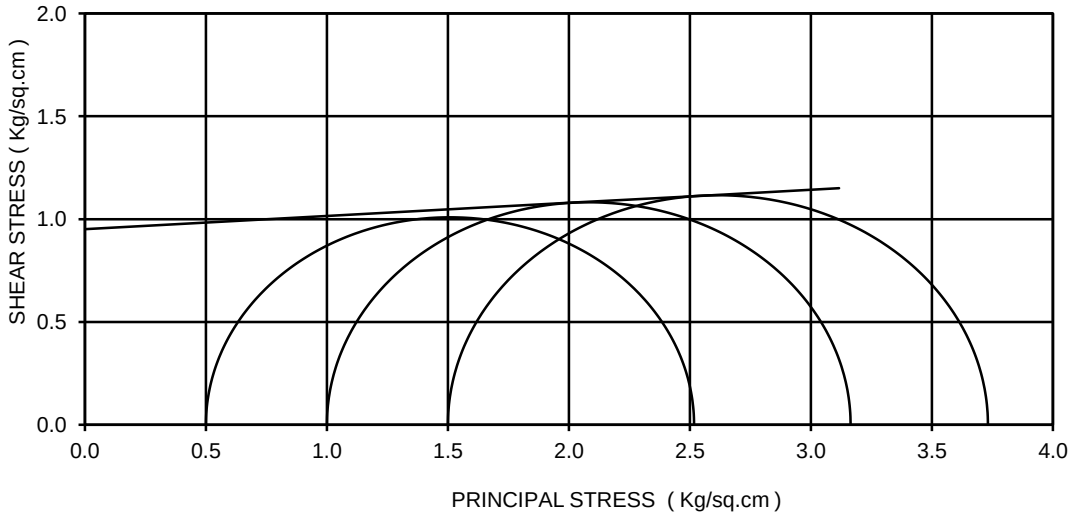


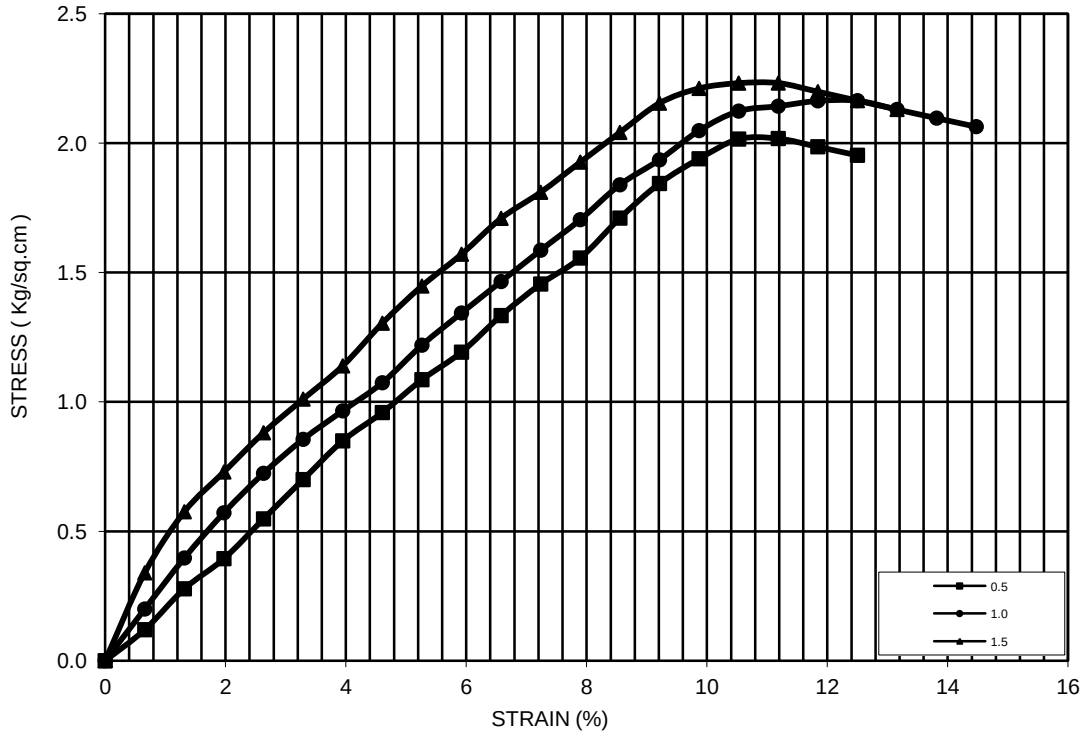
BORE HOLE NO: BH-A-2
CHAINAGE:36+816
SAMPLE NO.: UDS-2
DEPTH: 4.00 m
COHESION(C)= 0.12 kg/sq.cm
ANGLE OF FRICTION(Phi): 27 deg
TYPE OF THE TEST: DST



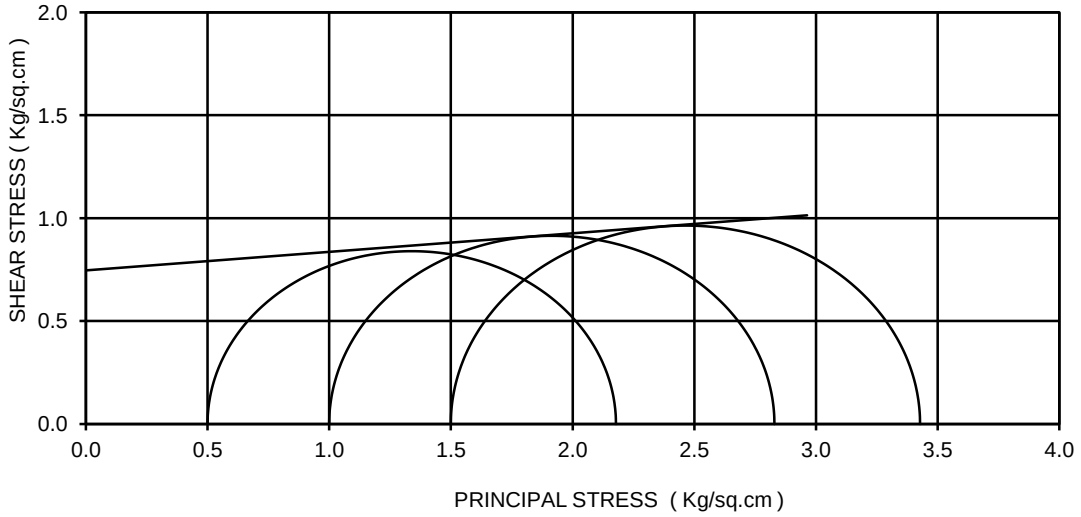


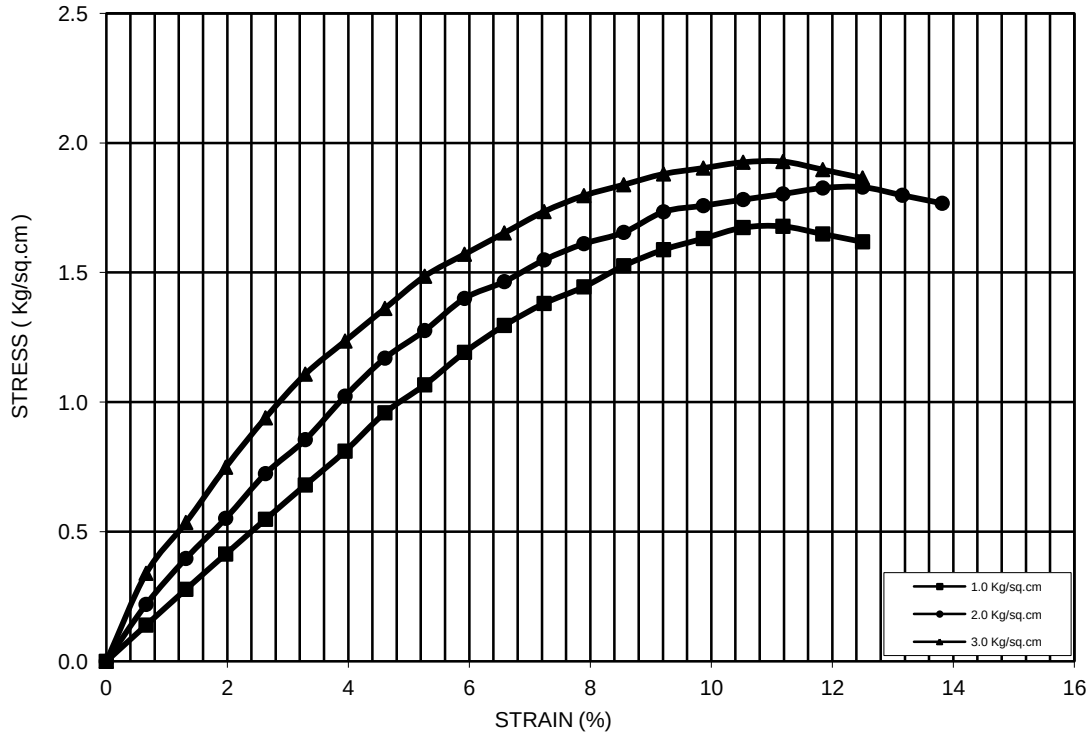
BORE HOLE NO: BH-CL
CHAINAGE: 38+701
SAMPLE NO.: UDS-1
DEPTH: 5.25 m
COHESION(C)= 0.95 kg/sq.cm
ANGLE OF FRICTION(Phi): 4 deg
TYPE OF THE TEST: UUT



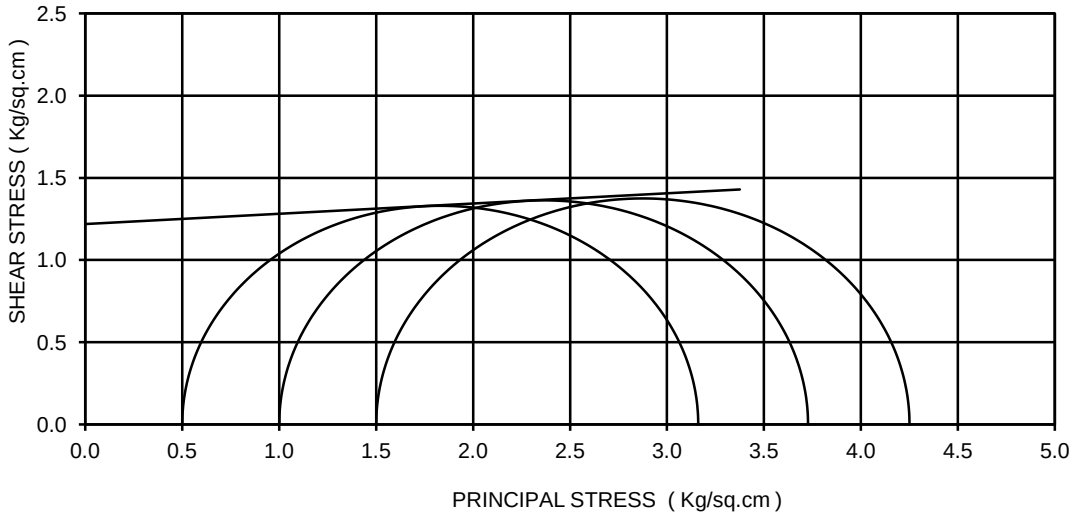


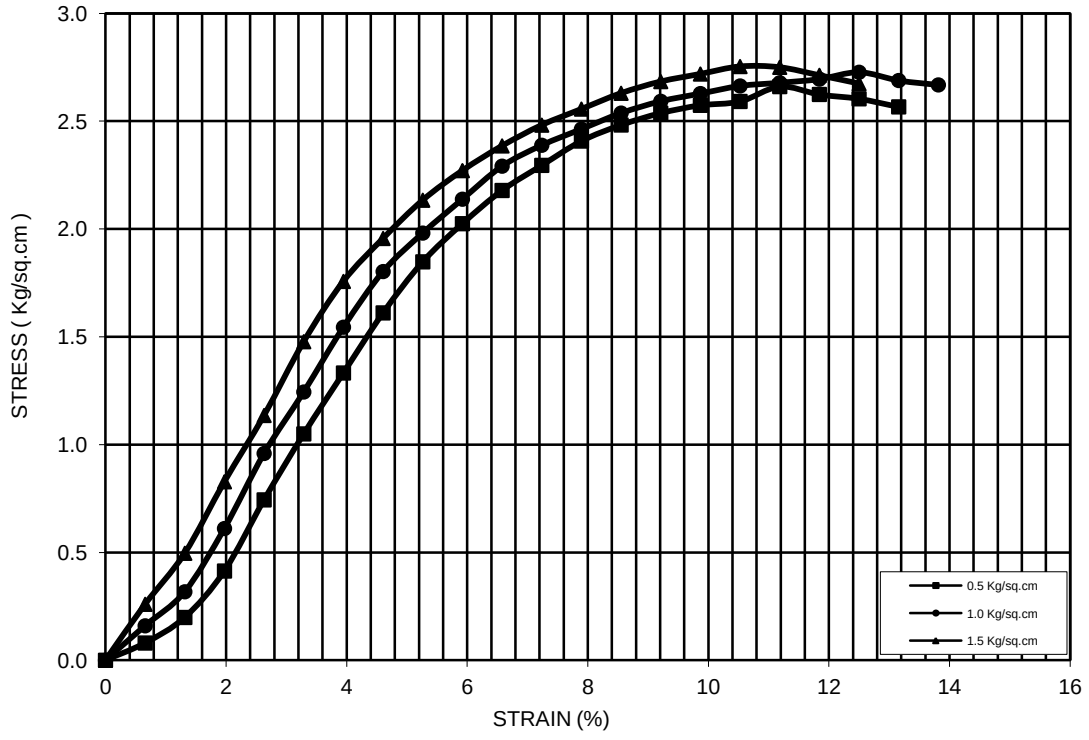
BORE HOLE NO: BH-CL
CHAINAGE:38+778
SAMPLE NO.: UDS-1
DEPTH: 5.25 m
COHESION(C)= 0.75 kg/sq.cm
ANGLE OF FRICTION(Phi): 5 deg
TYPE OF THE TEST: UUT



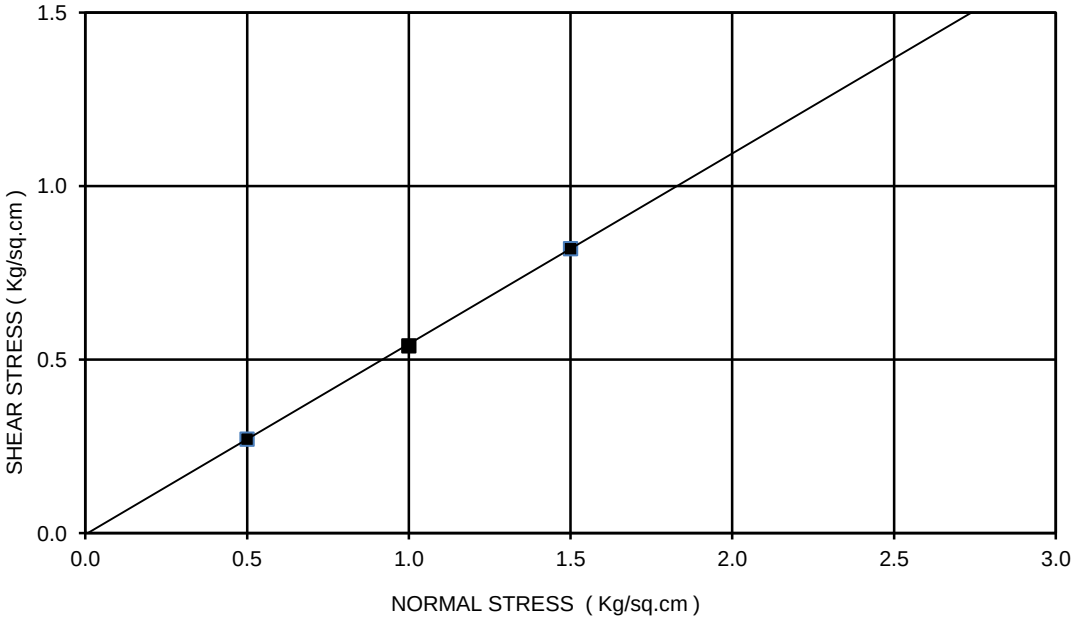


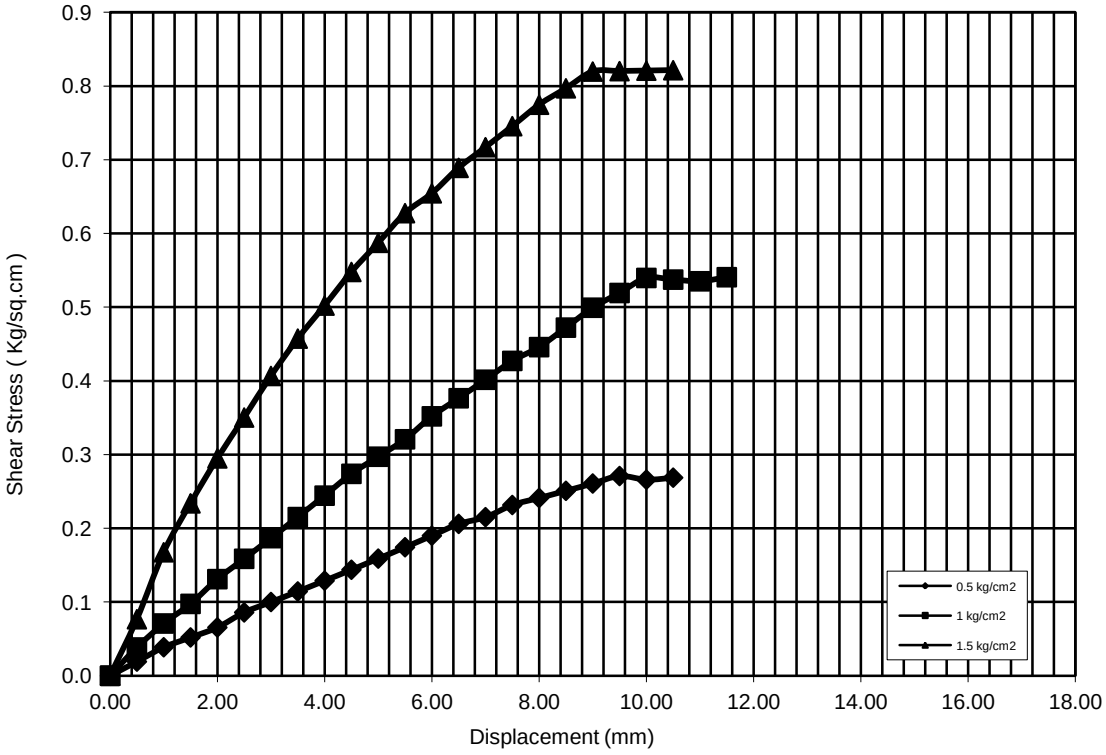
BORE HOLE NO: BH-CL
CHAINAGE: 39+060
SAMPLE NO.: UDS-1
DEPTH: 5.25 m
COHESION(C)= 1.22 kg/sq.cm
ANGLE OF FRICTION(Phi): 4 deg
TYPE OF THE TEST: UUT



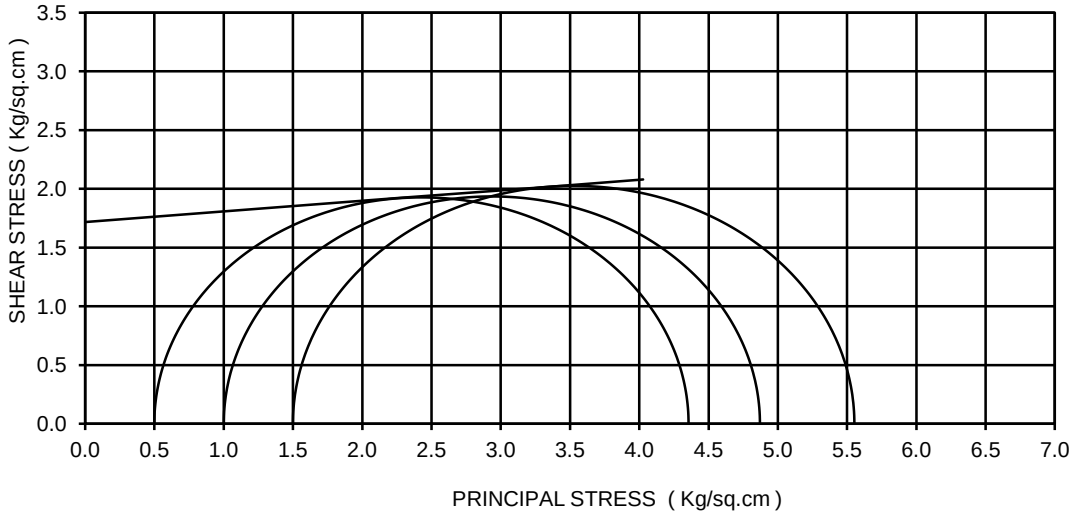


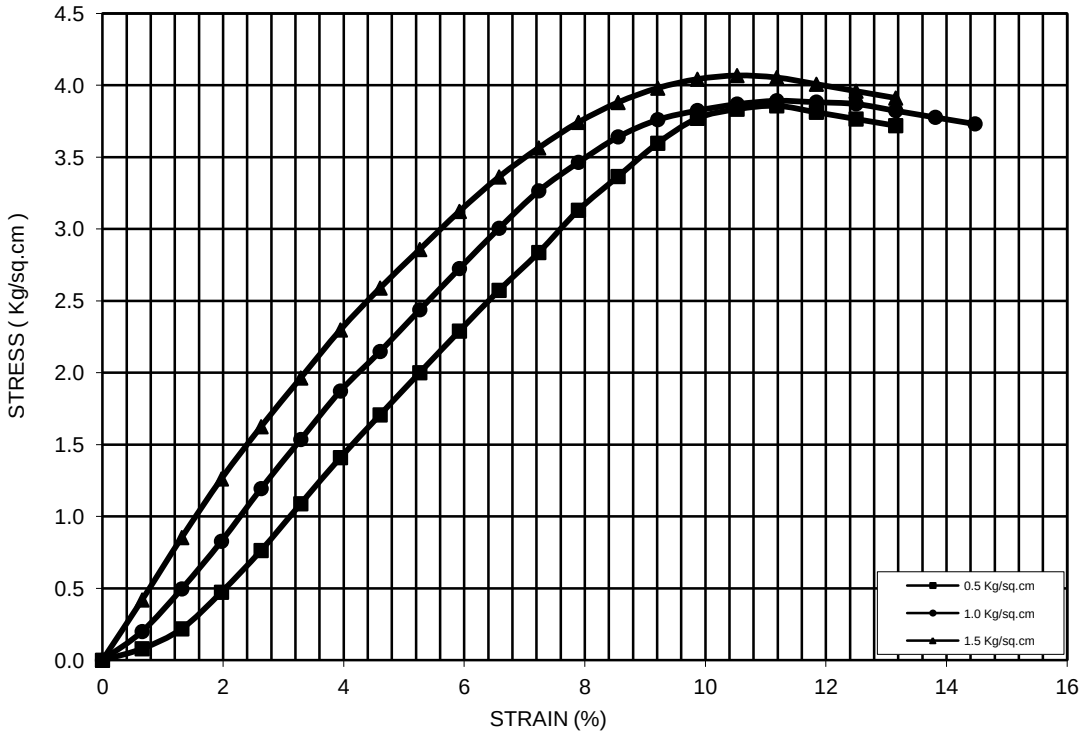
BORE HOLE NO: BH-CL
CHAINAGE:39+400
SAMPLE NO.: UDS-1
DEPTH: 2.25 m
COHESION(C)= 0.00 kg/sq.cm
ANGLE OF FRICTION(Phi): 29 deg
TYPE OF THE TEST: DST



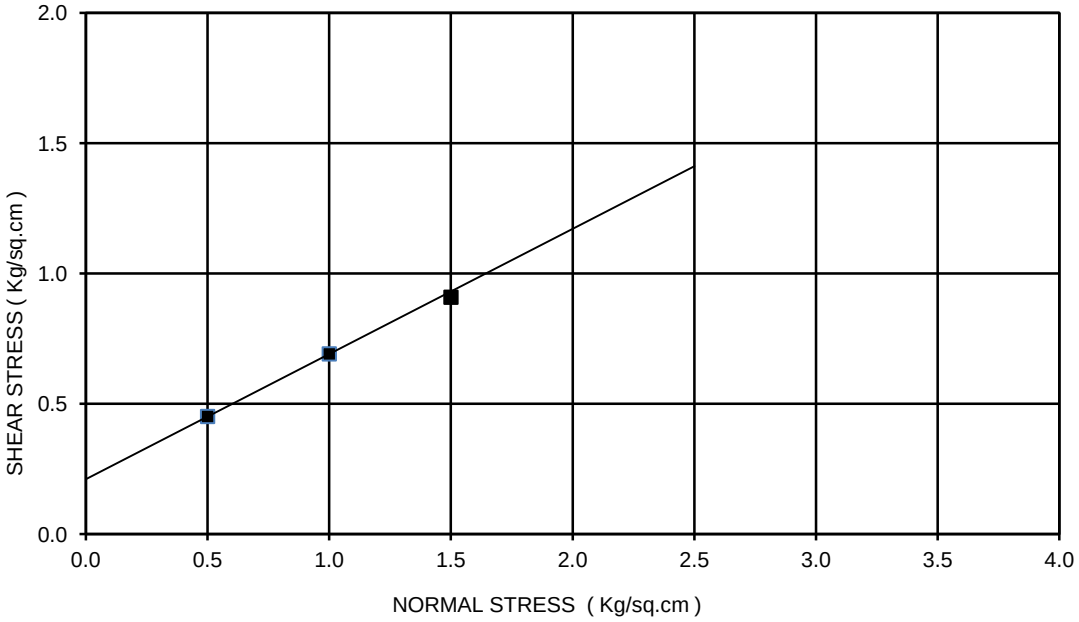


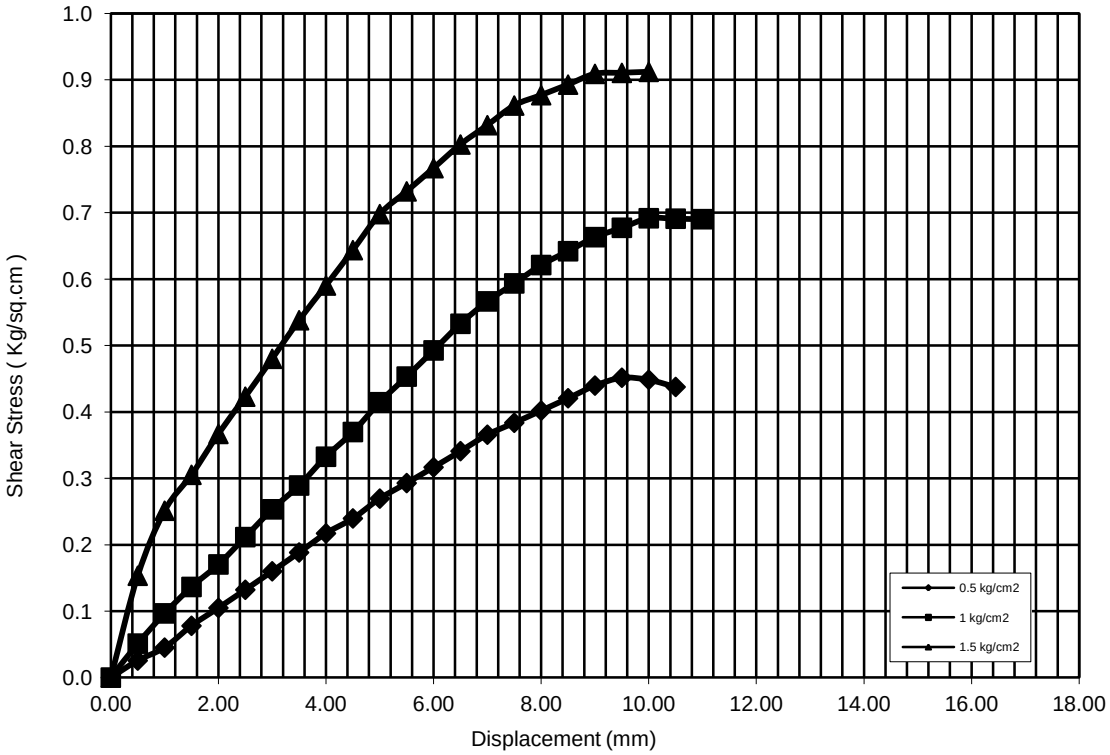
BORE HOLE NO: BH-CL
CHAINAGE:40+325
SAMPLE NO.: UDS-1
DEPTH: 5.25 m
COHESION(C)= 1.75 kg/sq.cm
ANGLE OF FRICTION(Phi): 5 deg
TYPE OF THE TEST: UUT



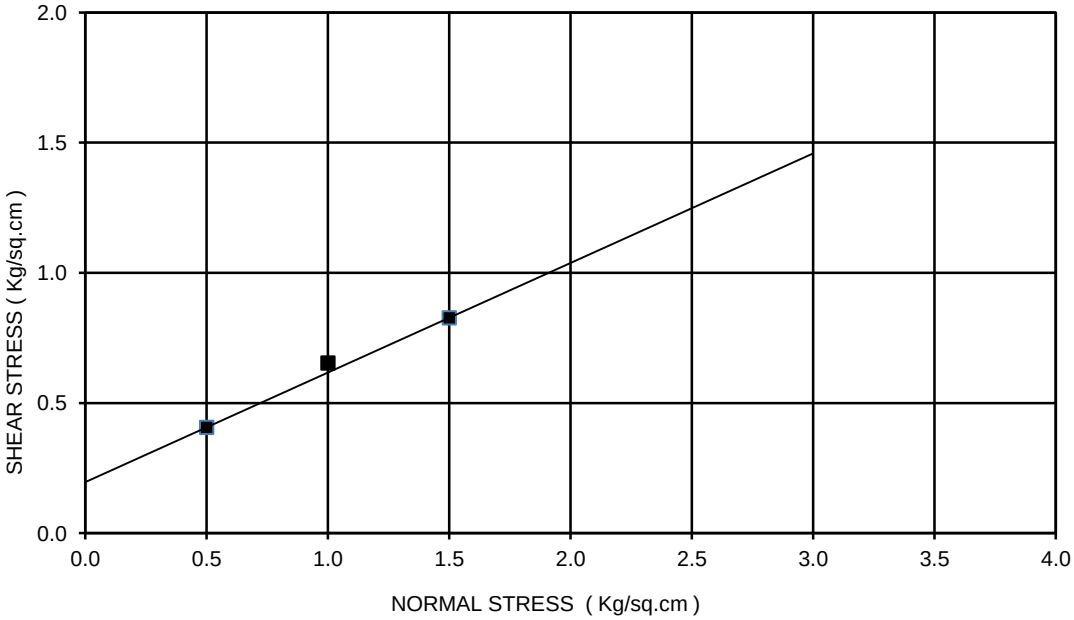


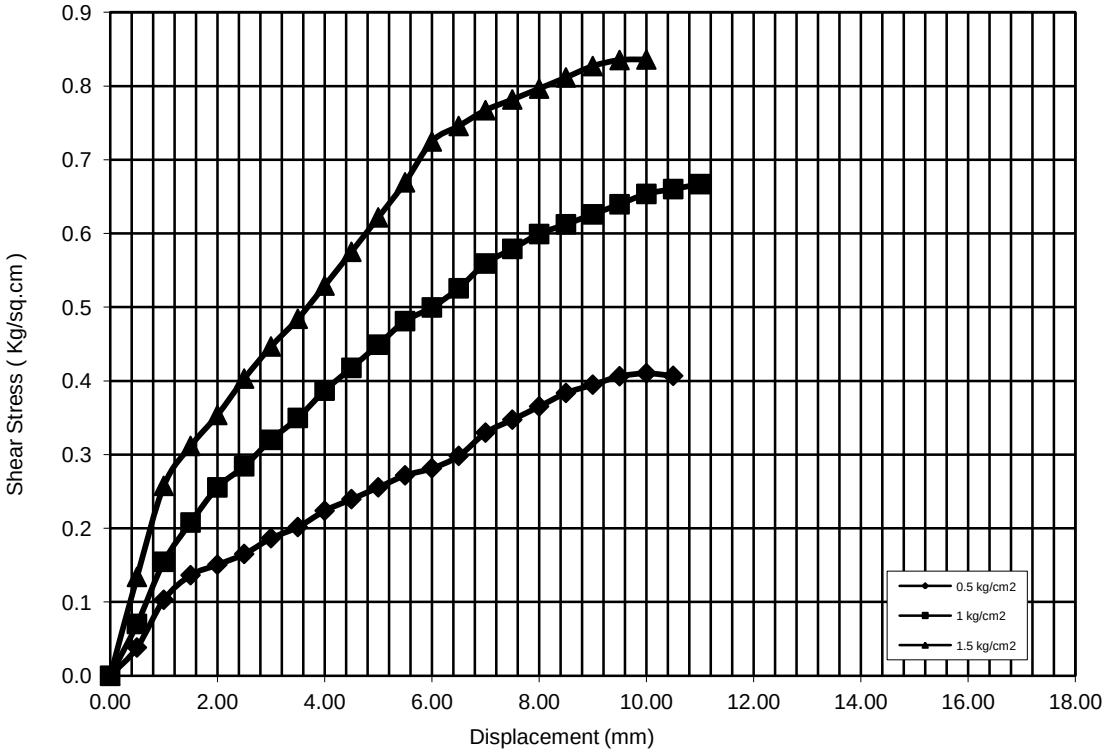
BORE HOLE NO: BH-CL
CHAINAGE: 40+573
SAMPLE NO.: UDS-2
DEPTH: 5.25 m
COHESION(C)= 0.21 kg/sq.cm
ANGLE OF FRICTION(Phi): 26 deg
TYPE OF THE TEST: DST



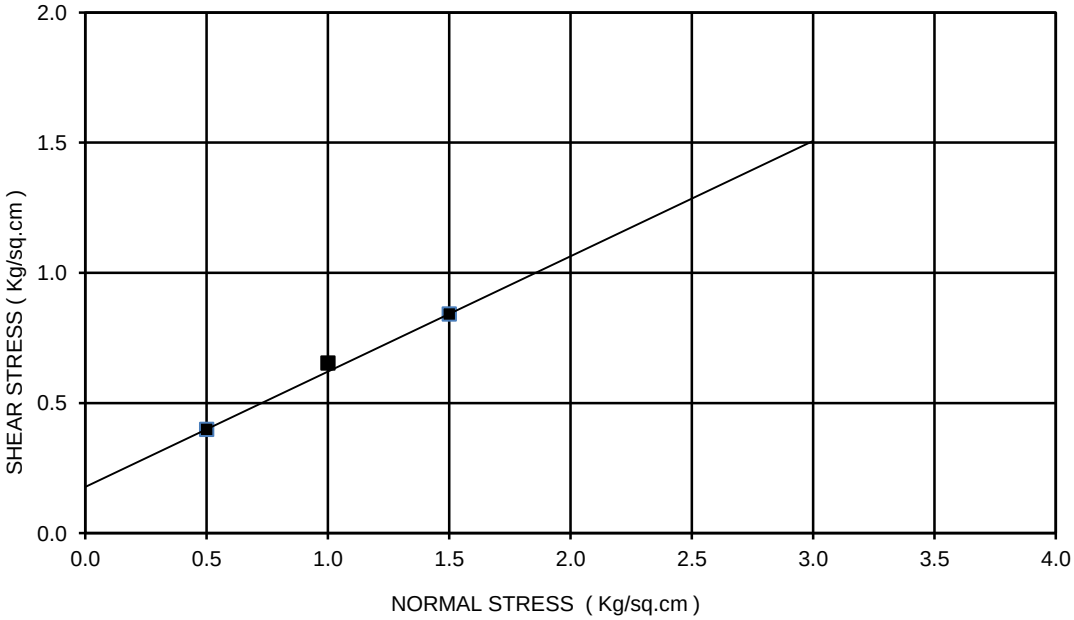


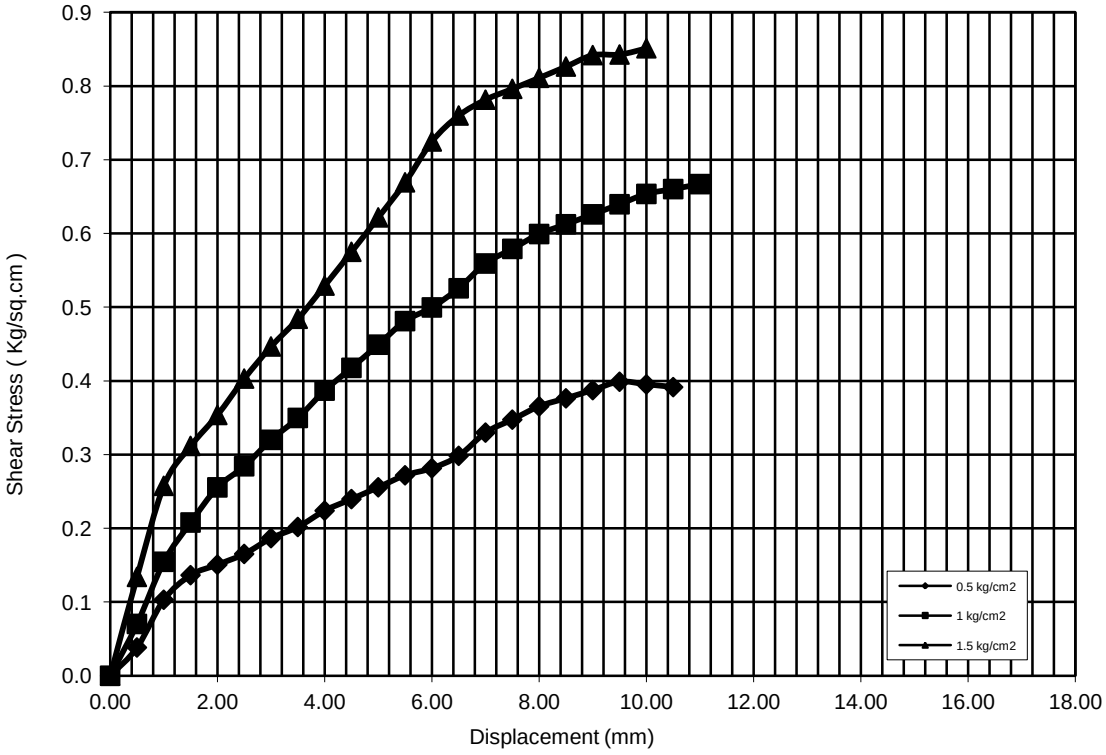
BORE HOLE NO: BH-A1
CHAINAGE: 41+056
SAMPLE NO.: UDS-4
DEPTH: 13.00 m
COHESION(C)= 0.08 kg/sq.cm
ANGLE OF FRICTION(Phi): 26 deg
TYPE OF THE TEST: DST



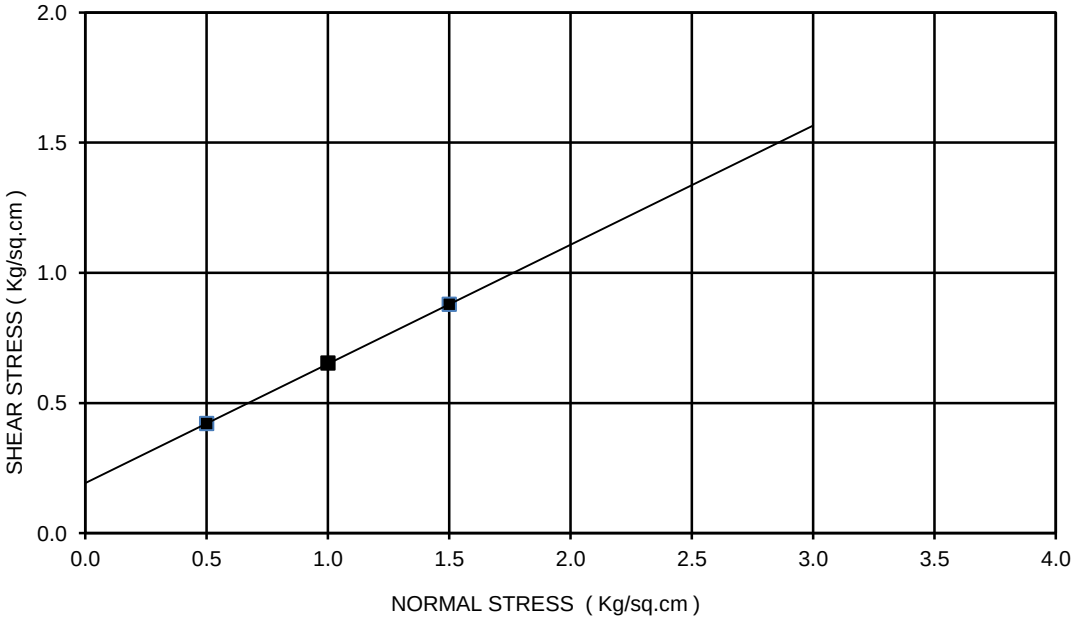


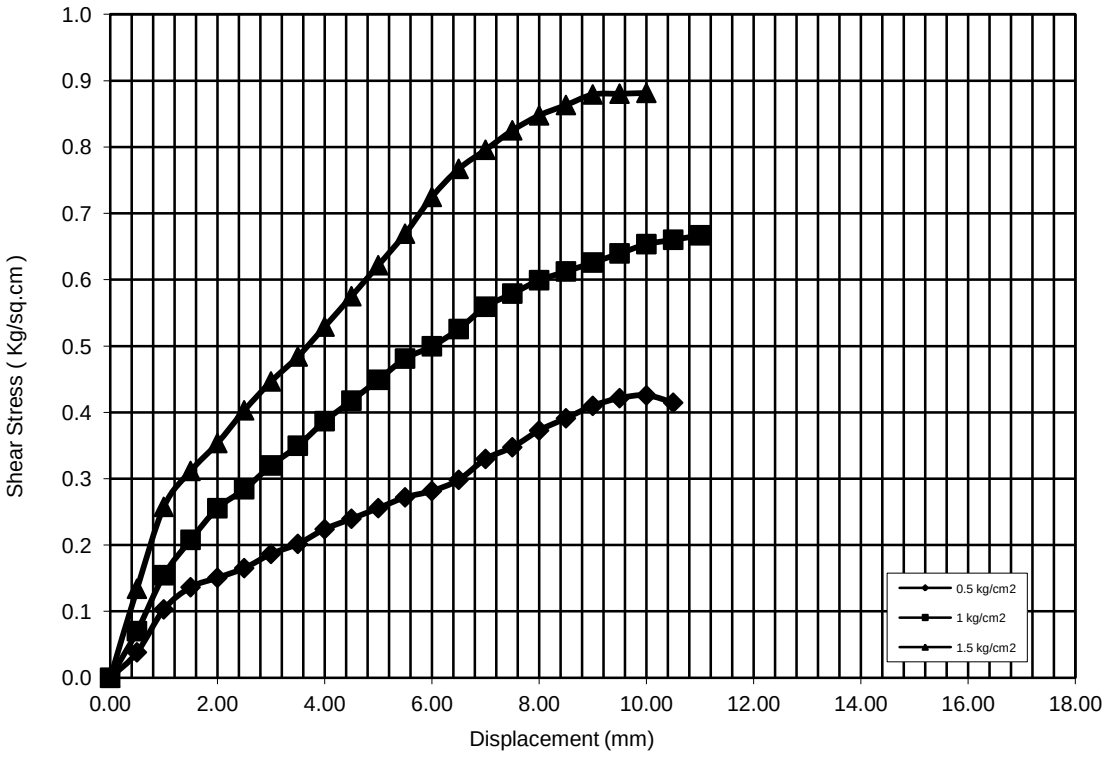
BORE HOLE NO: BH-A1
CHAINAGE: 41+056
SAMPLE NO.: UDS-4
DEPTH: 13.00 m
COHESION(C)= 0.08 kg/sq.cm
ANGLE OF FRICTION(Phi): 26 deg
TYPE OF THE TEST: DST



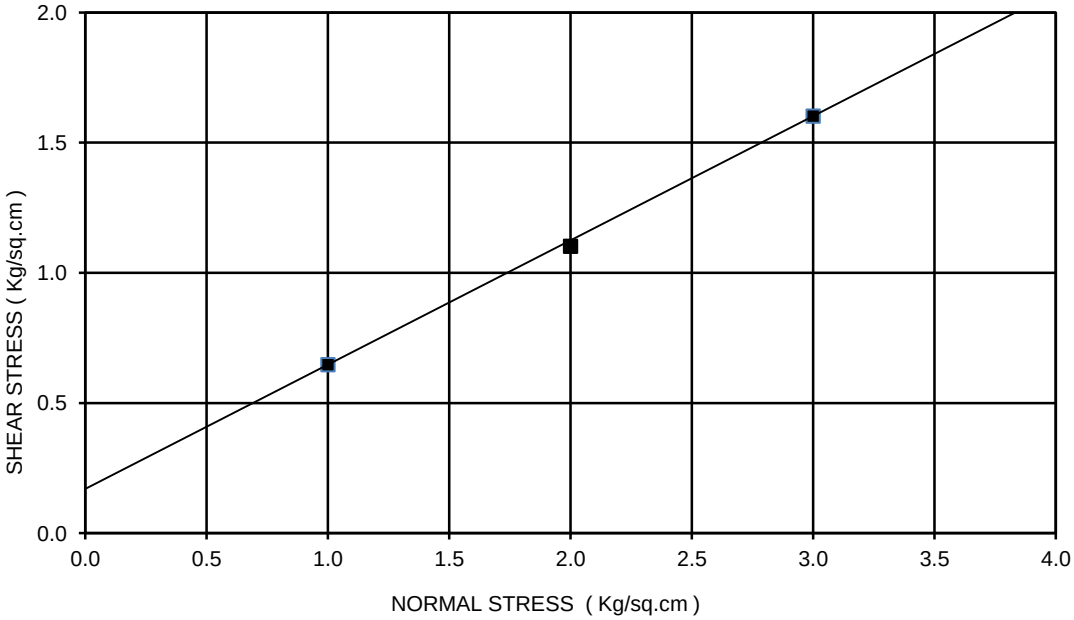


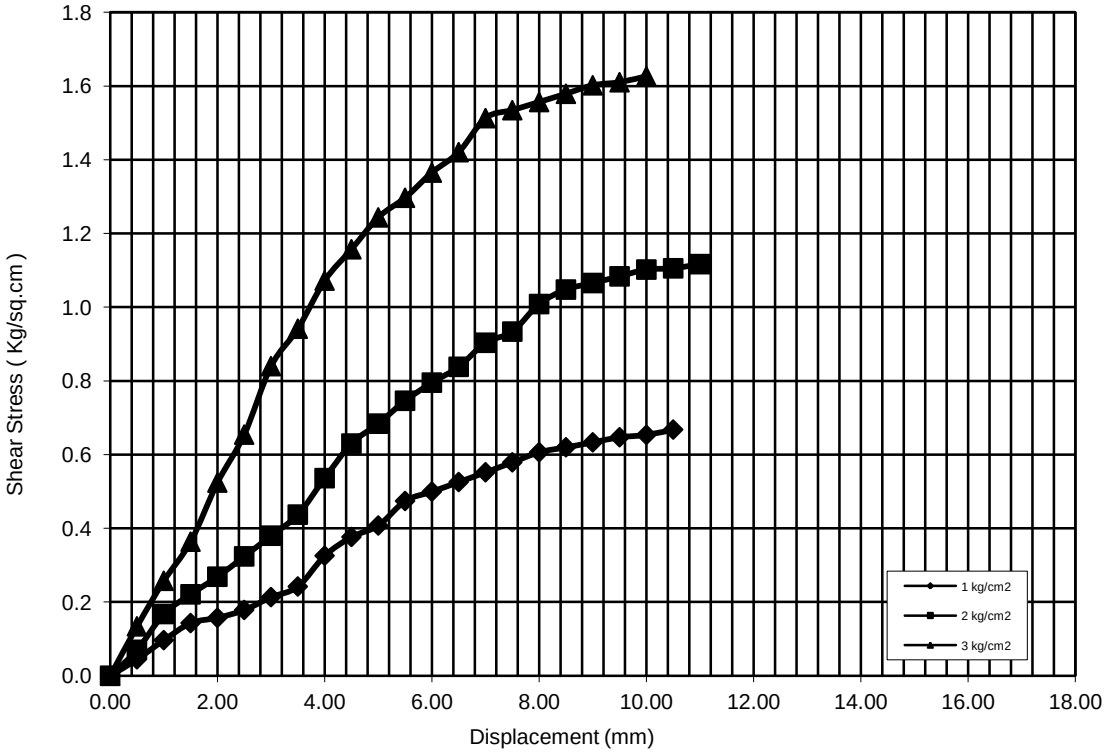
BORE HOLE NO: BH-A1
CHAINAGE: 41+056
SAMPLE NO.: UDS-4
DEPTH: 13.00 m
COHESION(C)= 0.08 kg/sq.cm
ANGLE OF FRICTION(Phi): 26 deg
TYPE OF THE TEST: DST



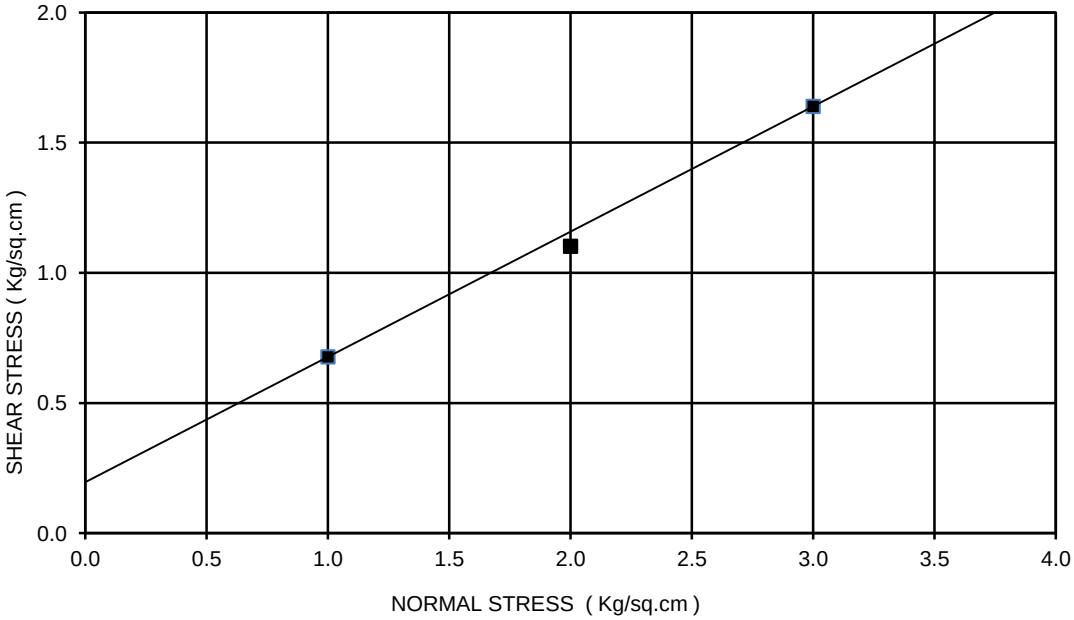


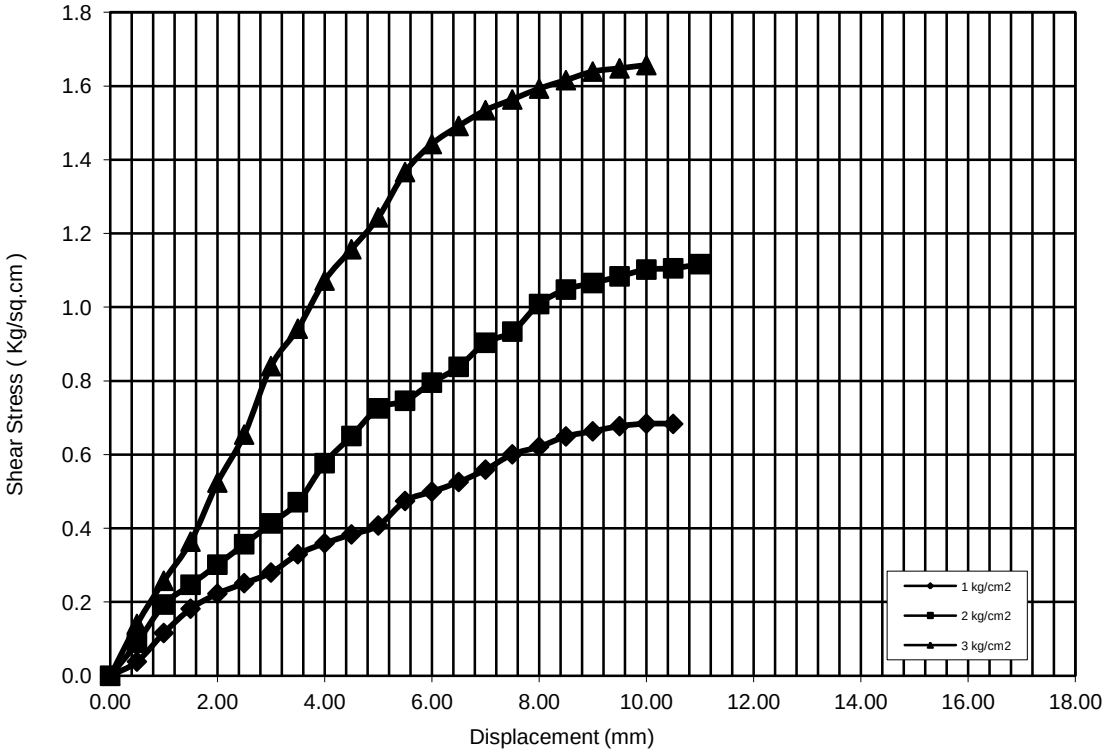
BORE HOLE NO: BH-A1
CHAINAGE: 41+056
SAMPLE NO.: UDS-4
DEPTH: 13.00 m
COHESION(C)= 0.08 kg/sq.cm
ANGLE OF FRICTION(Phi): 26 deg
TYPE OF THE TEST: DST



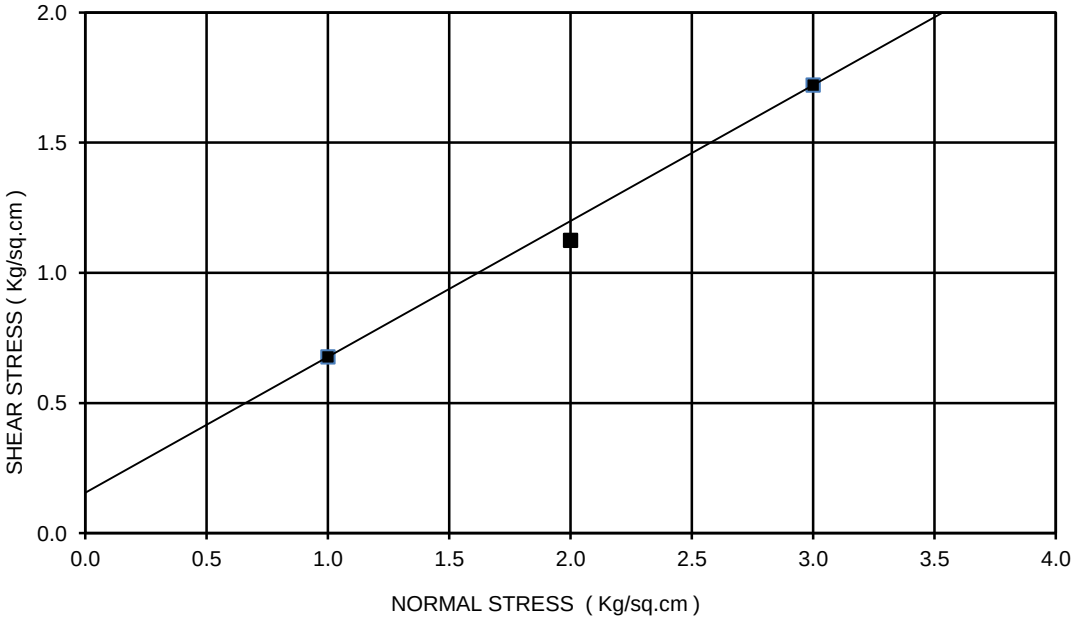


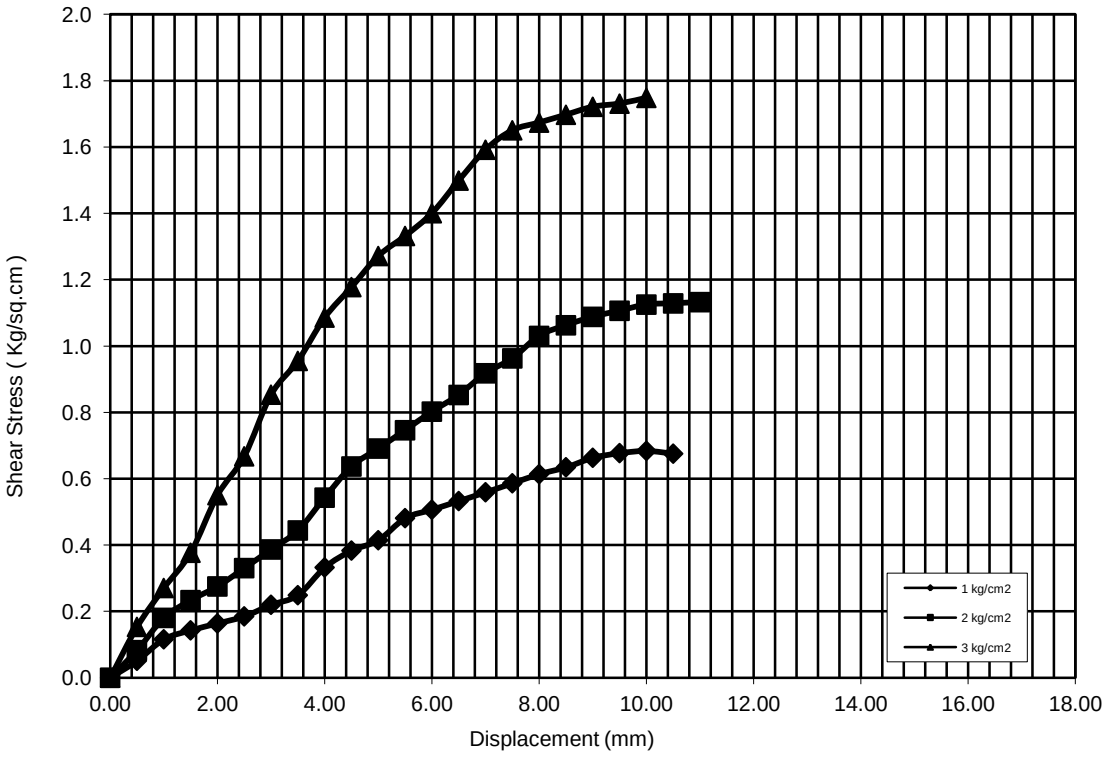
BORE HOLE NO: BH-A1
CHAINAGE: 41+056
SAMPLE NO.: UDS-4
DEPTH: 13.00 m
COHESION(C)= 0.08 kg/sq.cm
ANGLE OF FRICTION(Phi): 26 deg
TYPE OF THE TEST: DST



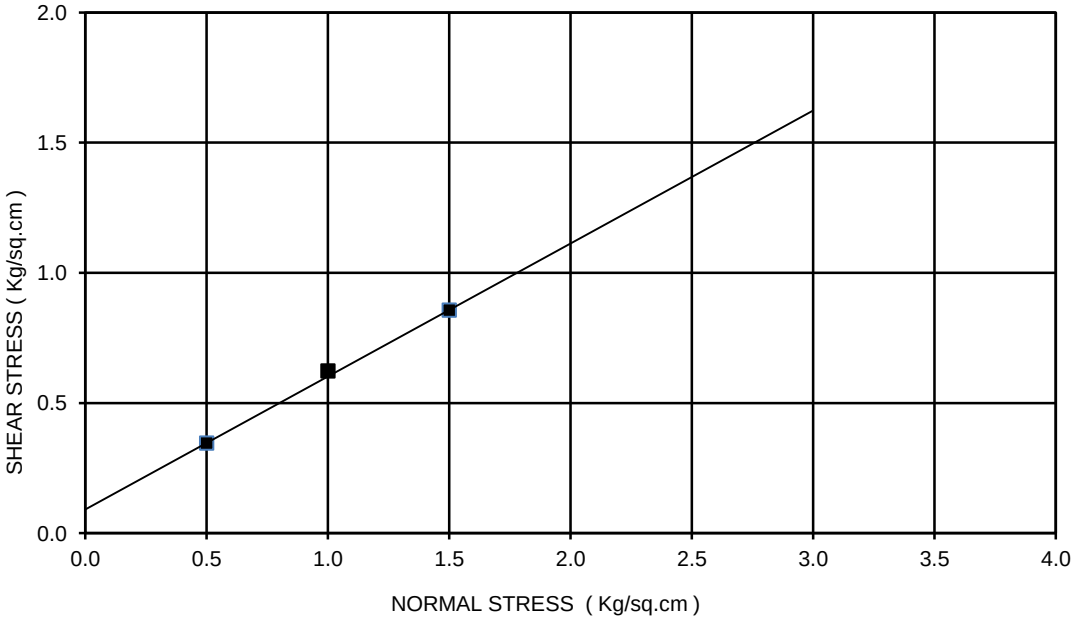


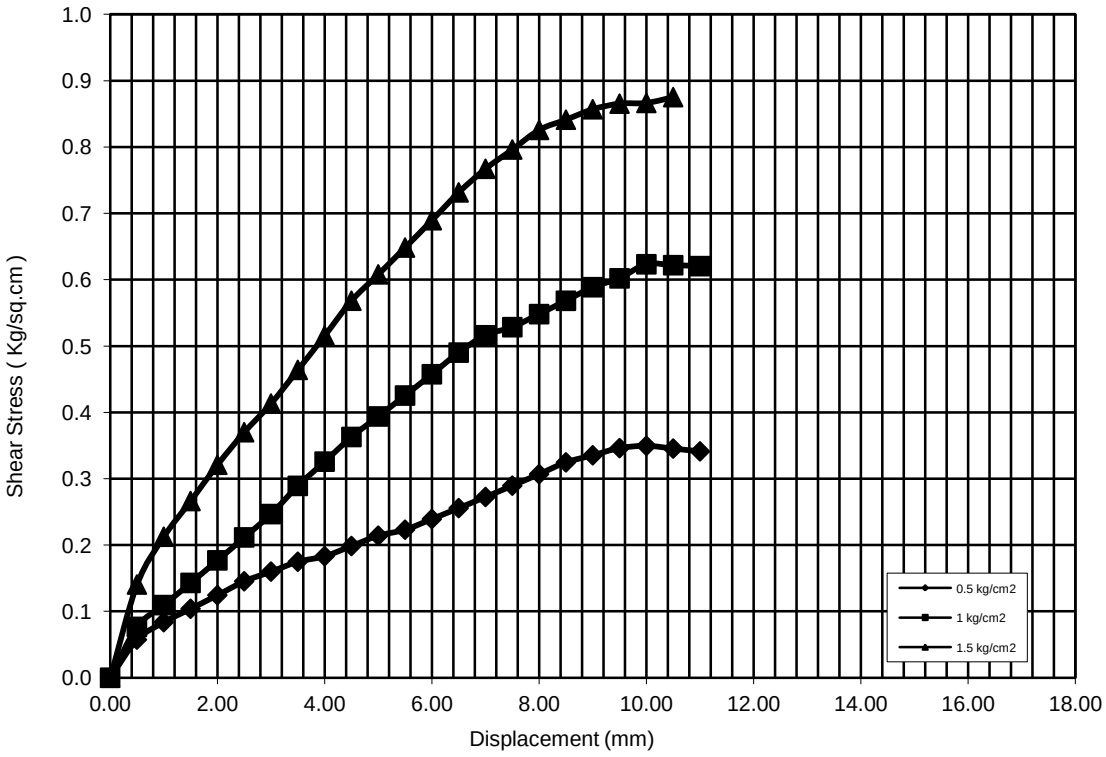
BORE HOLE NO: BH-A1
CHAINAGE: 41+056
SAMPLE NO.: UDS-4
DEPTH: 13.00 m
COHESION(C)= 0.08 kg/sq.cm
ANGLE OF FRICTION(Phi): 26 deg
TYPE OF THE TEST: DST



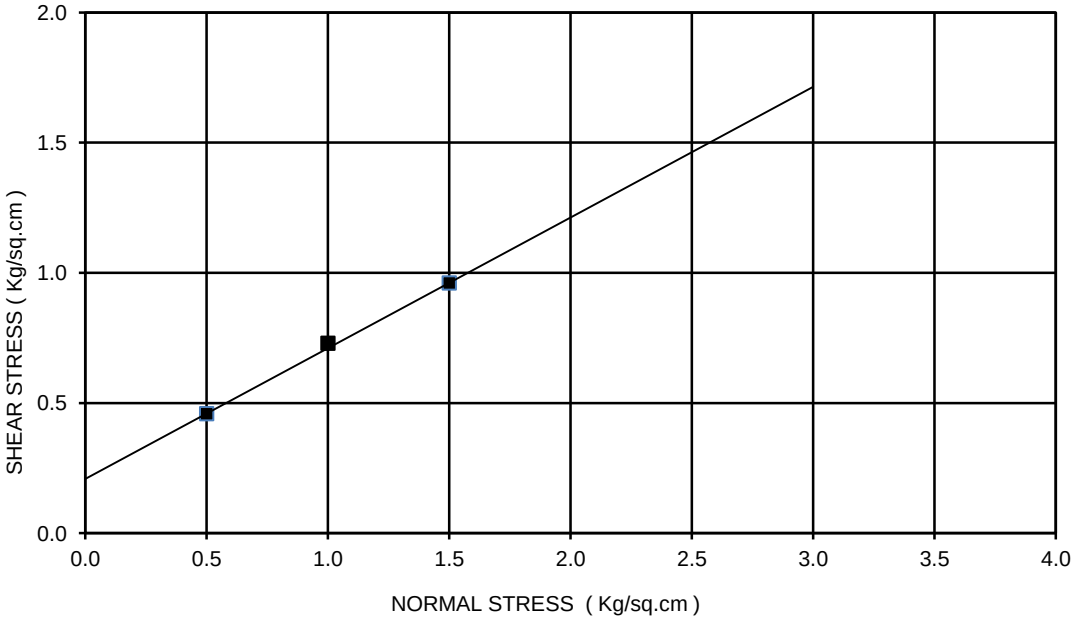


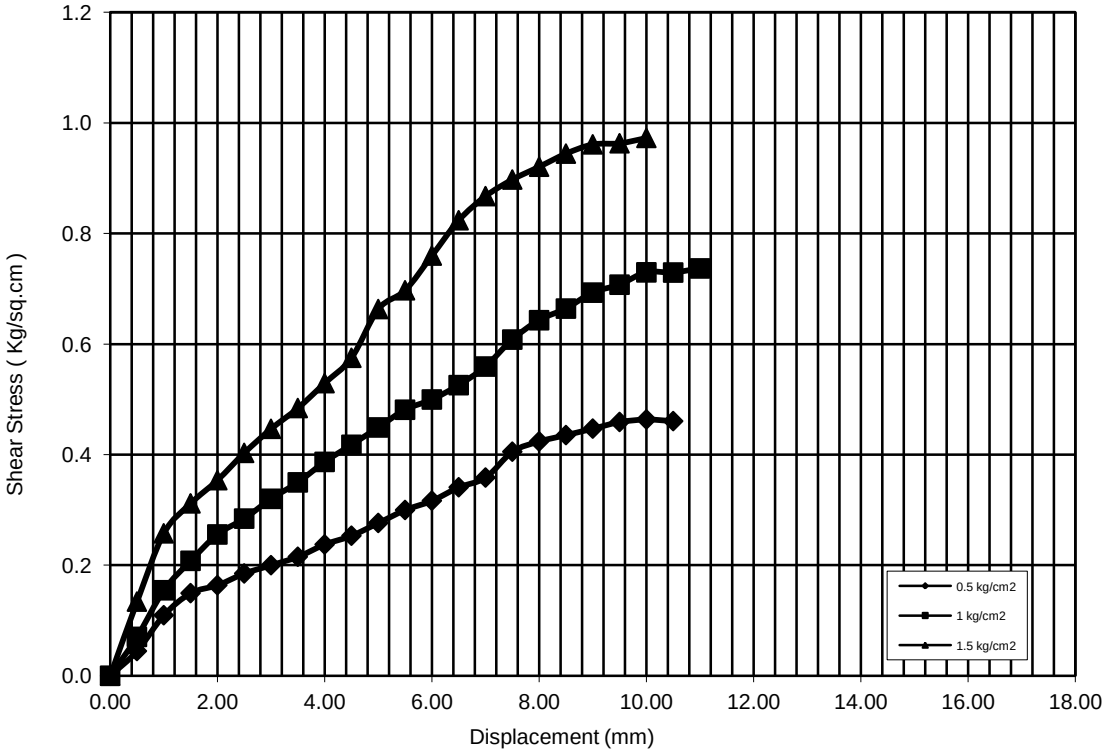
BORE HOLE NO: BH-A2
CHAINAGE: 41+056
SAMPLE NO.: UDS-1
DEPTH: 4.00 m
COHESION(C)= 0.08 kg/sq.cm
ANGLE OF FRICTION(Phi): 27 deg
TYPE OF THE TEST: DST



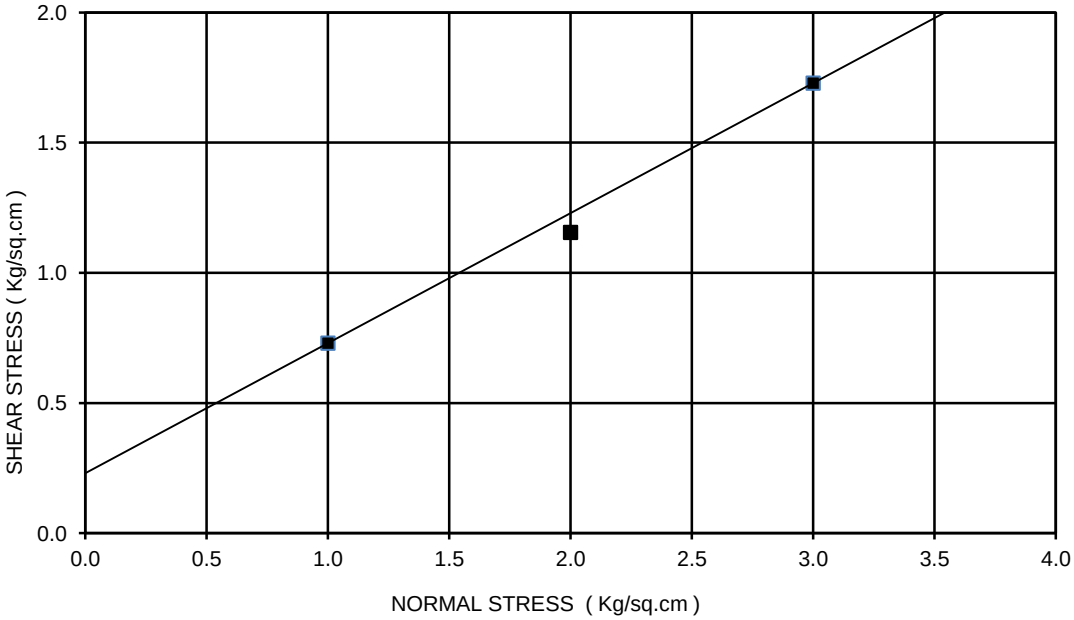


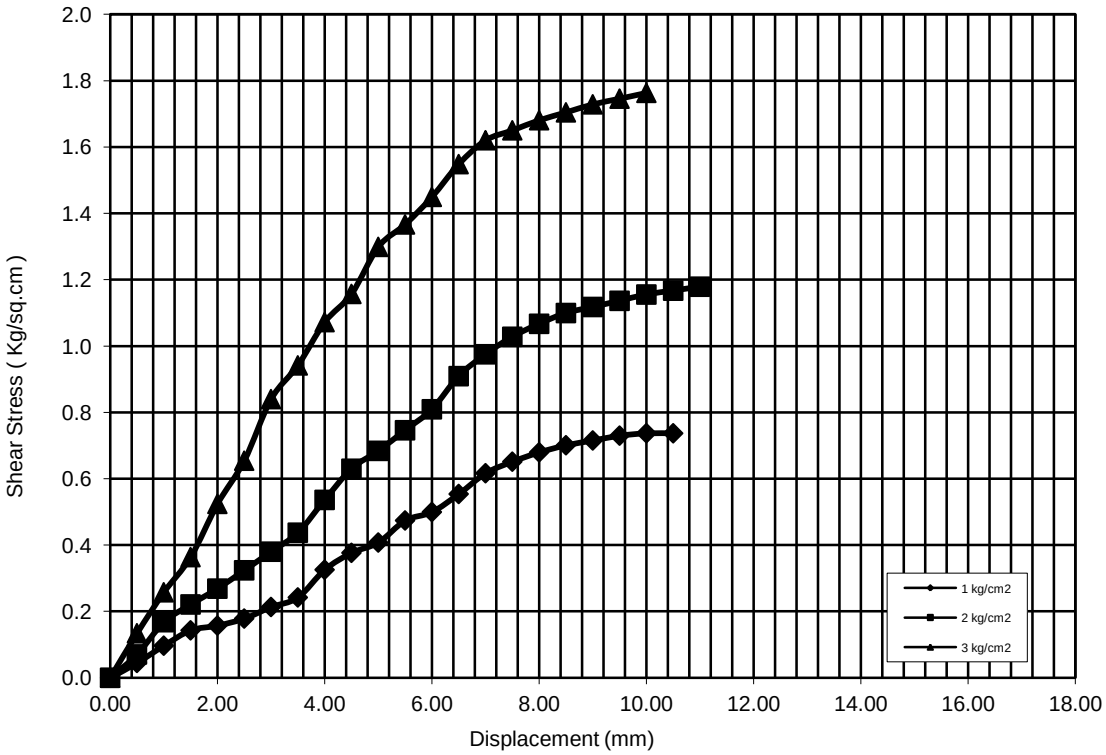
BORE HOLE NO: BH-A2
CHAINAGE: 41+056
SAMPLE NO.: UDS-4
DEPTH: 13.00 m
COHESION(C)= 0.08 kg/sq.cm
ANGLE OF FRICTION(Phi): 26 deg
TYPE OF THE TEST: DST



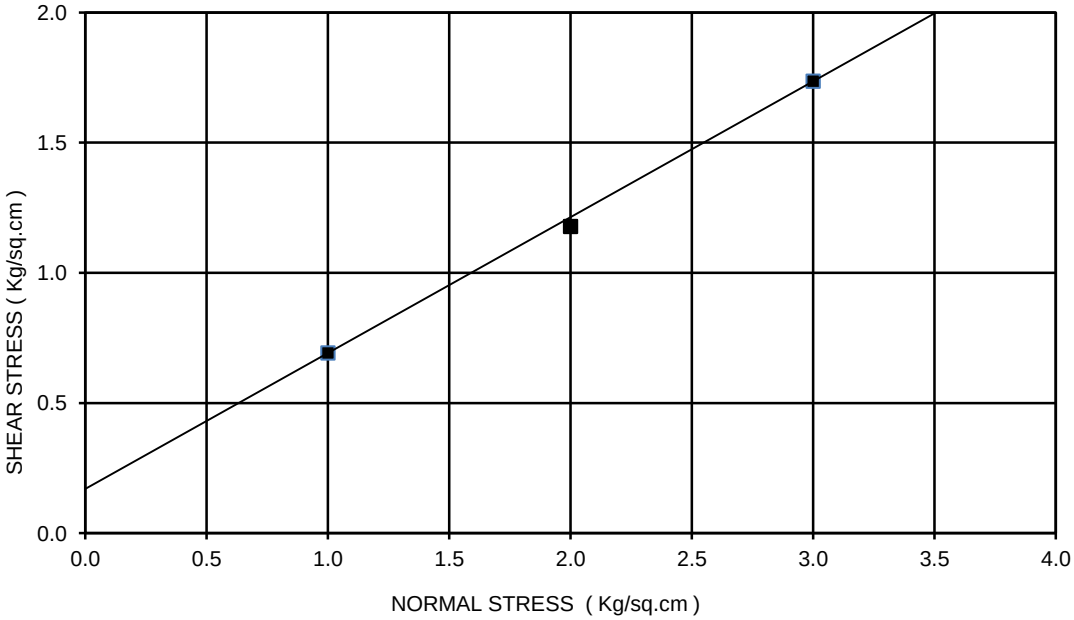


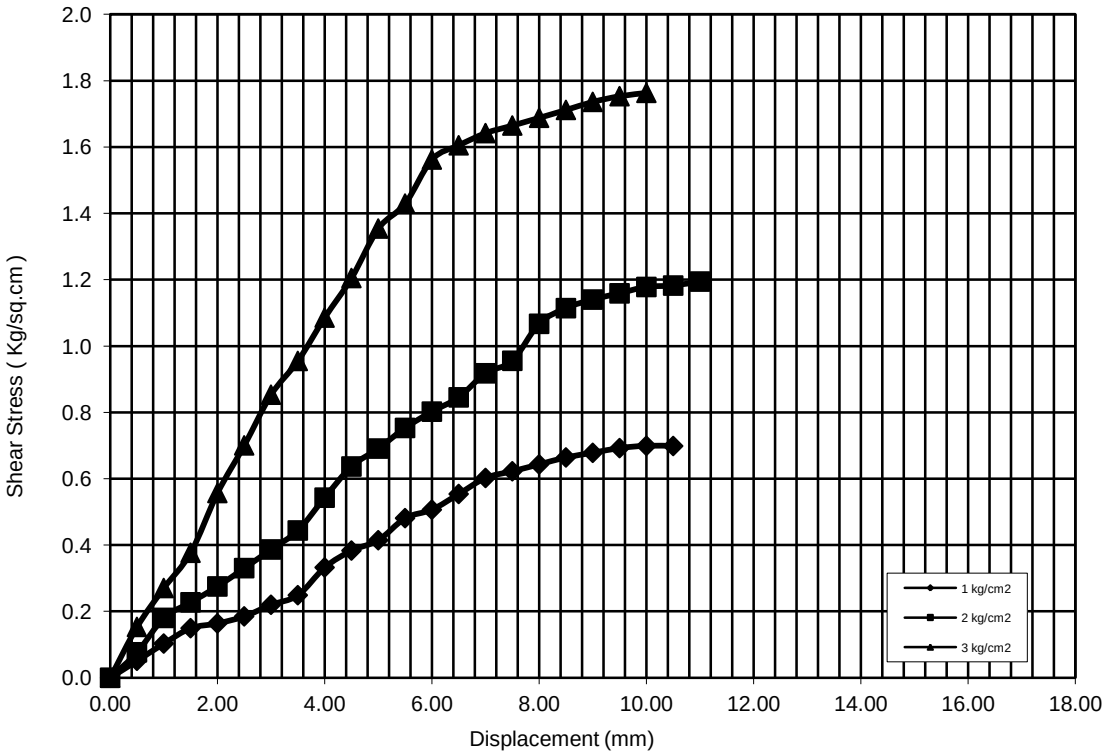
BORE HOLE NO: BH-A2
CHAINAGE: 41+056
SAMPLE NO.: UDS-4
DEPTH: 13.00 m
COHESION(C)= 0.08 kg/sq.cm
ANGLE OF FRICTION(Phi): 26 deg
TYPE OF THE TEST: DST



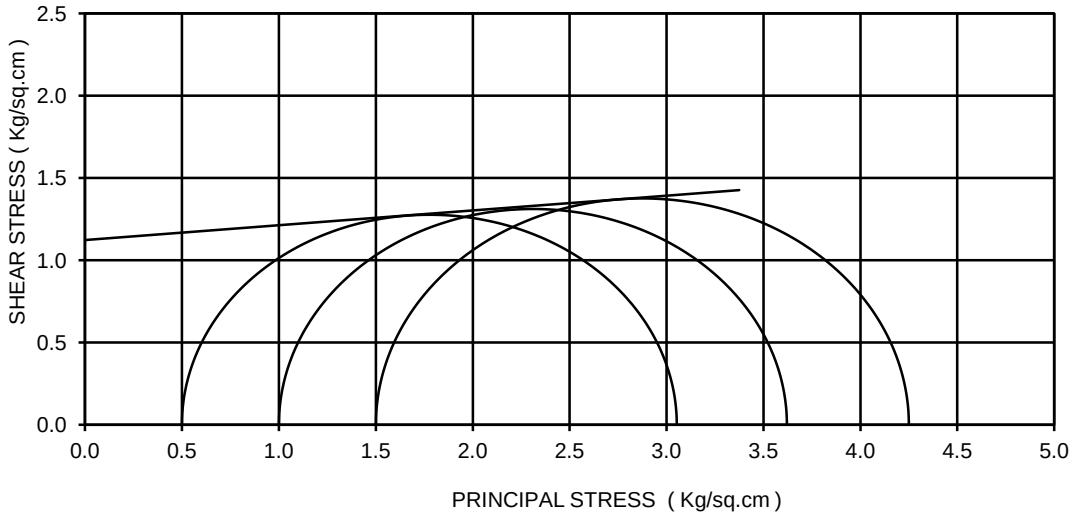


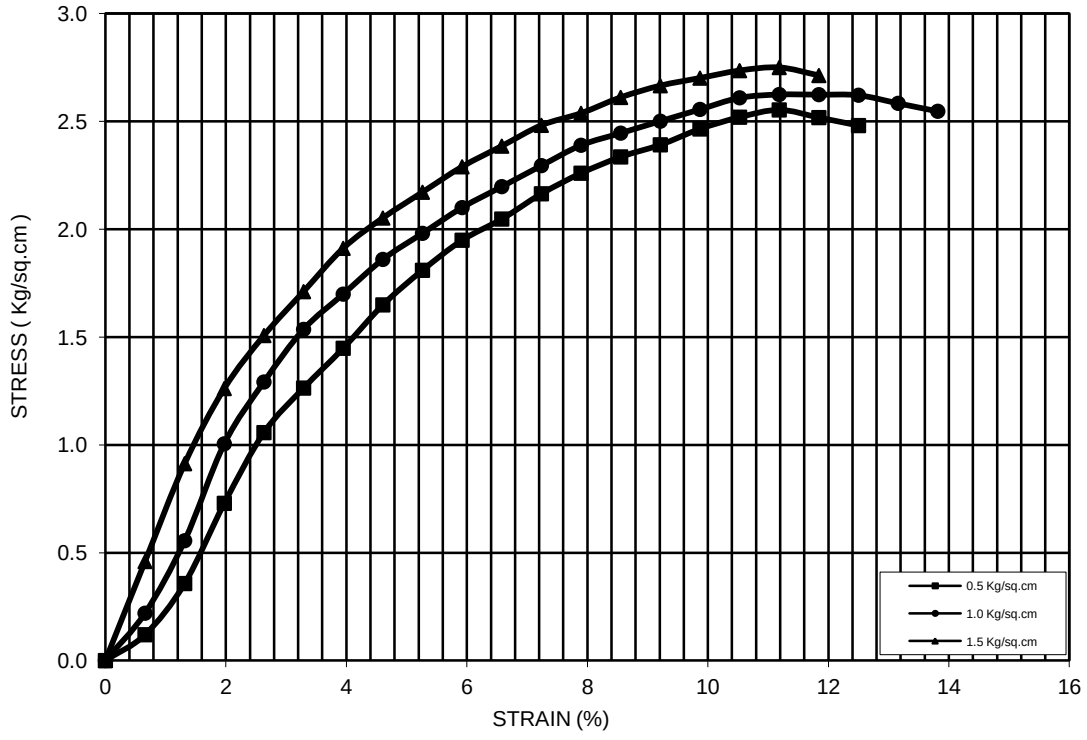
BORE HOLE NO: BH-A2
CHAINAGE: 41+056
SAMPLE NO.: UDS-4
DEPTH: 13.00 m
COHESION(C)= 0.08 kg/sq.cm
ANGLE OF FRICTION(Phi): 26 deg
TYPE OF THE TEST: DST



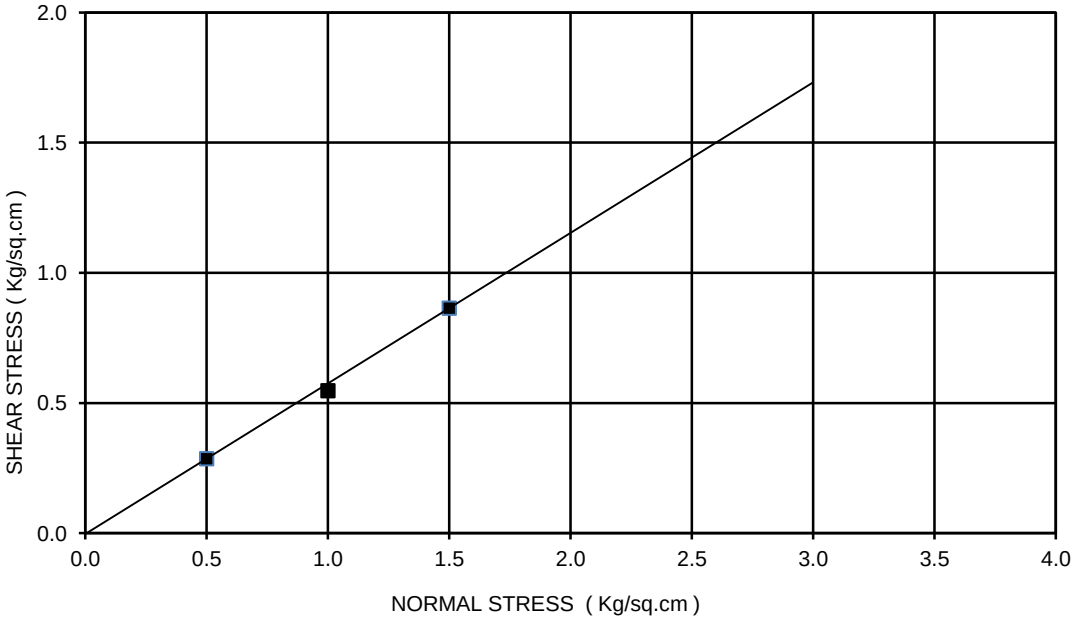


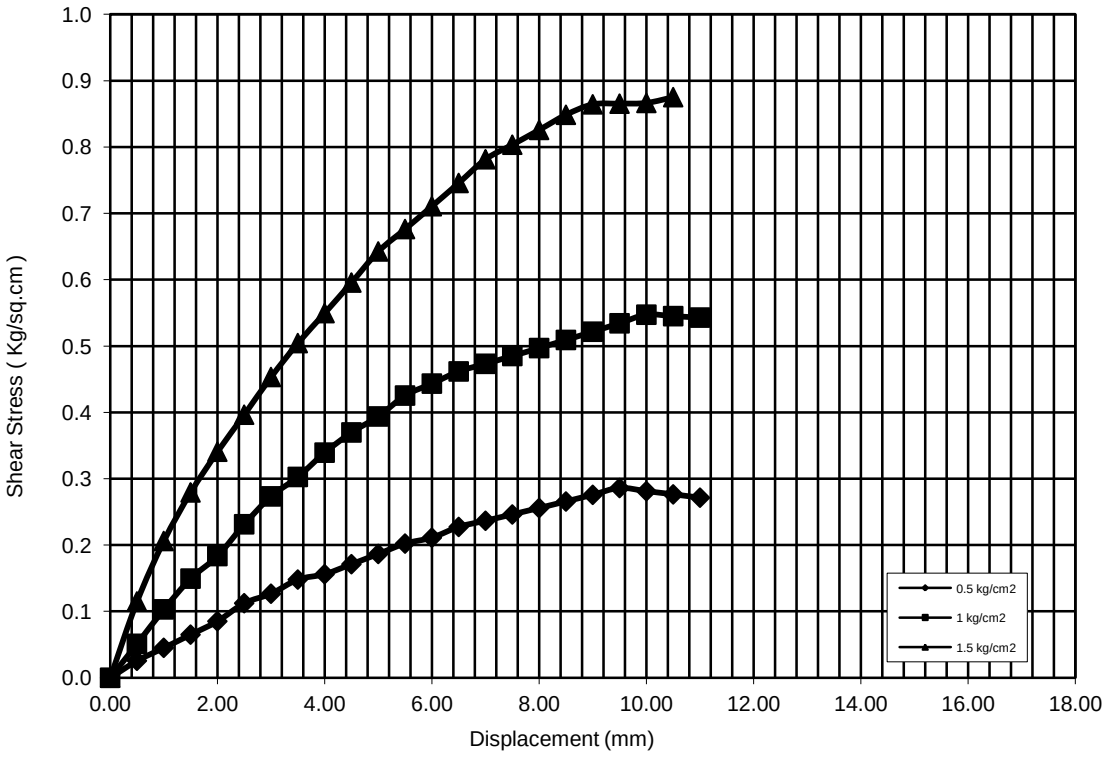
BORE HOLE NO: BH-CL
CHAINAGE:41+100
SAMPLE NO.: UDS-2
DEPTH: 5.25m
COHESION(C)= 1.12 kg/sq.cm
ANGLE OF FRICTION(Phi): 5 deg
TYPE OF THE TEST: UUT



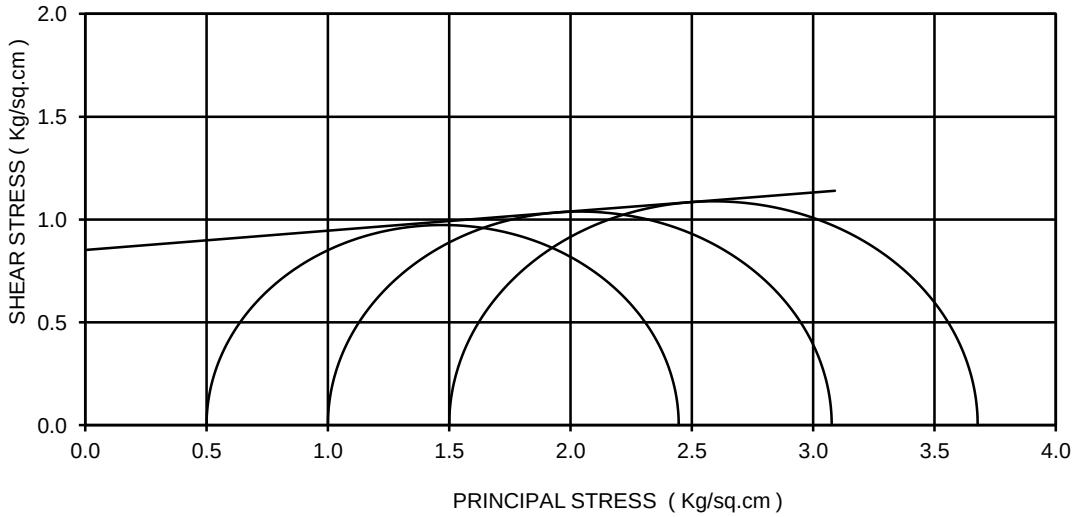


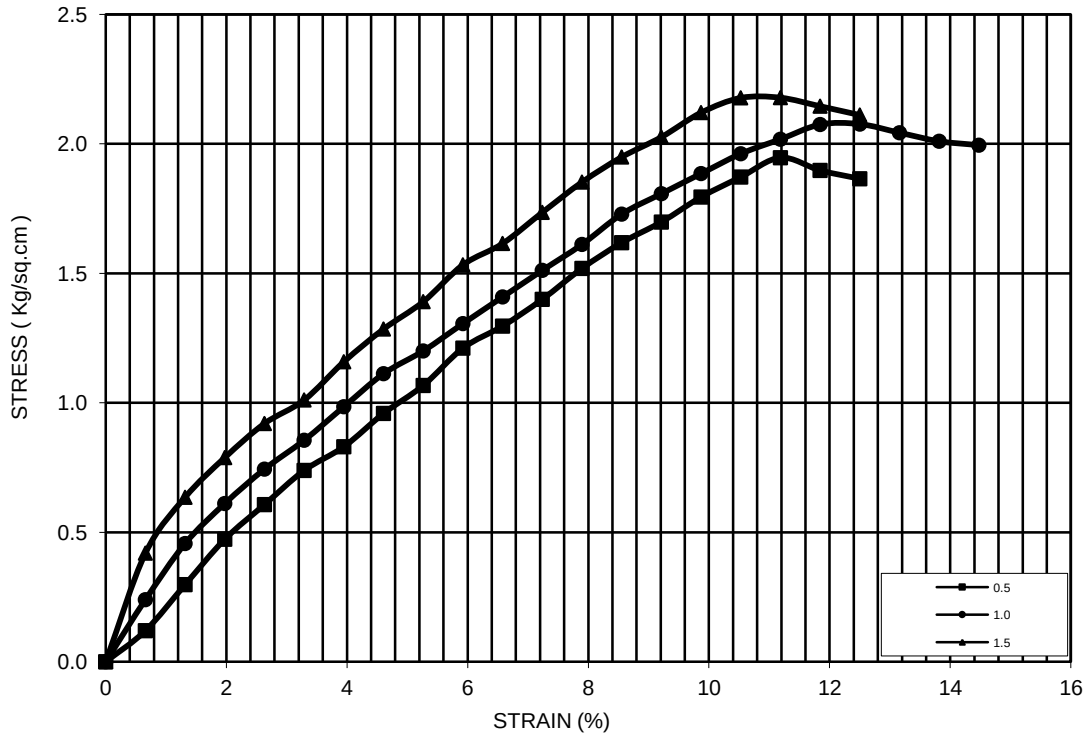
BORE HOLE NO: BH-CL
CHAINAGE:41+217
SAMPLE NO.: UDS-1
DEPTH: 2.25 m
COHESION(C)= 0.00 kg/sq.cm
ANGLE OF FRICTION(Phi): 30 deg
TYPE OF THE TEST: DST



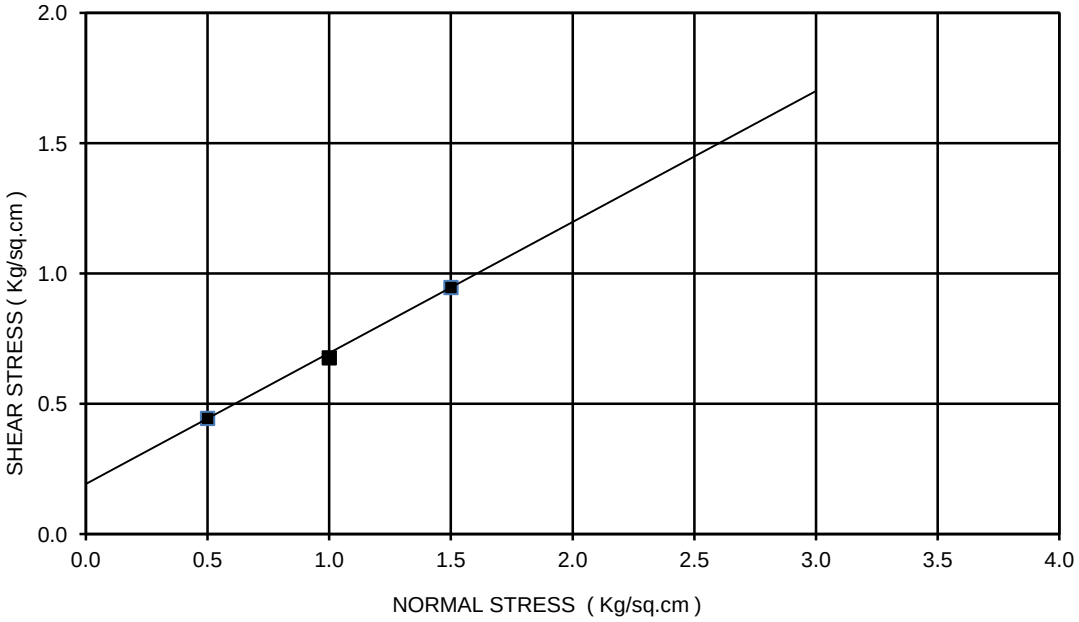


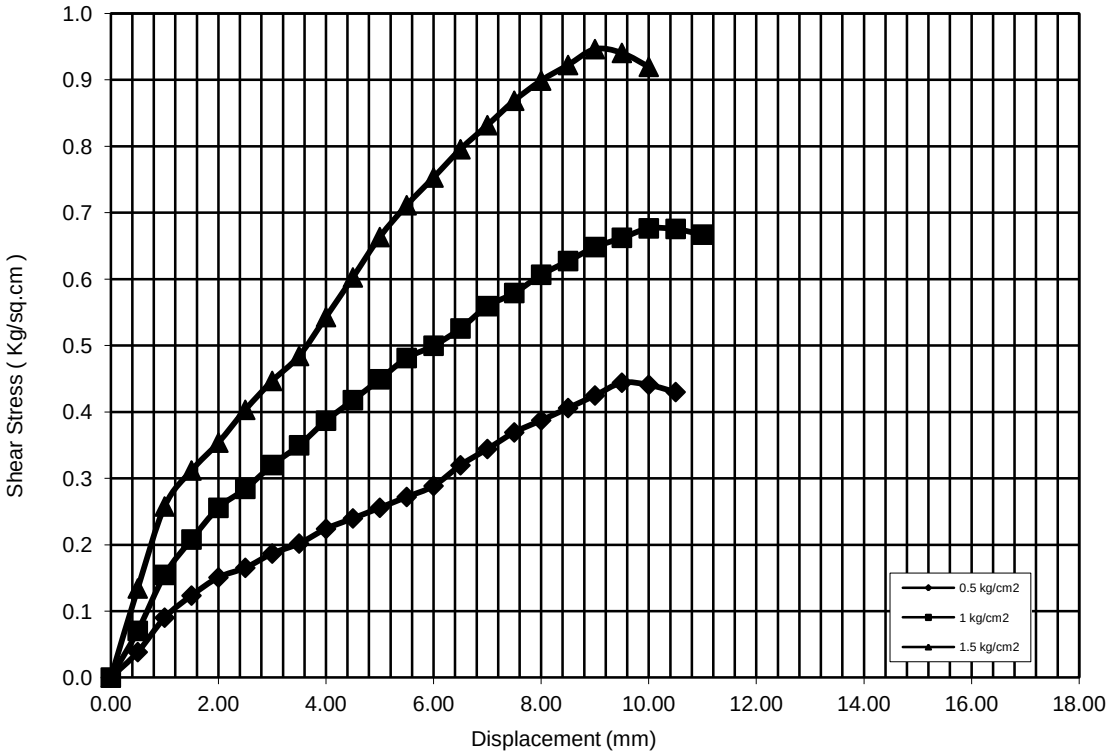
BORE HOLE NO: BH-CL
CHAINAGE : 41+235
SAMPLE NO.: UDS-1
DEPTH: 5.25 m
COHESION(C)= 0.85 kg/sq.cm
ANGLE OF FRICTION(Phi): 5 deg
TYPE OF THE TEST: UUT



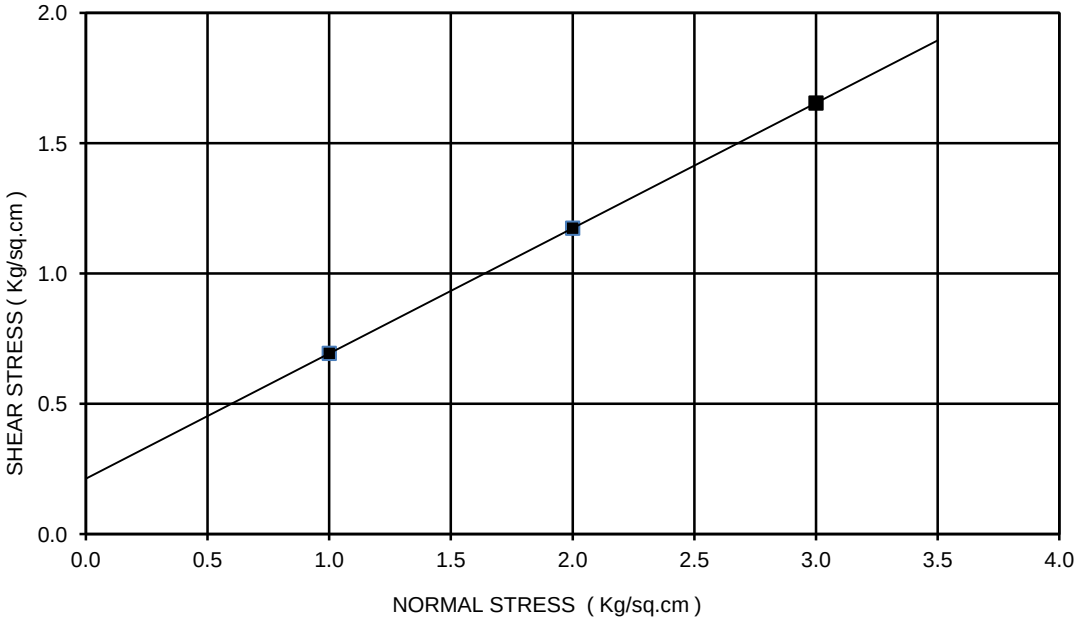


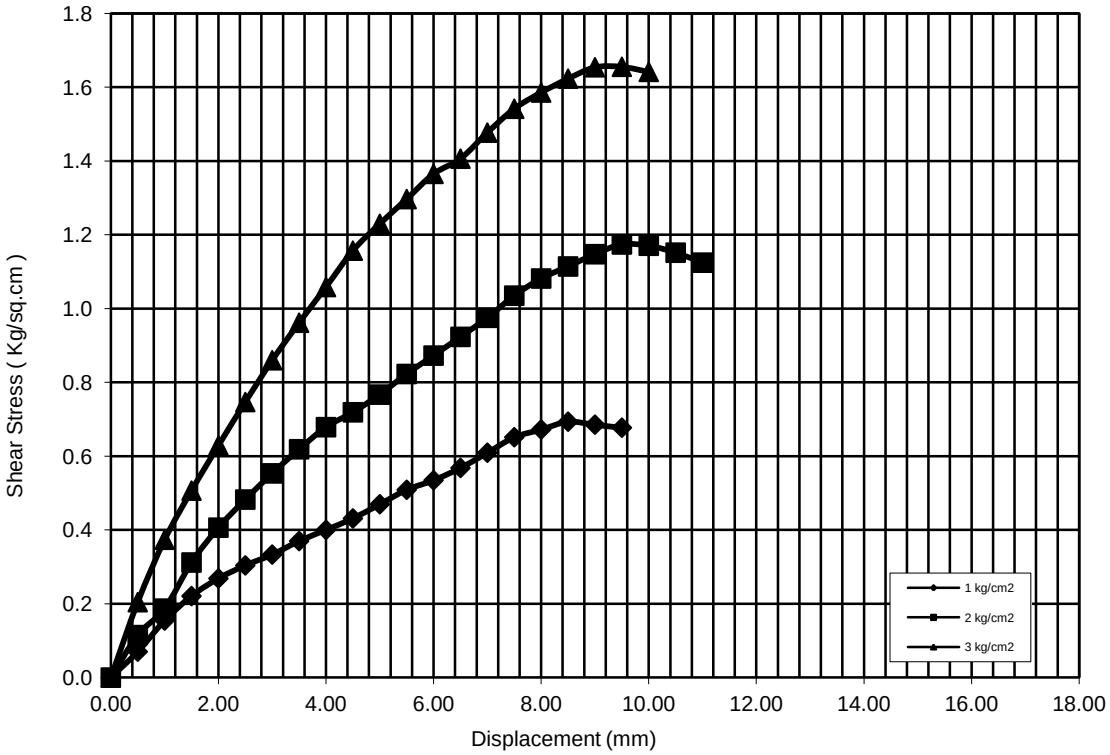
BORE HOLE NO: BH-A1
CHAINAGE: 41+390
SAMPLE NO.: UDS-4
DEPTH: 13.00 m
COHESION(C)= 0.08 kg/sq.cm
ANGLE OF FRICTION(Phi): 26 deg
TYPE OF THE TEST: DST



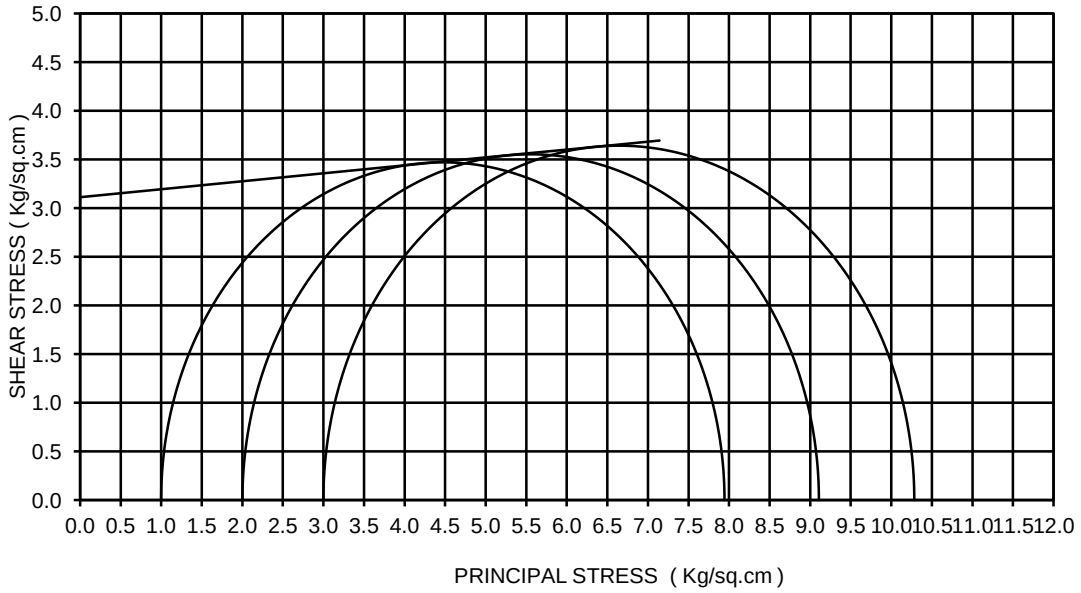


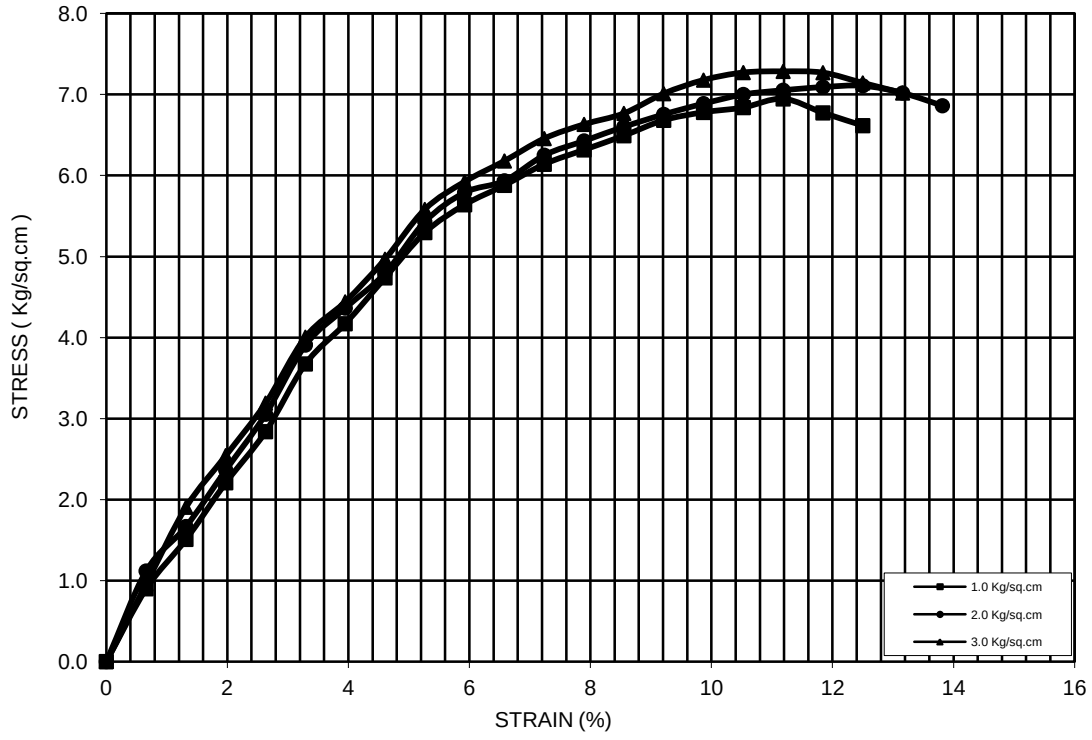
BORE HOLE NO: BH-A1
CHAINAGE: 41+390
SAMPLE NO.: UDS-4
DEPTH: 13.00 m
COHESION(C)= 0.08 kg/sq.cm
ANGLE OF FRICTION(Phi): 26 deg
TYPE OF THE TEST: DST



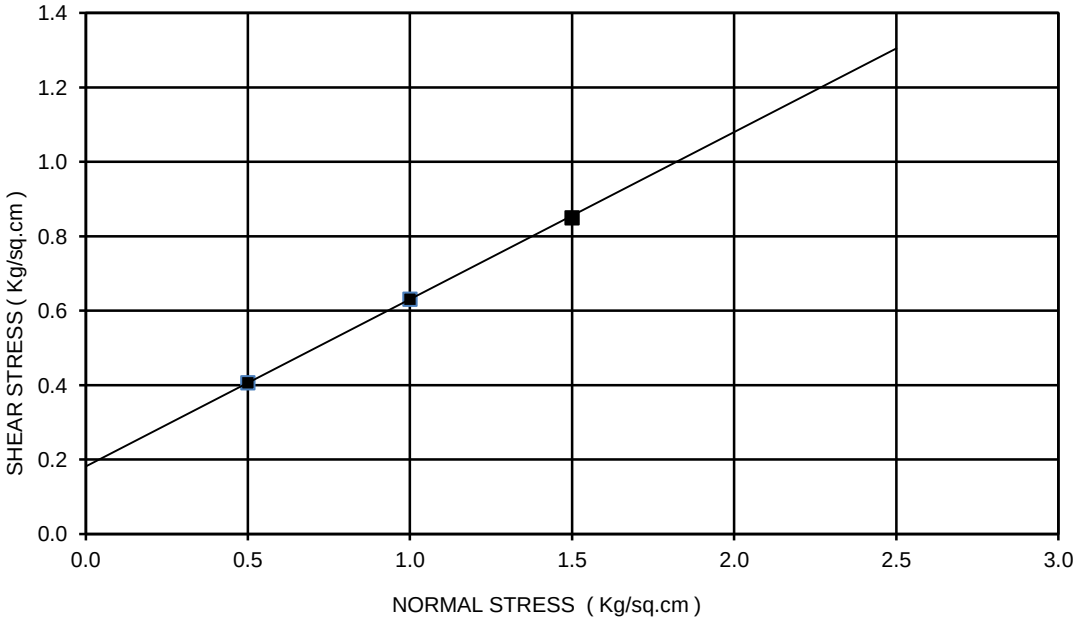


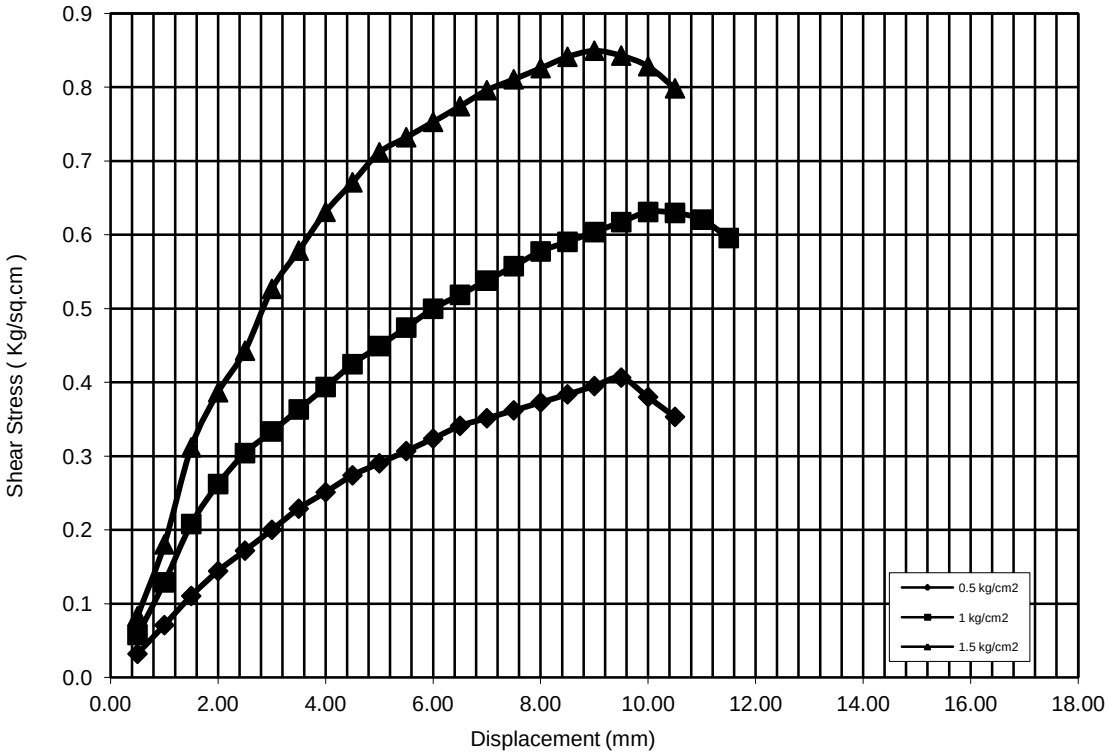
BORE HOLE NO: BH-A1
CHAINAGE: 41+390
SAMPLE NO.: UDS-2
DEPTH: 7.00 m
COHESION(C)= 1.19 kg/sq.cm
ANGLE OF FRICTION(Phi): 6 deg
TYPE OF THE TEST: UUT



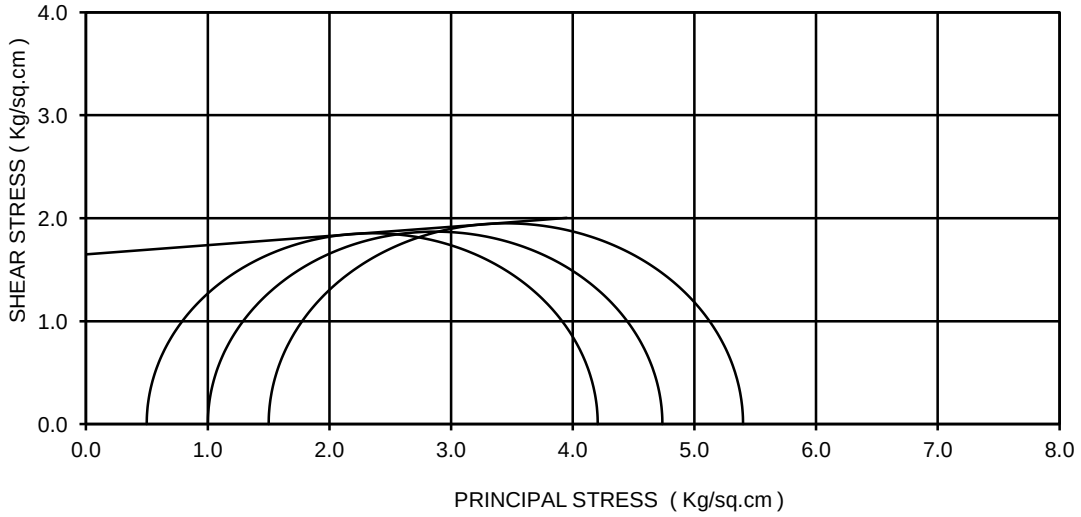


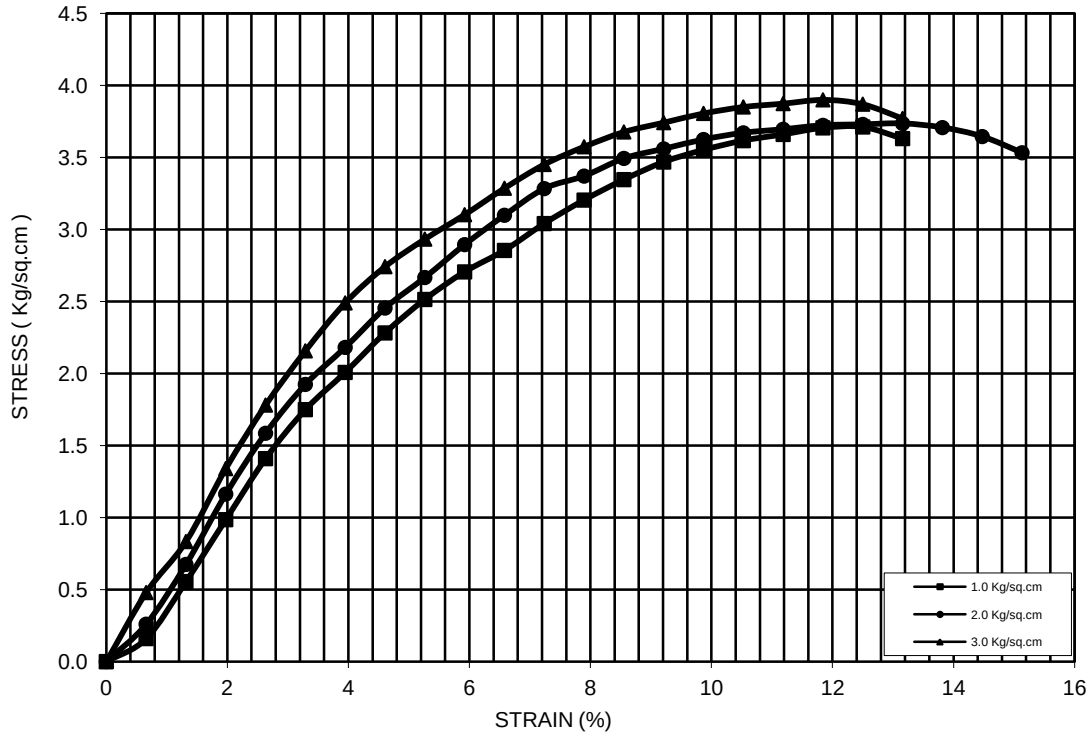
BORE HOLE NO: BH-A2
CHAINAGE: 41+390
SAMPLE NO.: SPT-14
DEPTH: 22.50 m
COHESION(C)= 0.2 kg/sq.cm
ANGLE OF FRICTION(Phi): 24 deg
TYPE OF THE TEST: DST+



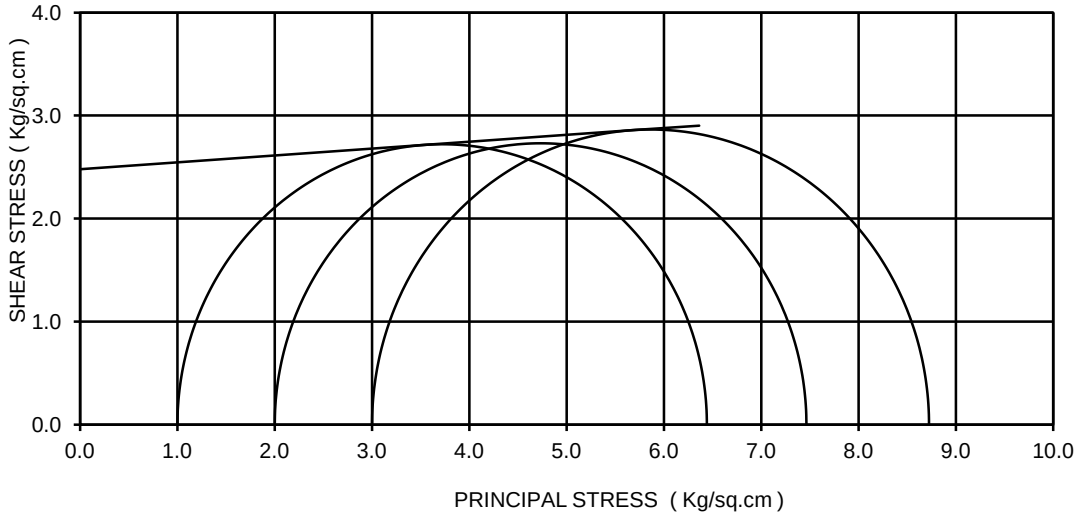


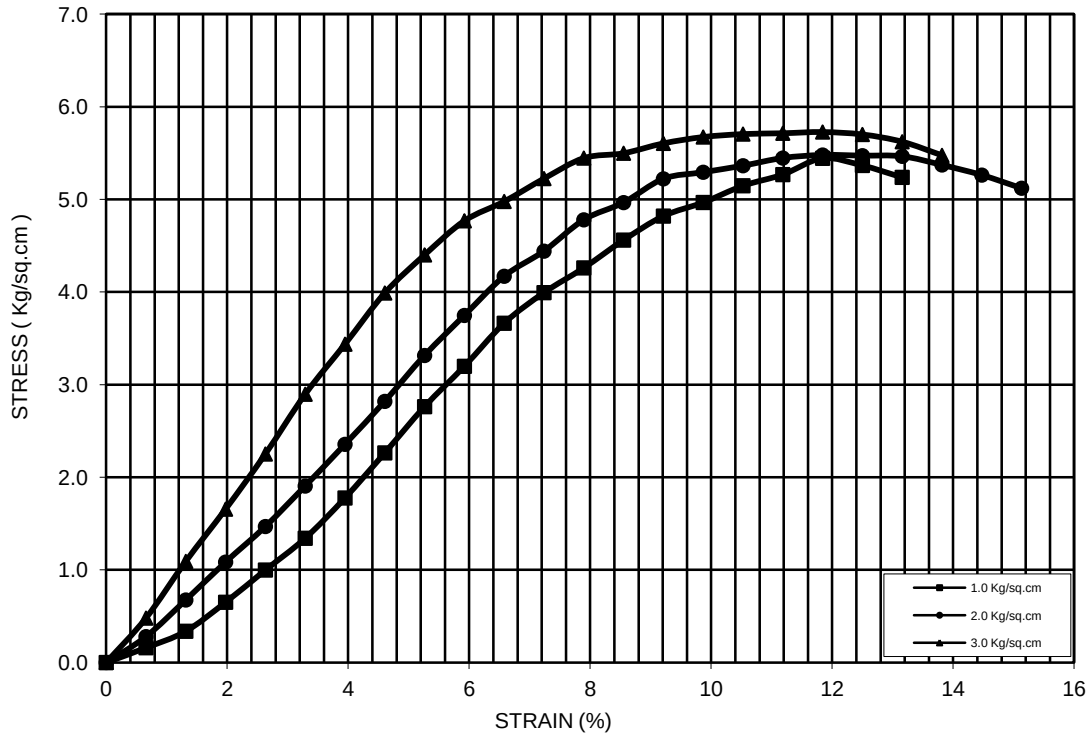
BORE HOLE NO: BH-A2
CHAINAGE: 41+390
SAMPLE NO.: SPT-28
DEPTH: 43.50 m
COHESION(C)= 1.5 kg/sq.cm
ANGLE OF FRICTION(Phi): 13 deg
TYPE OF THE TEST: UUT+



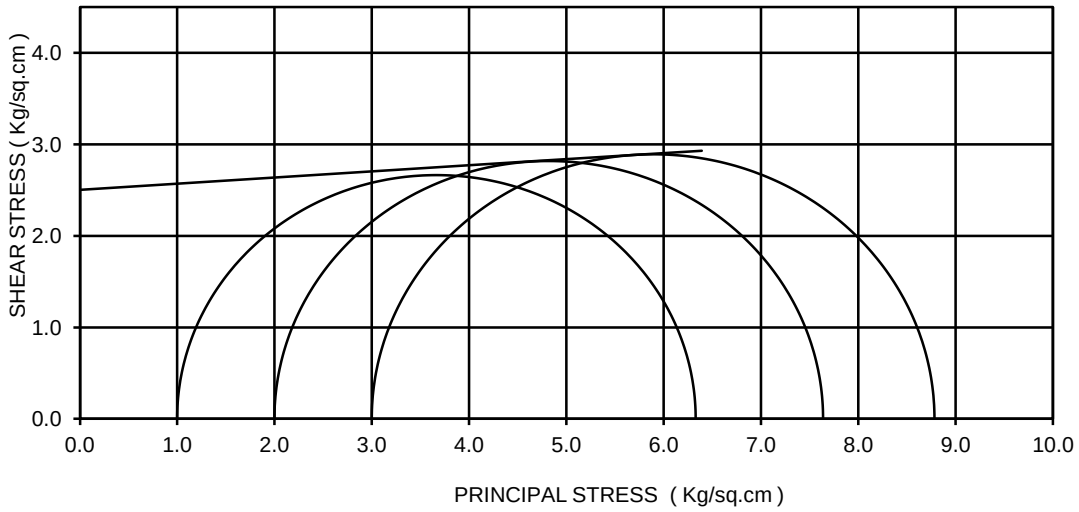


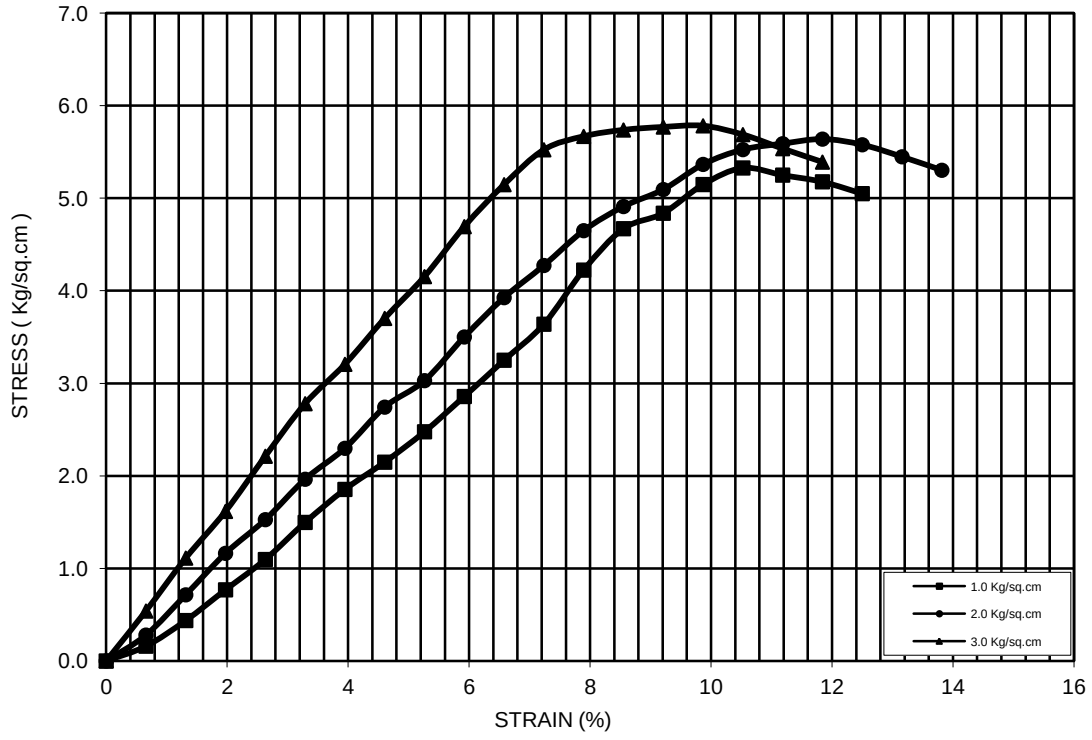
BORE HOLE NO: BH-A2
CHAINAGE: 41+390
SAMPLE NO.: DS-2
DEPTH: 43.00 m
COHESION(C)= 1.32 kg/sq.cm
ANGLE OF FRICTION(Phi): 9 deg
TYPE OF THE TEST: UUT+



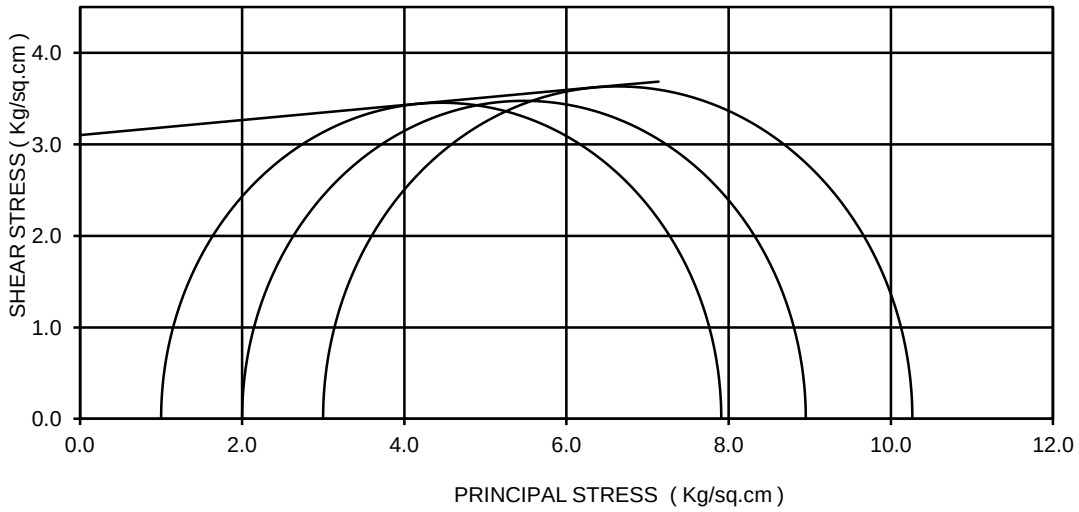


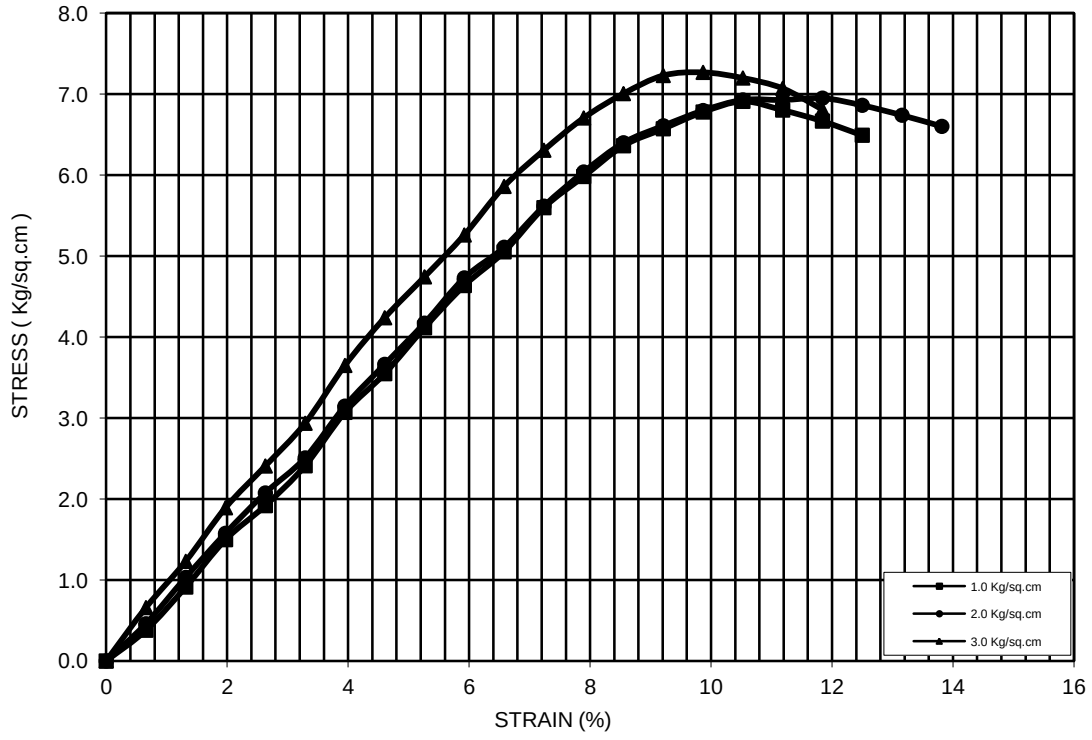
BORE HOLE NO: BH-A2
CHAINAGE: 41+390
SAMPLE NO.: SPT-28
DEPTH: 43.50 m
COHESION(C)= 1.15 kg/sq.cm
ANGLE OF FRICTION(Phi): 9 deg
TYPE OF THE TEST: UUT+



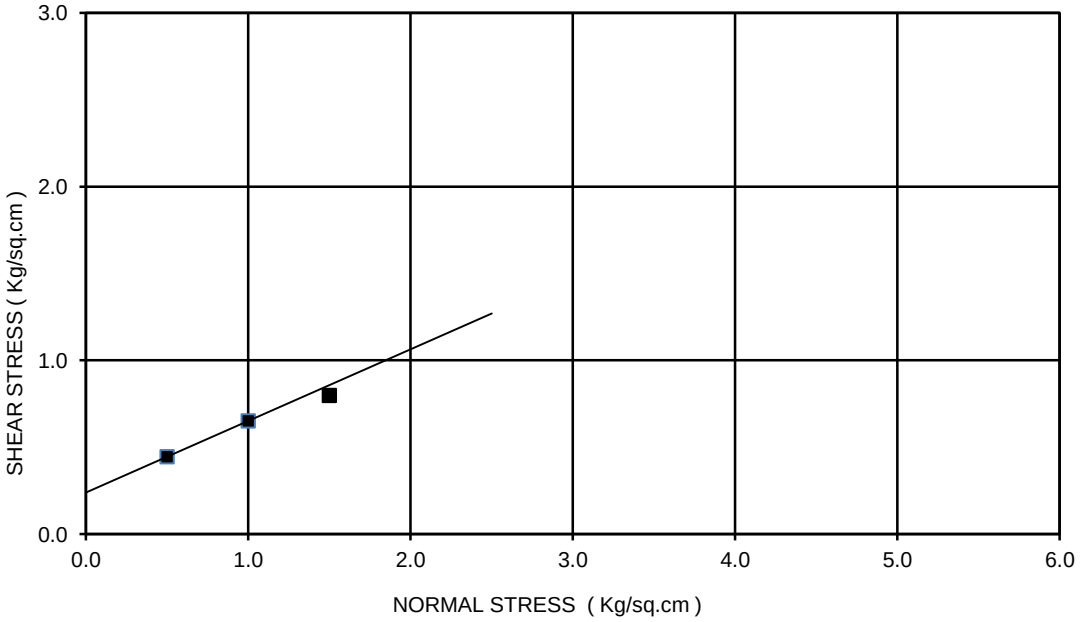


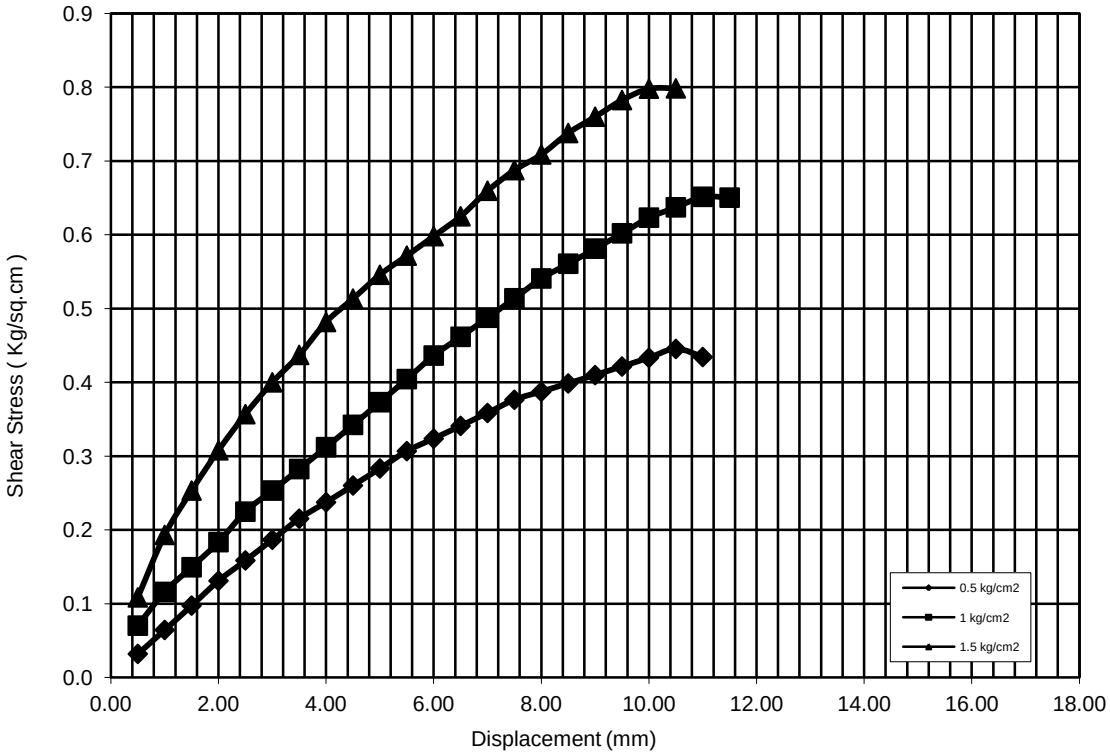
BORE HOLE NO: BH-A2
CHAINAGE: 41+390
SAMPLE NO.: UDS-8
DEPTH: 23.50 m
COHESION(C)= 1.74 kg/sq.cm
ANGLE OF FRICTION(Phi): 9 deg
TYPE OF THE TEST: UUT



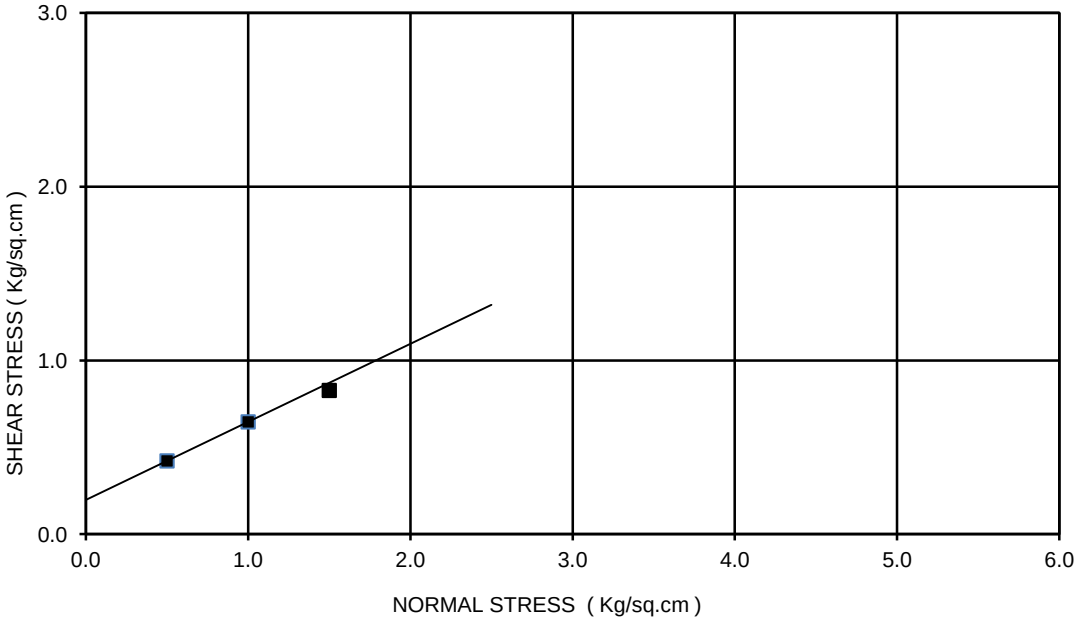


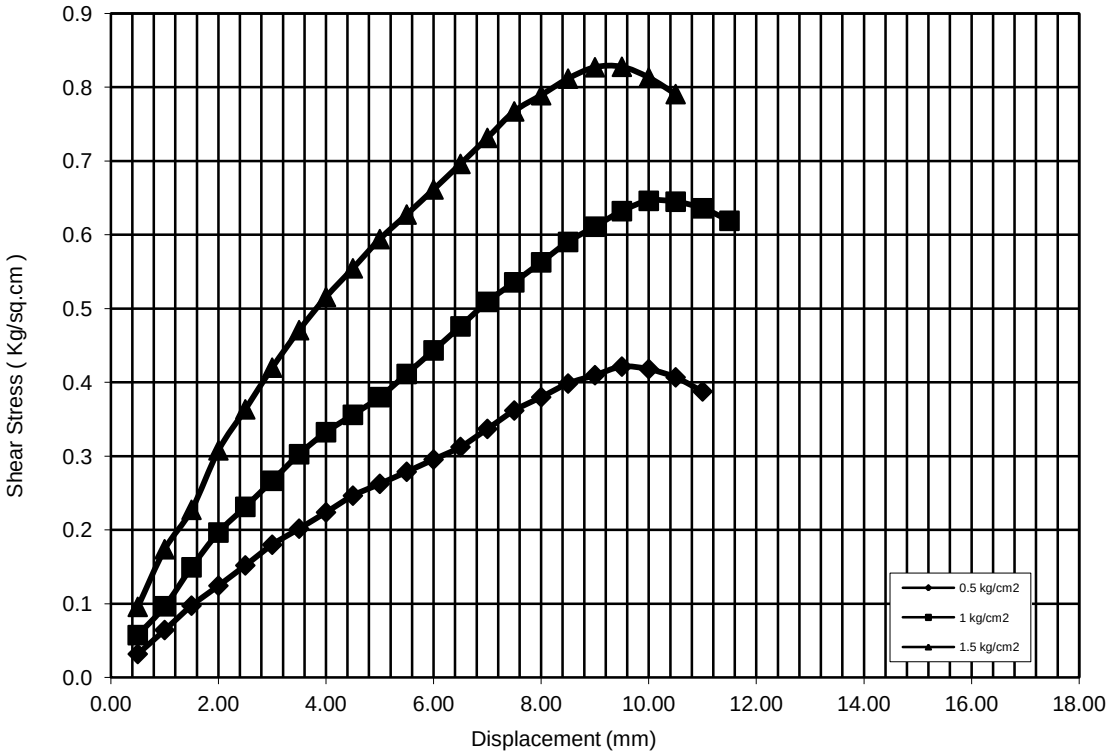
BORE HOLE NO: BH-A1
CHAINAGE: 42+256
SAMPLE NO.: UDS-2
DEPTH: 7.00 m
COHESION(C)= 0.25 kg/sq.cm
ANGLE OF FRICTION(Phi): 20 deg
TYPE OF THE TEST: DST



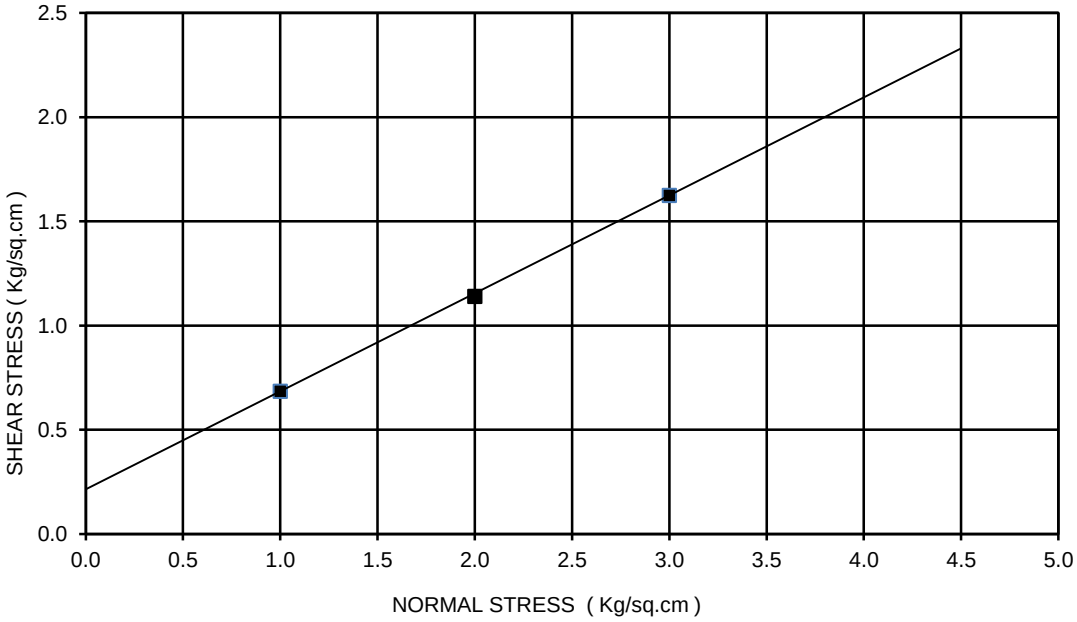


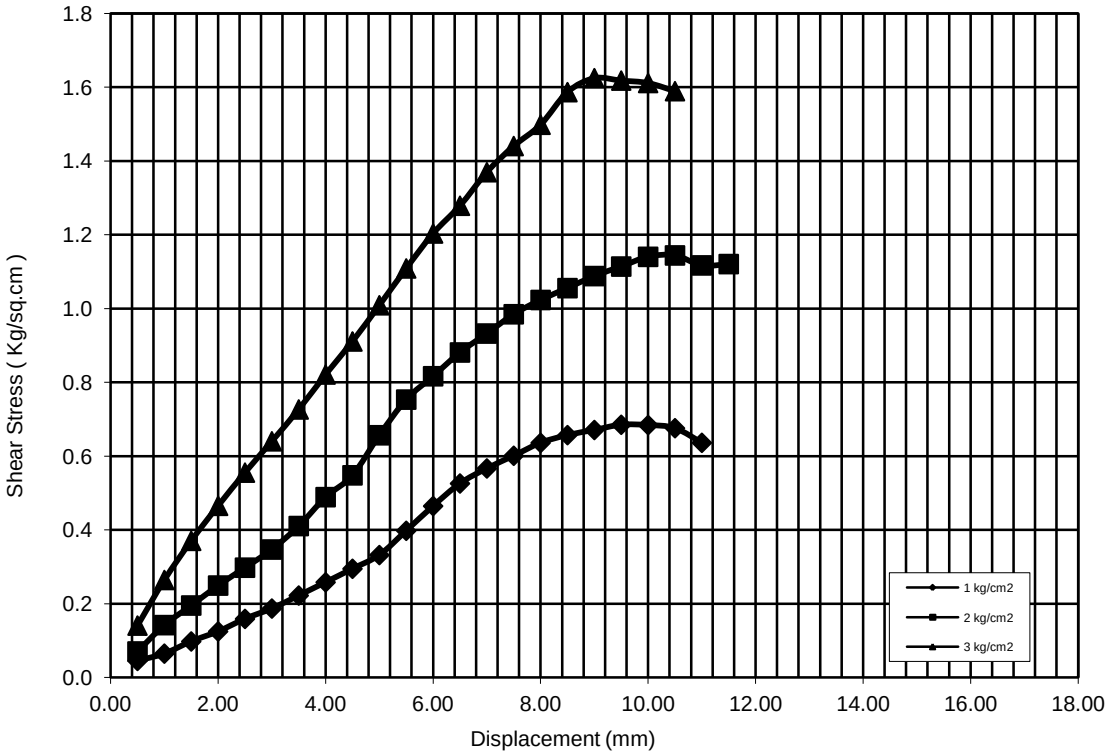
BORE HOLE NO: BH-A1
CHAINAGE: 42+256
SAMPLE NO.: UDS-3
DEPTH: 13.00 m
COHESION(C)= 0.14 kg/sq.cm
ANGLE OF FRICTION(Phi): 23 deg
TYPE OF THE TEST: DST



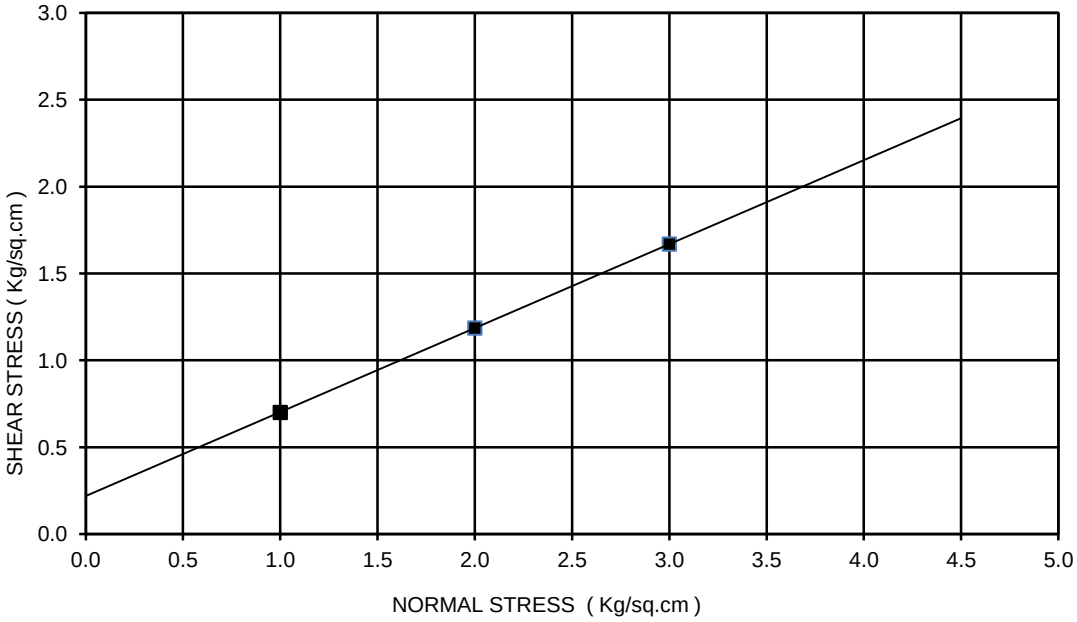


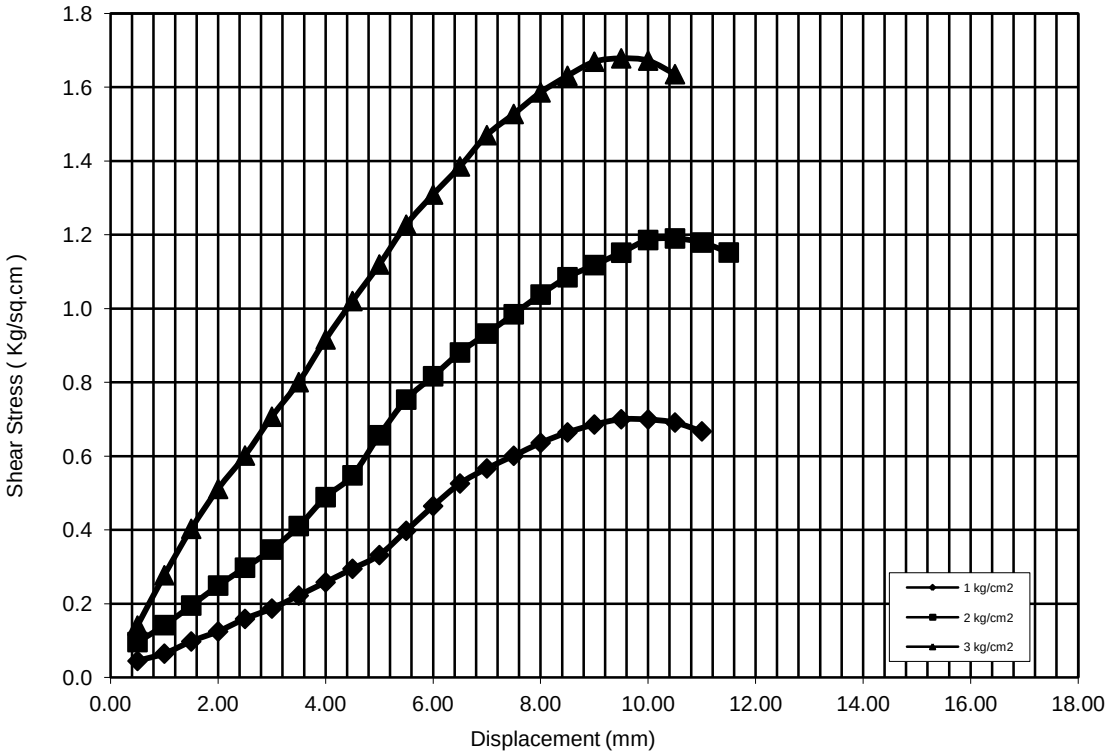
BORE HOLE NO: BH-A1
CHAINAGE: 42+256
SAMPLE NO.: UDS-5
DEPTH: 14.50 m
COHESION(C)= 0.27 kg/sq.cm
ANGLE OF FRICTION(Phi): 23 deg
TYPE OF THE TEST: DST+



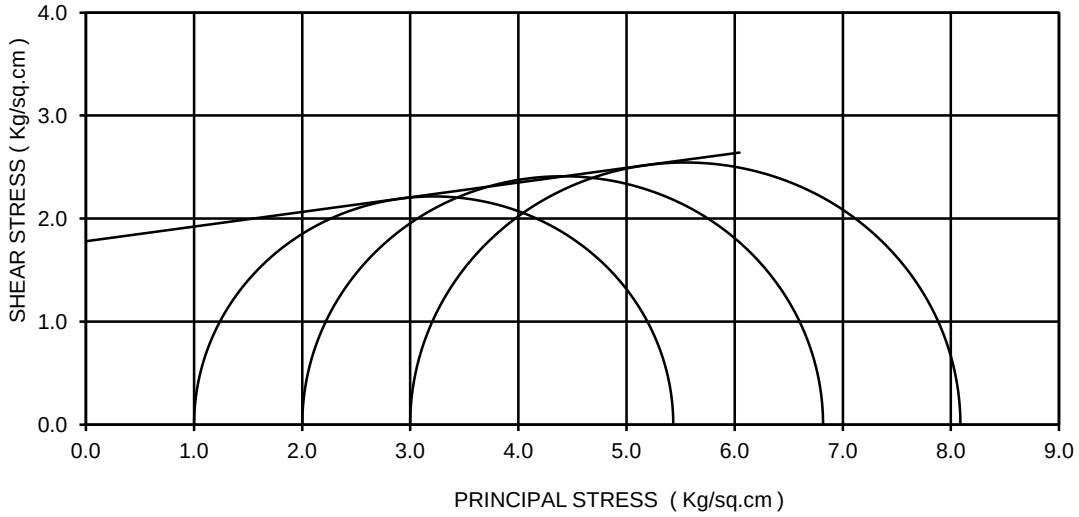


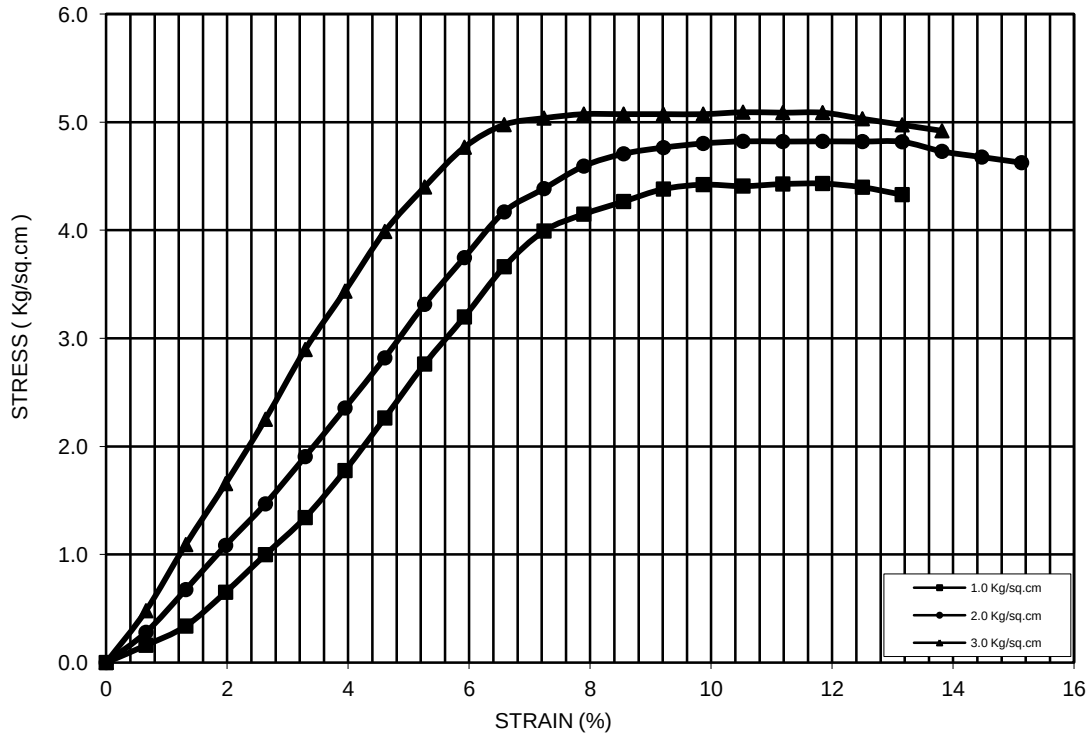
BORE HOLE NO: BH-A1
CHAINAGE: 42+256
SAMPLE NO.: UDS-7
DEPTH: 20.50 m
COHESION(C)= 0.29 kg/sq.cm
ANGLE OF FRICTION(Phi): 23 deg
TYPE OF THE TEST: DST



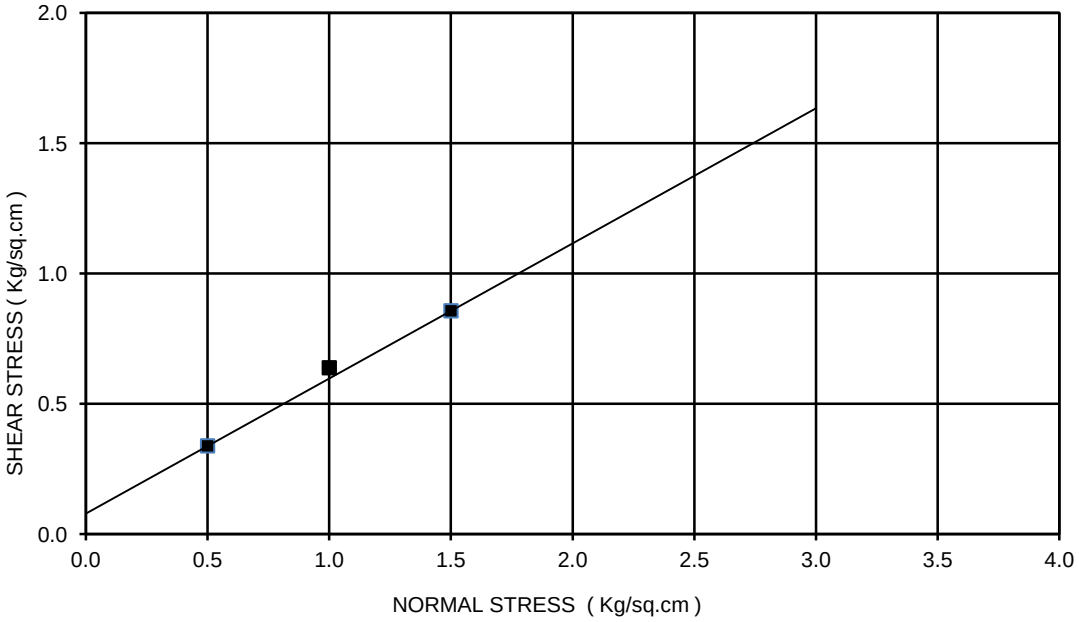


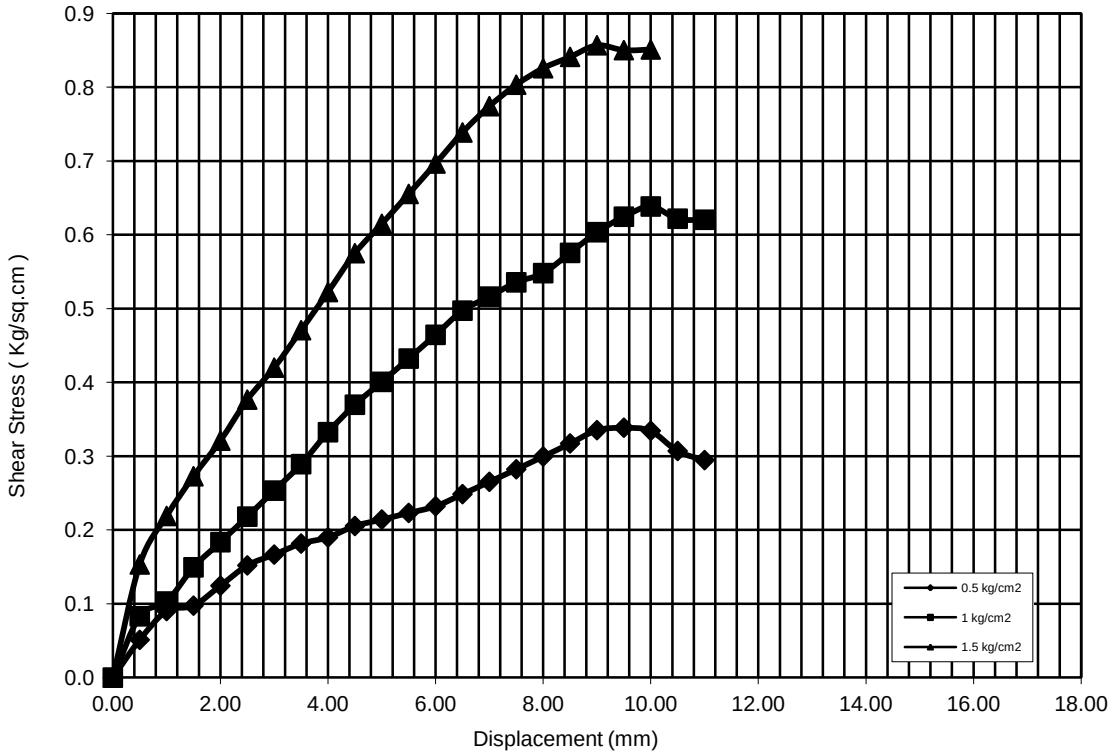
BORE HOLE NO: BH-A1
CHAINAGE: 42+256
SAMPLE NO.: DS-2
DEPTH: 43.00 m
COHESION(C)= 1.32 kg/sq.cm
ANGLE OF FRICTION(Phi): 9 deg
TYPE OF THE TEST: UUT+



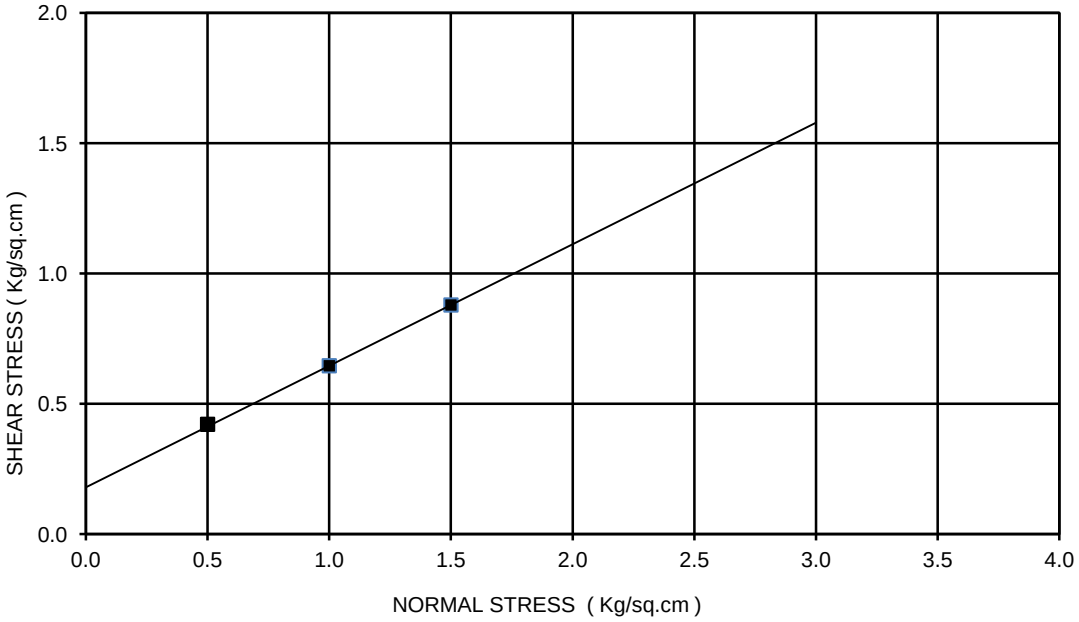


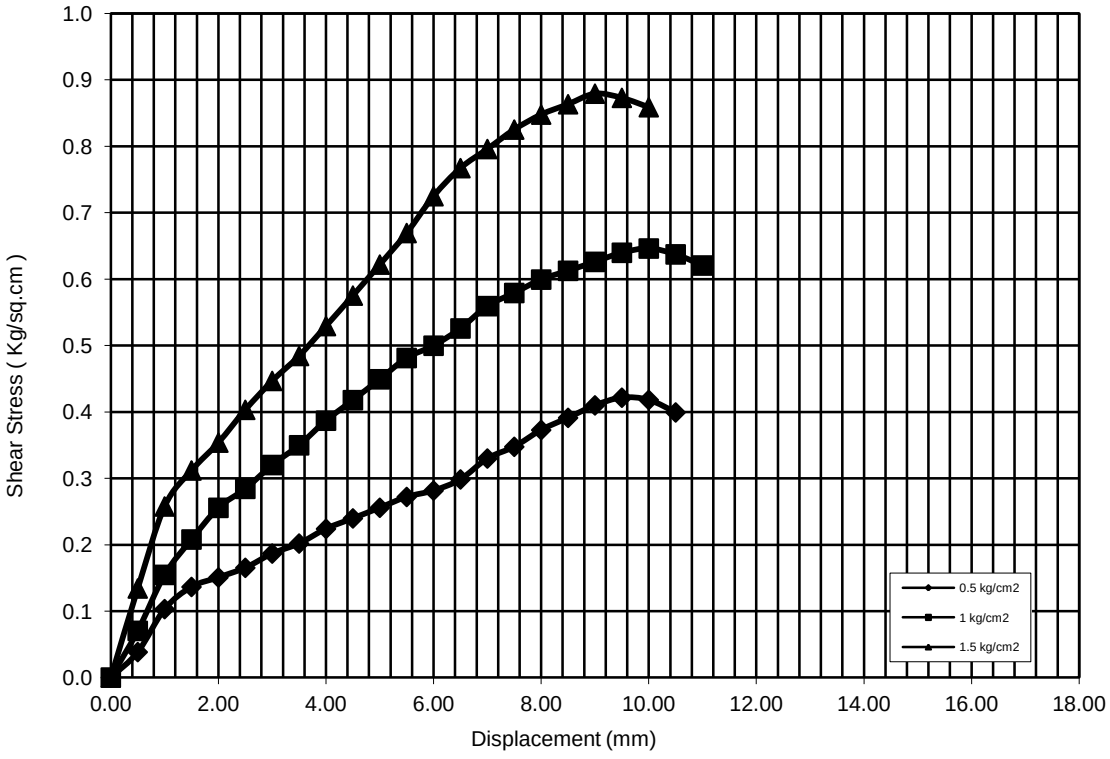
BORE HOLE NO: BH-P2
CHAINAGE: 42+256
SAMPLE NO.: UDS-1
DEPTH: 4.00 m
COHESION(C)= 0.08 kg/sq.cm
ANGLE OF FRICTION(Phi): 27 deg
TYPE OF THE TEST: DST



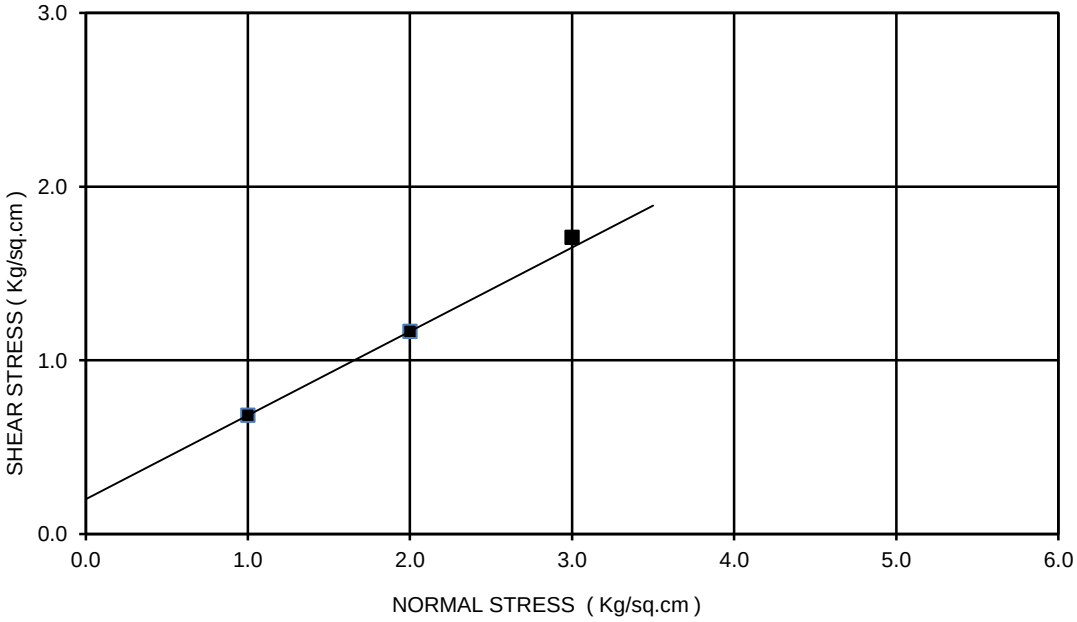


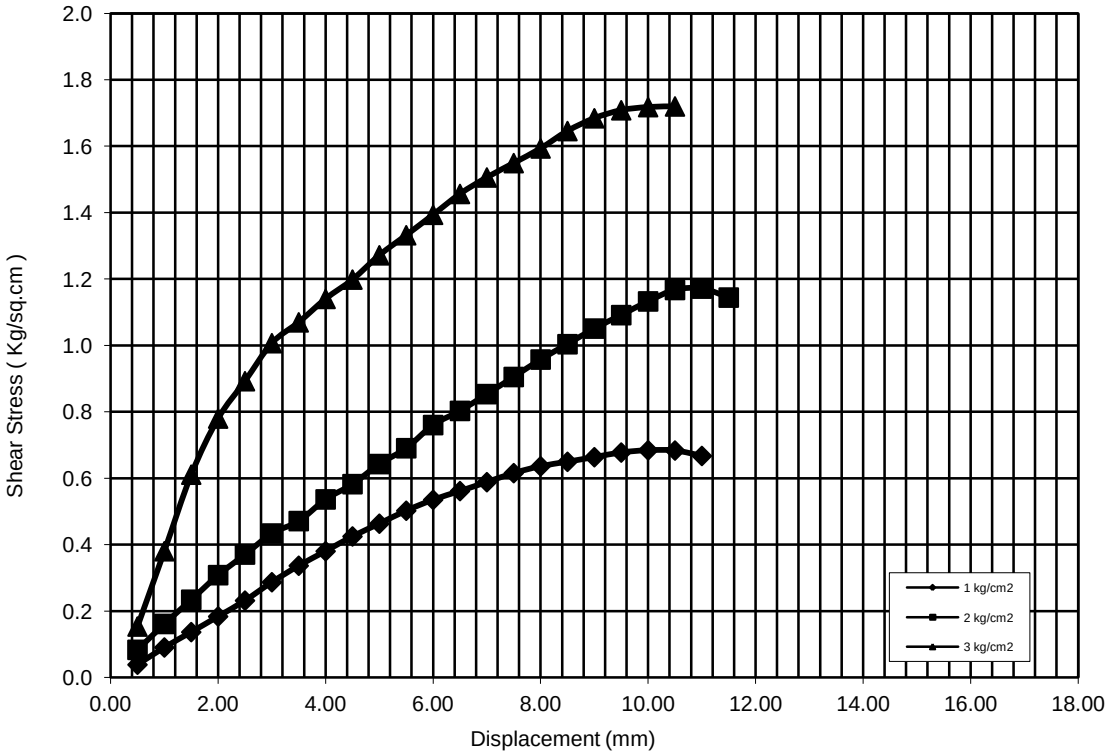
BORE HOLE NO: BH-P2
CHAINAGE: 42+256
SAMPLE NO.: UDS-3
DEPTH: 7 m
COHESION(C)= 0.2 kg/sq.cm
ANGLE OF FRICTION(Phi): 24 deg
TYPE OF THE TEST: DST



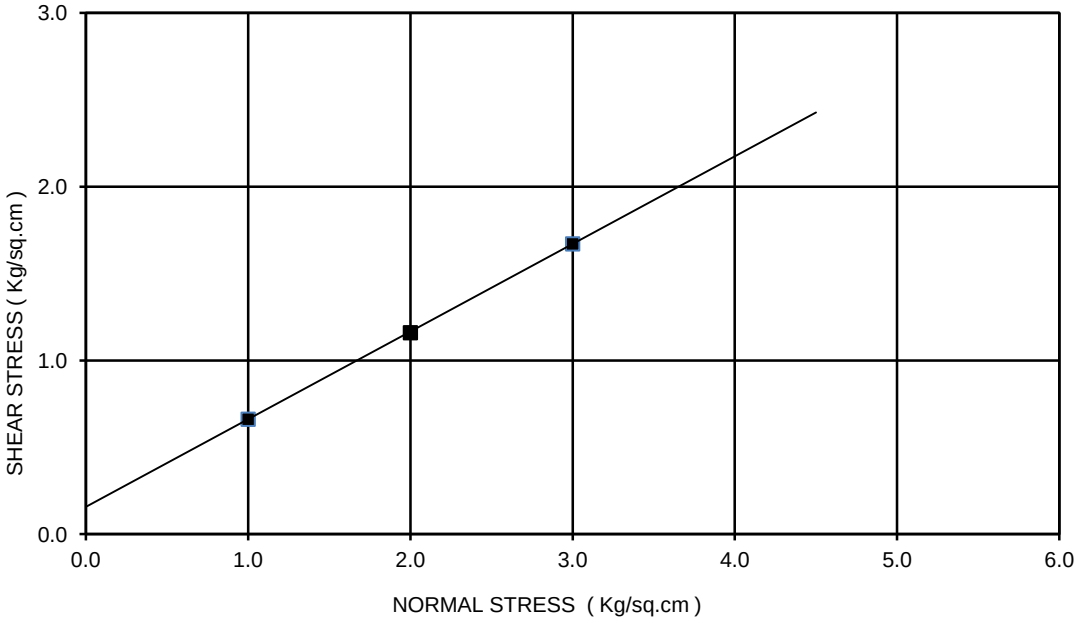


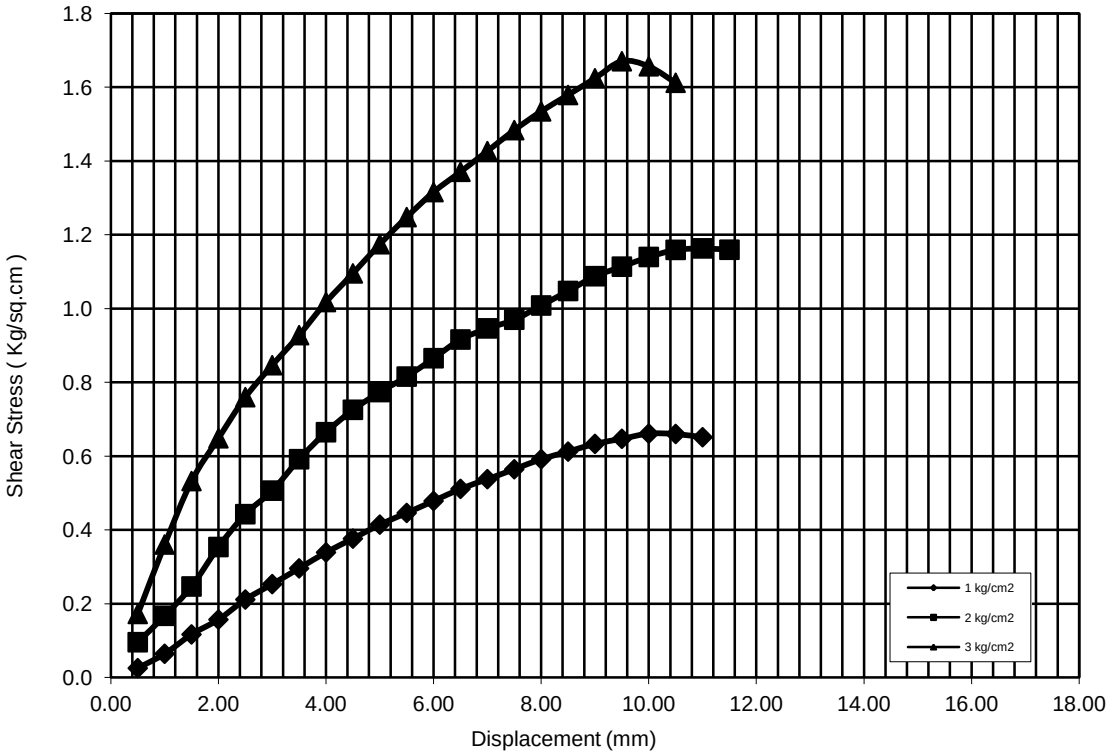
BORE HOLE NO: BH-P2
CHAINAGE: 42+256
SAMPLE NO.: SPT-9
DEPTH: 15.00 m
COHESION(C)= 0.06 kg/sq.cm
ANGLE OF FRICTION(Phi): 29 deg
TYPE OF THE TEST: DST



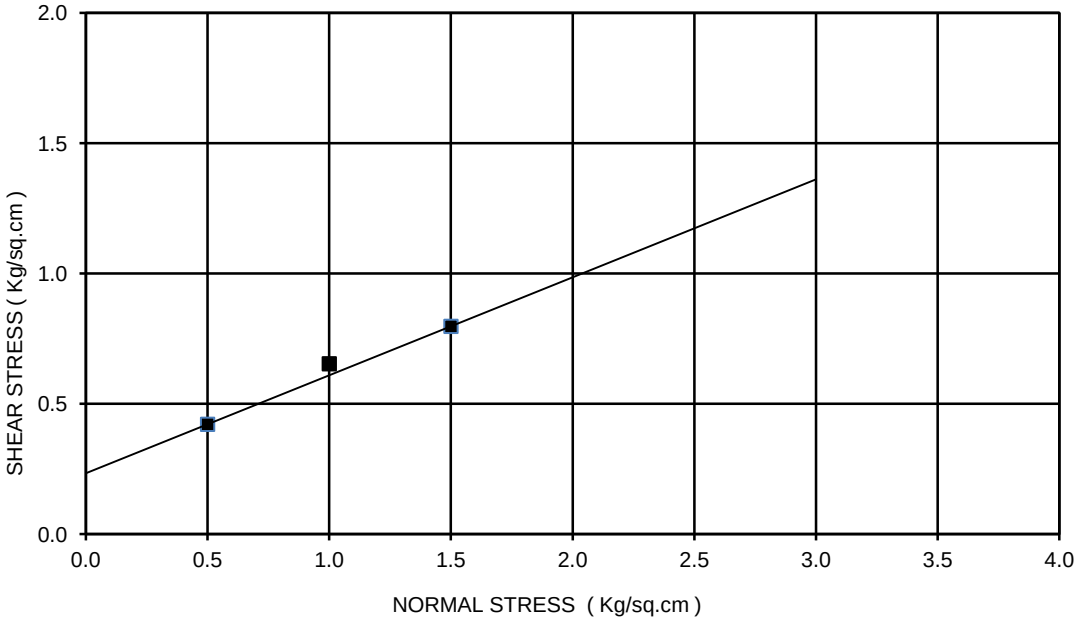


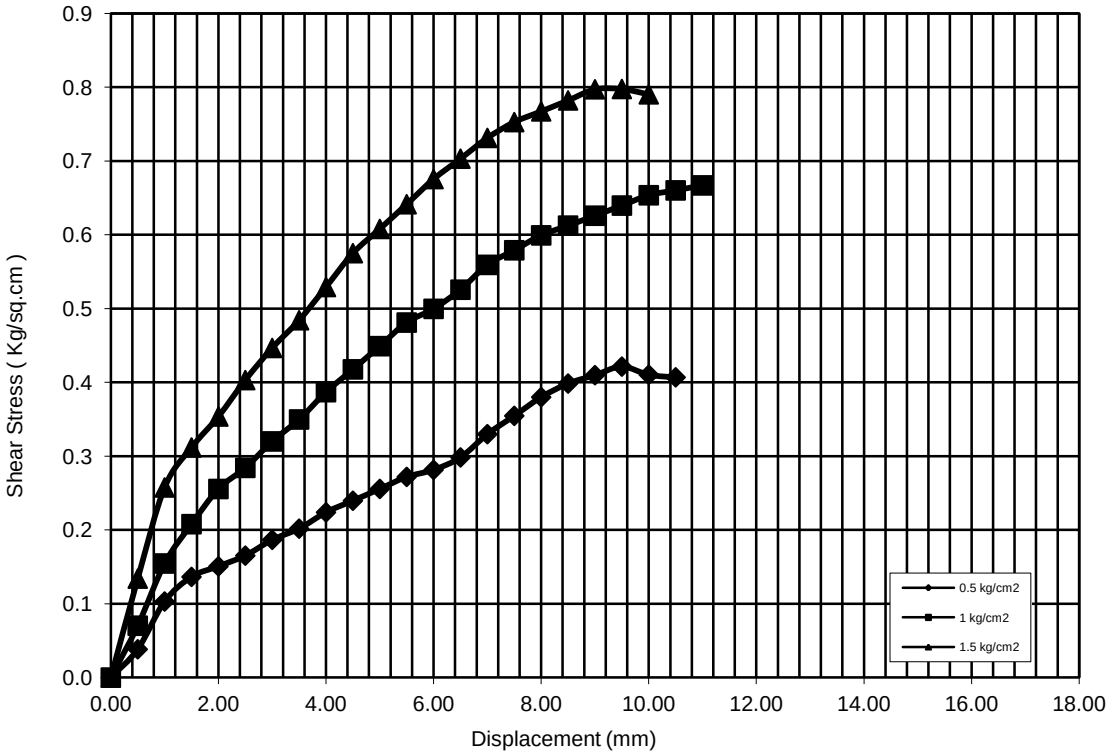
BORE HOLE NO: BH-P2
CHAINAGE: 42+256
SAMPLE NO.: SPT-17
DEPTH: 27.00 m
COHESION(C)= 0.04 kg/sq.cm
ANGLE OF FRICTION(Phi): 30 deg
TYPE OF THE TEST: DST+



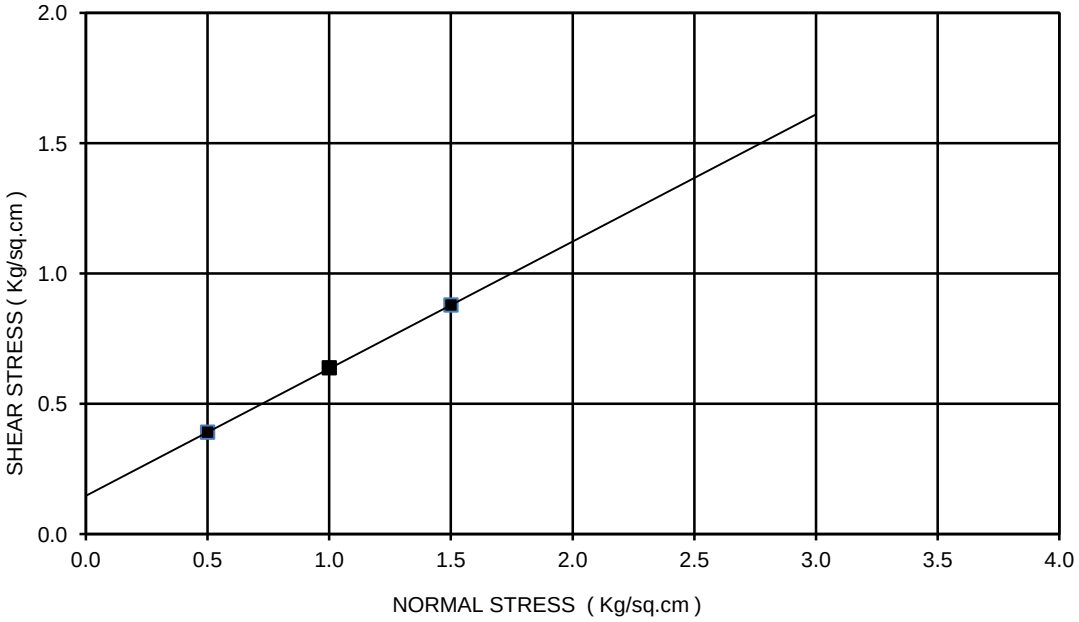


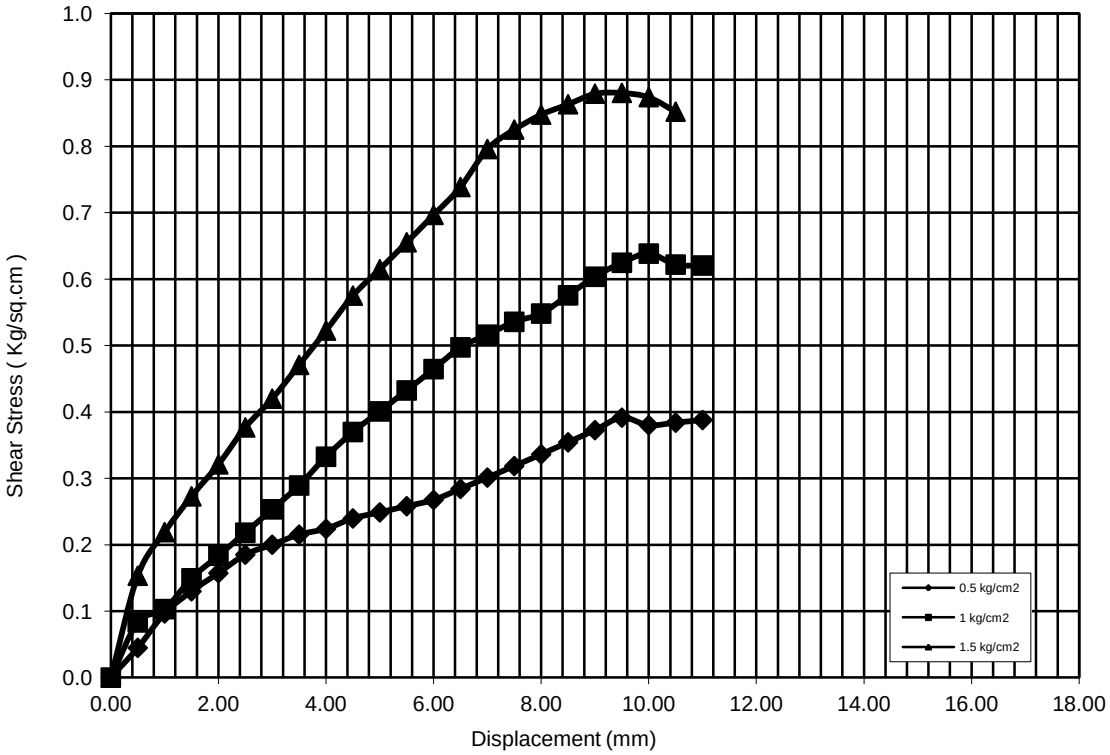
BORE HOLE NO: BH-P3
CHAINAGE: 42+256
SAMPLE NO.: UDS-4
DEPTH: 13.00 m
COHESION(C)= 0.08 kg/sq.cm
ANGLE OF FRICTION(Phi): 26 deg
TYPE OF THE TEST: DST



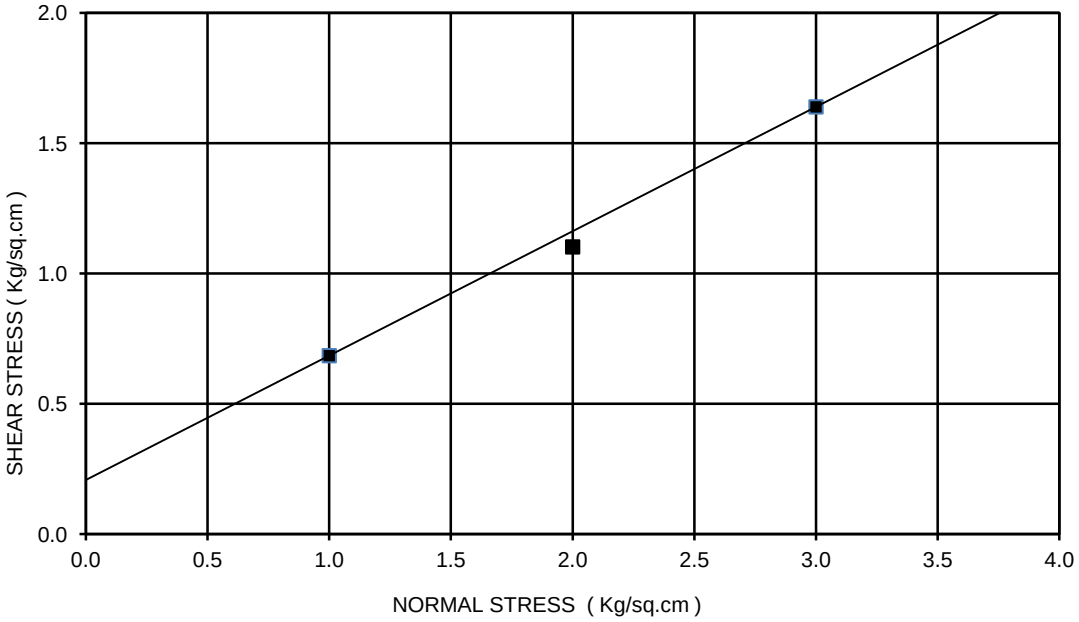


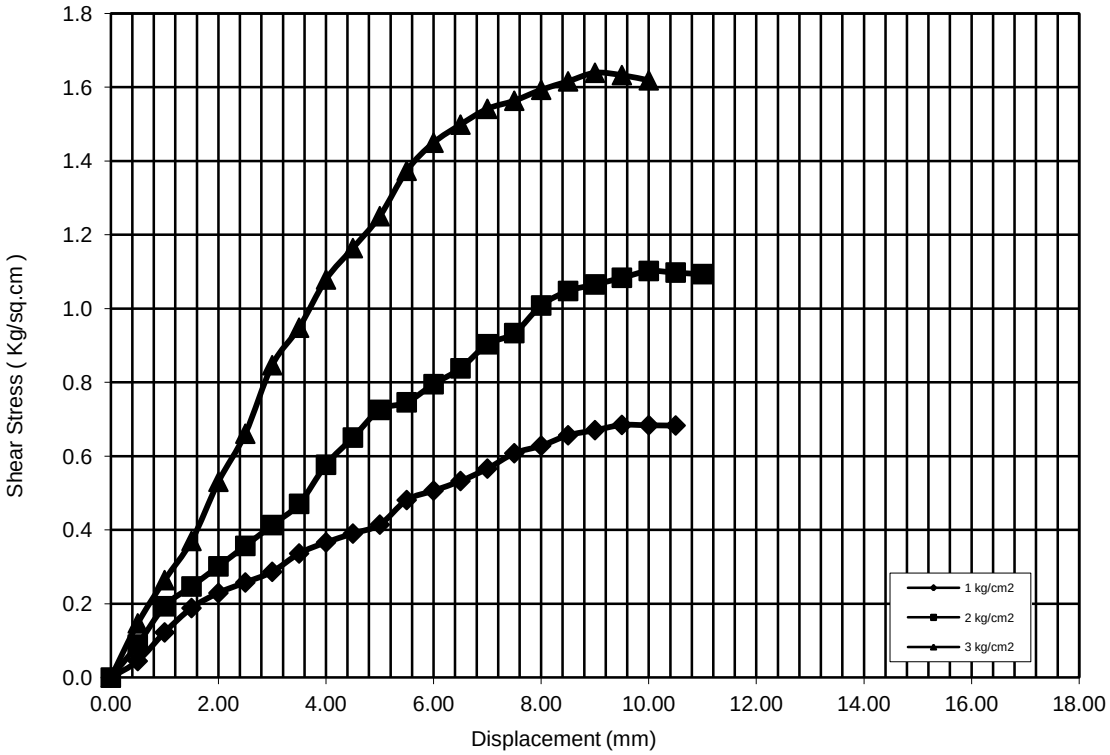
BORE HOLE NO: BH-P3
CHAINAGE: 42+256
SAMPLE NO.: UDS-1
DEPTH: 1.00 m
COHESION(C)= 0.09 kg/sq.cm
ANGLE OF FRICTION(Phi): 27 deg
TYPE OF THE TEST: DST



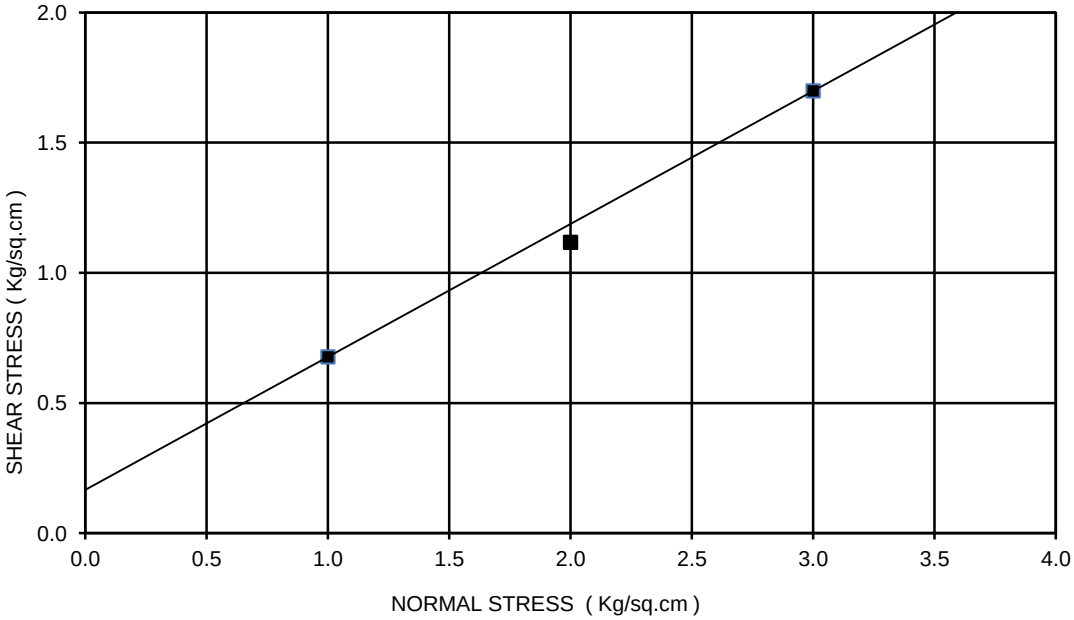


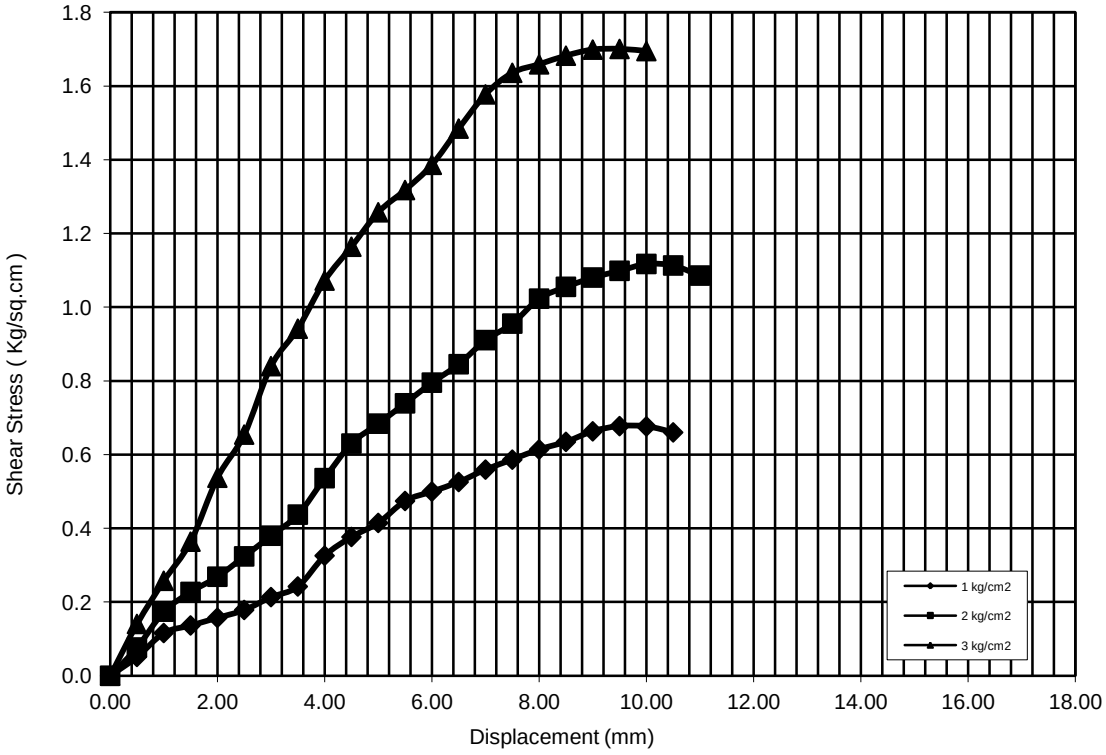
BORE HOLE NO: BH-P3
CHAINAGE: 42+256
SAMPLE NO.: UDS-4
DEPTH: 13.00 m
COHESION(C)= 0.08 kg/sq.cm
ANGLE OF FRICTION(Phi): 26 deg
TYPE OF THE TEST: DST



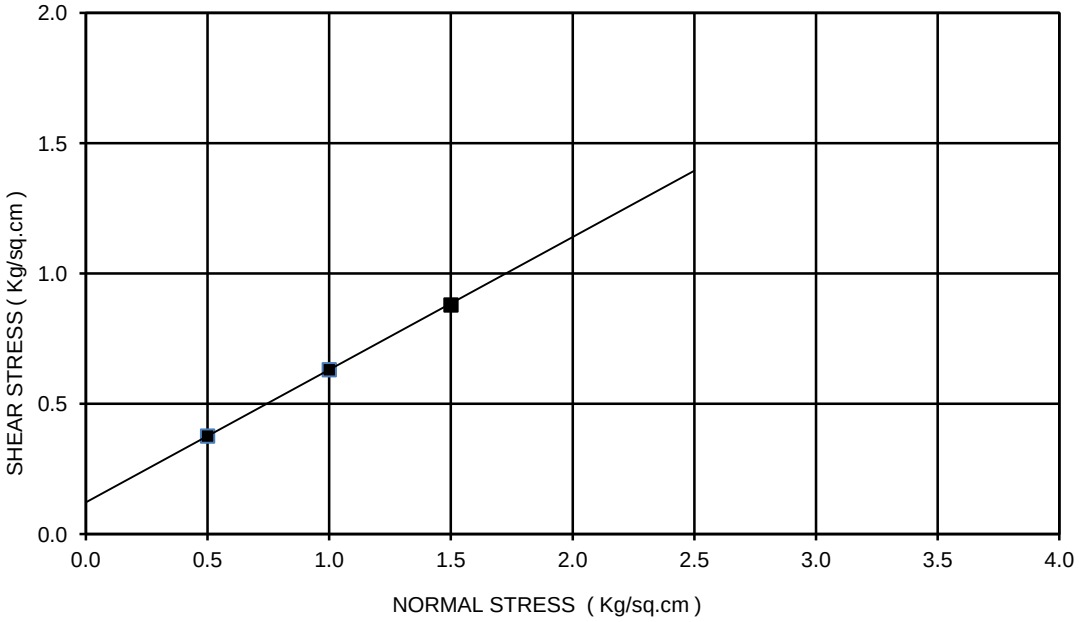


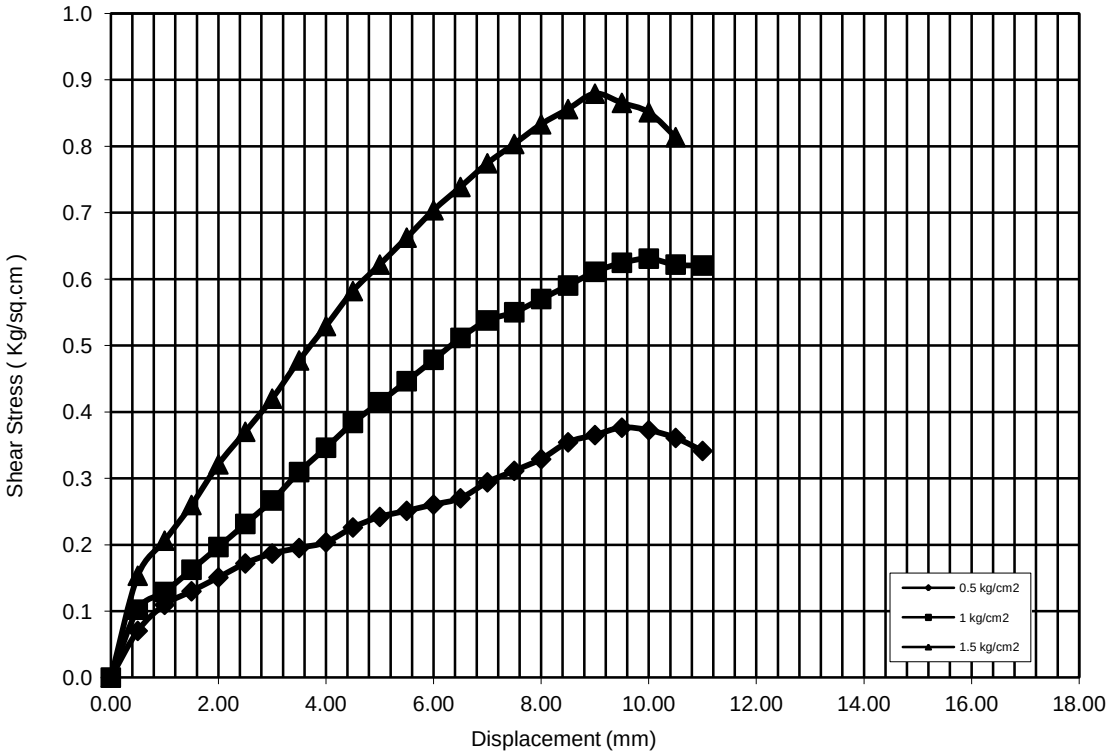
BORE HOLE NO: BH-P3
CHAINAGE: 42+256
SAMPLE NO.: UDS-4
DEPTH: 13.00 m
COHESION(C)= 0.08 kg/sq.cm
ANGLE OF FRICTION(Phi): 26 deg
TYPE OF THE TEST: DST



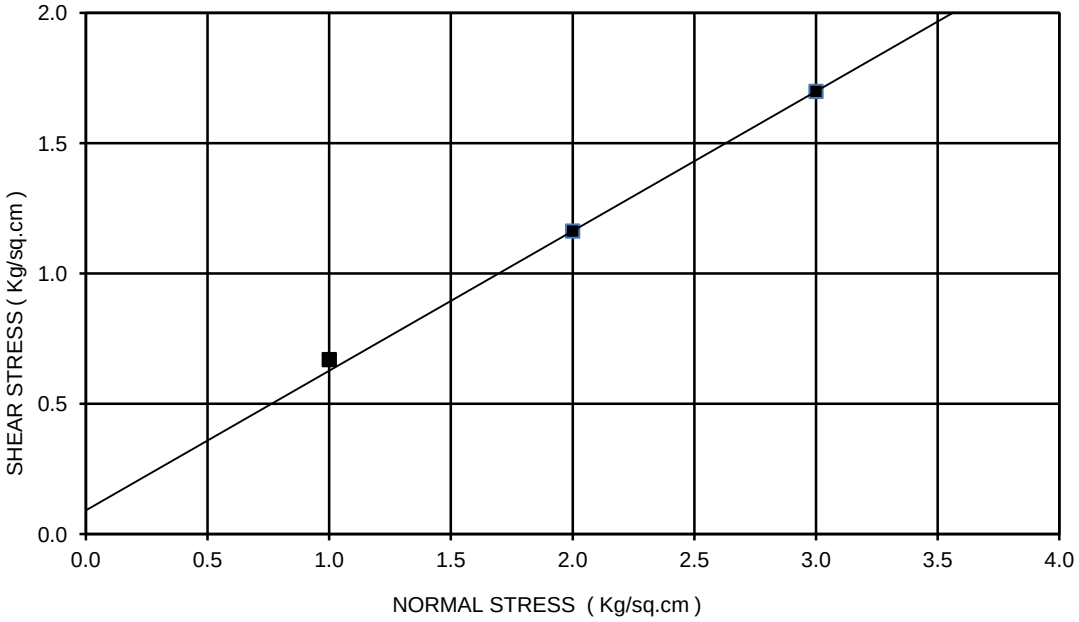


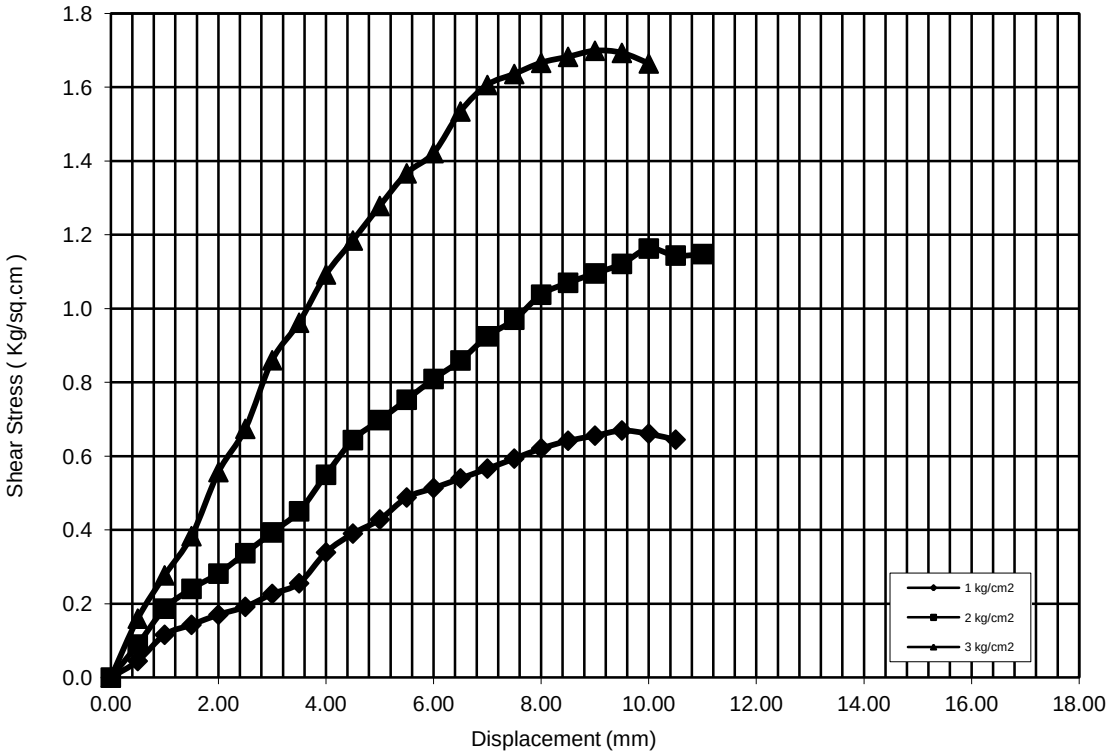
BORE HOLE NO: BH-P4
CHAINAGE: 42+256
SAMPLE NO.: UDS-1
DEPTH: 2.50 m
COHESION(C)= 0.08 kg/sq.cm
ANGLE OF FRICTION(Phi): 28 deg
TYPE OF THE TEST: DST



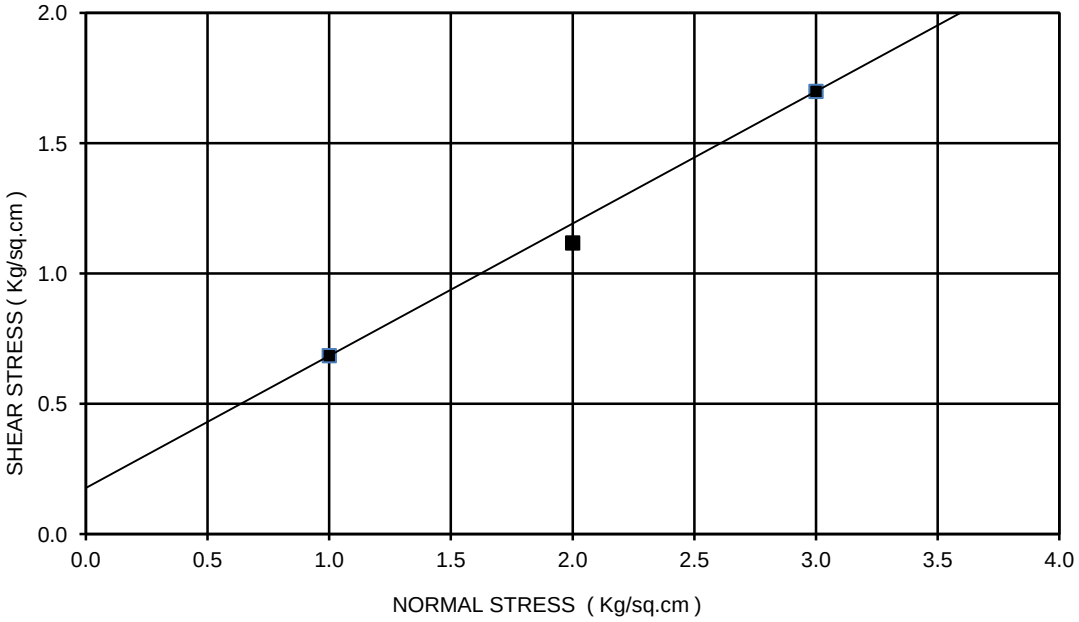


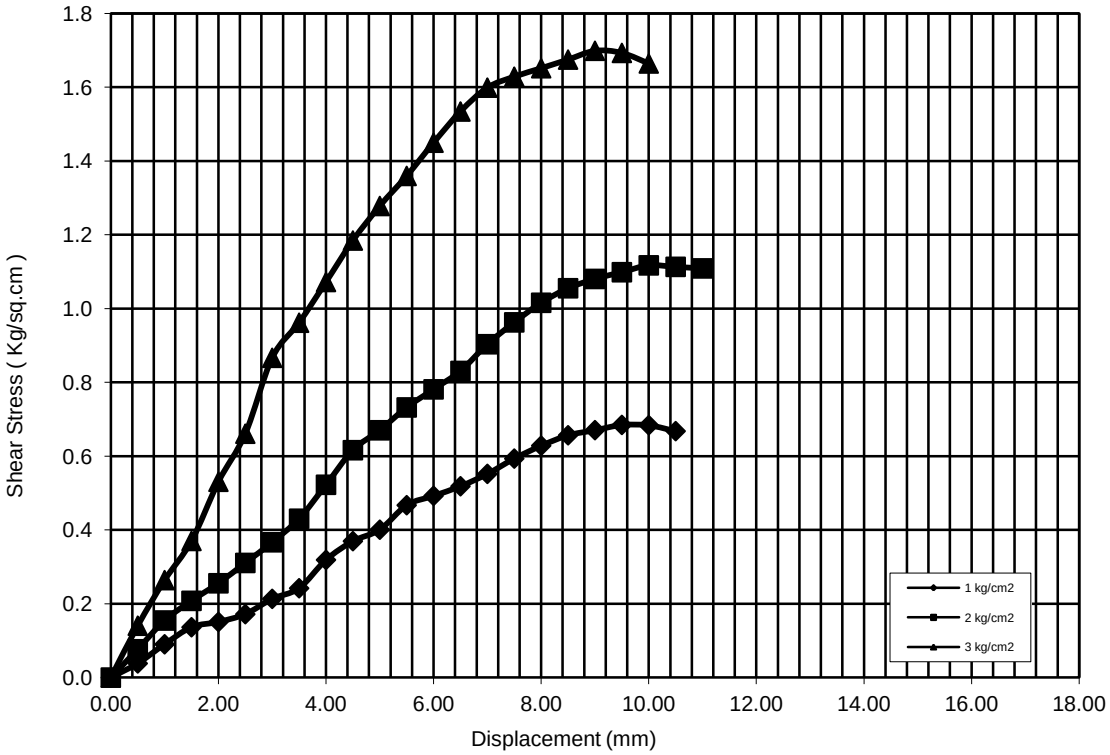
BORE HOLE NO: BH-P4
CHAINAGE: 42+256
SAMPLE NO.: UDS-8
DEPTH: 23.50 m
COHESION(C)= -0.01 kg/sq.cm
ANGLE OF FRICTION(Phi): 30 deg
TYPE OF THE TEST: DST



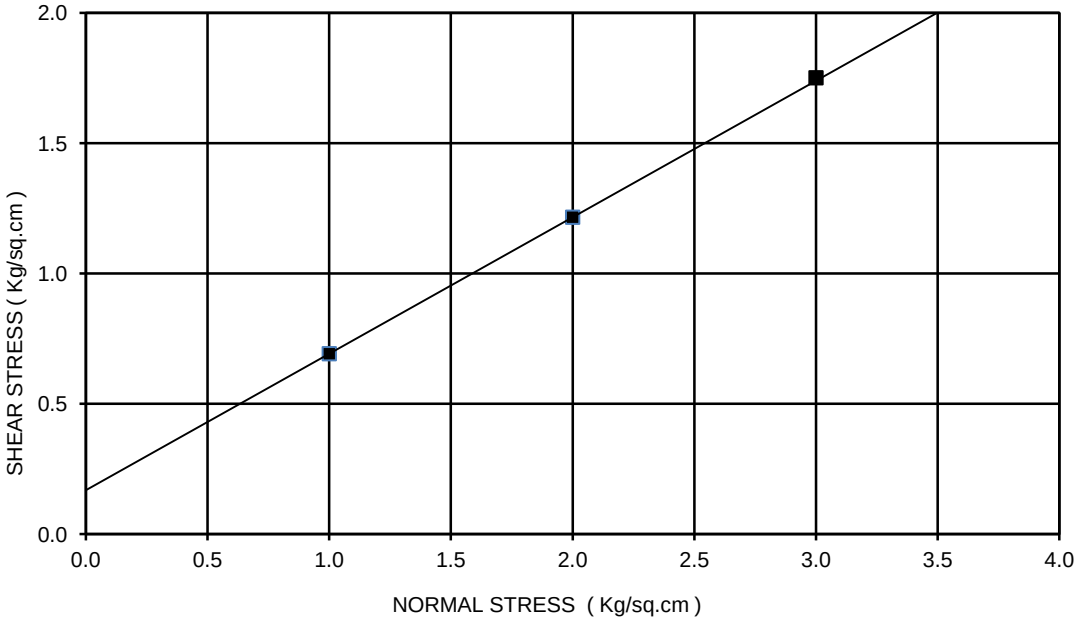


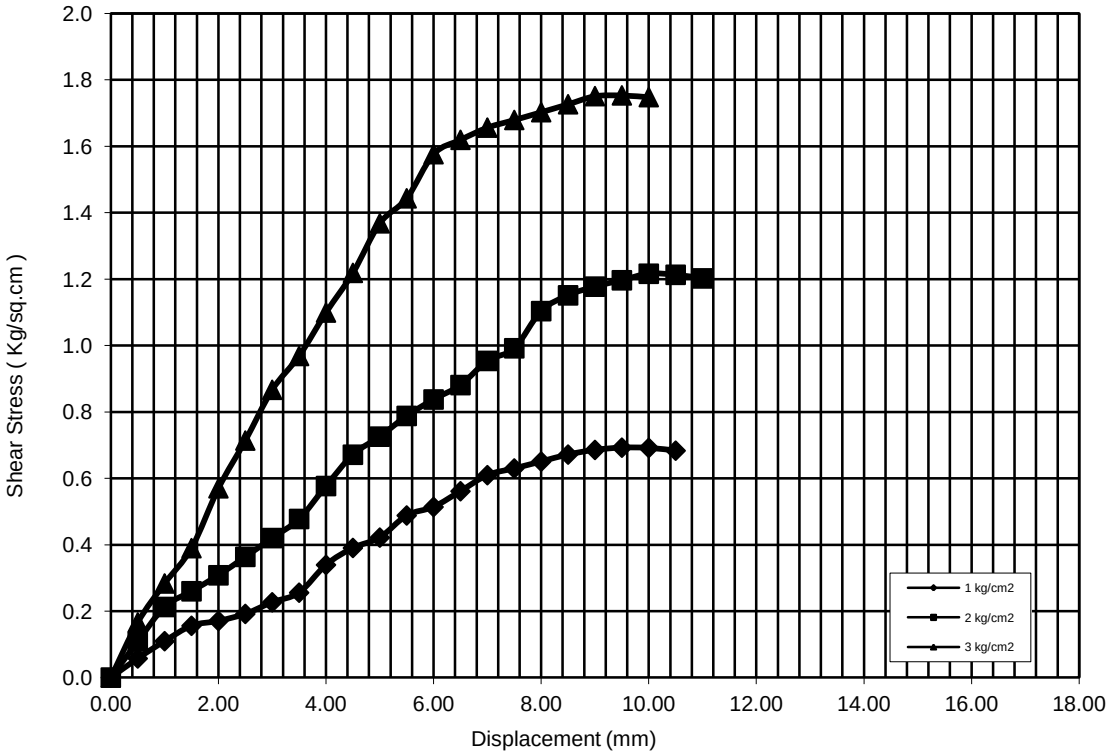
BORE HOLE NO: BH-P4
CHAINAGE: 42+256
SAMPLE NO.: UDS-4
DEPTH: 13.00 m
COHESION(C)= 0.08 kg/sq.cm
ANGLE OF FRICTION(Phi): 26 deg
TYPE OF THE TEST: DST



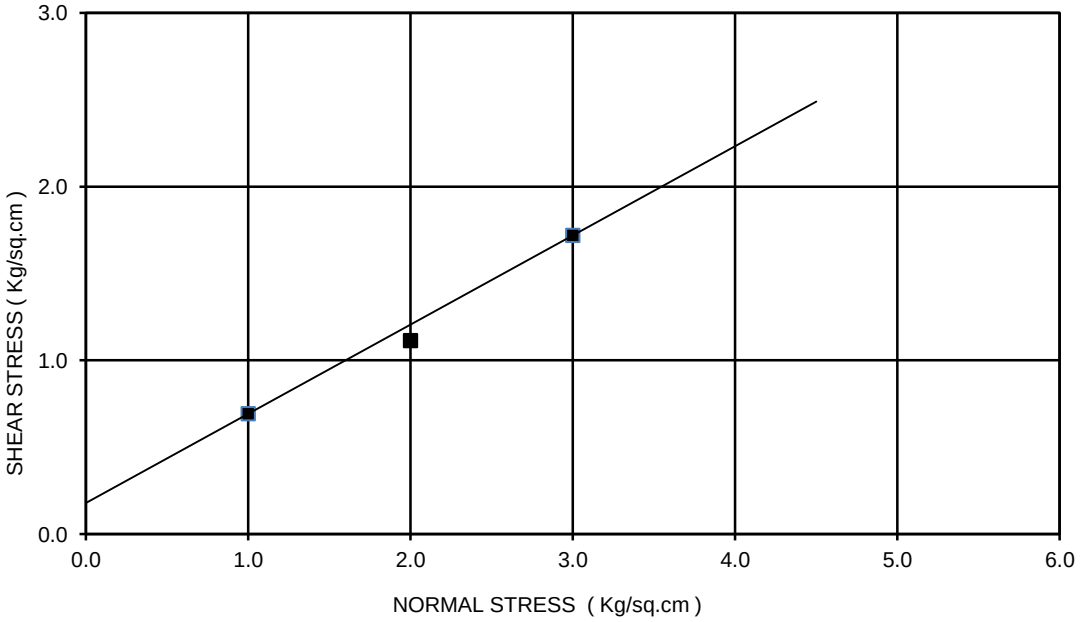


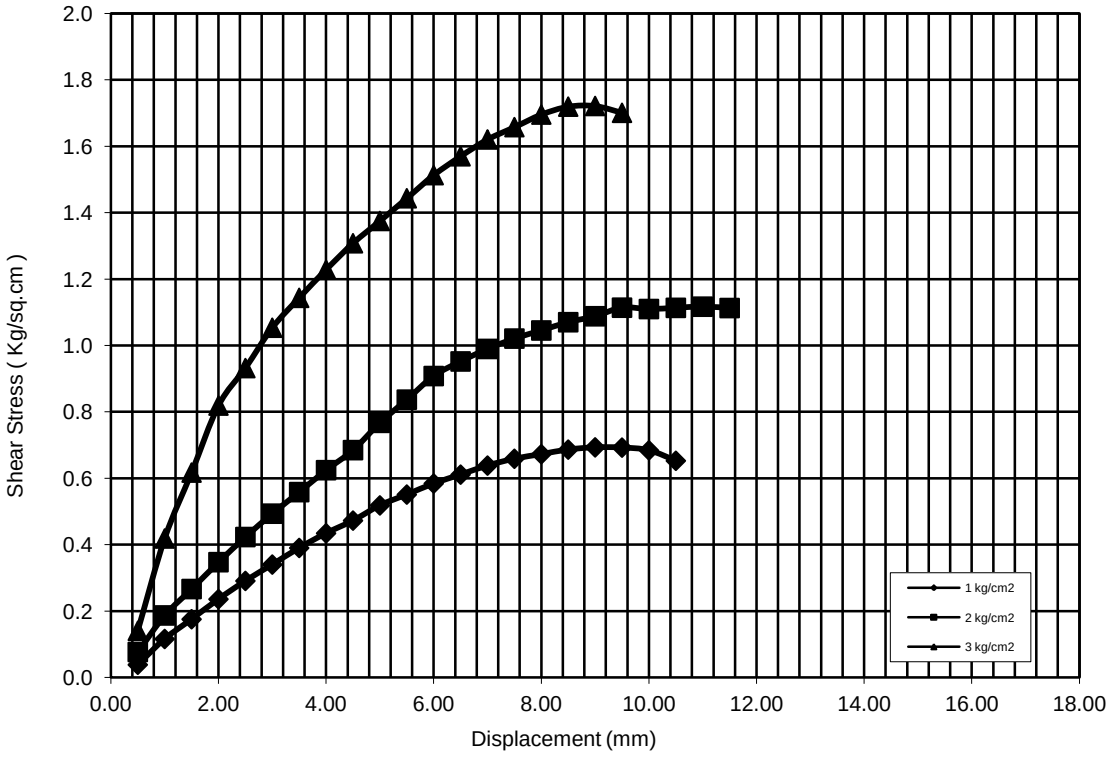
BORE HOLE NO: BH-P4
CHAINAGE: 42+256
SAMPLE NO.: UDS-6
DEPTH: 17.50 m
COHESION(C)= 0.18 kg/sq.cm
ANGLE OF FRICTION(Phi): 27 deg
TYPE OF THE TEST: DST



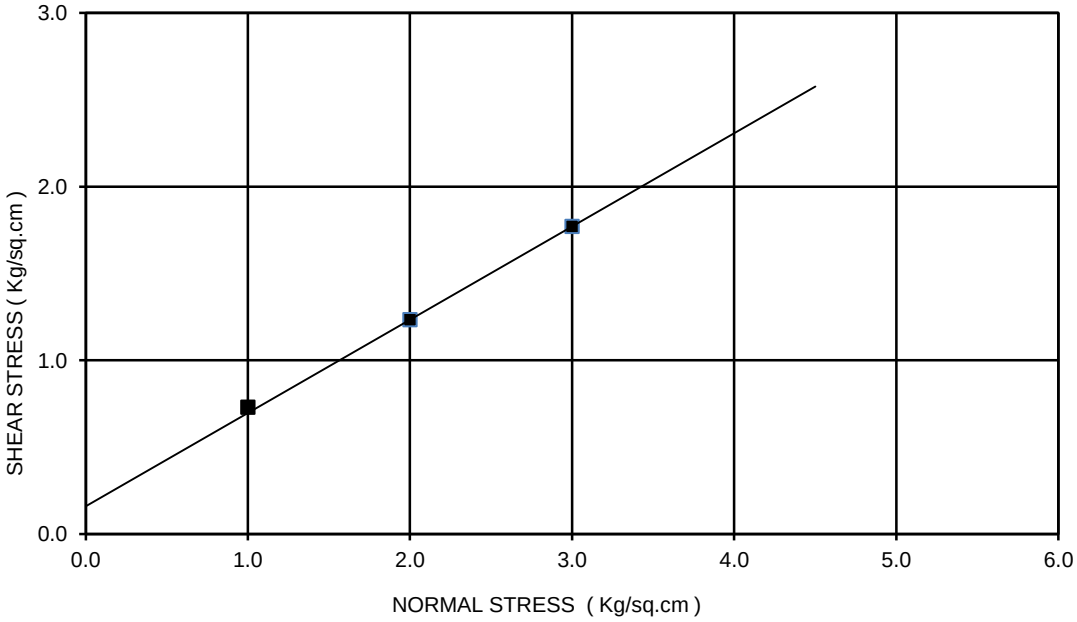


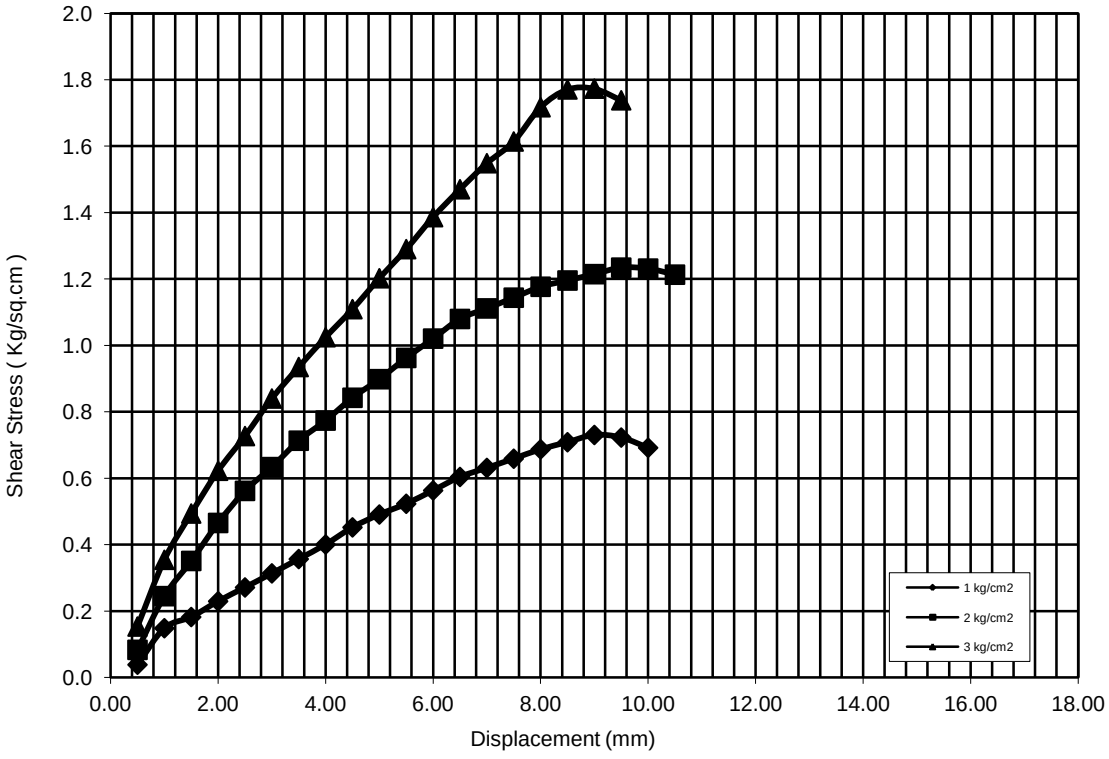
BORE HOLE NO: BH-P6
CHAINAGE: 42+256
SAMPLE NO.: SPT-28
DEPTH: 43.50 m
COHESION(C)= 0.24 kg/sq.cm
ANGLE OF FRICTION(Phi): 24 deg
TYPE OF THE TEST: DST



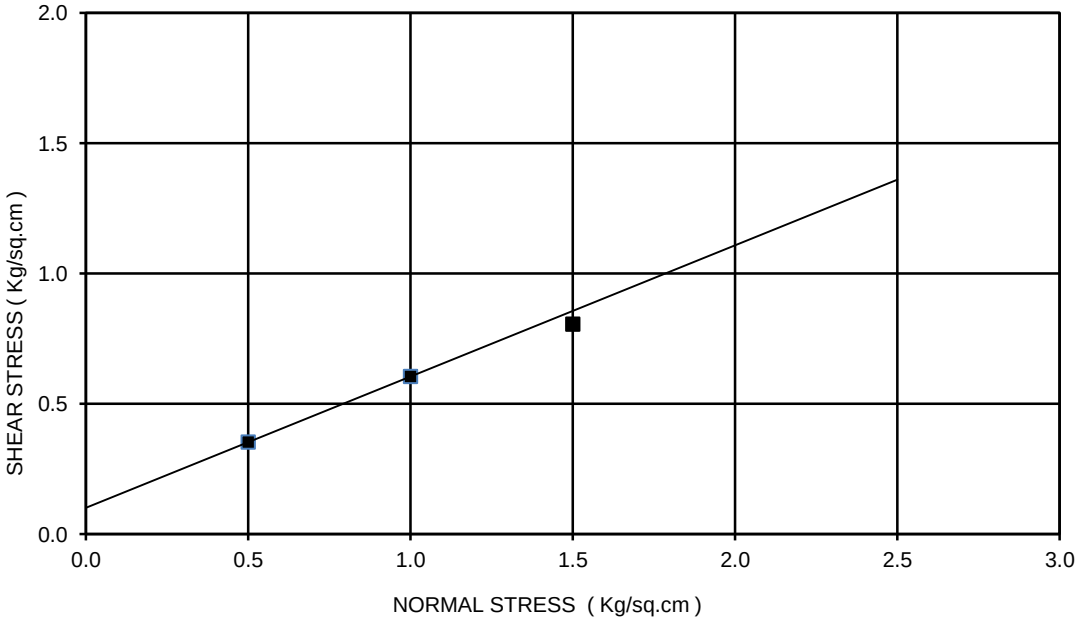


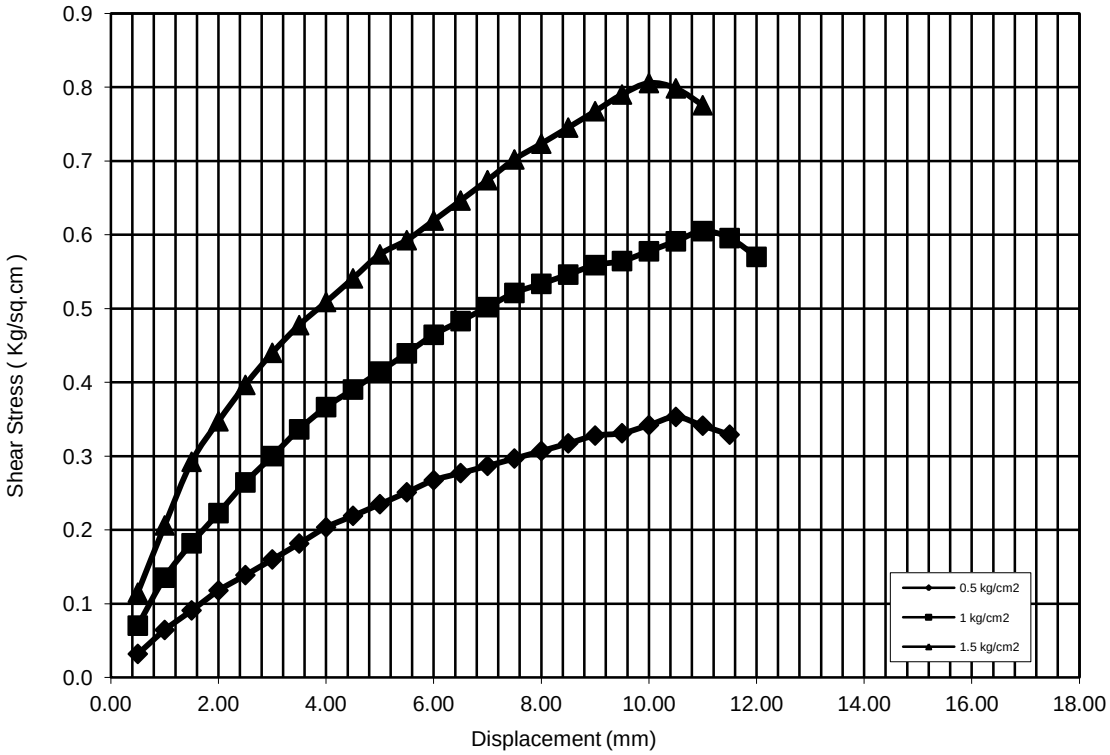
BORE HOLE NO: BH-P6
CHAINAGE: 42+256
SAMPLE NO.: UDS-5
DEPTH: 22.00 m
COHESION(C)= 0.35 kg/sq.cm
ANGLE OF FRICTION(Phi): 24 deg
TYPE OF THE TEST: DST



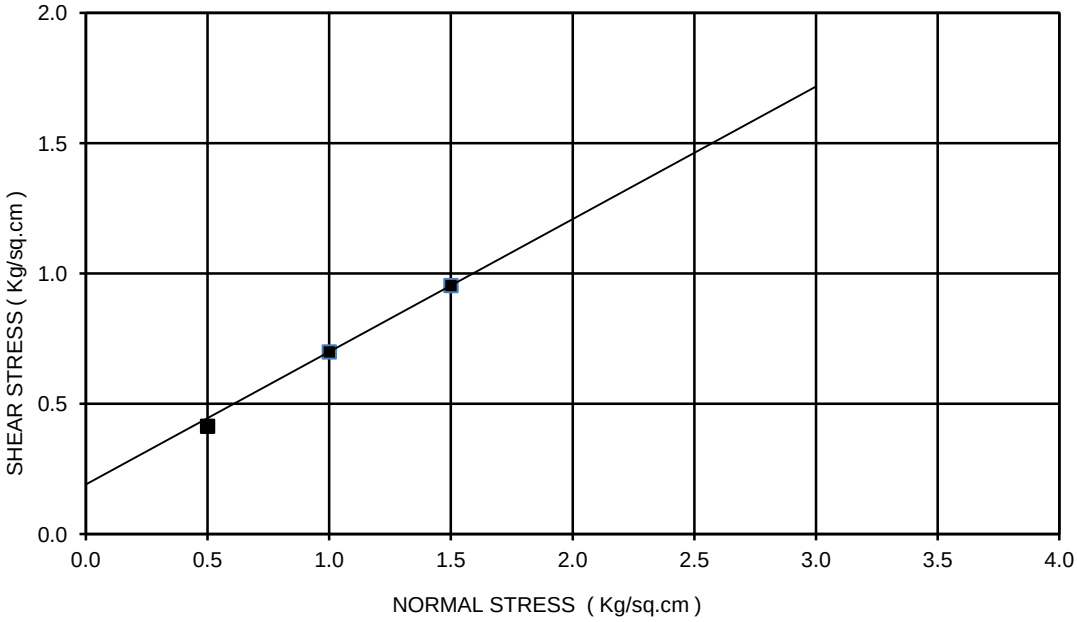


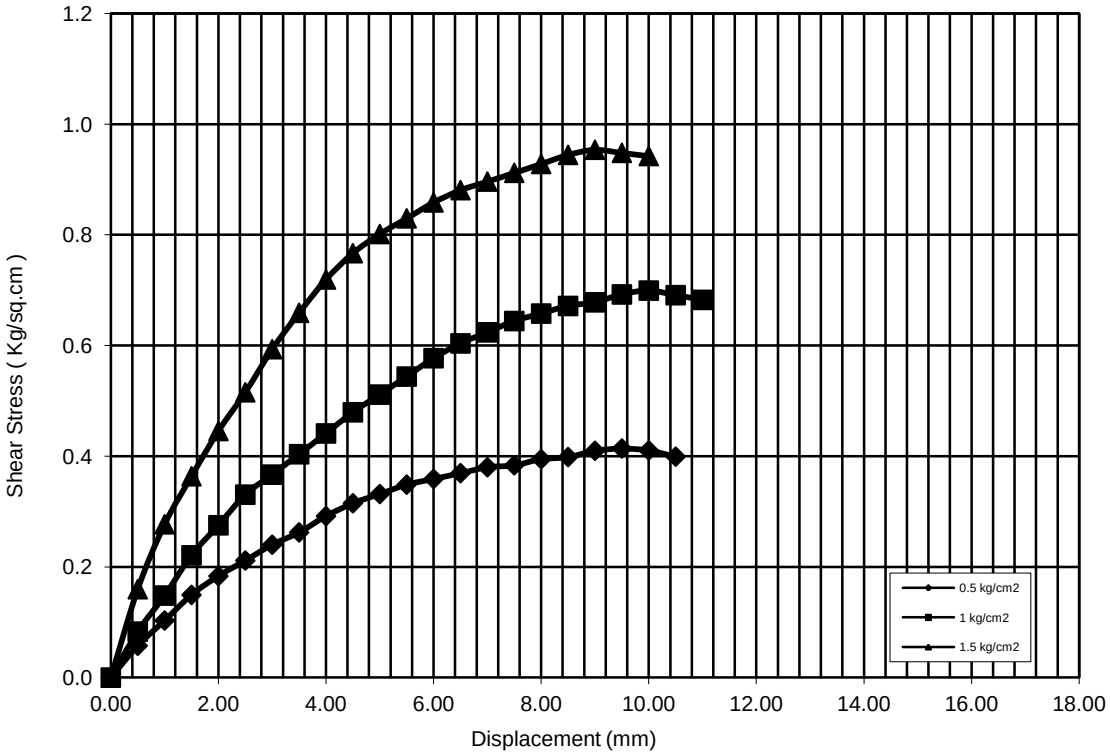
BORE HOLE NO: BH-P13
CHAINAGE: 42+256
SAMPLE NO.: UDS-1
DEPTH: 4.00 m
COHESION(C)= 0.17 kg/sq.cm
ANGLE OF FRICTION(Phi): 22 deg
TYPE OF THE TEST: DST



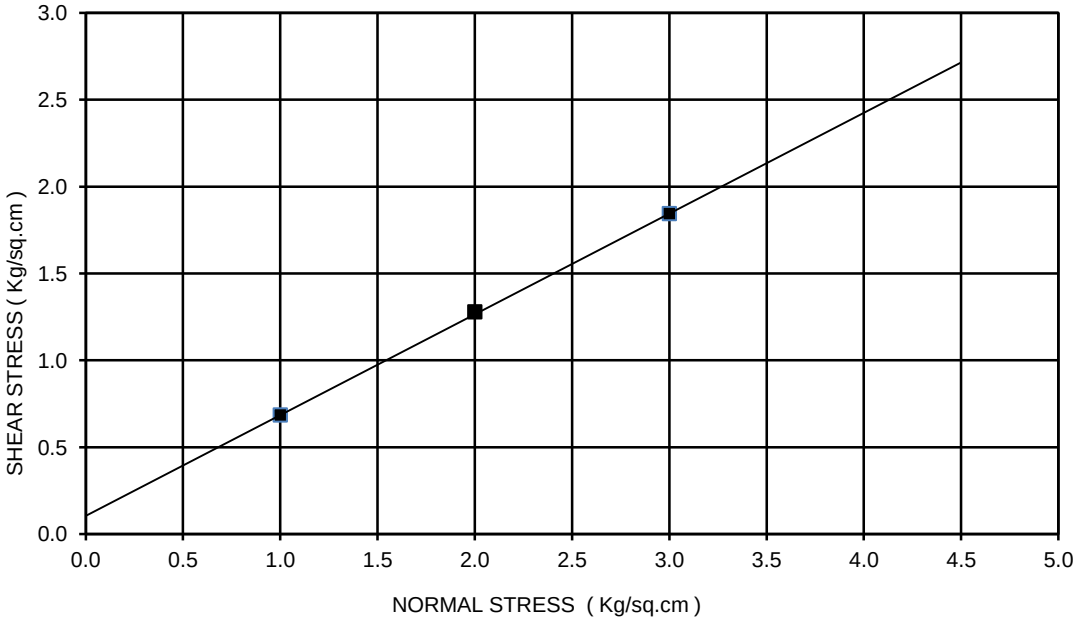


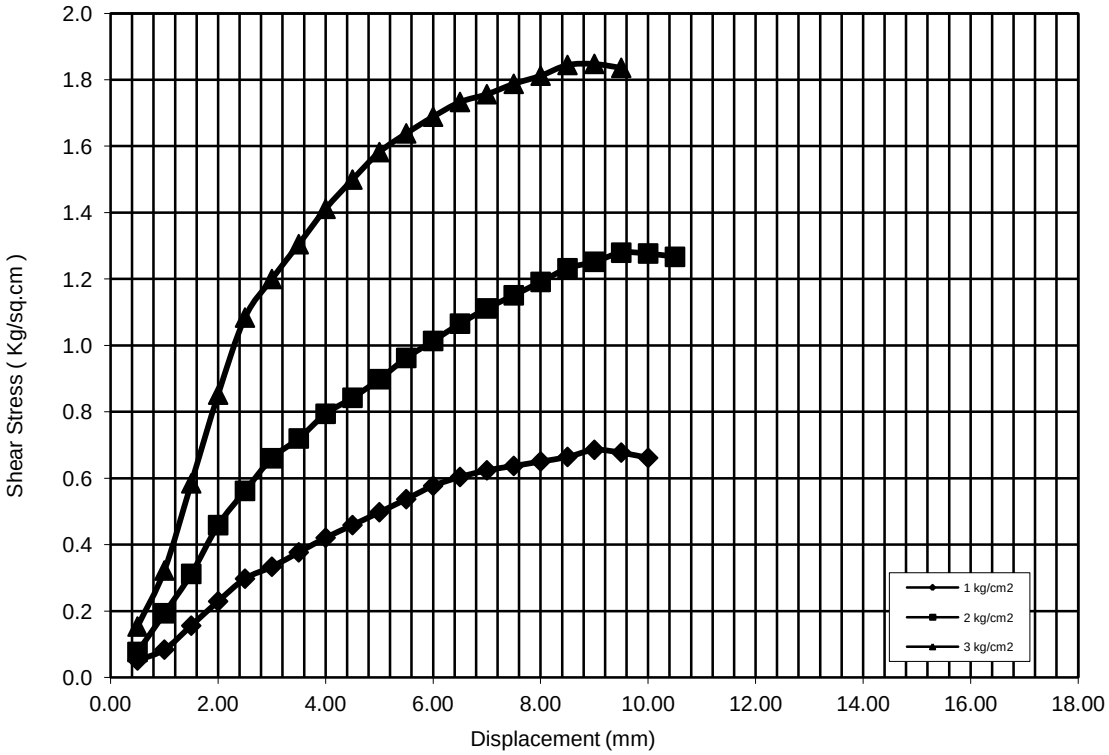
BORE HOLE NO: BH-P13
CHAINAGE: 42+256
SAMPLE NO.: UDS-1
DEPTH: 2.50 m
COHESION(C)= 0.16 kg/sq.cm
ANGLE OF FRICTION(Phi): 25 deg
TYPE OF THE TEST: DST



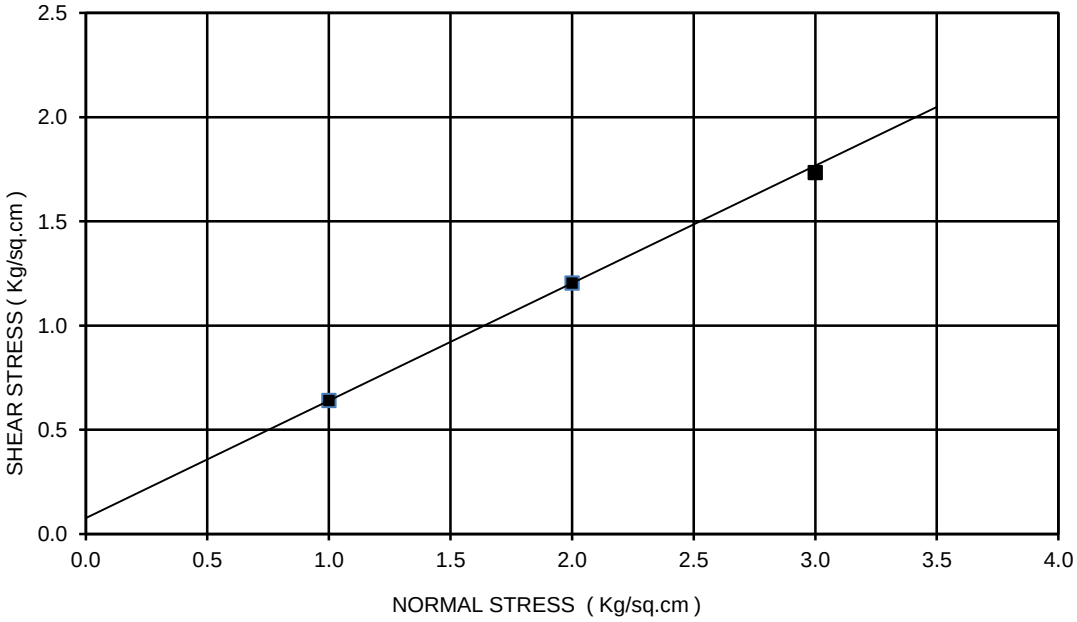


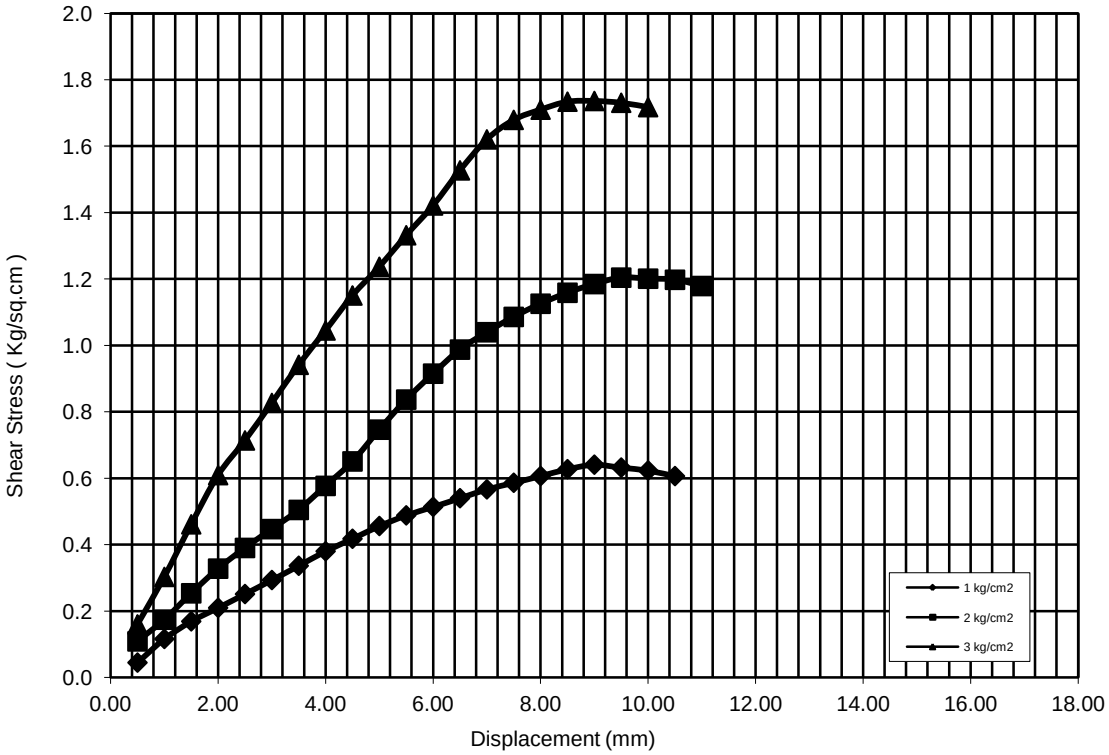
BORE HOLE NO: BH-P13
CHAINAGE: 42+256
SAMPLE NO.: UDS-2
DEPTH: 7.00 m
COHESION(C)= 0.11 kg/sq.cm
ANGLE OF FRICTION(Phi): 30 deg
TYPE OF THE TEST: DST



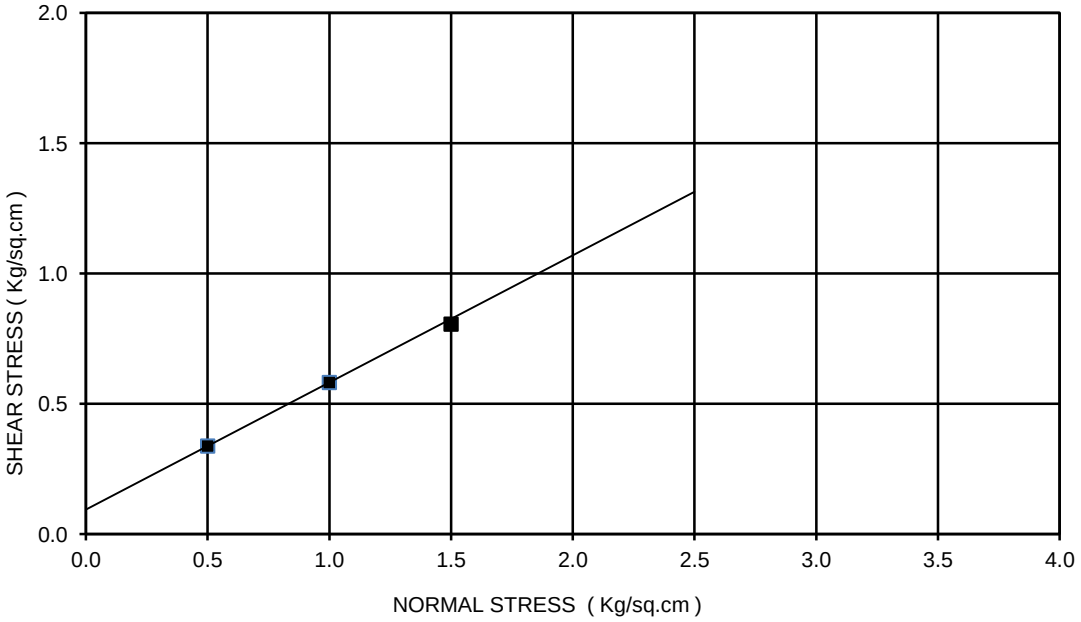


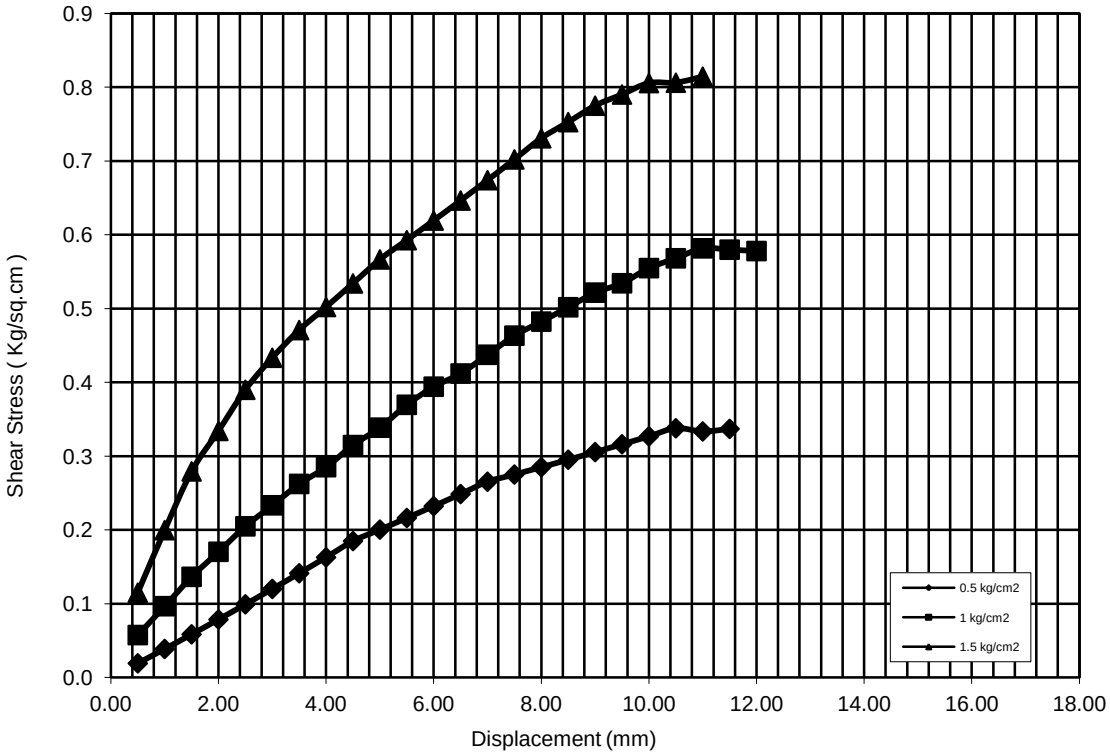
BORE HOLE NO: BH-P13
CHAINAGE: 42+256
SAMPLE NO.: UDS-2
DEPTH: 7.00 m
COHESION(C)= 0.08 kg/sq.cm
ANGLE OF FRICTION(Phi): 29 deg
TYPE OF THE TEST: DST



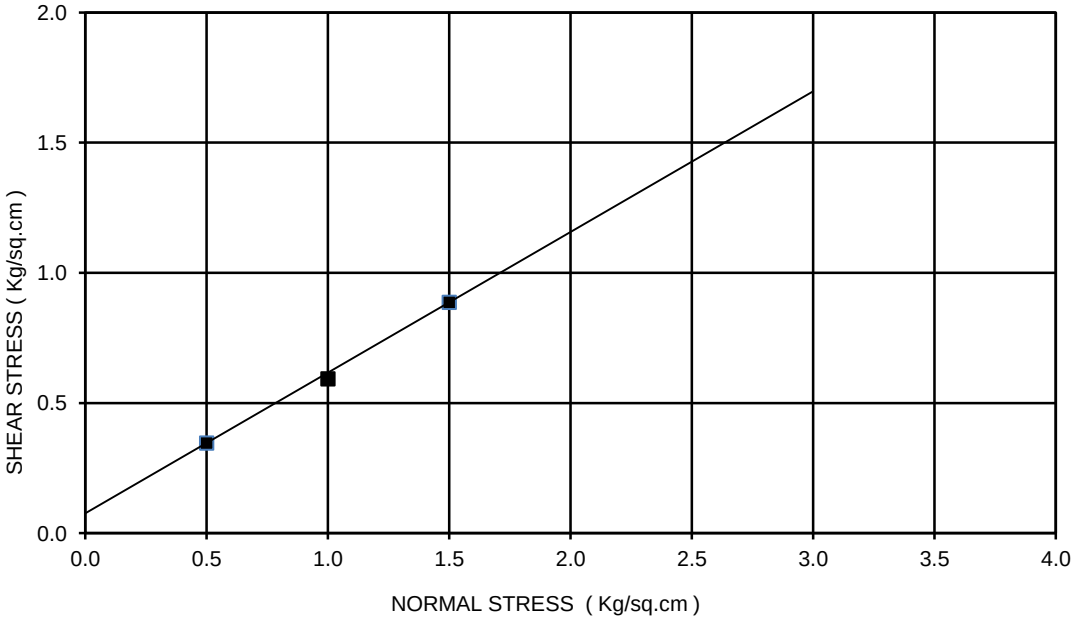


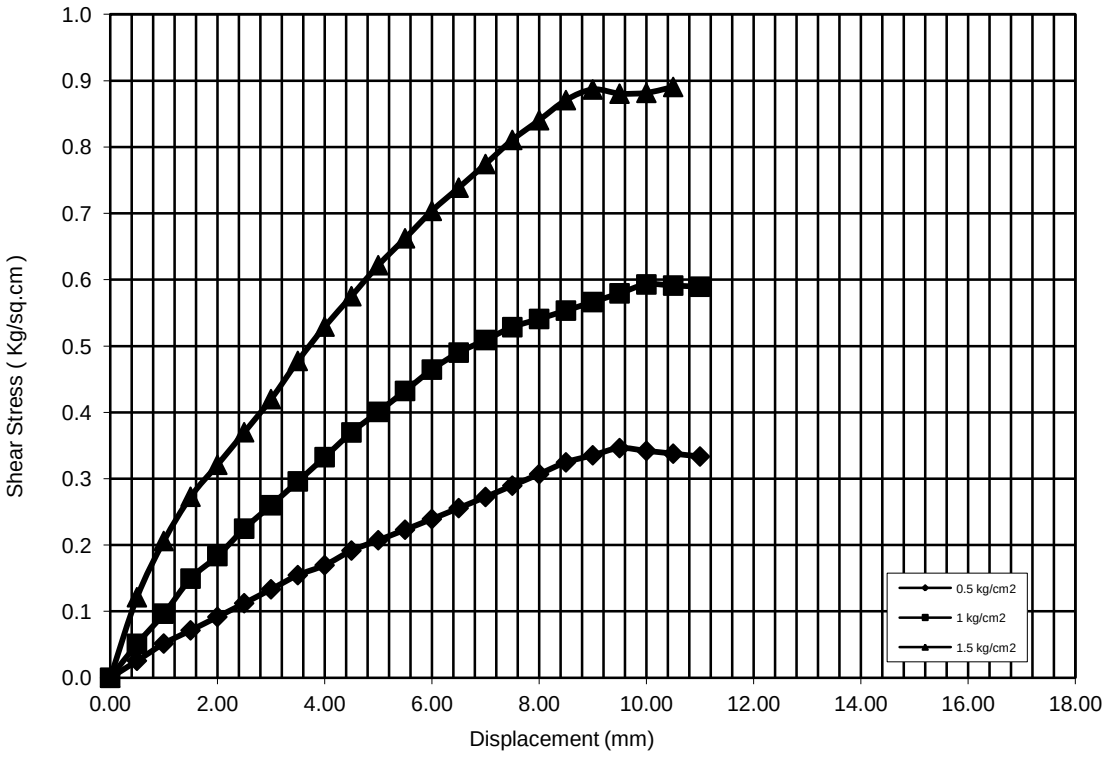
BORE HOLE NO: BH-PLT-02
CHAINAGE:43+100
SAMPLE NO.: UDS-1
DEPTH: 0.75 m
COHESION(C)= 0.09 kg/sq.cm
ANGLE OF FRICTION(Phi): 26 deg
TYPE OF THE TEST: DST



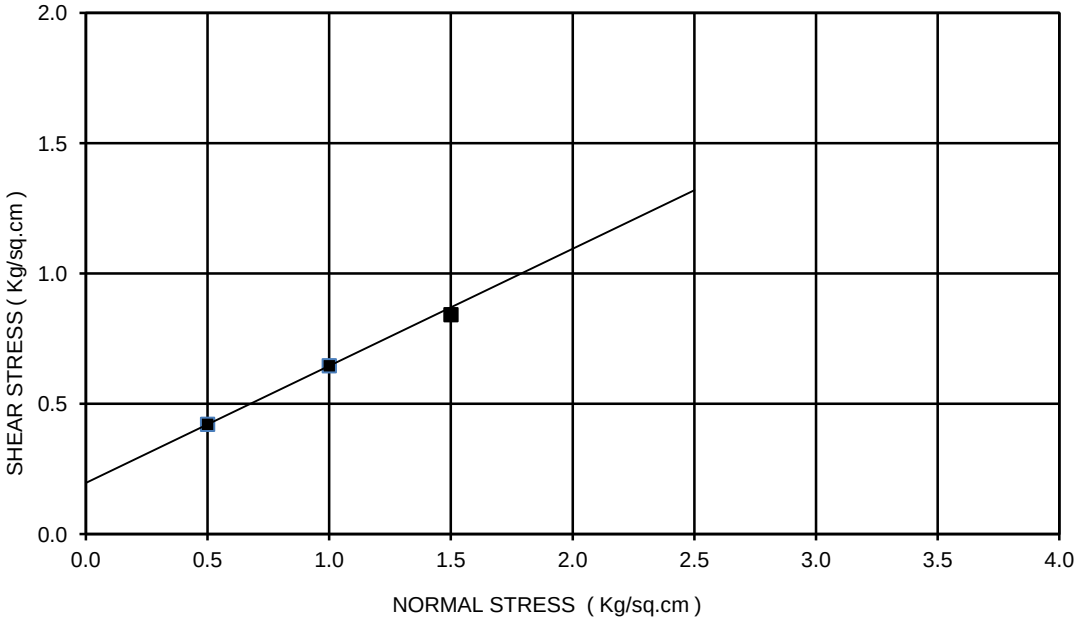


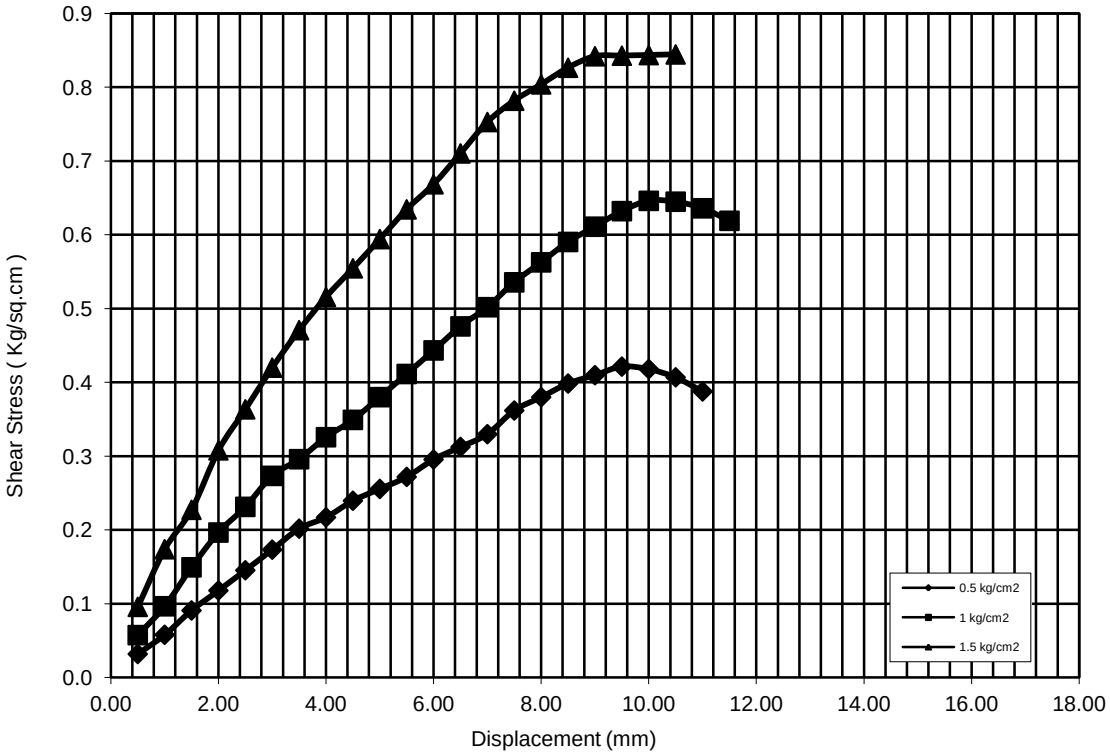
BORE HOLE NO: BH-CL
CHAINAGE: 43+452
SAMPLE NO.: UDS-1
DEPTH: 2.25 m
COHESION(C)= 0.08 kg/sq.cm
ANGLE OF FRICTION(Phi): 28 deg
TYPE OF THE TEST: DST



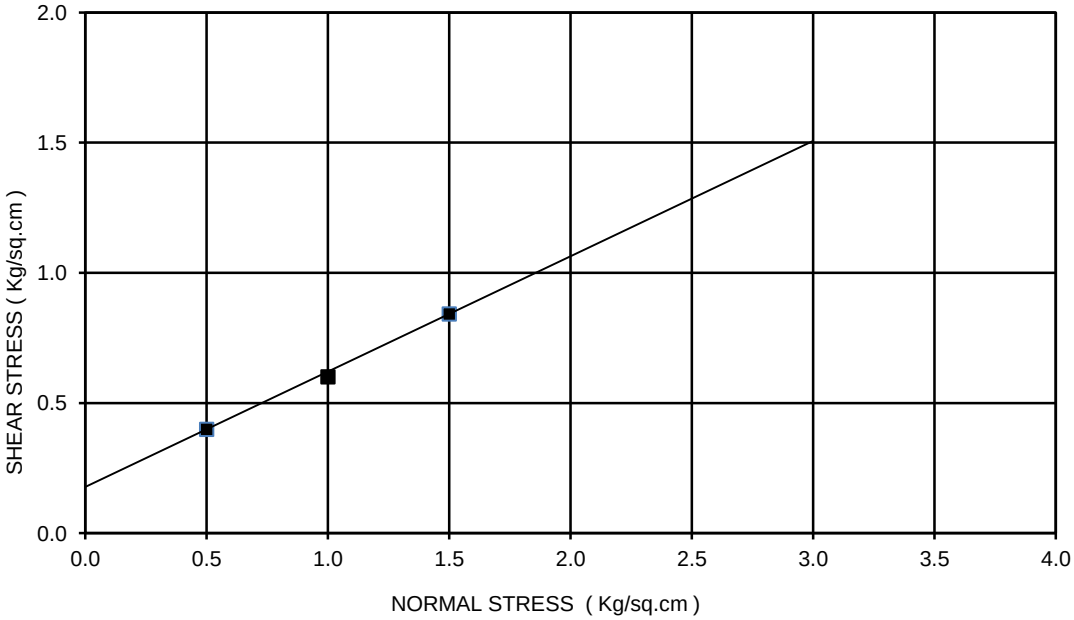


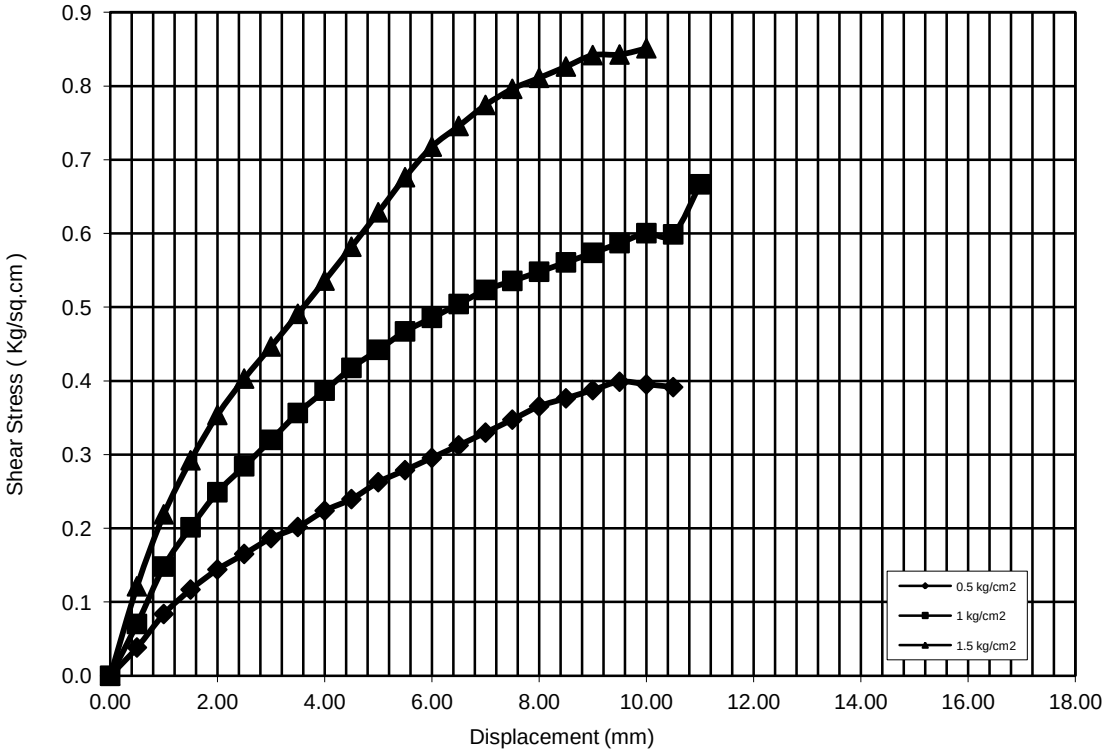
BORE HOLE NO: BH-CL
CHAINAGE: 43+585
SAMPLE NO.: UDS-1
DEPTH: 2.25 m
COHESION(C)= 0.20 kg/sq.cm
ANGLE OF FRICTION(Phi): 24 deg
TYPE OF THE TEST: DST



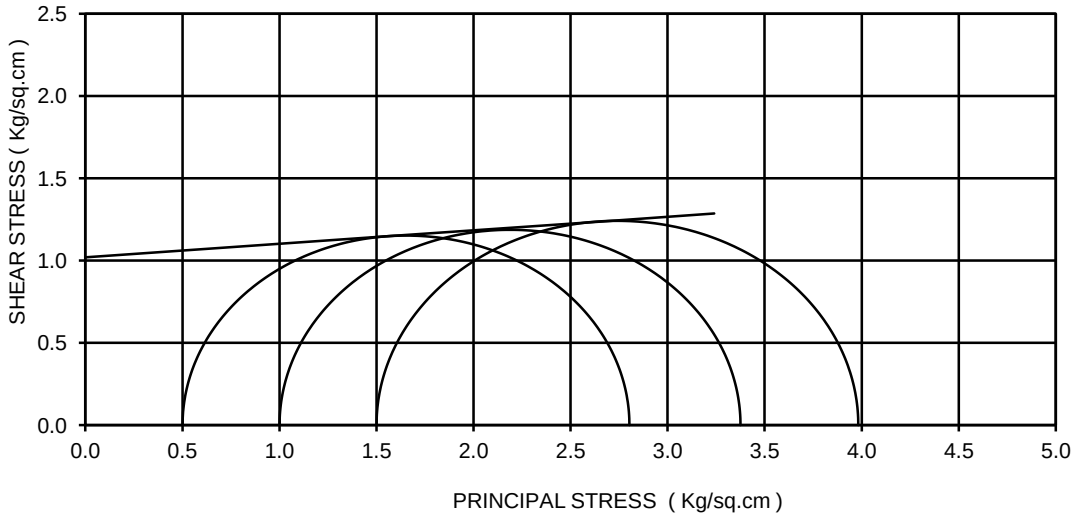


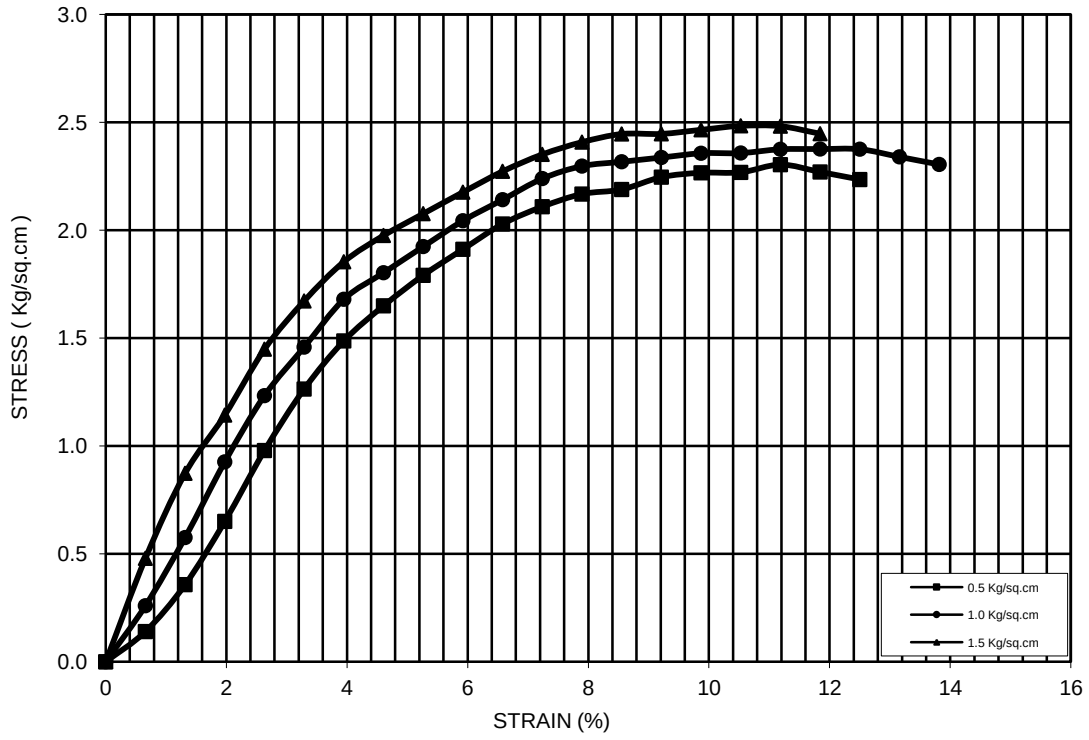
BORE HOLE NO: BH-CL
CHAINAGE : 43+732
SAMPLE NO.: UDS-1
DEPTH: 1.00 m
COHESION(C)= 0.18 kg/sq.cm
ANGLE OF FRICTION(Phi): 24 deg
TYPE OF THE TEST: DST



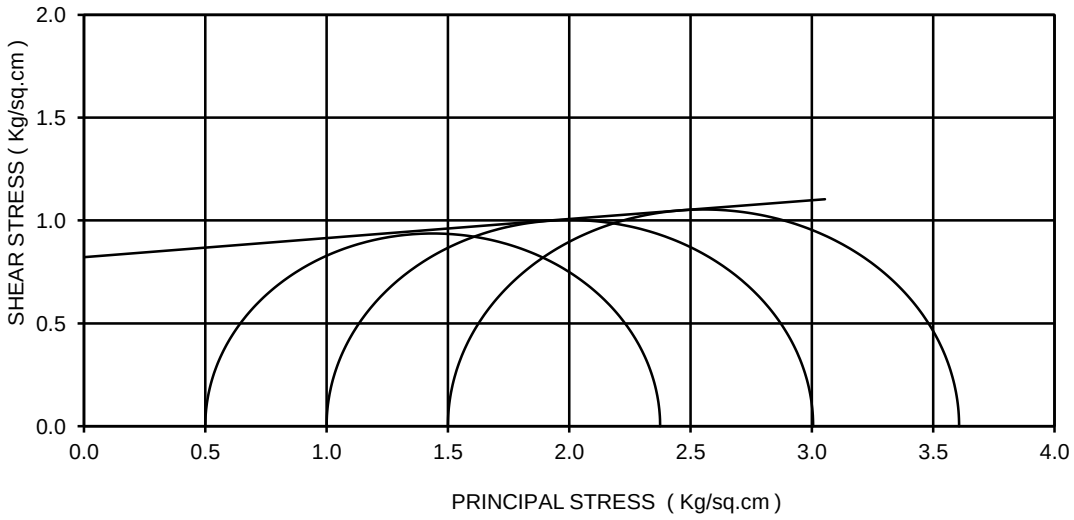


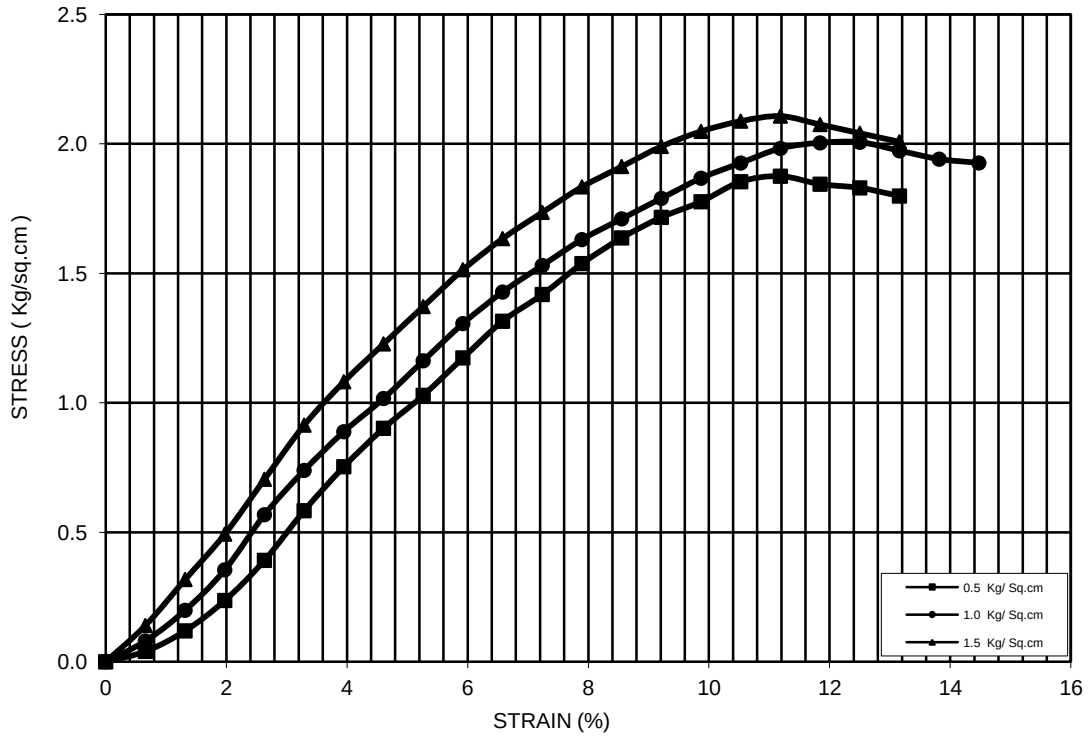
BORE HOLE NO: BH-CL
CHAINAGE: 44+050
SAMPLE NO.: UDS-1
DEPTH: 5.25 m
COHESION(C)= 1.02 kg/sq.cm
ANGLE OF FRICTION(Phi): 5 deg
TYPE OF THE TEST: UUT



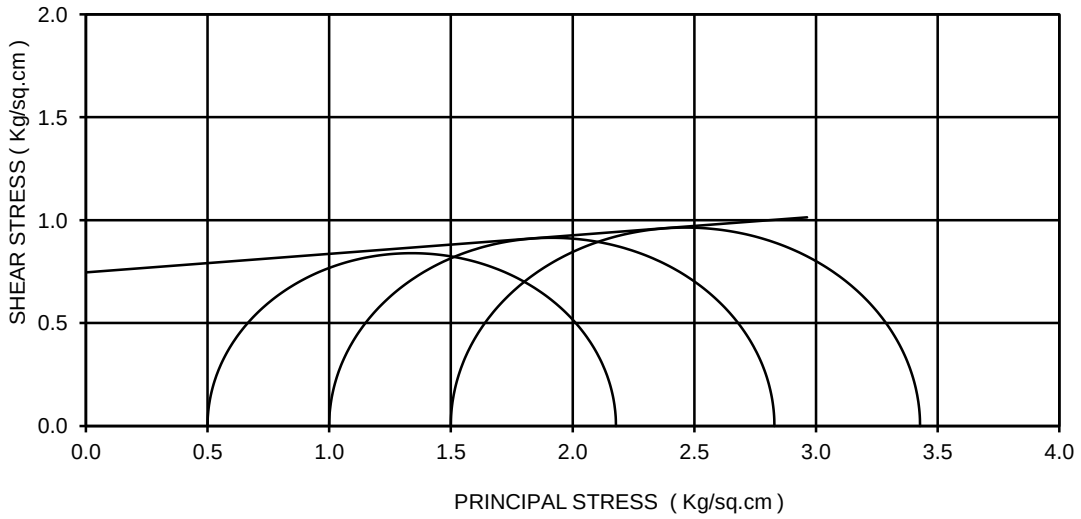


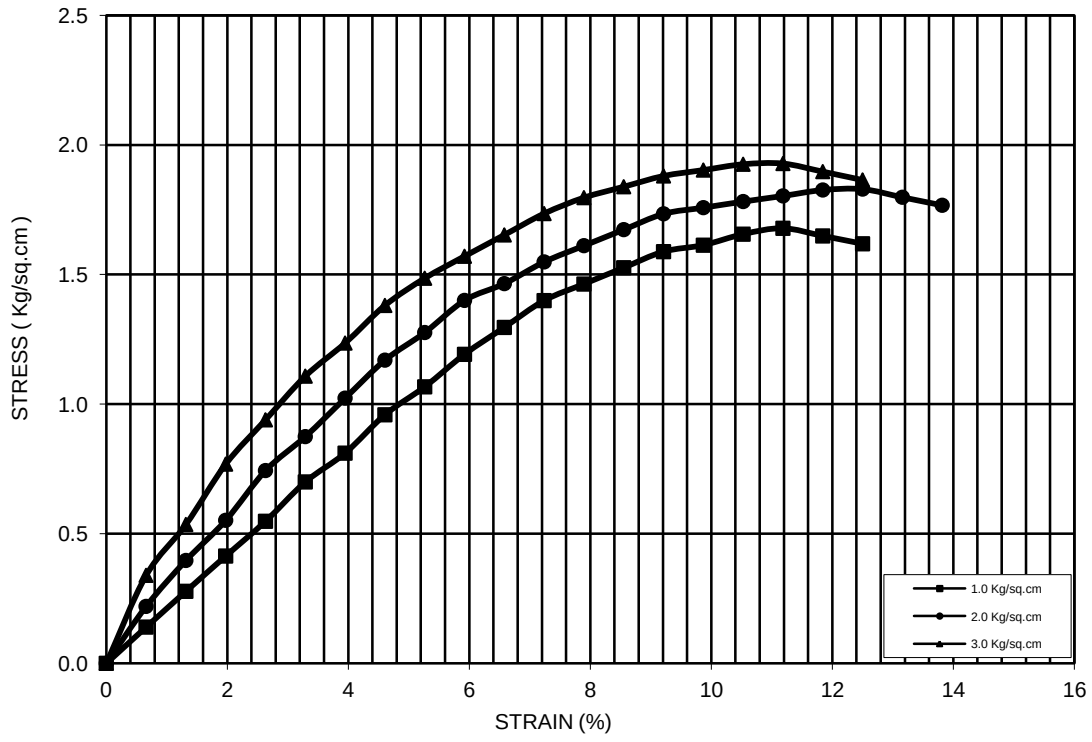
BORE HOLE NO: BH-CL
CHAINAGE:44+116
SAMPLE NO.: UDS-1
DEPTH: 5.25 m
COHESION(C)= 0.82 kg/sq.cm
ANGLE OF FRICTION(Phi): 5 deg
TYPE OF THE TEST: UUT



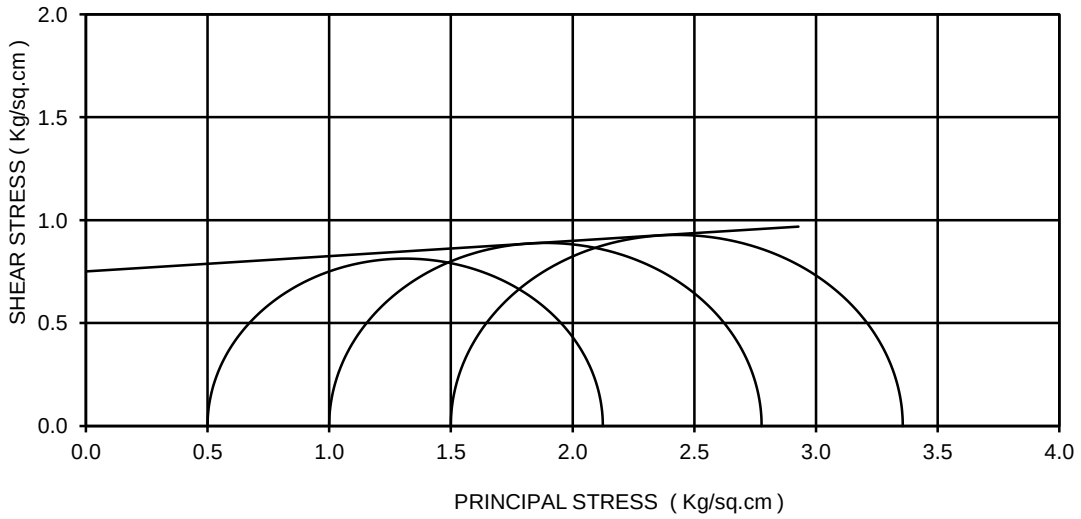


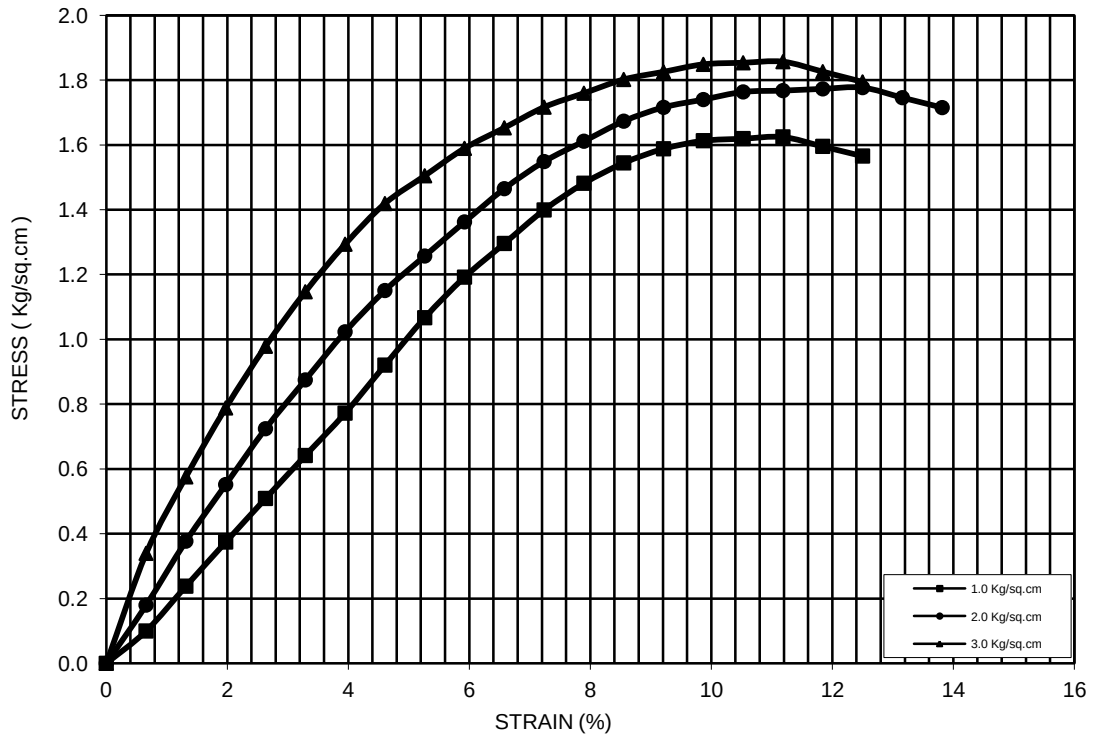
BORE HOLE NO: BH-CL
CHAINAGE: 44+641
SAMPLE NO.: UDS-1
DEPTH: 5.25 m
COHESION(C)= 0.75 kg/sq.cm
ANGLE OF FRICTION(Phi): 5 deg
TYPE OF THE TEST: UUT



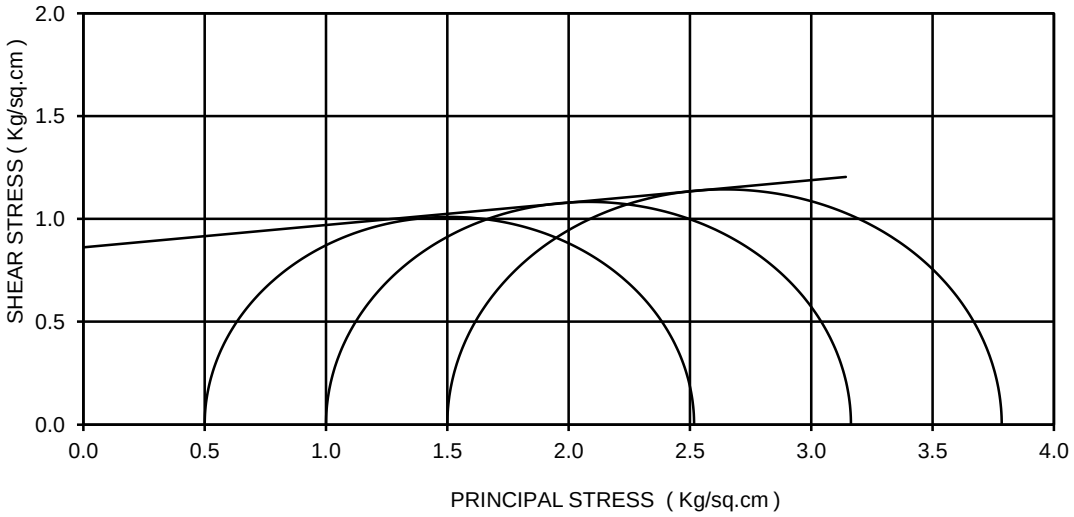


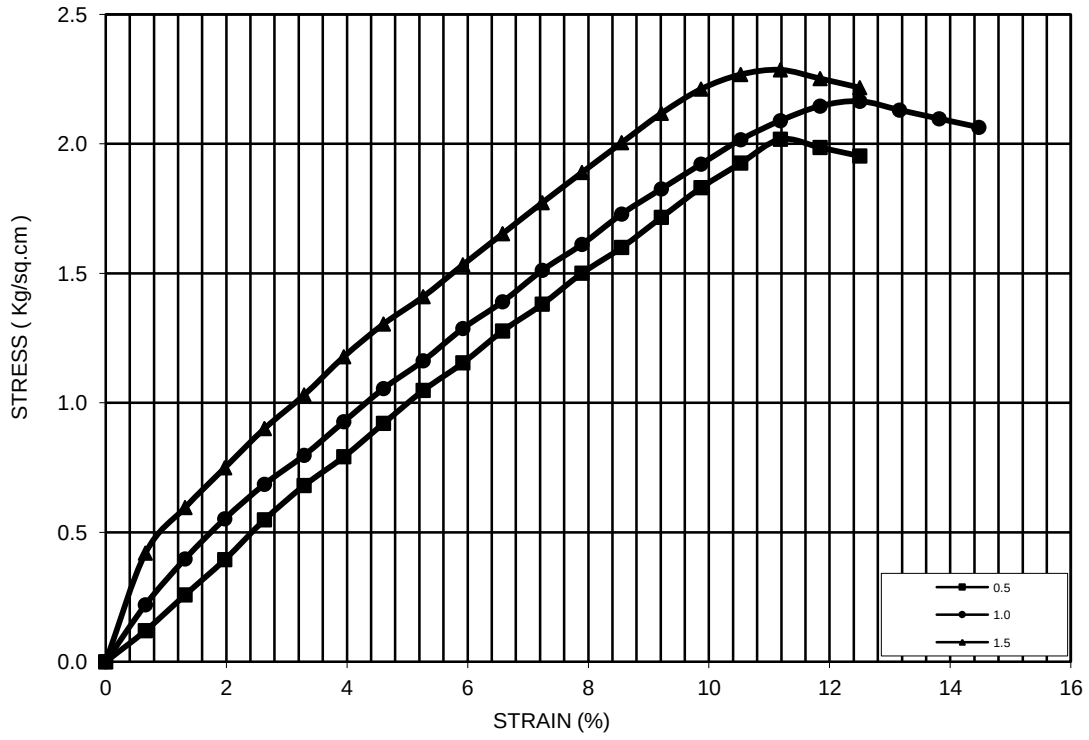
BORE HOLE NO: BH-CL
CHAINAGE:44+910
SAMPLE NO.: UDS-1
DEPTH: 5.25 m
COHESION(C)= 0.75 kg/sq.cm
ANGLE OF FRICTION(Phi): 4 deg
TYPE OF THE TEST: UUT



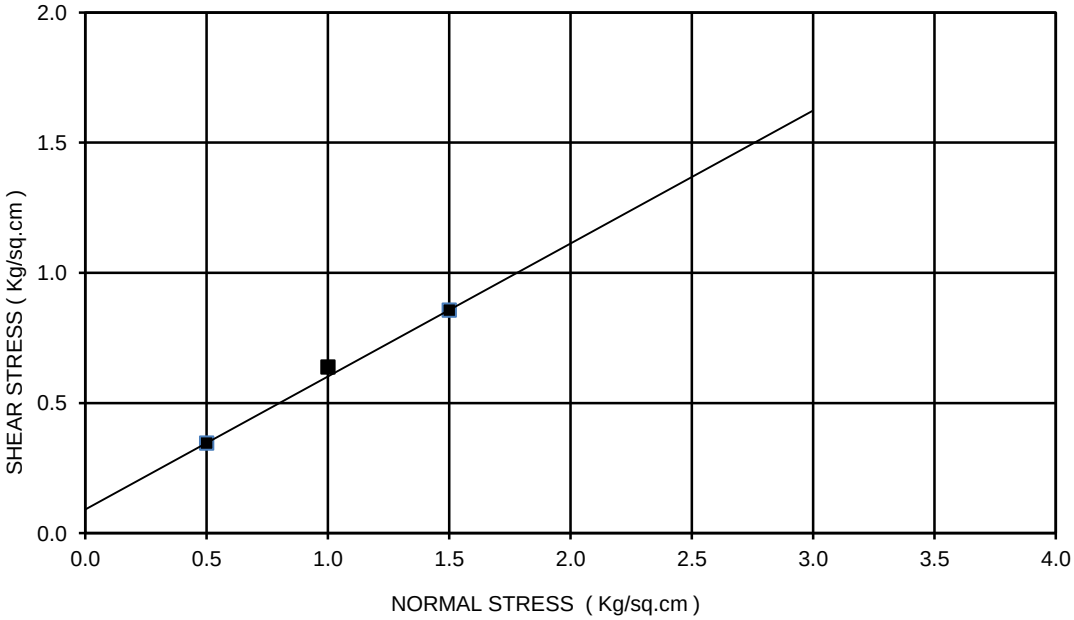


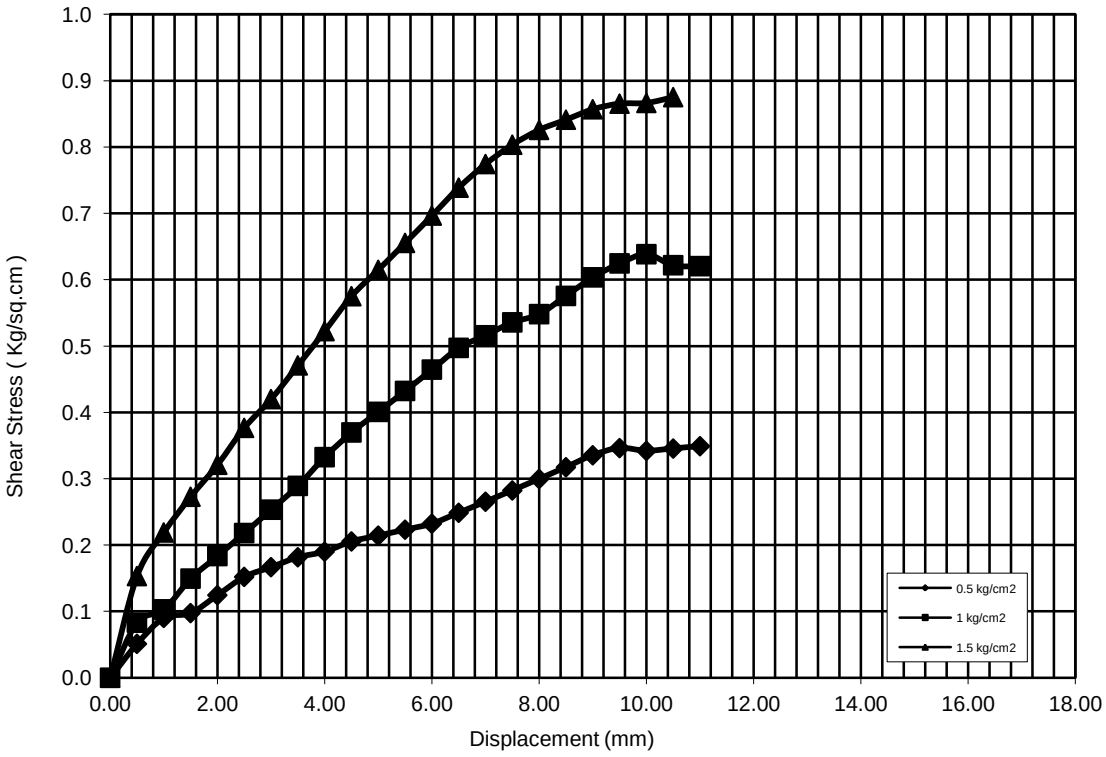
BORE HOLE NO: BH-CL
CHAINAGE:45+048
SAMPLE NO.: UDS-2
DEPTH: 5.25 m
COHESION(C)= 0.85 kg/sq.cm
ANGLE OF FRICTION(Phi): 6 deg
TYPE OF THE TEST: UUT



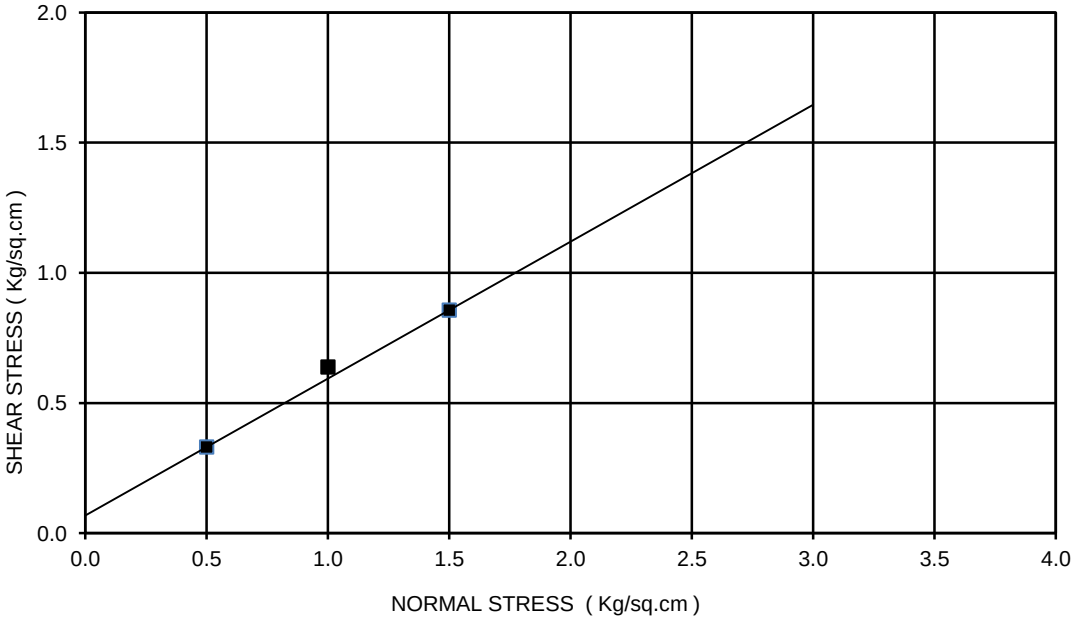


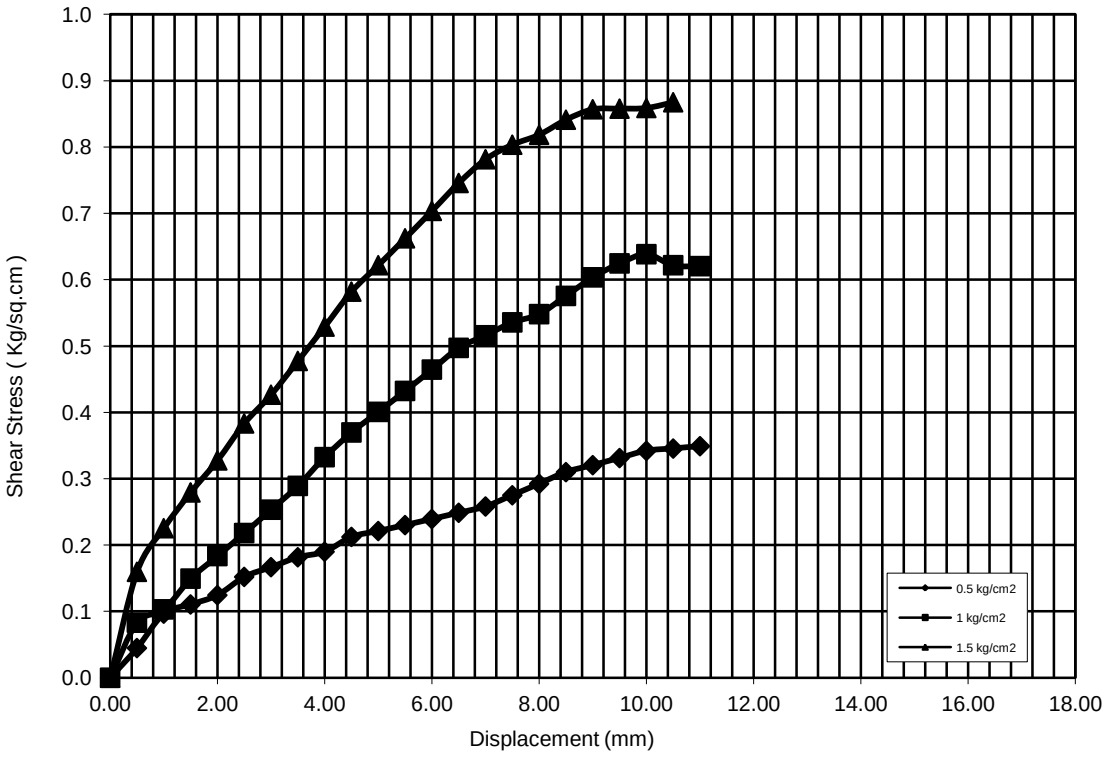
BORE HOLE NO: BH-A1
CHAINAGE: 45+480
SAMPLE NO.: UDS-1
DEPTH: 4.00 m
COHESION(C)= 0.08 kg/sq.cm
ANGLE OF FRICTION(Phi): 27 deg
TYPE OF THE TEST: DST



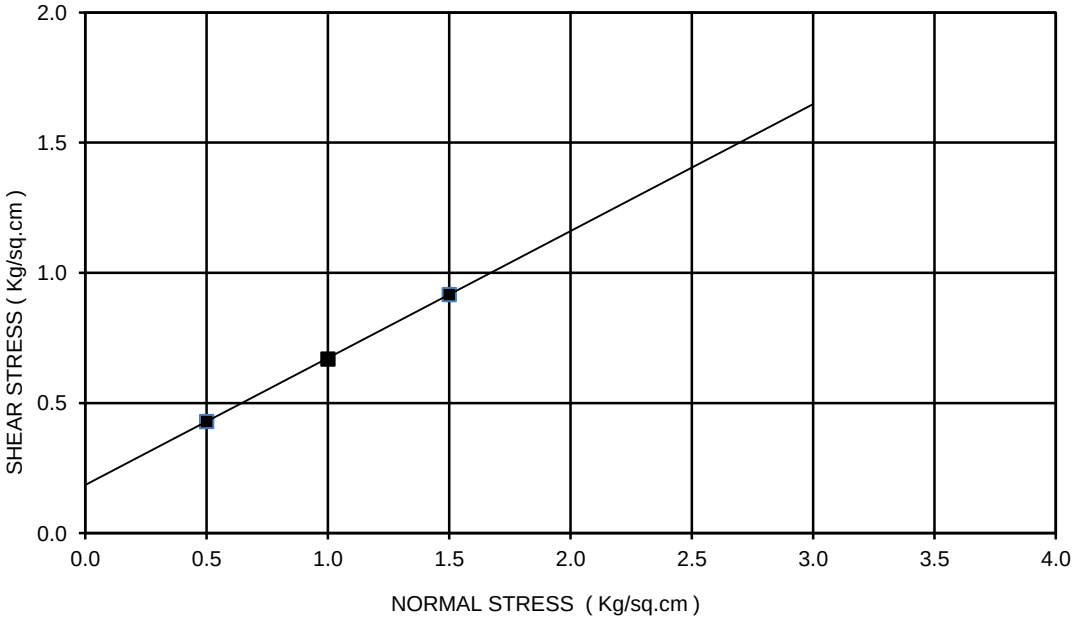


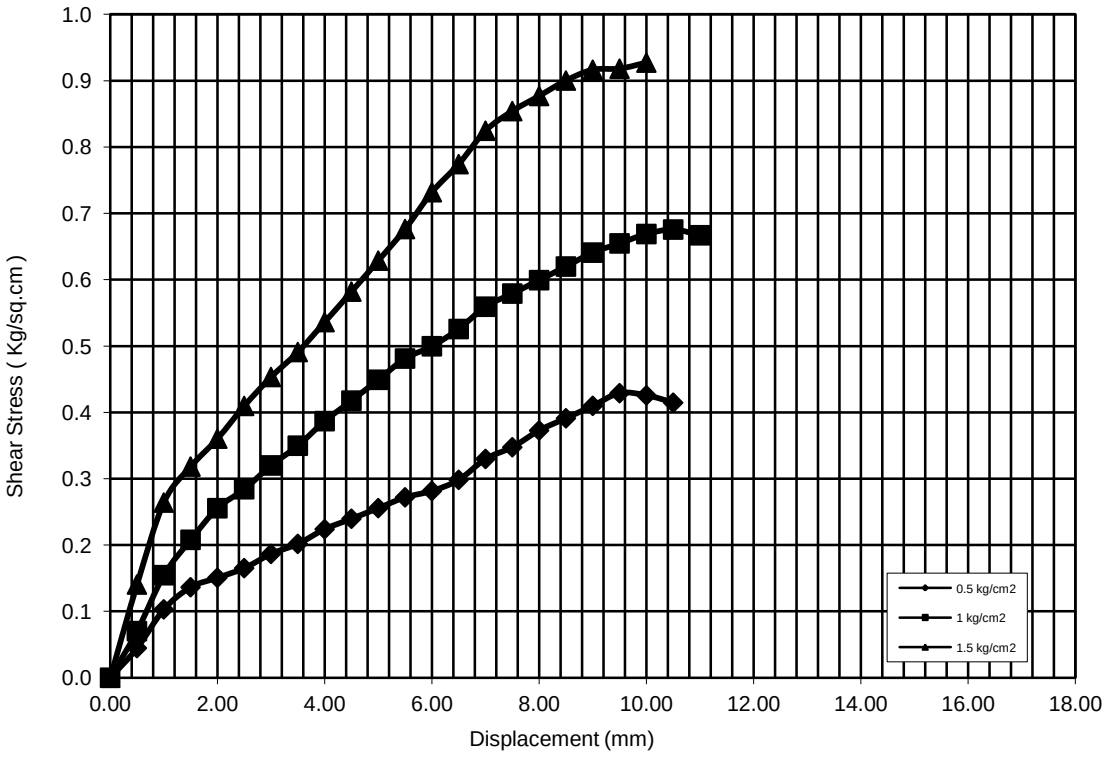
BORE HOLE NO: BH-A1
CHAINAGE: 45+480
SAMPLE NO.: UDS-1
DEPTH: 4.00 m
COHESION(C)= 0.08 kg/sq.cm
ANGLE OF FRICTION(Phi): 27 deg
TYPE OF THE TEST: DST



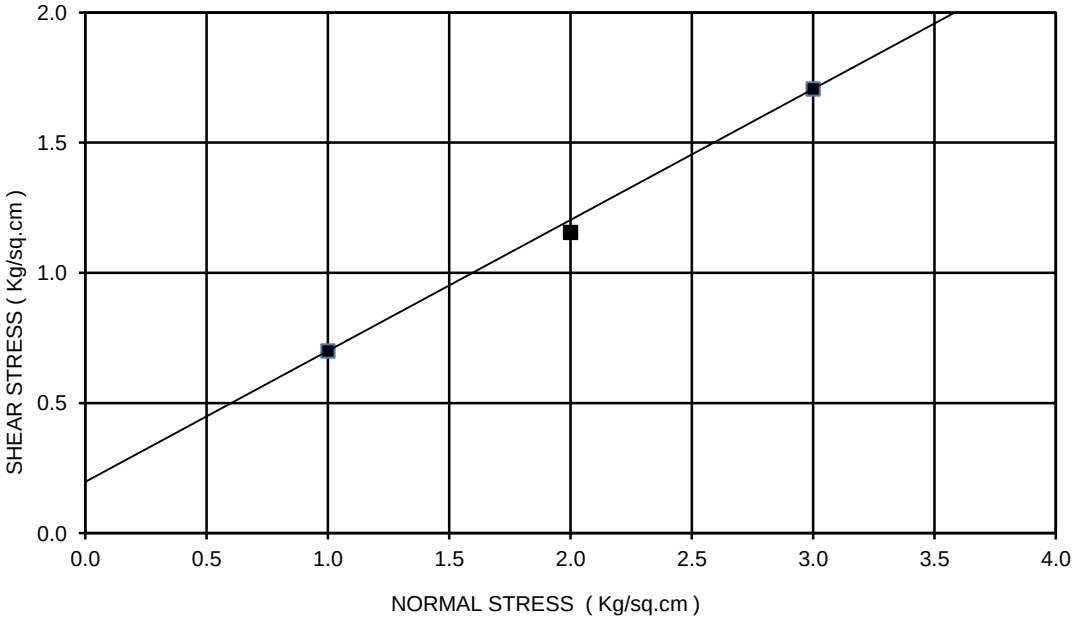


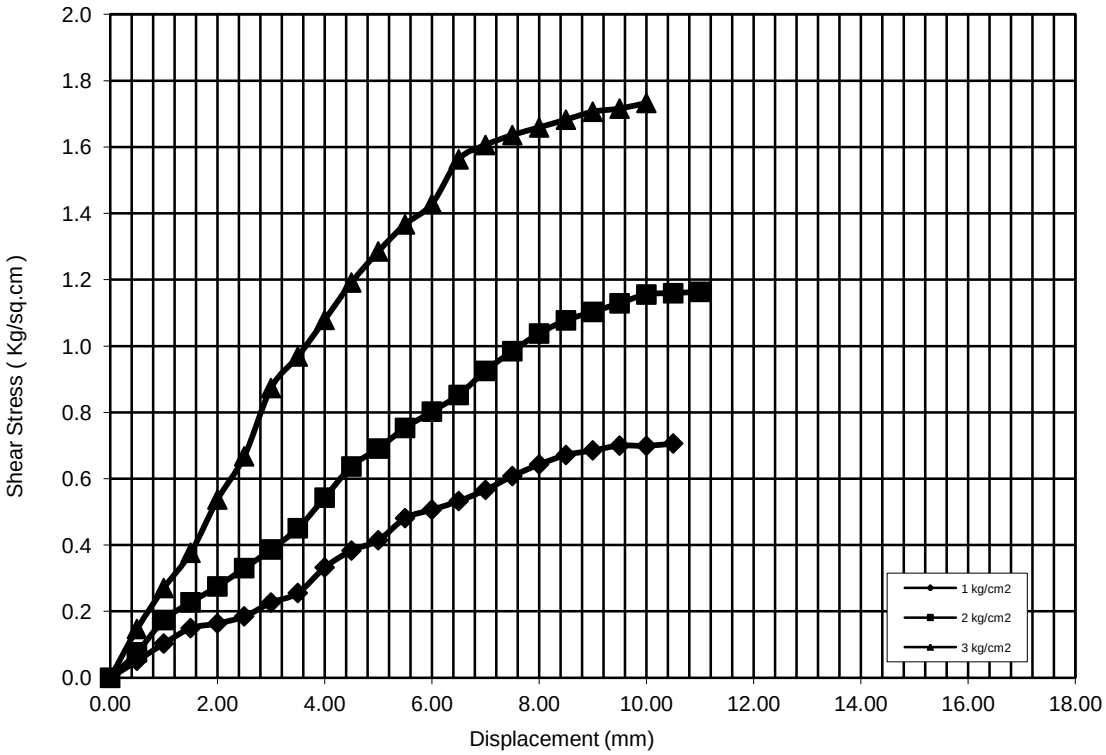
BORE HOLE NO: BH-A1
CHAINAGE: 45+480
SAMPLE NO.: UDS-4
DEPTH: 13.00 m
COHESION(C)= 0.08 kg/sq.cm
ANGLE OF FRICTION(Phi): 26 deg
TYPE OF THE TEST: DST



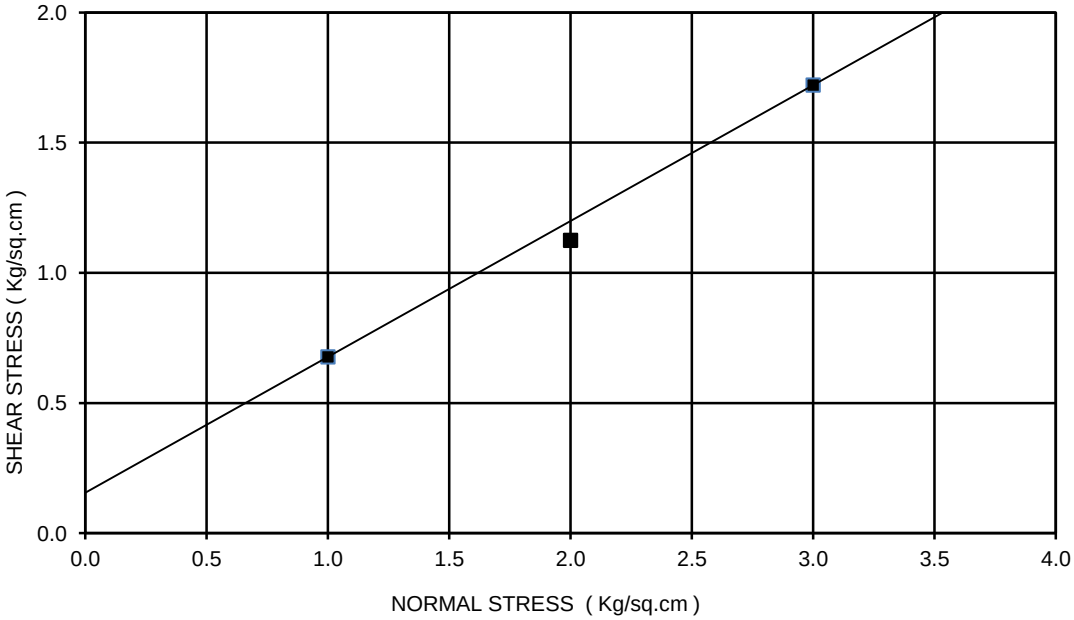


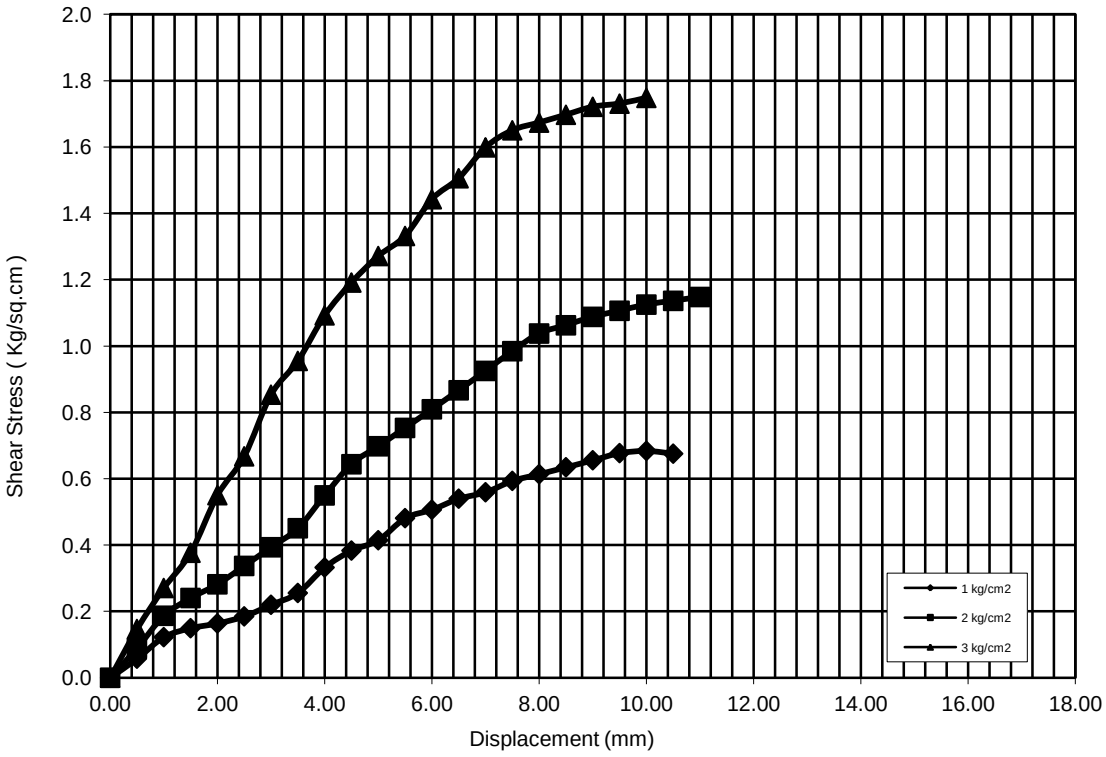
BORE HOLE NO: BH-A1
CHAINAGE: 45+480
SAMPLE NO.: UDS-4
DEPTH: 13.00 m
COHESION(C)= 0.08 kg/sq.cm
ANGLE OF FRICTION(Phi): 26 deg
TYPE OF THE TEST: DST



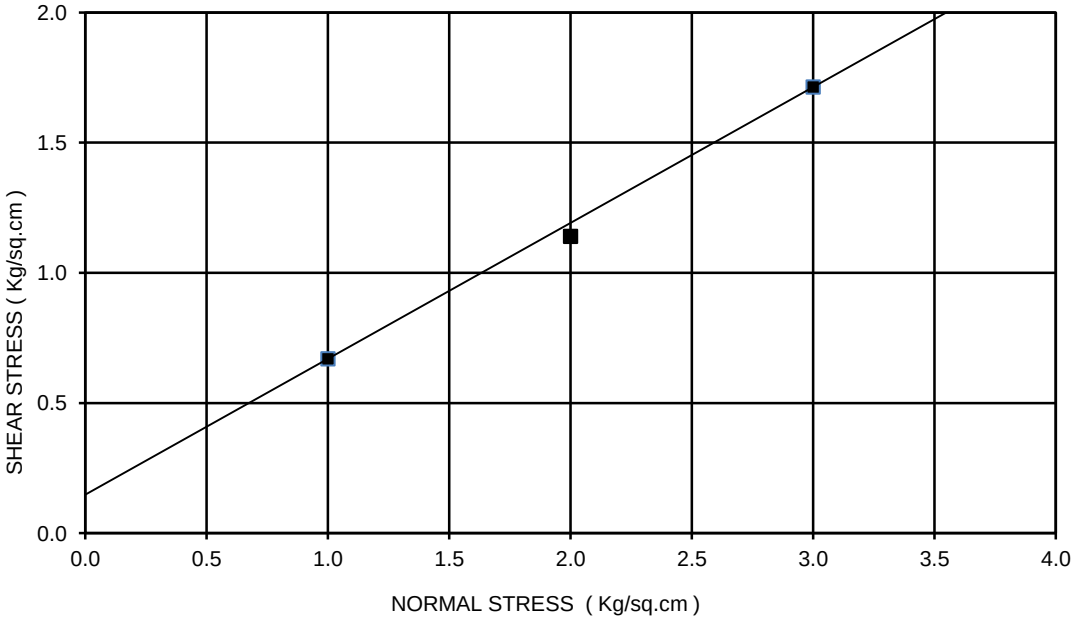


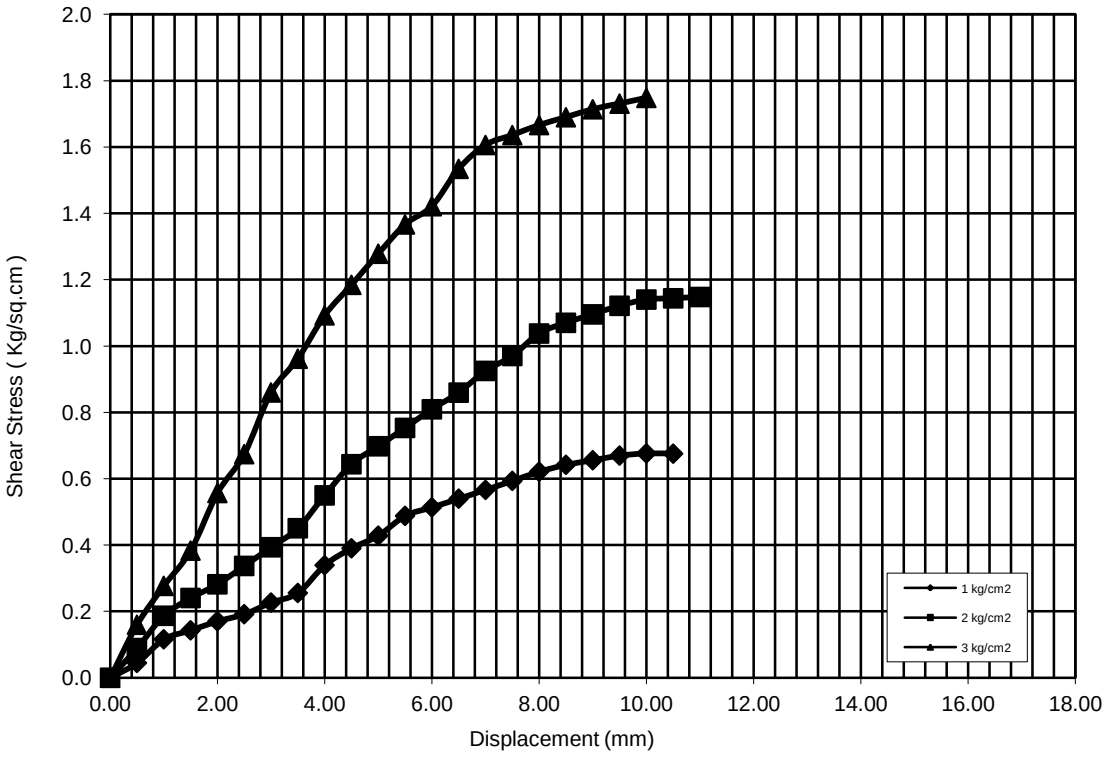
BORE HOLE NO: BH-A1
CHAINAGE: 45+480
SAMPLE NO.: UDS-4
DEPTH: 13.00 m
COHESION(C)= 0.08 kg/sq.cm
ANGLE OF FRICTION(Phi): 26 deg
TYPE OF THE TEST: DST



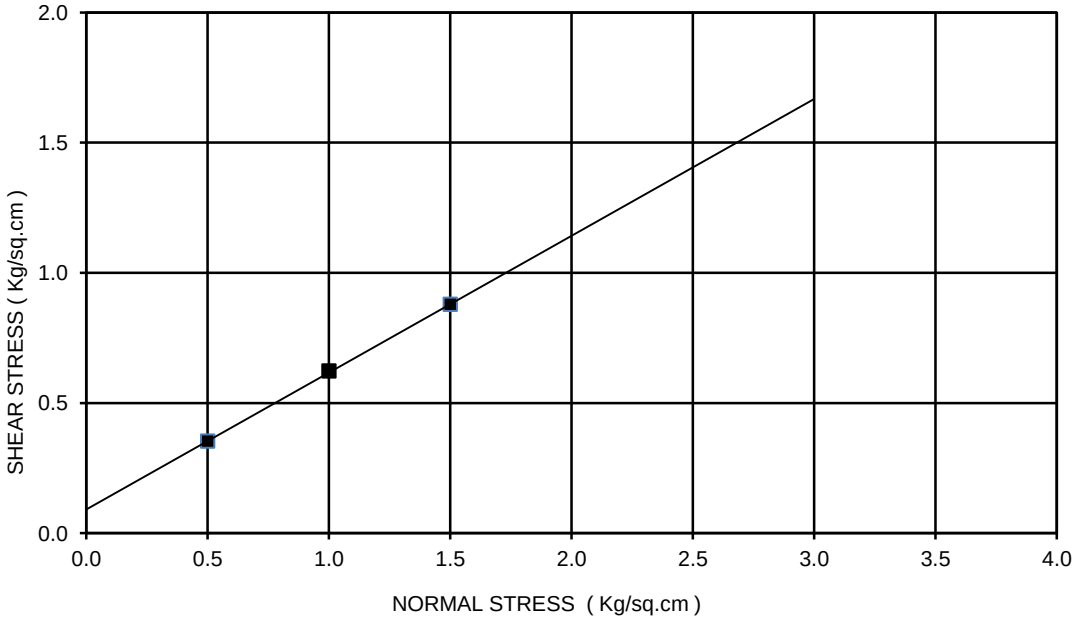


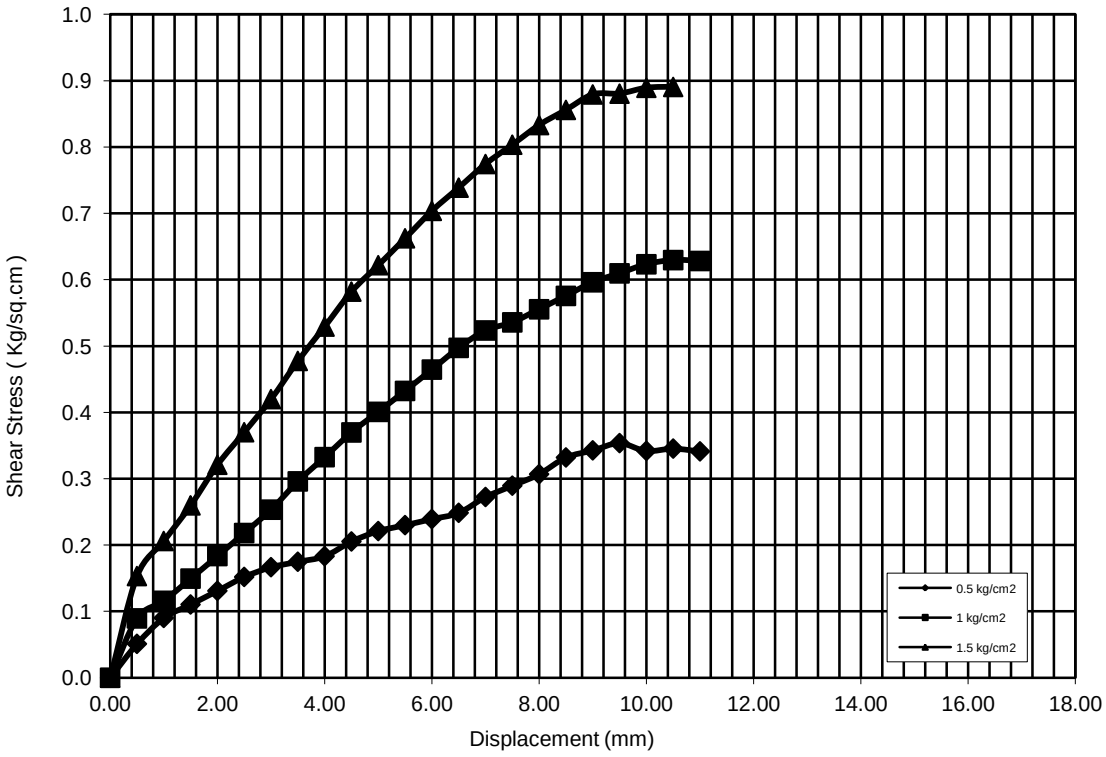
BORE HOLE NO: BH-A2
CHAINAGE: 45+480
SAMPLE NO.: UDS-4
DEPTH: 13.00 m
COHESION(C)= 0.08 kg/sq.cm
ANGLE OF FRICTION(Phi): 26 deg
TYPE OF THE TEST: DST



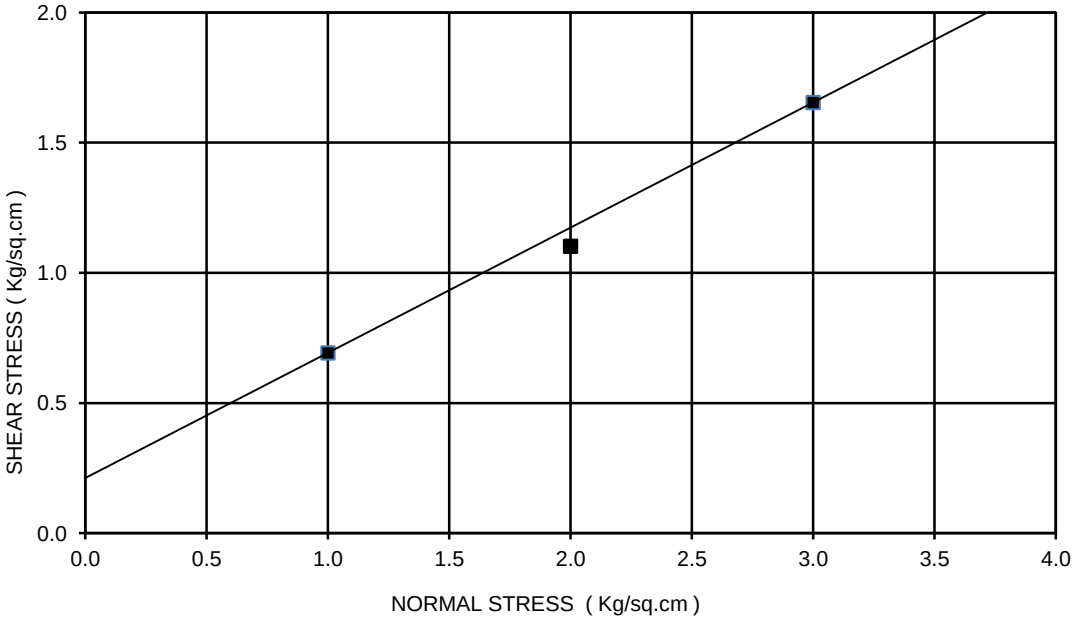


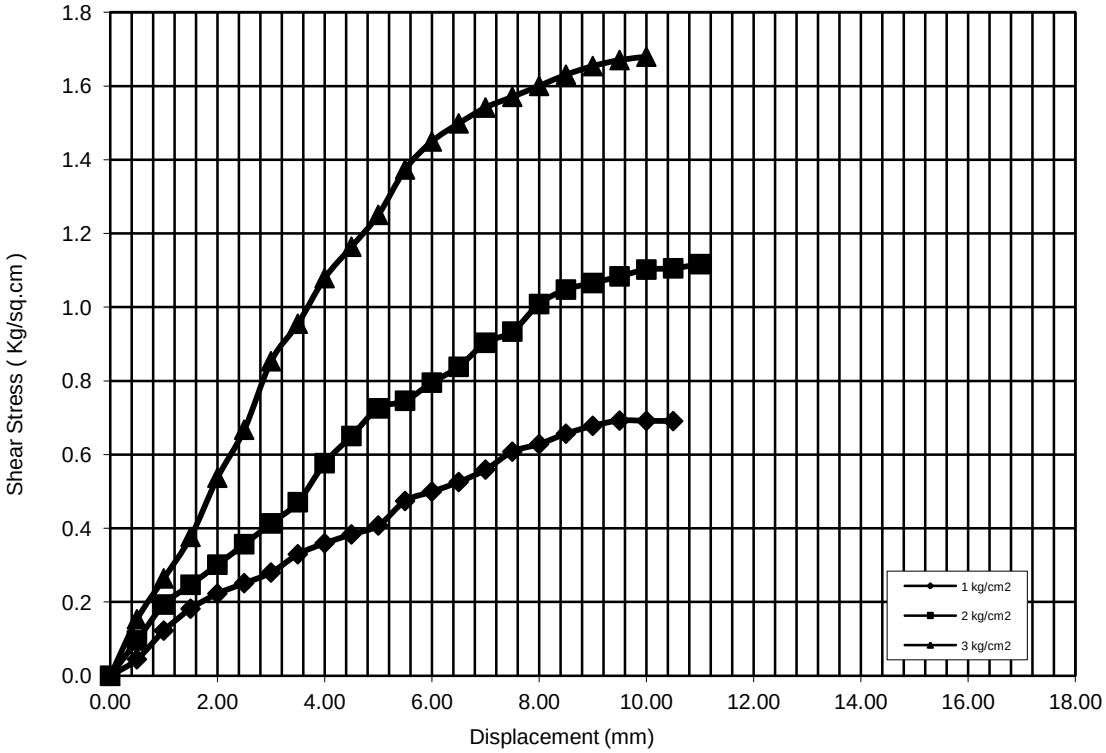
BORE HOLE NO: BH-A2
CHAINAGE: 45+480
SAMPLE NO.: UDS-1
DEPTH: 4.00 m
COHESION(C)= 0.08 kg/sq.cm
ANGLE OF FRICTION(Phi): 27 deg
TYPE OF THE TEST: DST



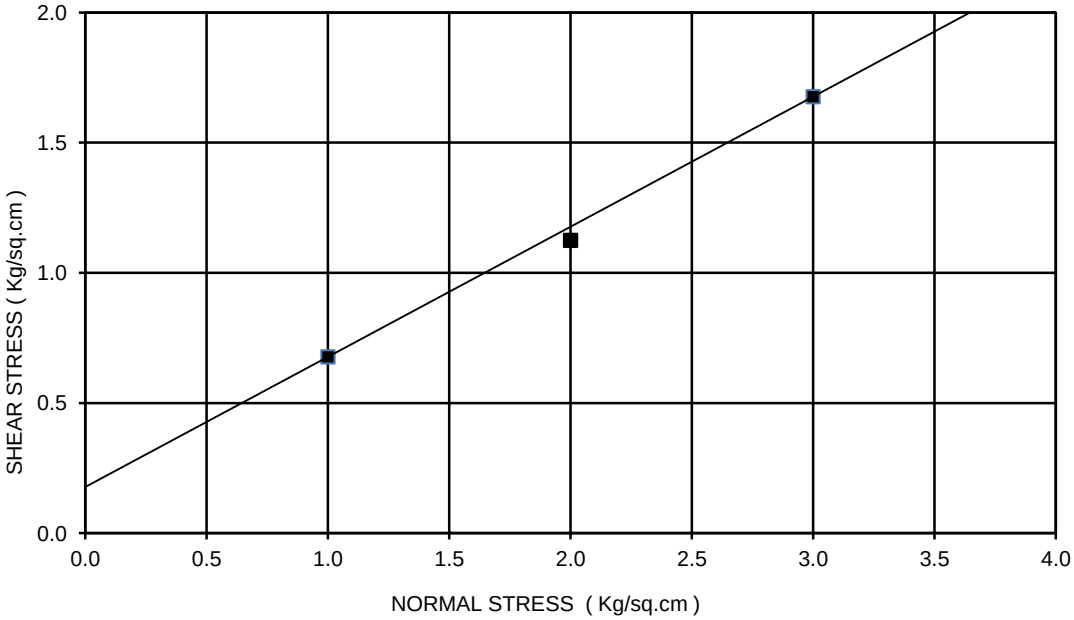


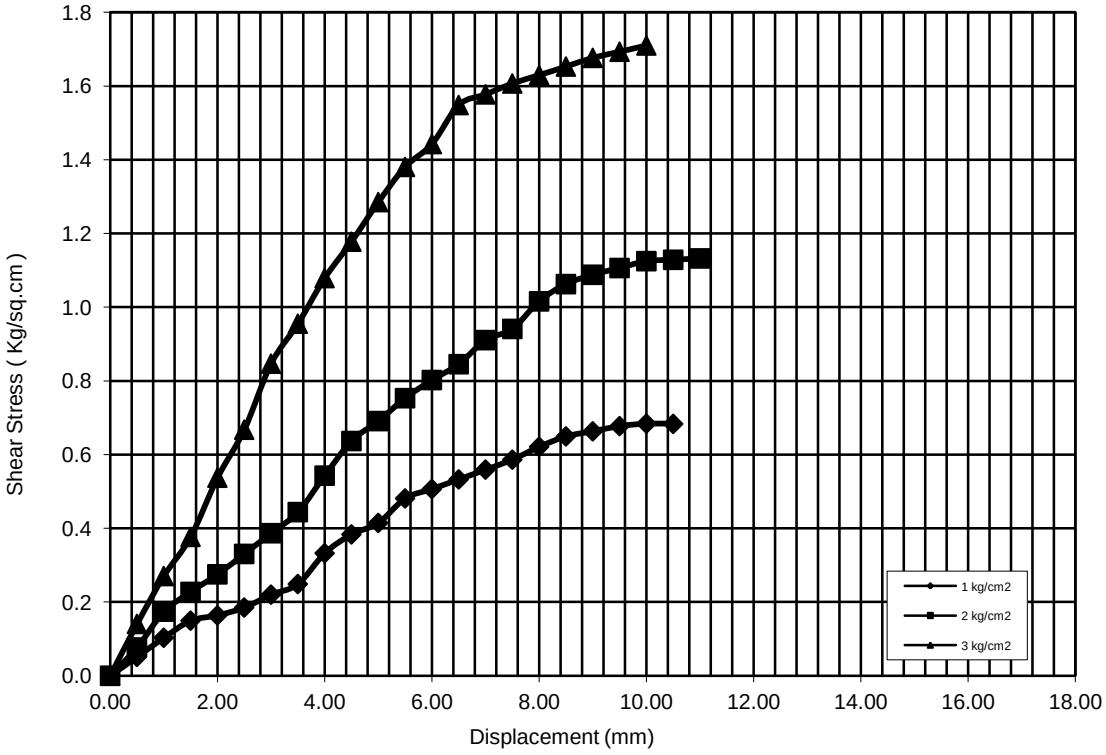
BORE HOLE NO: BH-A2
CHAINAGE: 45+480
SAMPLE NO.: UDS-4
DEPTH: 13.00 m
COHESION(C)= 0.08 kg/sq.cm
ANGLE OF FRICTION(Phi): 26 deg
TYPE OF THE TEST: DST



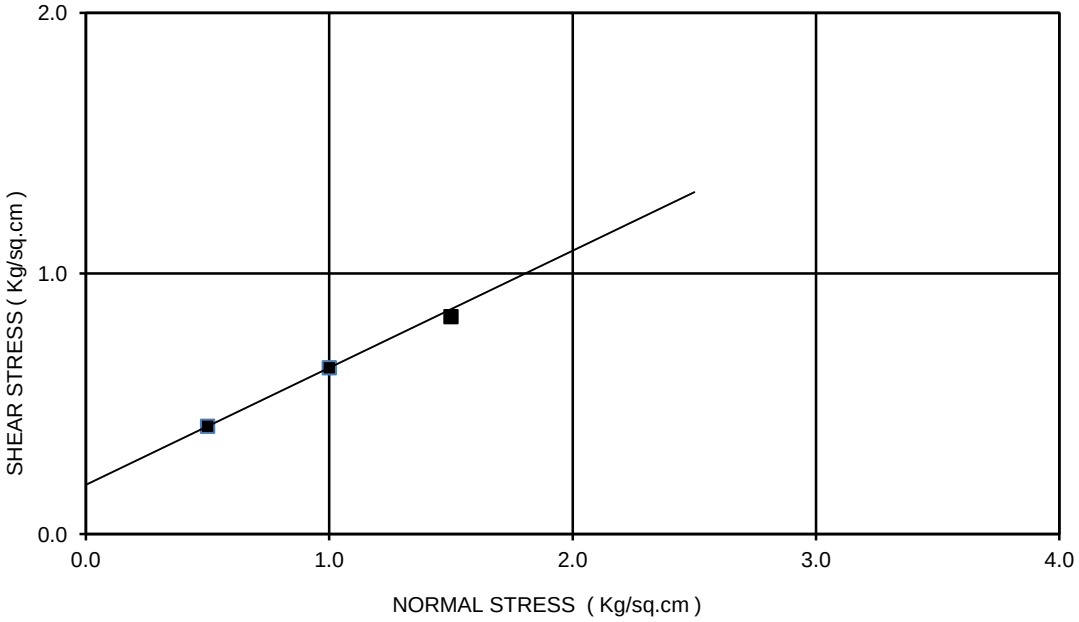


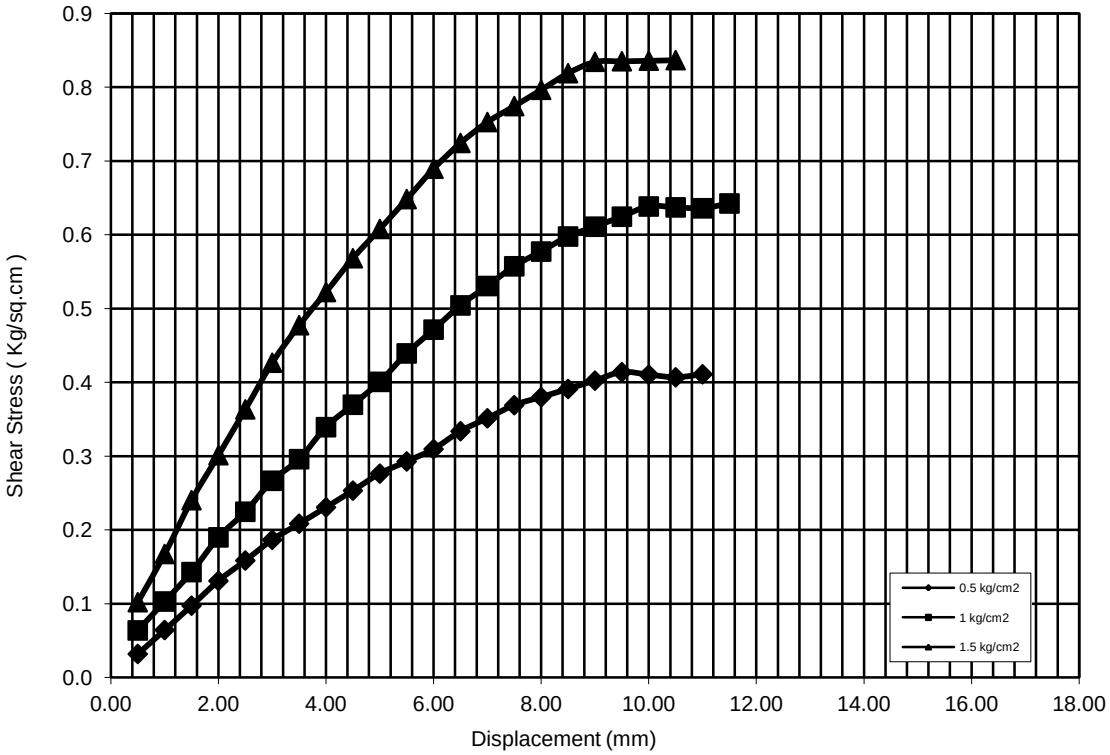
BORE HOLE NO: BH-A2
CHAINAGE: 45+480
SAMPLE NO.: UDS-4
DEPTH: 13.00 m
COHESION(C)= 0.08 kg/sq.cm
ANGLE OF FRICTION(Phi): 26 deg
TYPE OF THE TEST: DST

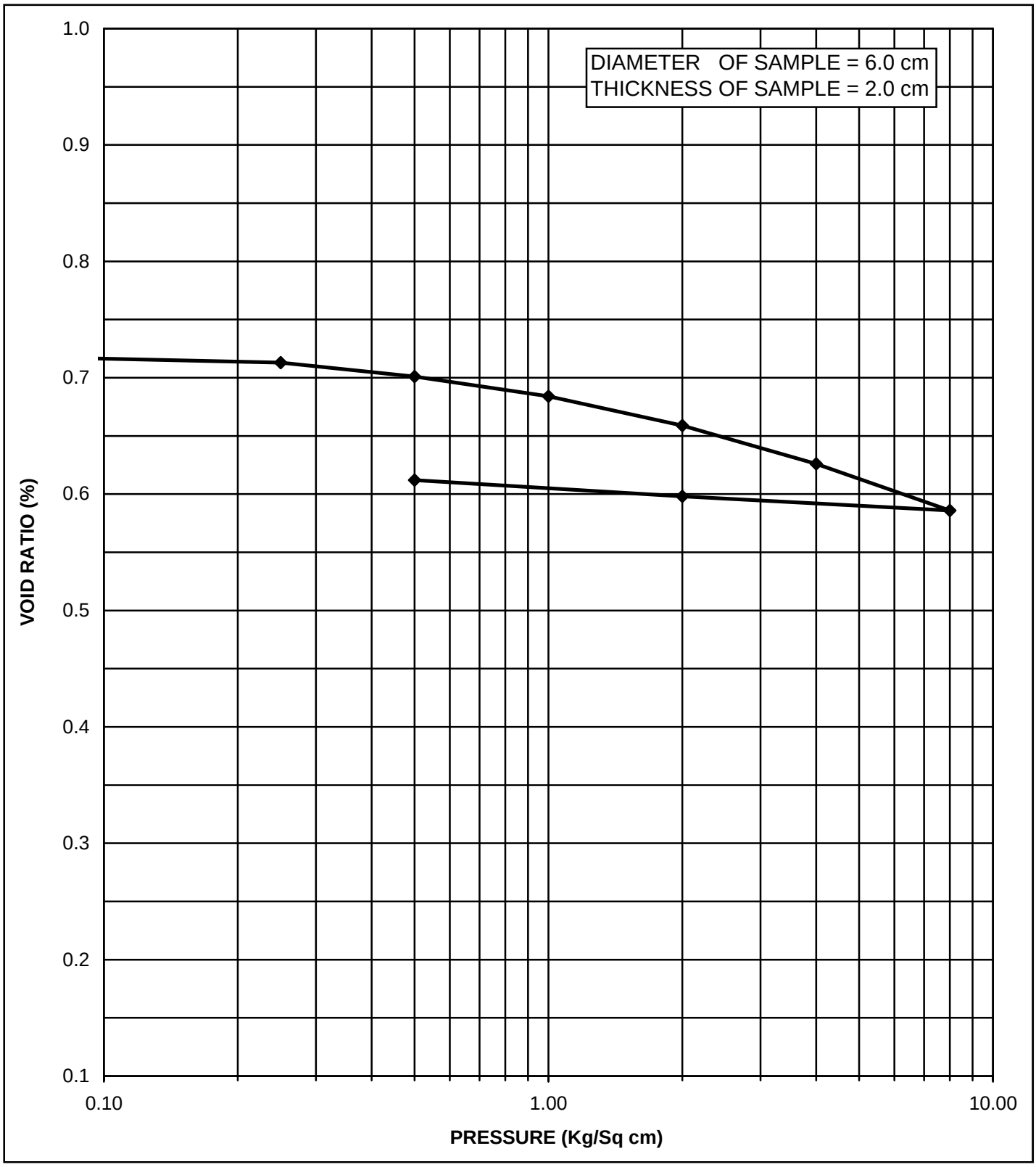




BORE HOLE NO: BH-CL
CHAINAGE: 45+612
SAMPLE NO.: UDS-1
DEPTH: 2.25 m
COHESION(C)= 0.19 kg/sq.cm
ANGLE OF FRICTION(Phi): 24 deg
TYPE OF THE TEST: DST







CHAINAGE :- 30+478
BORE HOLE NO. = BH-CL
SAMPLE NO. = UDS-1

DEPTH = 1.00 M

TYPE OF SOIL = CL

INITIAL WATER CONTENT = 13.24 %

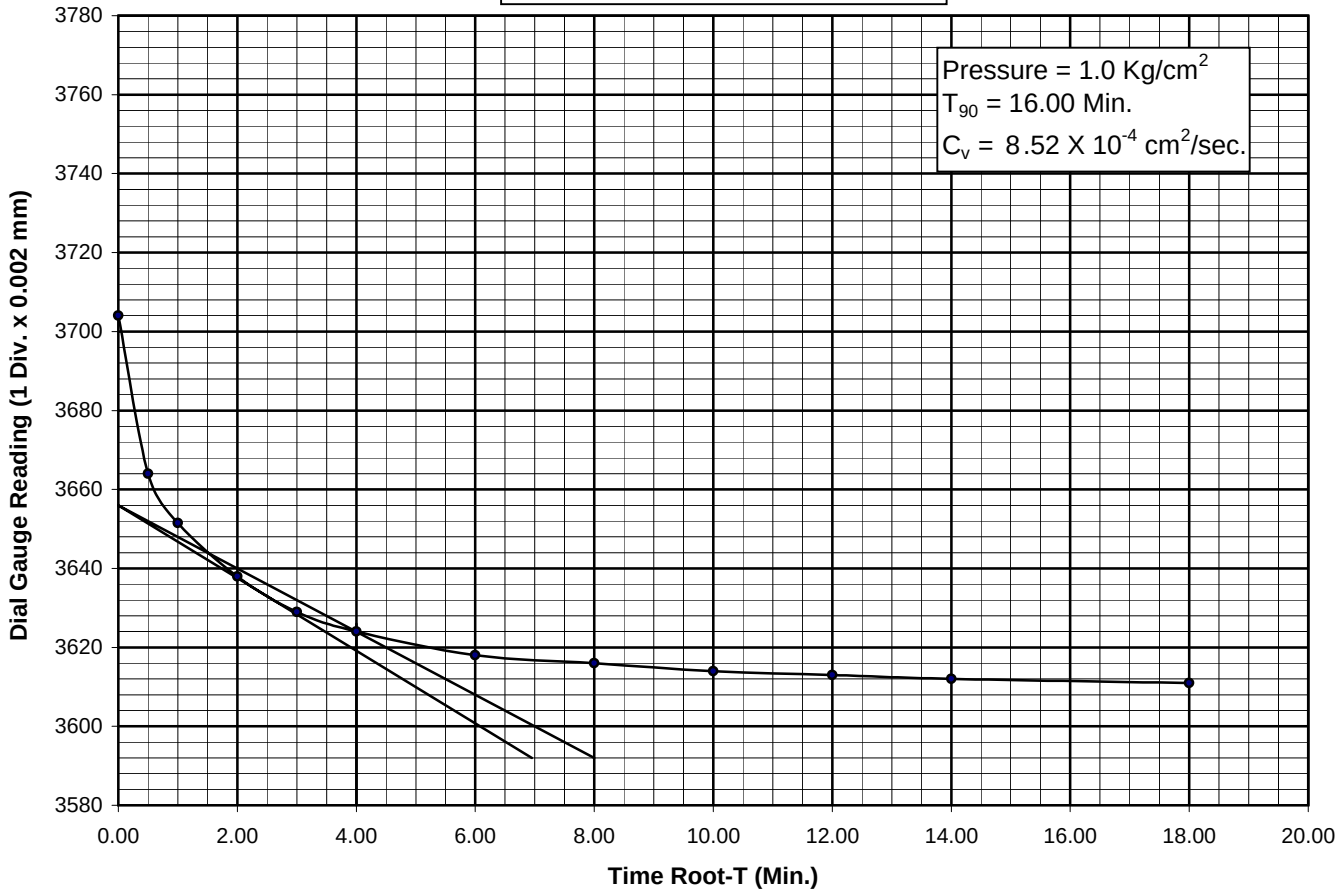
DRY DENSITY = 1.55 gm/cm^3

VOID RATIO (e_o) = 0.725

COMPRESSION INDEX (C_c) = 0.133

FIGURE NO. PRESSURE Vs VOID RATIO CURVE (e-log p)

BORE HOLE NO. = BH-CL
SAMPLE NO. = UDS-1
DEPTH = 1.00 M



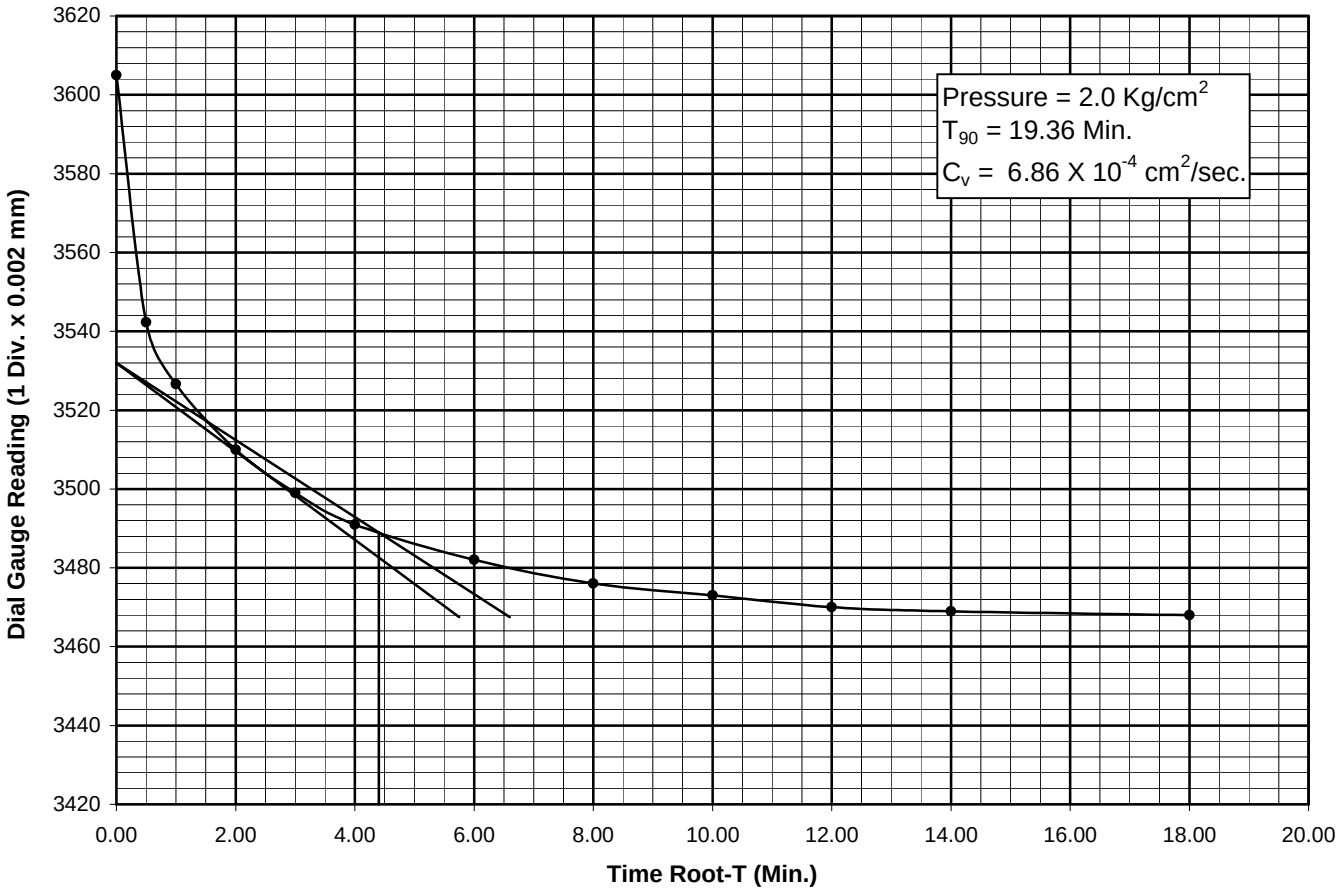
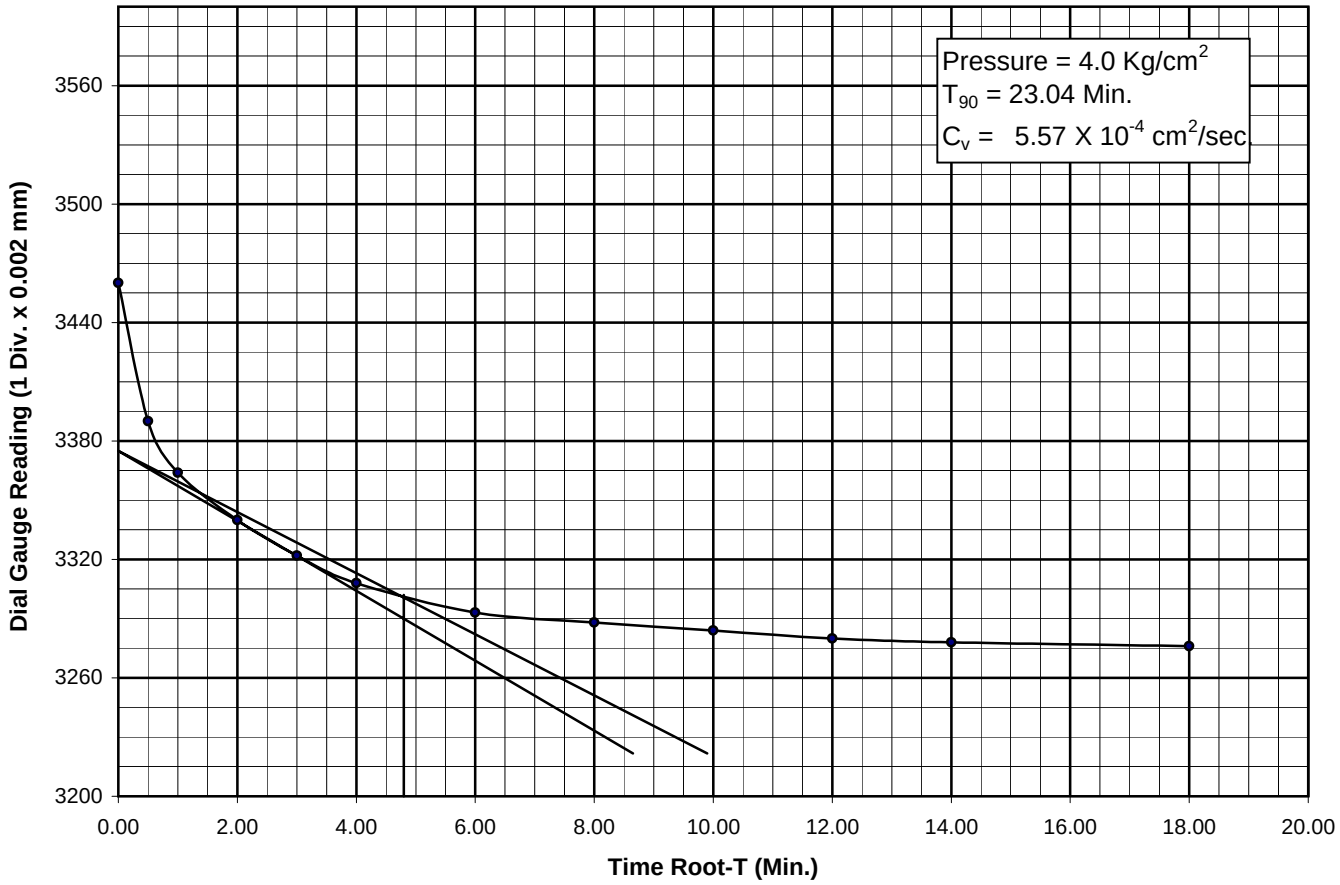


Figure No. -

BORE HOLE NO. = BH-CL
SAMPLE NO. = UDS-1
DEPTH = 1.00 M



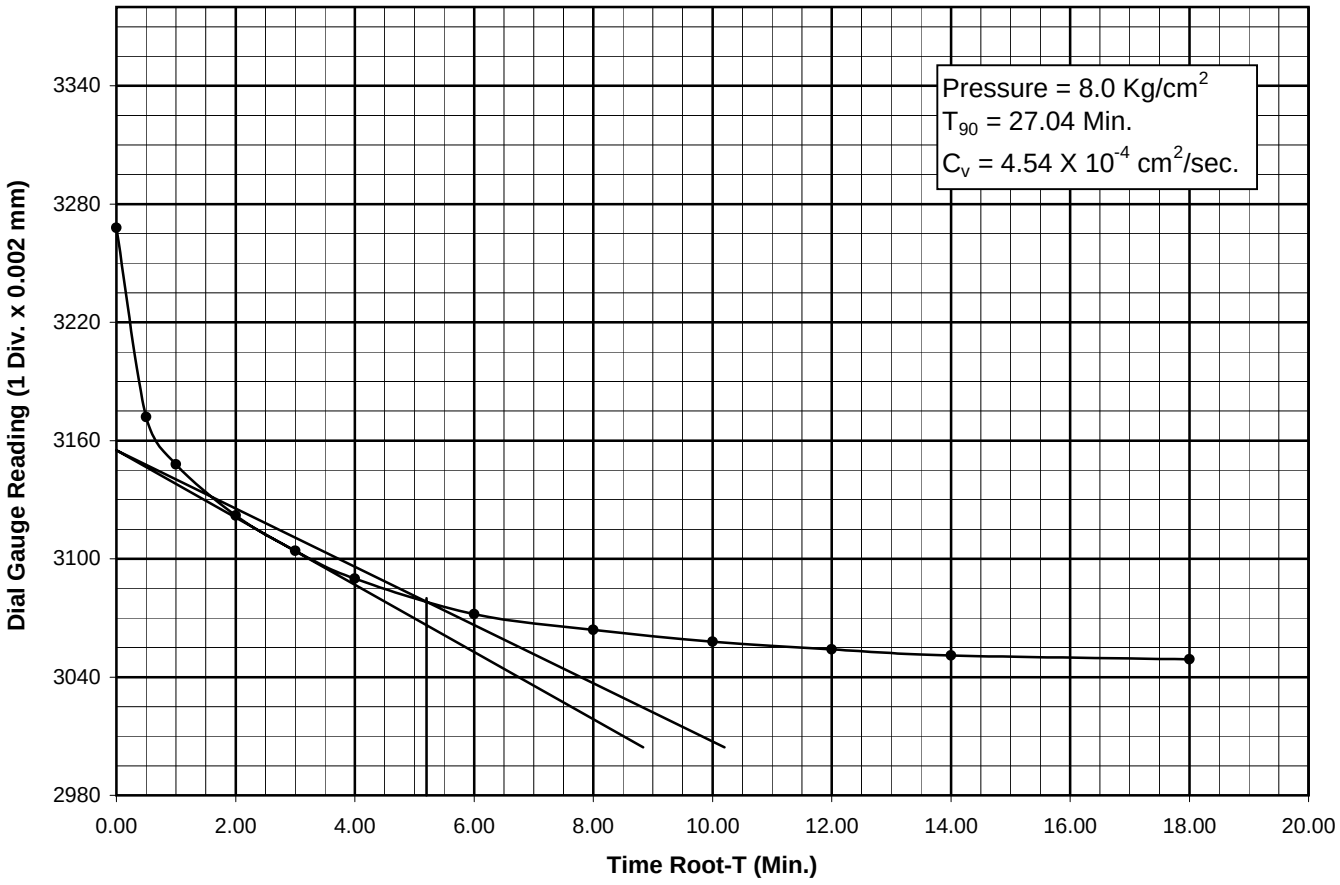
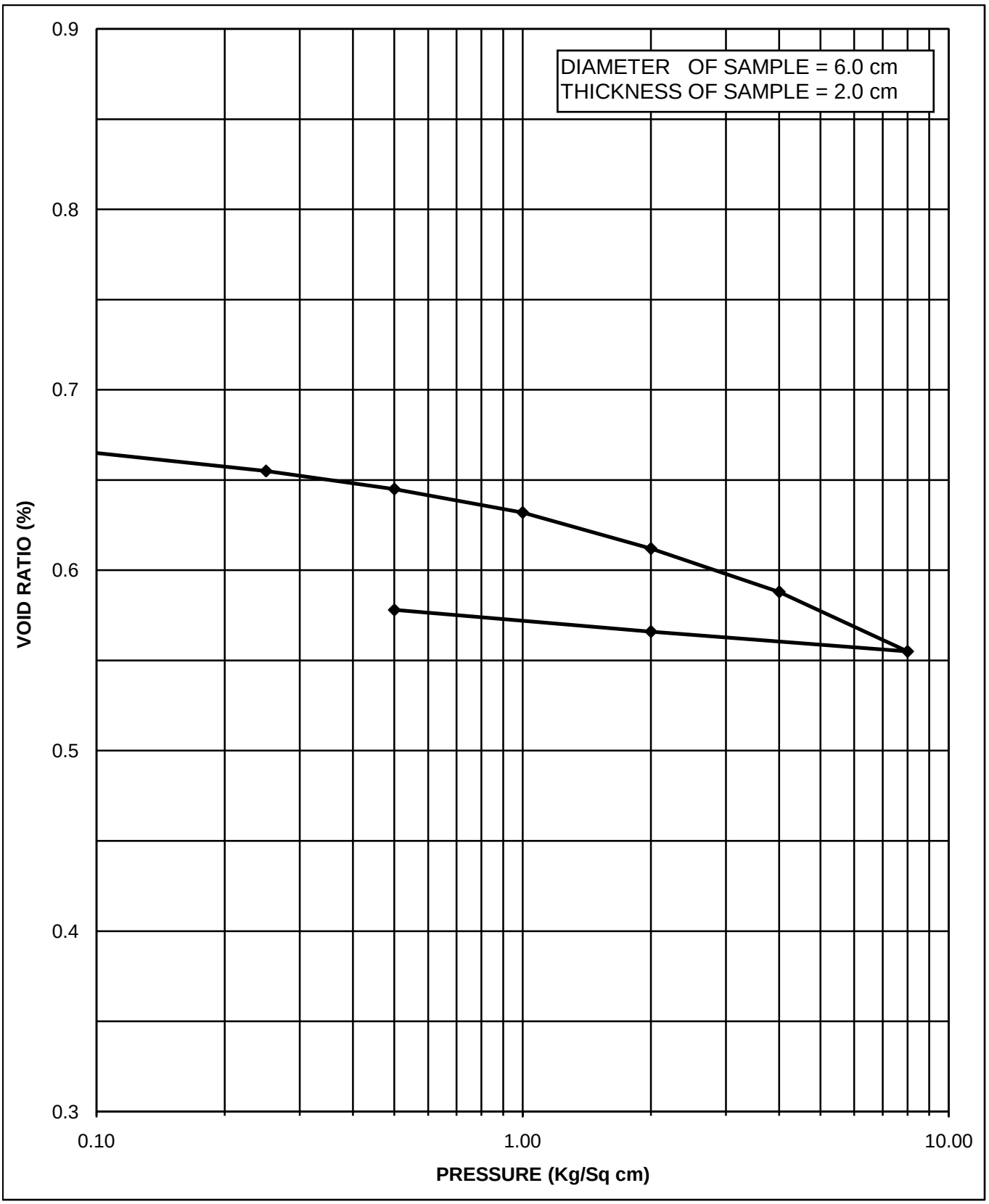


Figure No. -



CHAINAGE: 30+488

BORE HOLE NO. = BH-A1

SAMPLE NO. = UDS-3

DEPTH = 8.50 M

TYPE OF SOIL = CI

INITIAL WATER CONTENT = 15.04 %

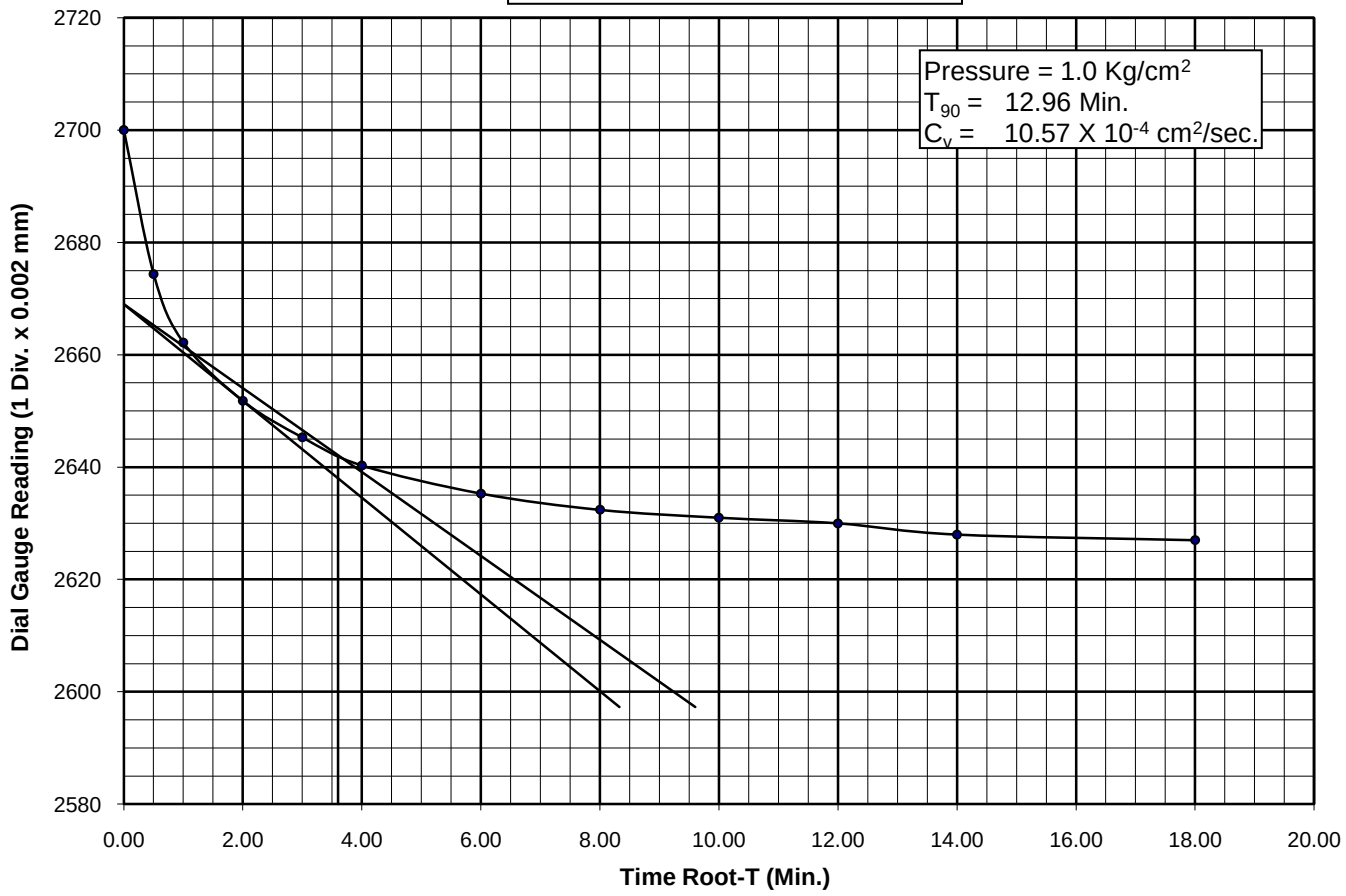
DRY DENSITY = 1.61 gm/cm^3

VOID RATIO (e_o) = 0.665

COMPRESSION INDEX (C_c) = 0.110

FIGURE NO. PRESSURE Vs VOID RATIO CURVE (e-log p)

CHAINAGE: 30+488
BORE HOLE NO. = BH-A1
SAMPLE NO. = UDS-3
DEPTH = 8.50 M



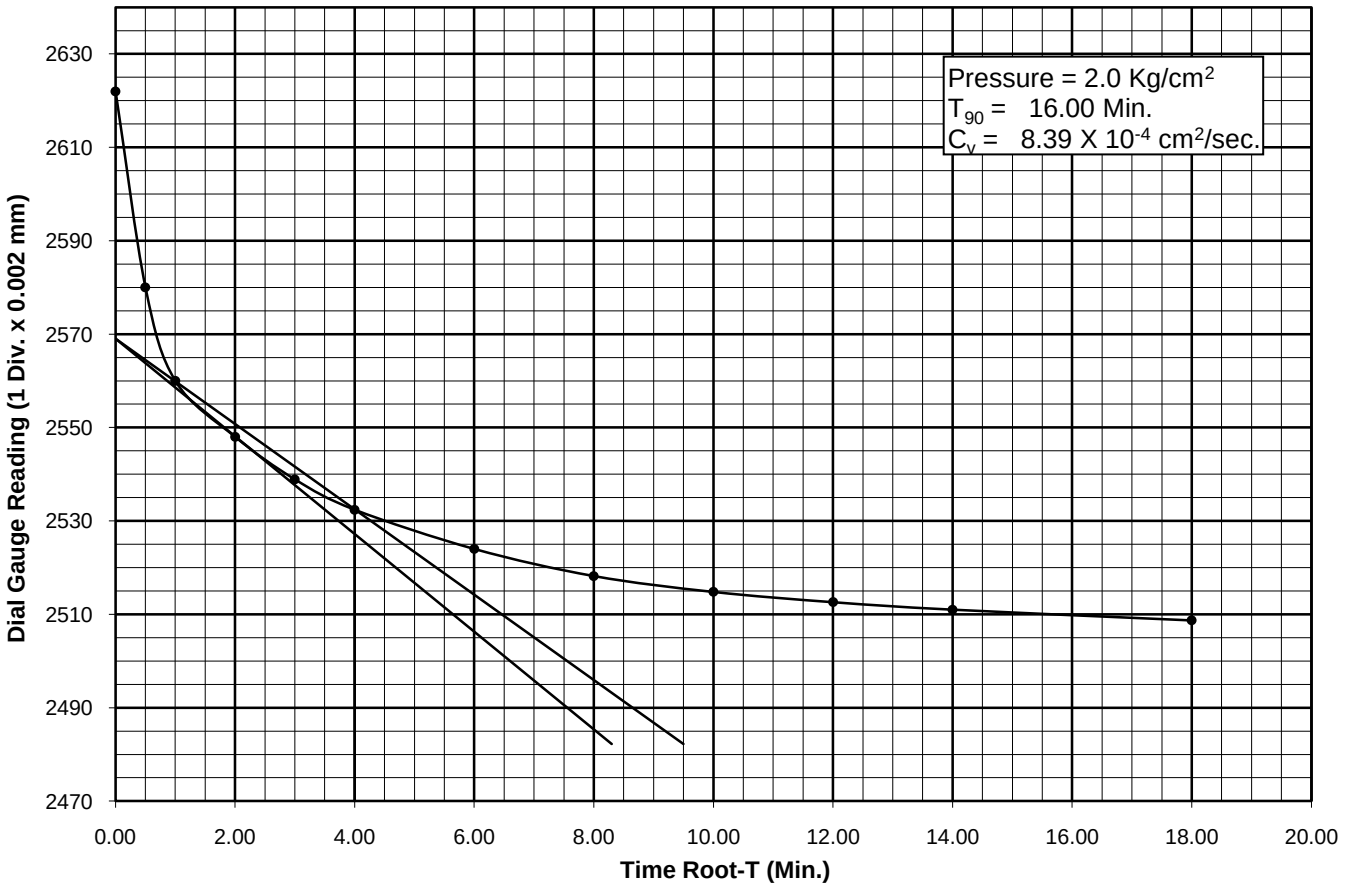
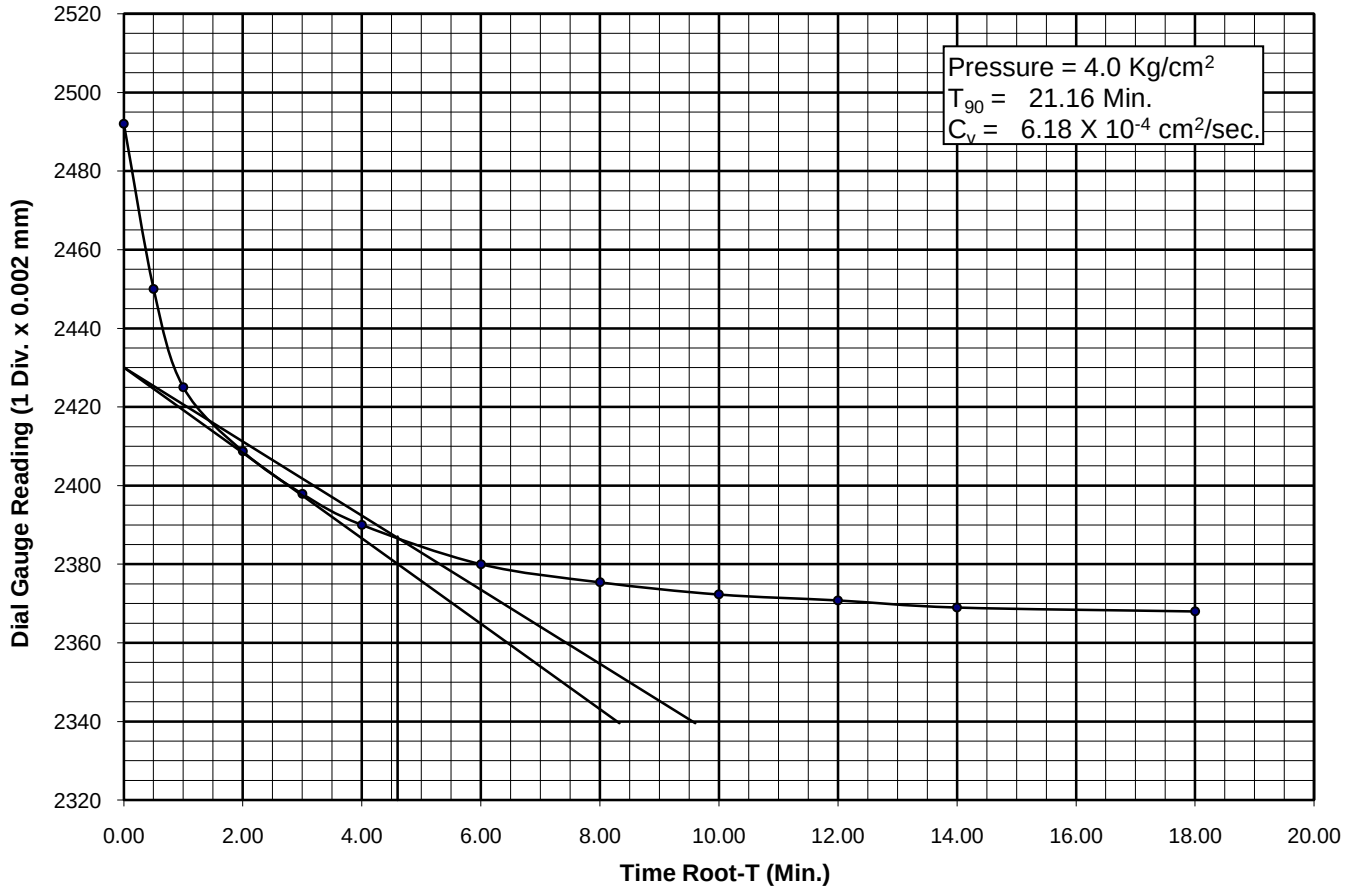


Figure No. -

CHAINAGE	=	30+488
BORE HOLE NO.	=	BH-A1
SAMPLE NO.	=	UDS-3
DEPTH	=	8.50 M



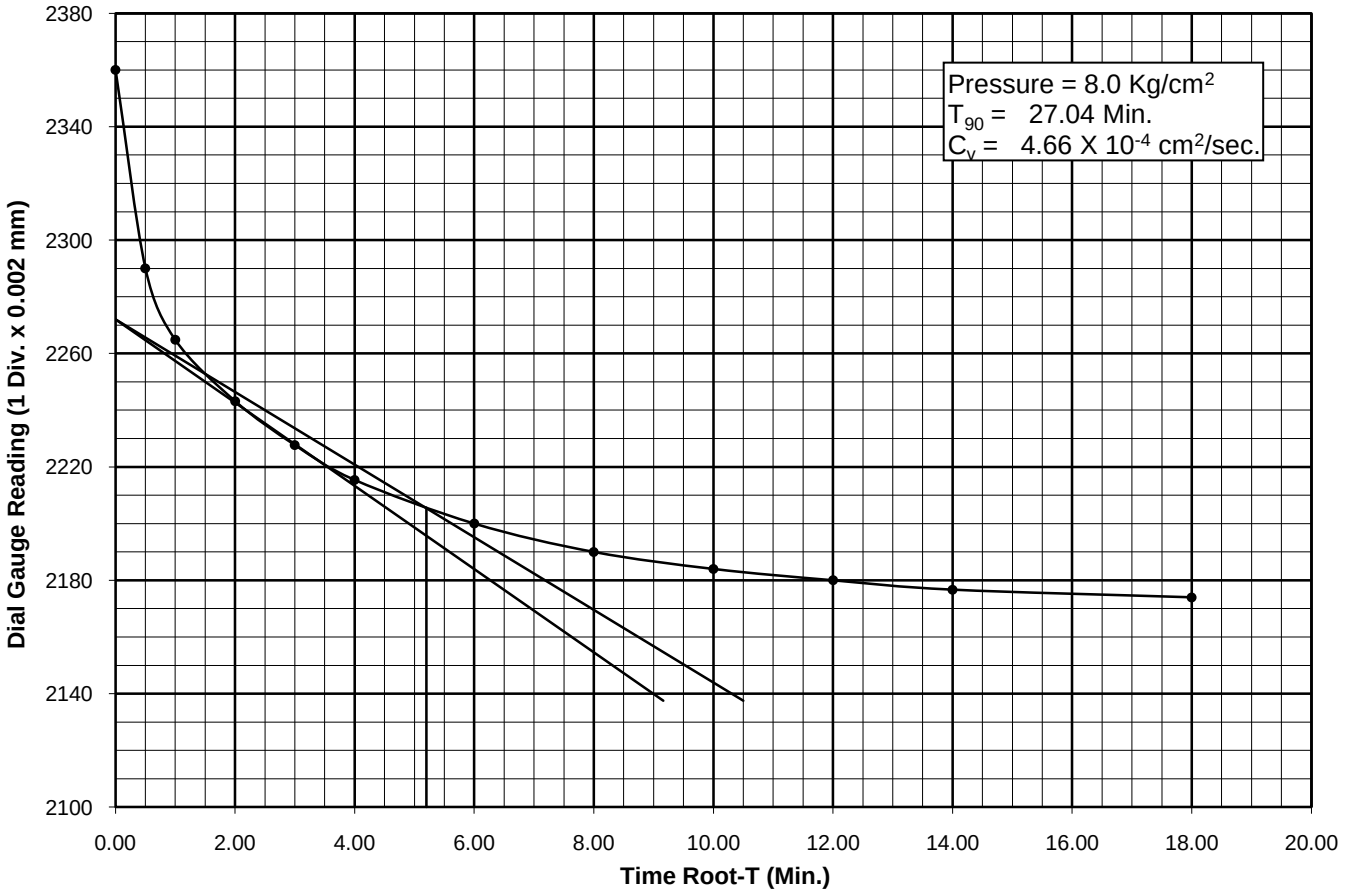
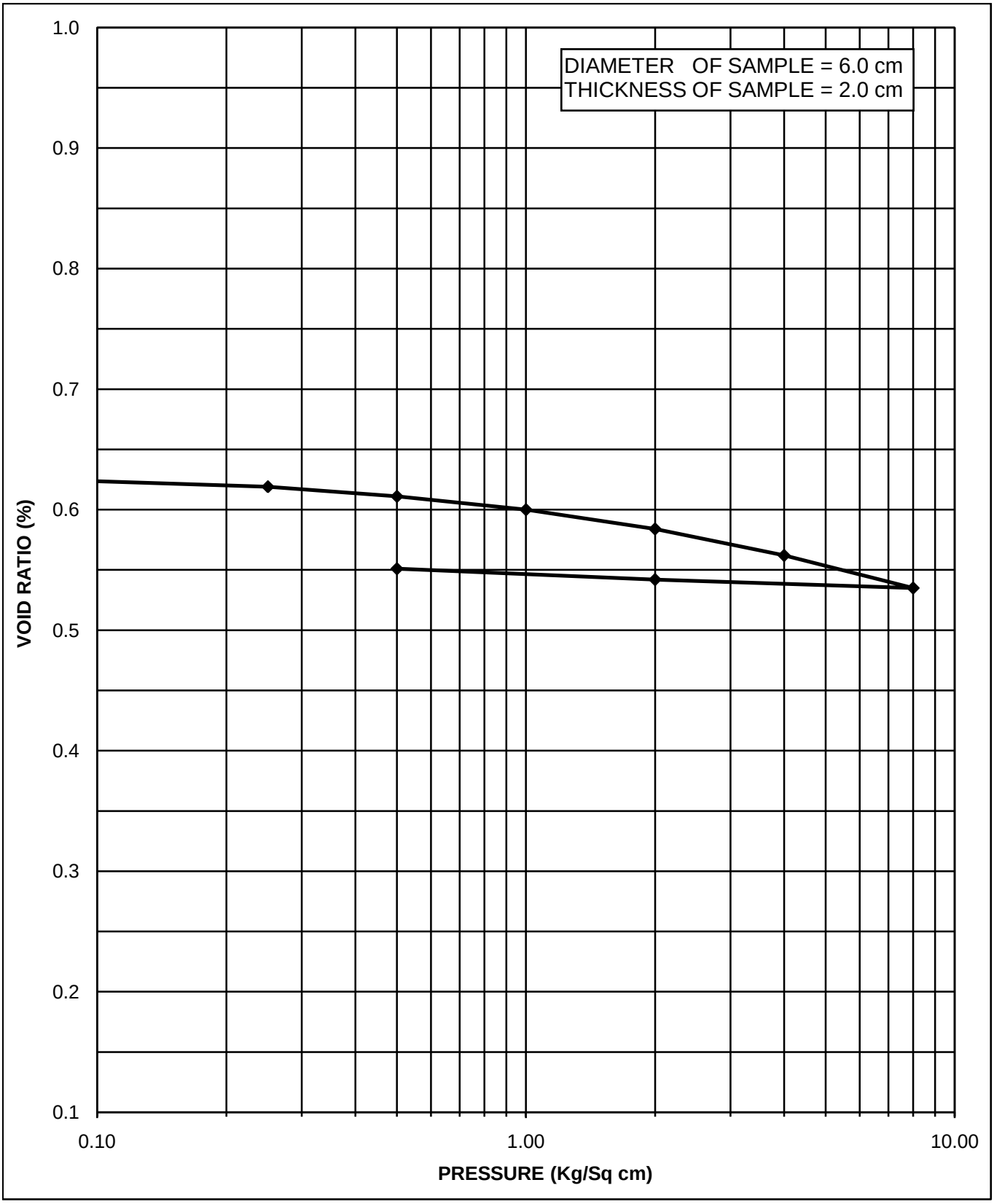


Figure No. -



CHAINAGE: 30+488

BORE HOLE NO. = BH-A2

SAMPLE NO. = UDS-8

DEPTH = 25.00 M

TYPE OF SOIL = CI

INITIAL WATER CONTENT = 18.10 %

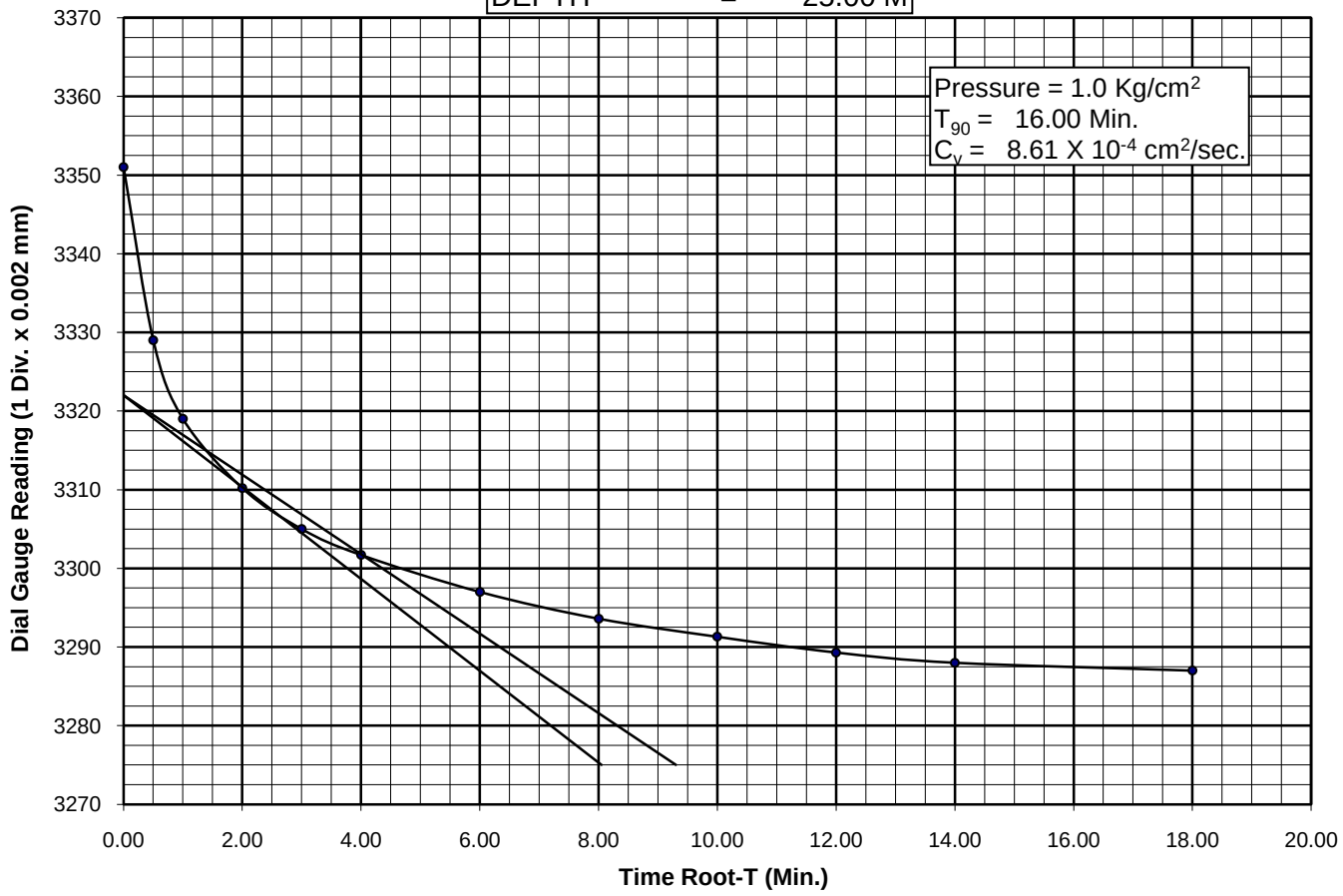
DRY DENSITY = 1.65 gm/cm^3

VOID RATIO (e_o) = 0.625

COMPRESSION INDEX (C_c) = 0.090

FIGURE NO. PRESSURE Vs VOID RATIO CURVE (e-log p)

CHAINAGE = 30+488
BORE HOLE NO. = BH-A2
SAMPLE NO. = UDS-8
DEPTH = 25.00 M



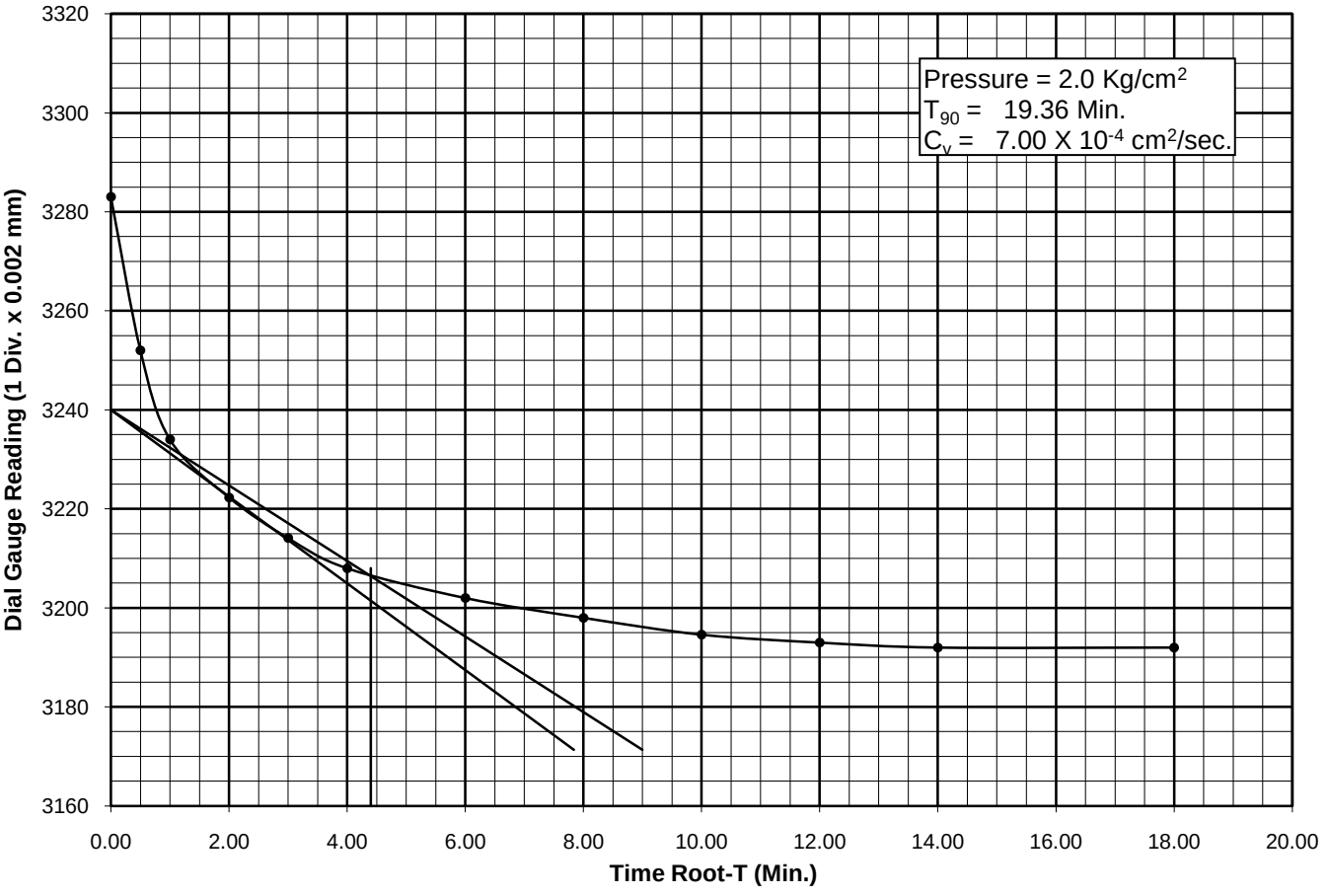
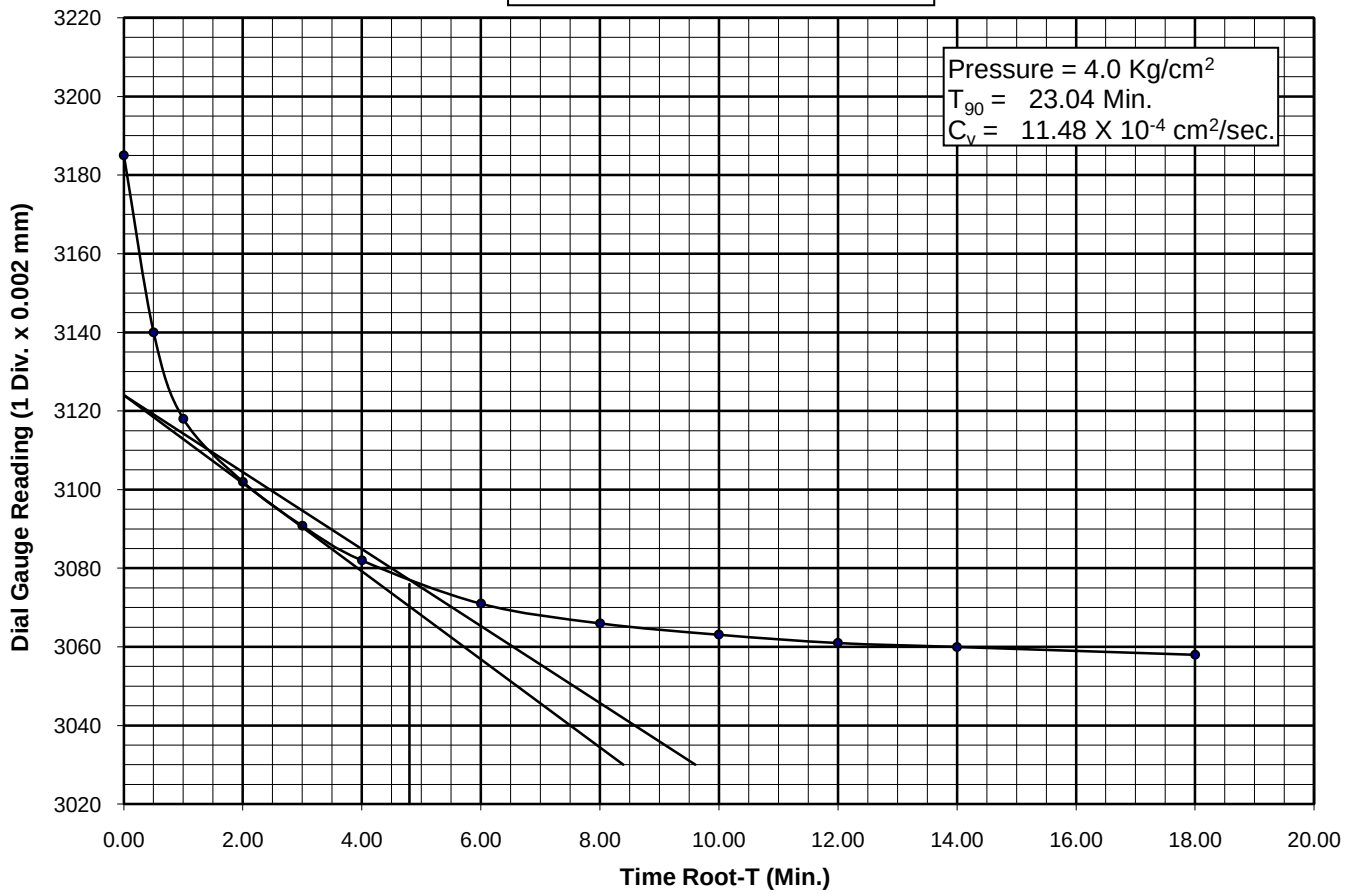


Figure No. -

CHAINAGE	=	30+488
BORE HOLE NO.	=	BH-A2
SAMPLE NO.	=	UDS-8
DEPTH	=	25.00 M



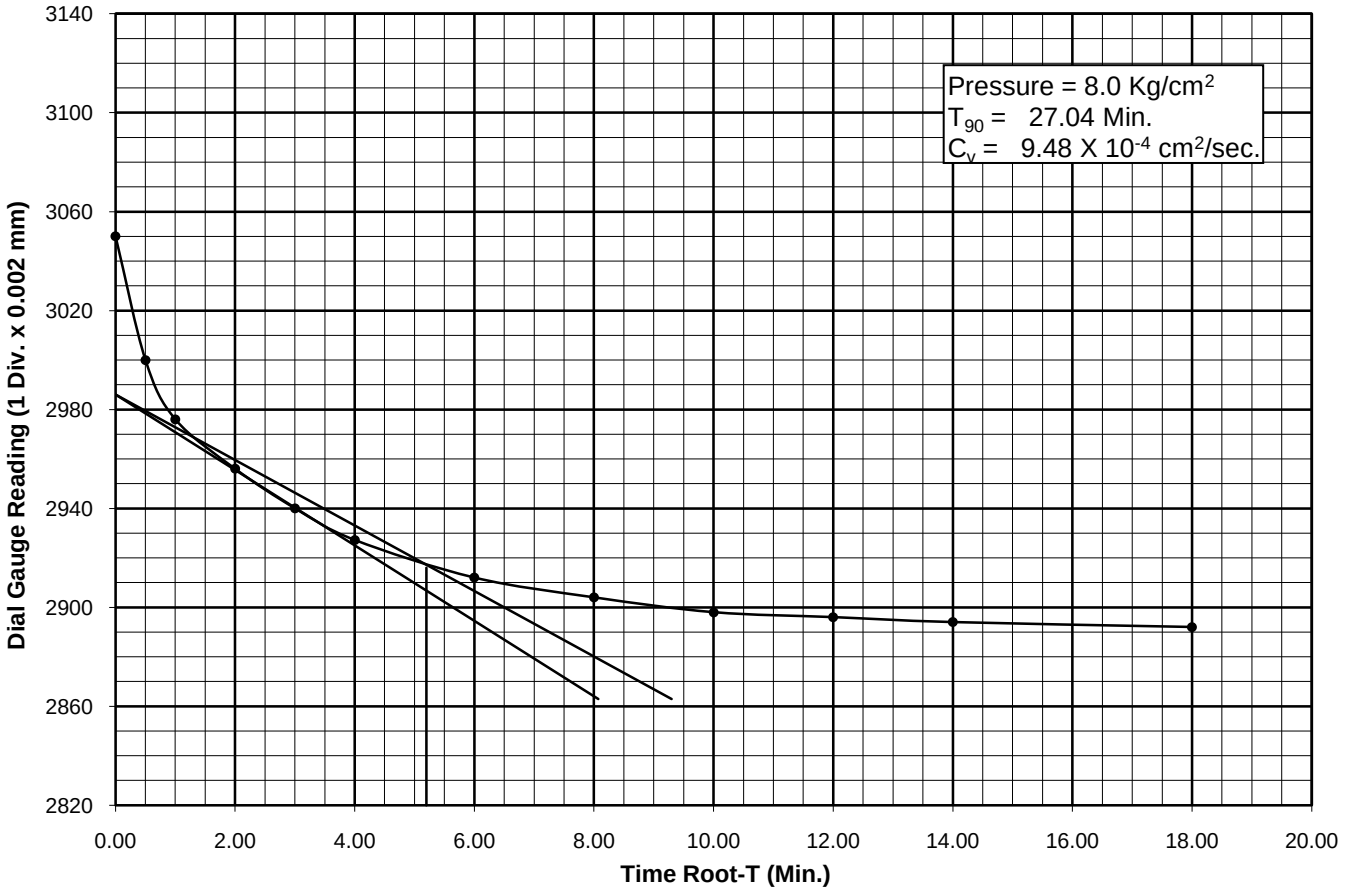
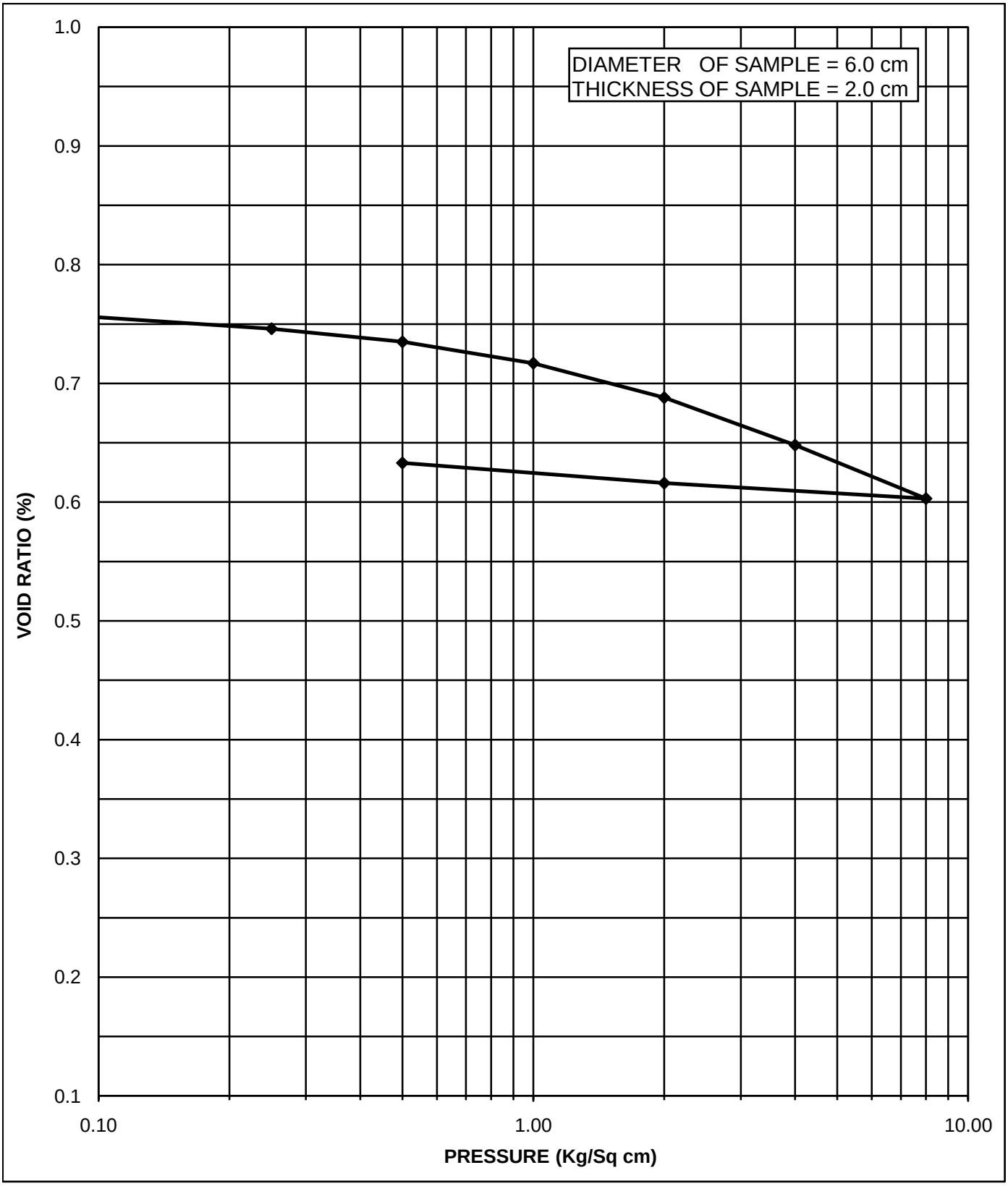


Figure No. -



CHAINAGE: 32+160

BORE HOLE NO. = BH-CL

SAMPLE NO. = UDS-1

DEPTH = 1.00 M

TYPE OF SOIL = CI

INITIAL WATER CONTENT = 12.10 %

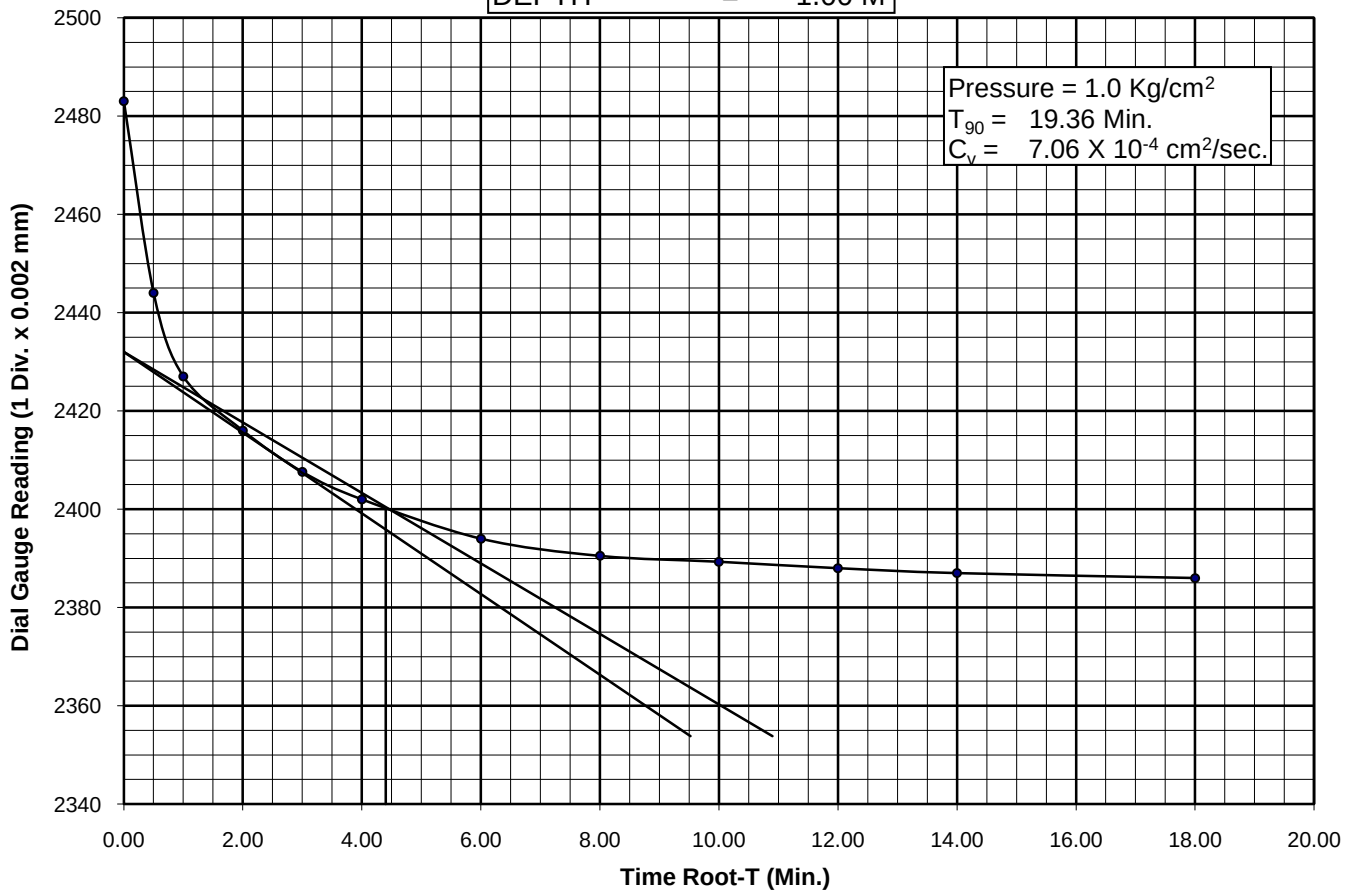
DRY DENSITY = 1.52 gm/cm^3

VOID RATIO (e_o) = 0.755

COMPRESSION INDEX (C_c) = 0.150

FIGURE NO. PRESSURE Vs VOID RATIO CURVE (e-log p)

CHAINAGE = 32+160
BORE HOLE NO. = BH-CL
SAMPLE NO. = UDS-1
DEPTH = 1.00 M



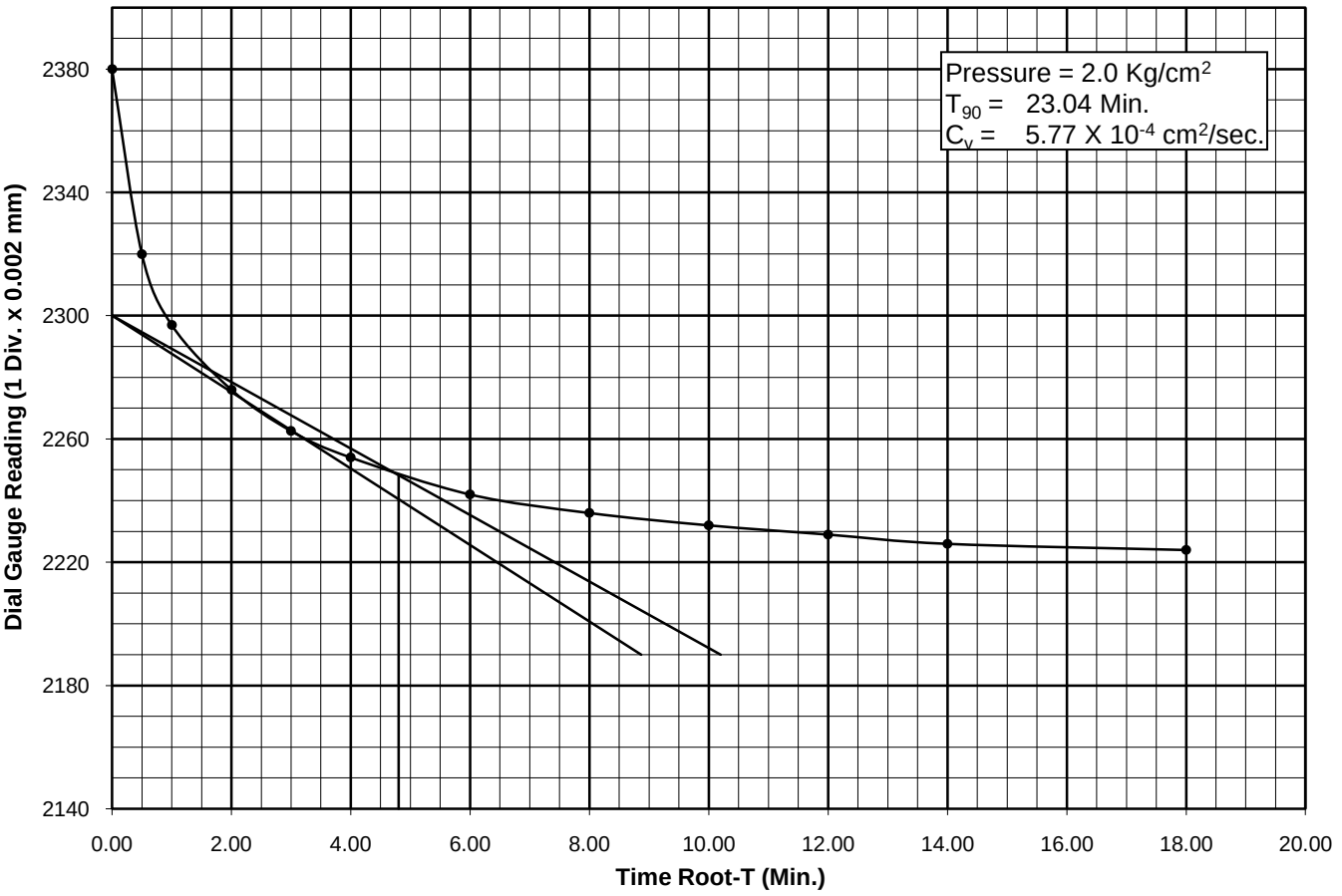
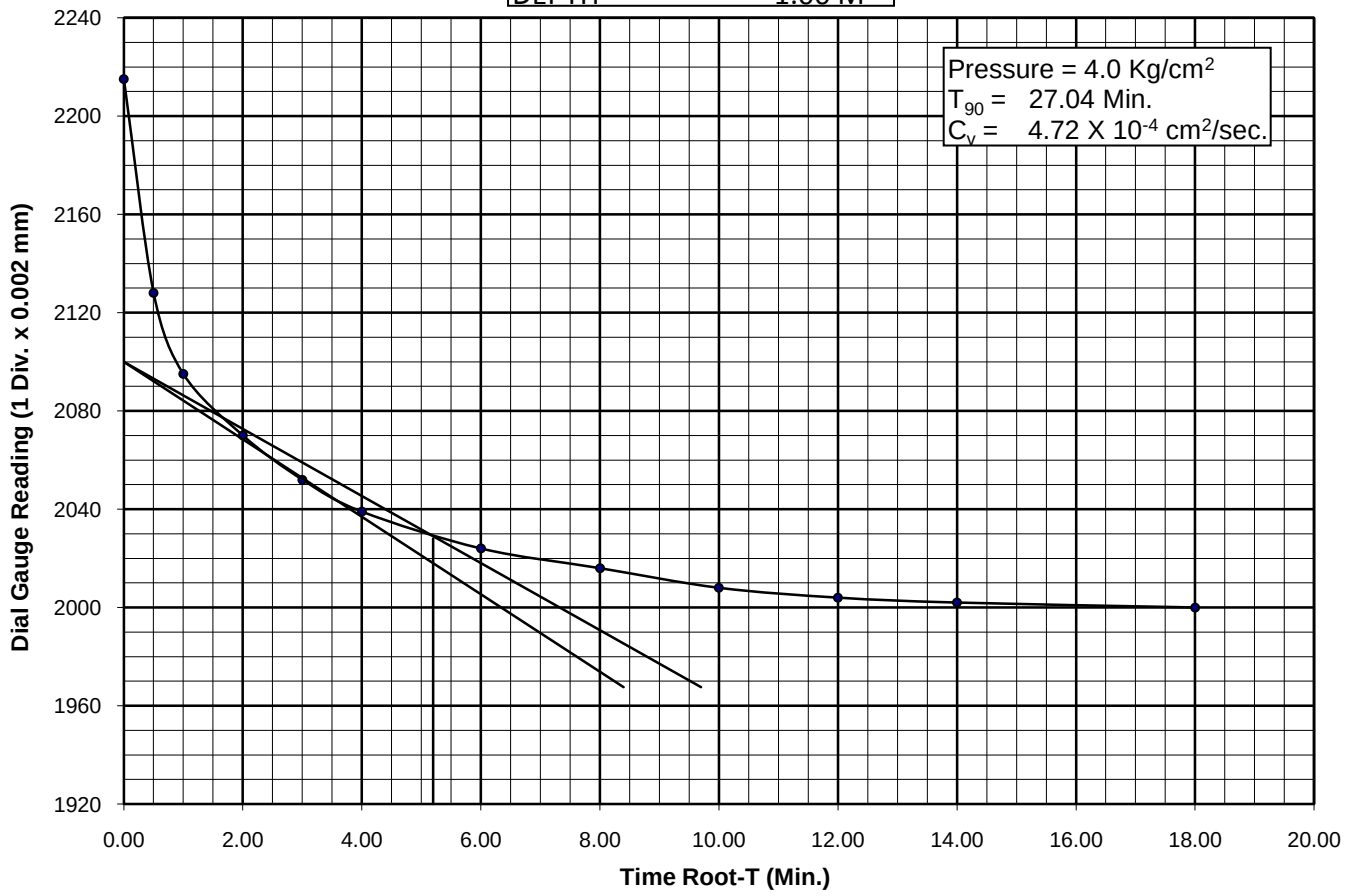


Figure No. -

CHAINAGE = 32+160
BORE HOLE NO. = BH-CL
SAMPLE NO. = UDS-1
DEPTH = 1.00 M



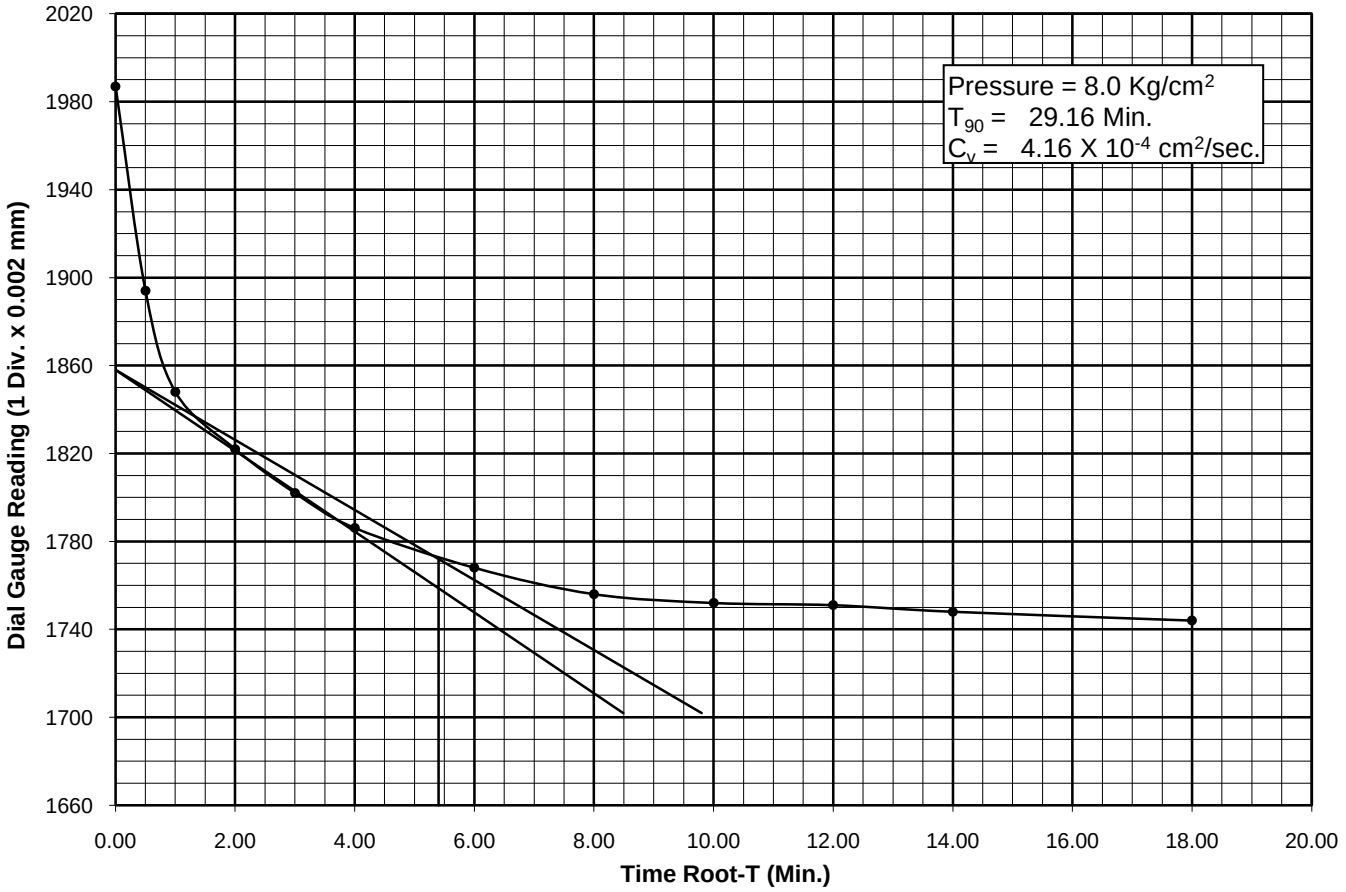
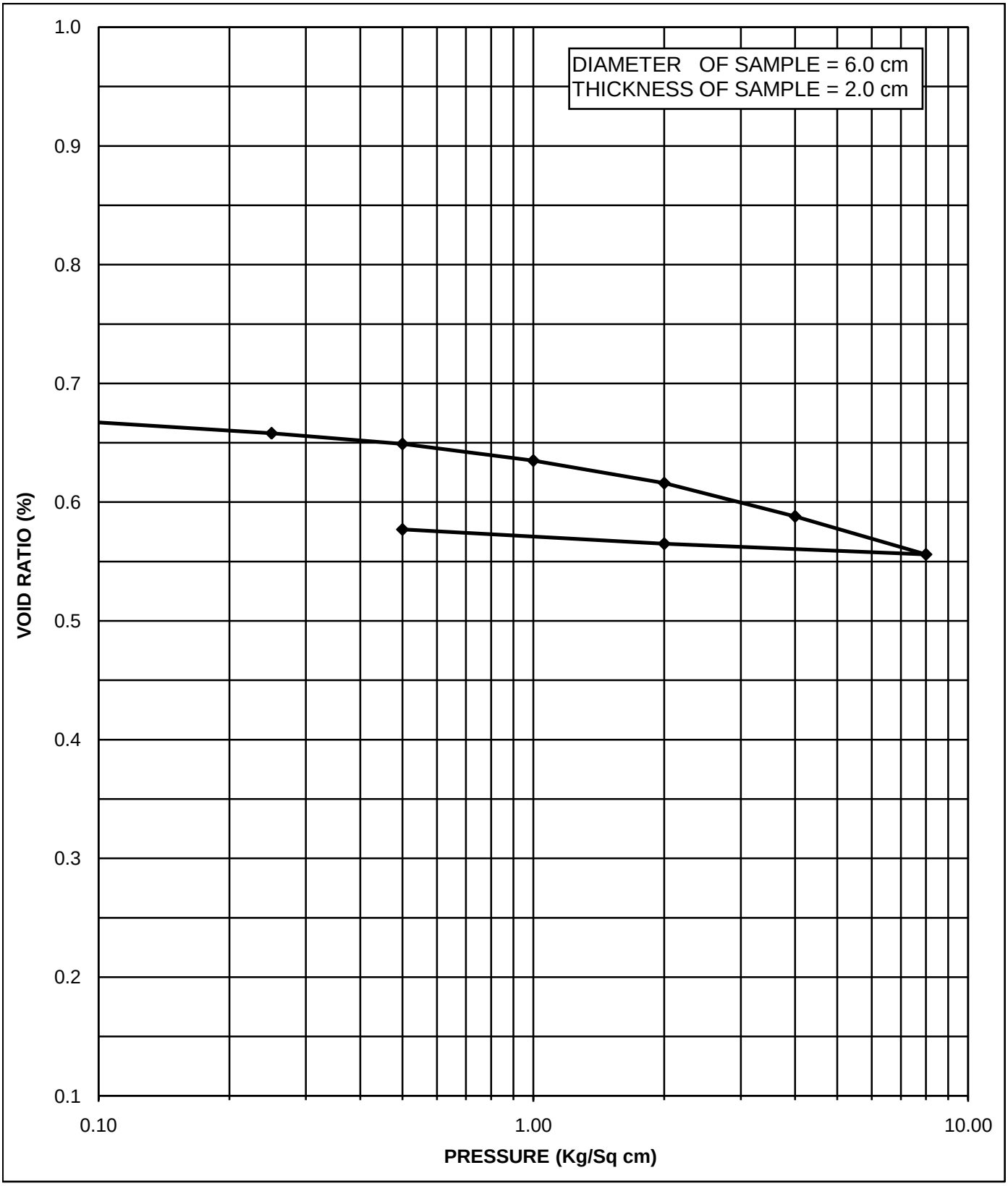


Figure No. -



CHAINAGE: 32+738

BORE HOLE NO. = BH-CL

SAMPLE NO. = UDS-3

DEPTH = 8.50 M

TYPE OF SOIL = CL

INITIAL WATER CONTENT = 15.26 %

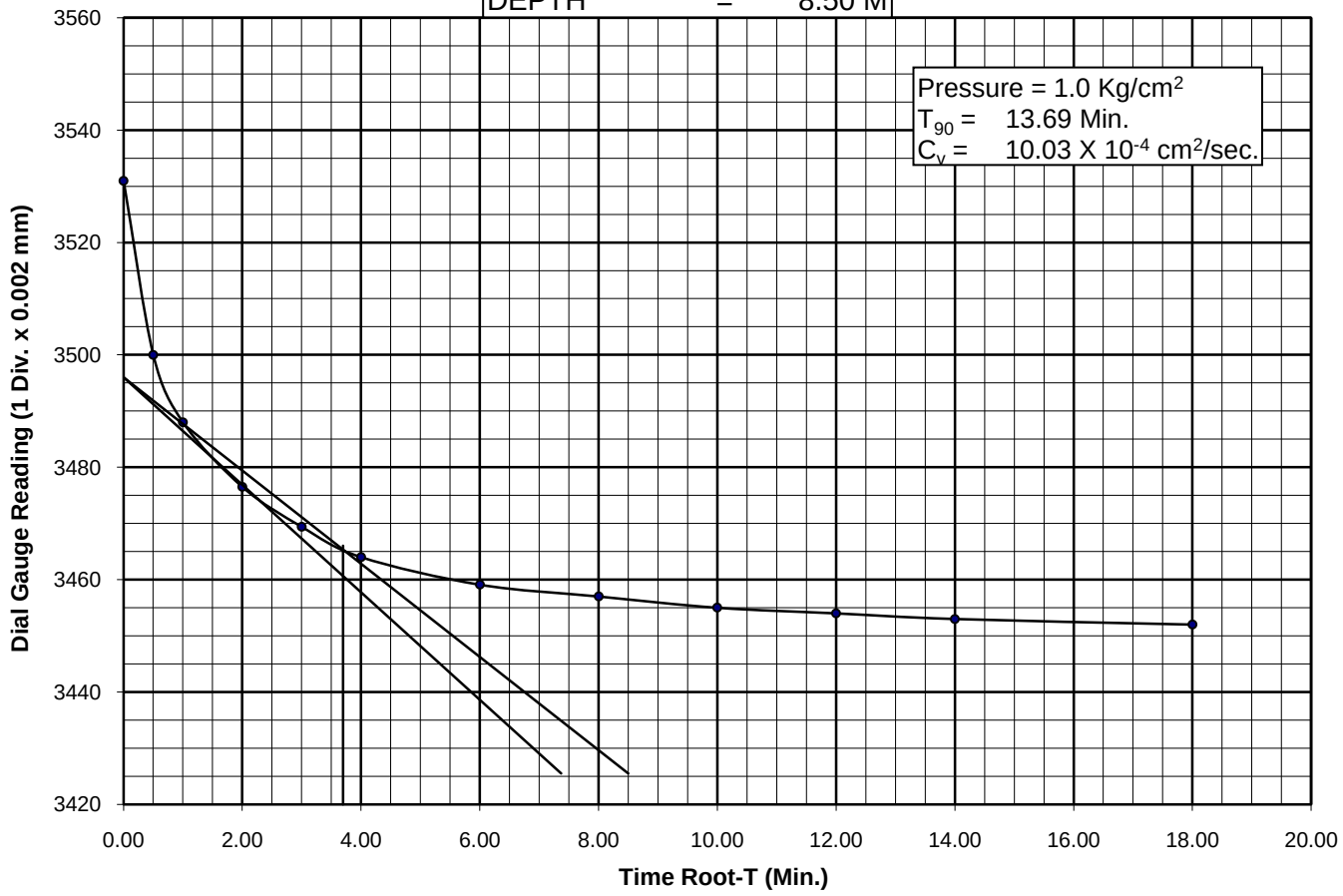
DRY DENSITY = 1.61 gm/cm^3

VOID RATIO (e_o) = 0.665

COMPRESSION INDEX (C_c) = 0.106

FIGURE NO. PRESSURE Vs VOID RATIO CURVE (e-log p)

CHAINAGE = 32+738
BORE HOLE NO. = BH-CL
SAMPLE NO. = UDS-3
DEPTH = 8.50 M



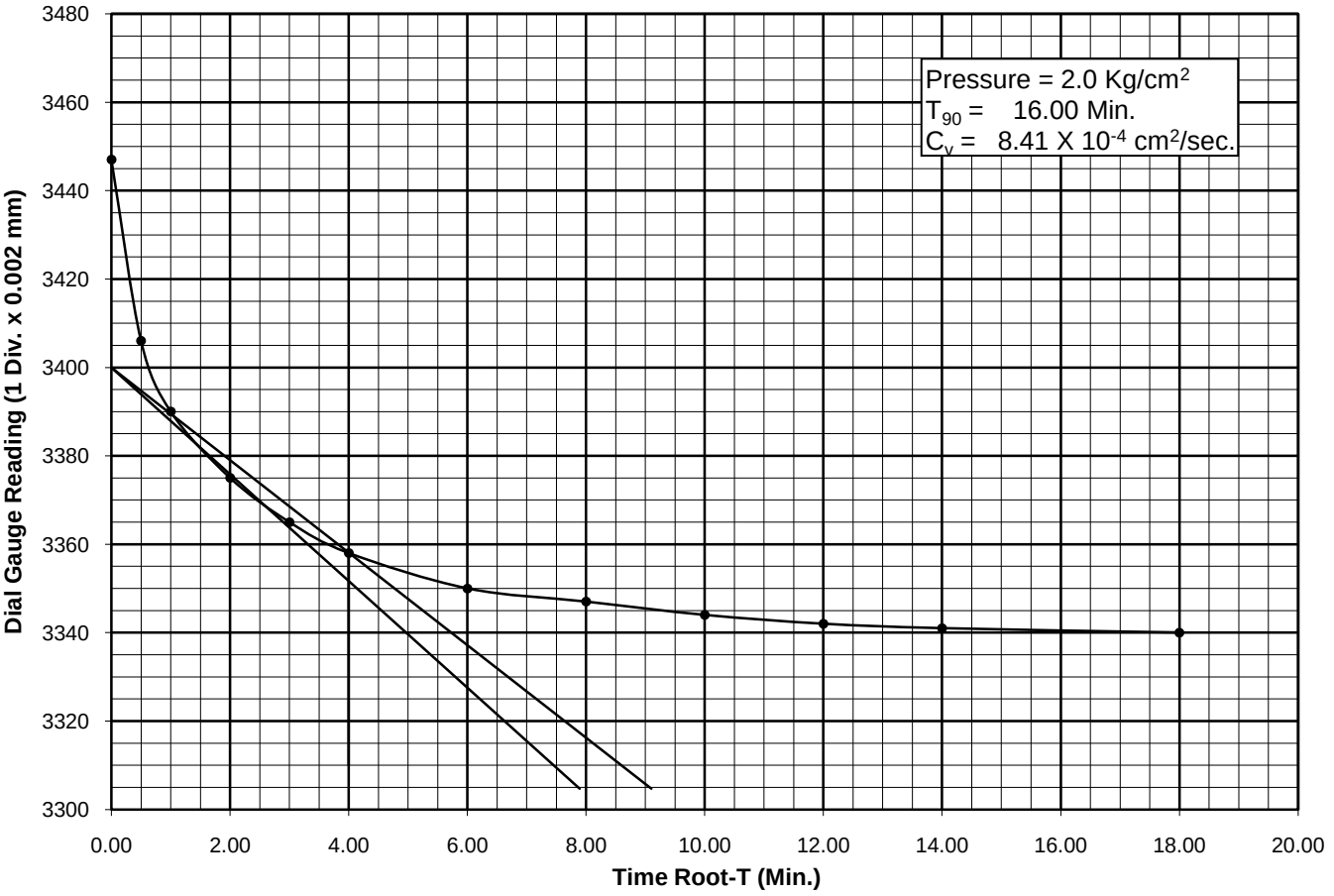
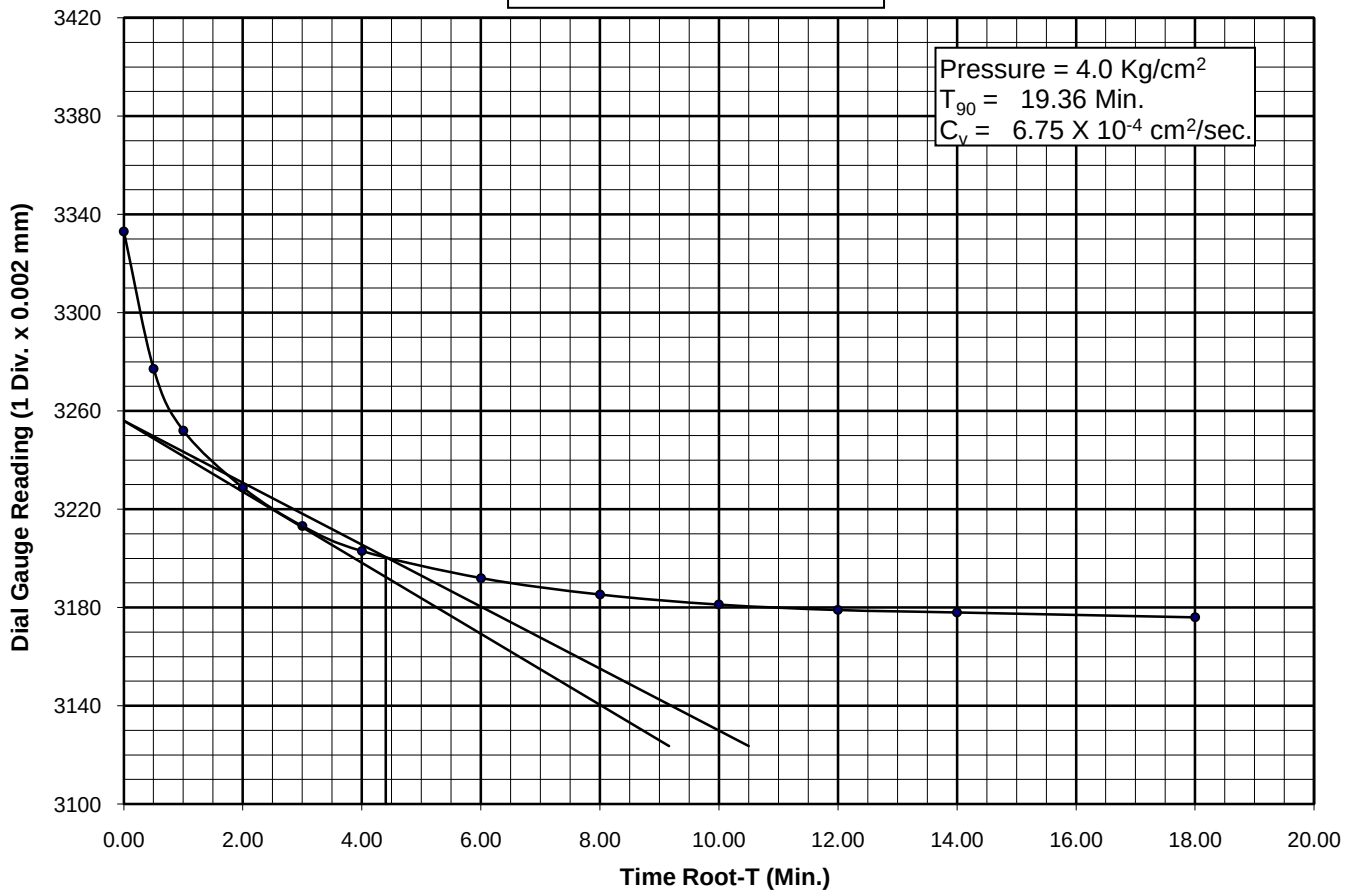


Figure No. -

CHAINAGE	=	32+738
BORE HOLE NO.	=	BH-CL
SAMPLE NO.	=	UDS-3
DEPTH	=	8.50 M



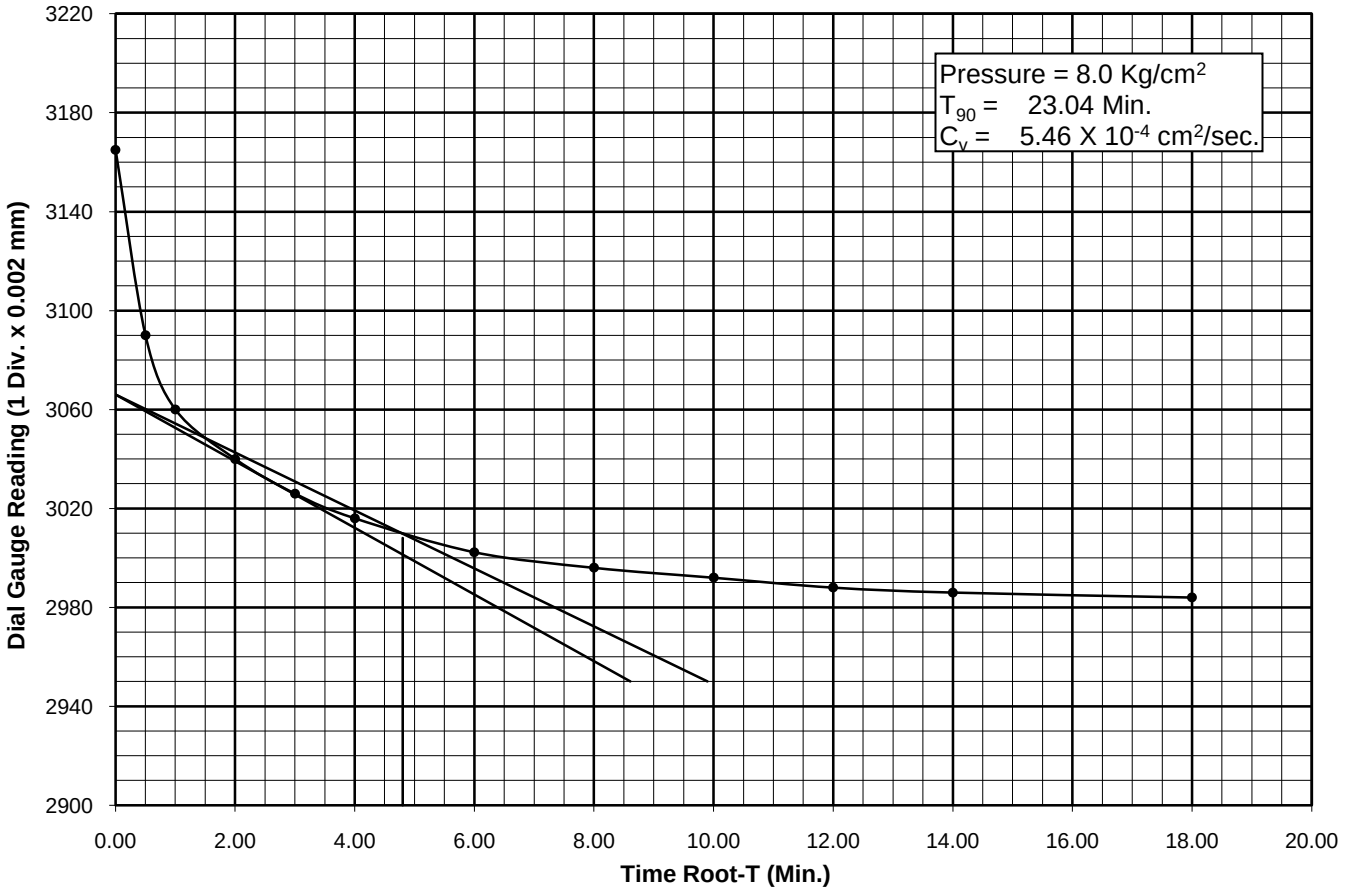
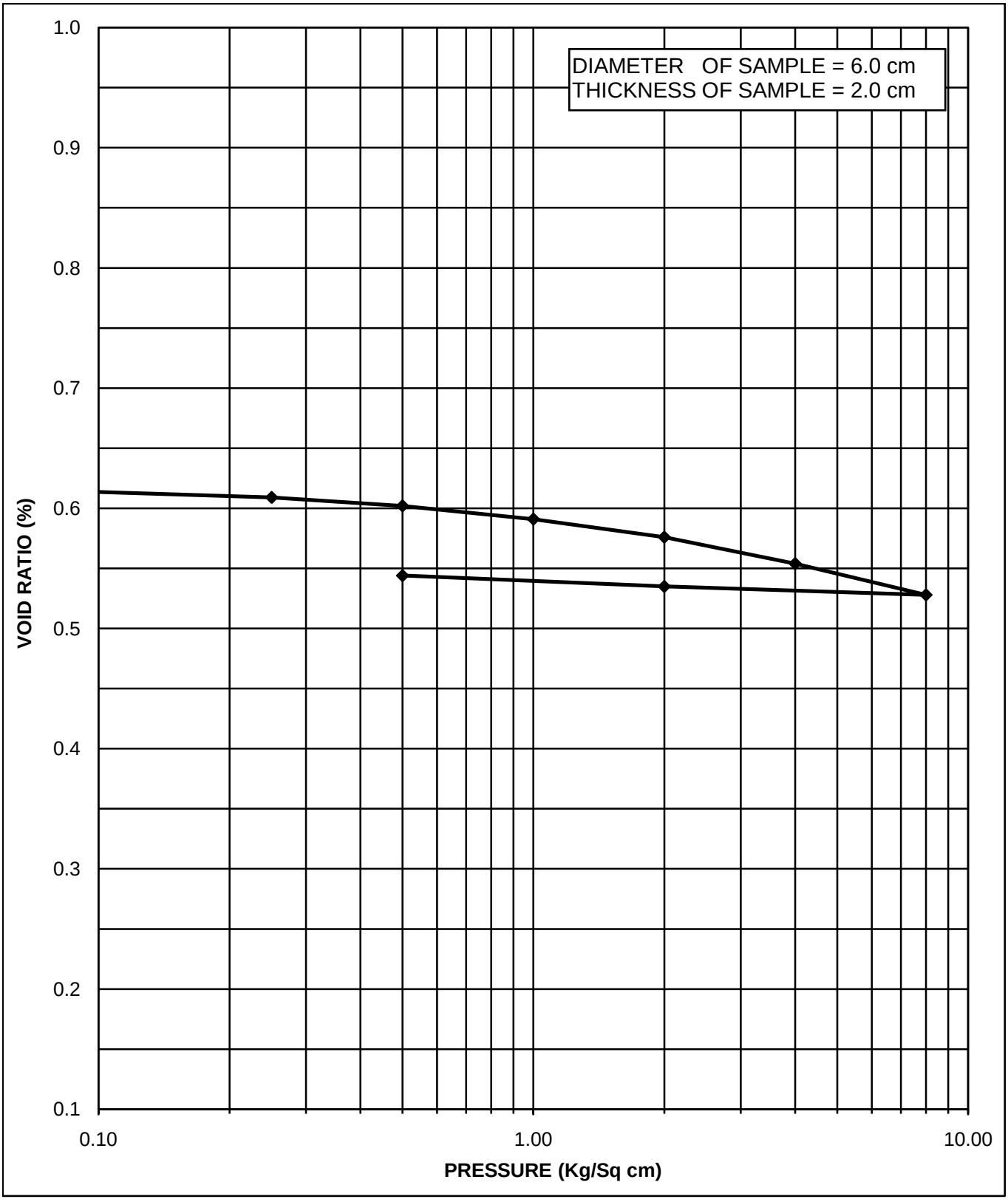


Figure No. -



CHAINAGE: 33+713

BORE HOLE NO. = BH-A2

SAMPLE NO. = UDS-4

DEPTH = 10.00 M

TYPE OF SOIL = CL

INITIAL WATER CONTENT = 15.04 %

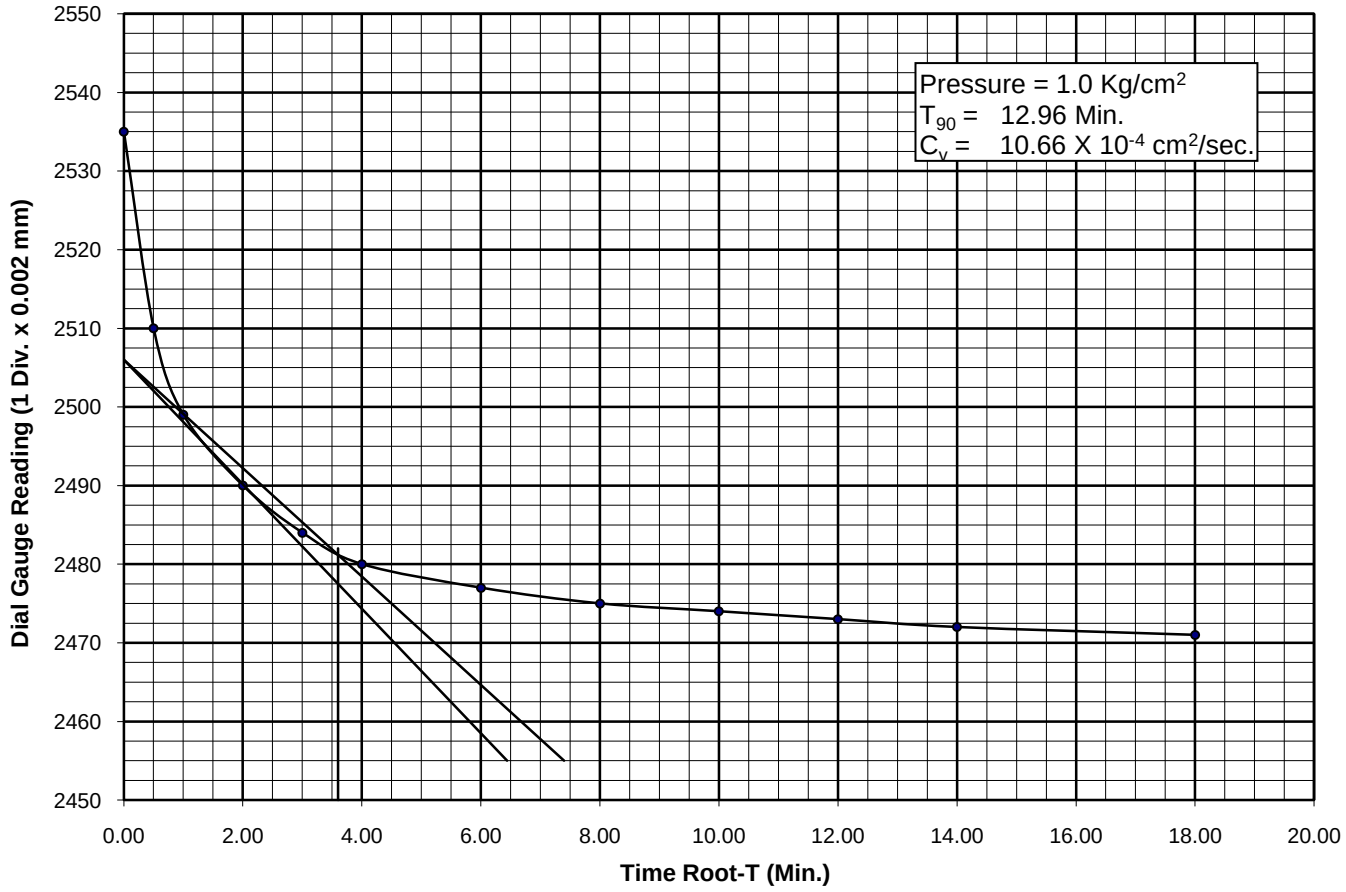
DRY DENSITY = 1.66 gm/cm^3

VOID RATIO (e_o) = 0.615

COMPRESSION INDEX (C_c) = 0.086

FIGURE NO. PRESSURE Vs VOID RATIO CURVE (e-log p)

CHAINAGE	=	33+713
BORE HOLE NO.	=	BH-A2
SAMPLE NO.	=	UDS-4
DEPTH	=	10.00 M



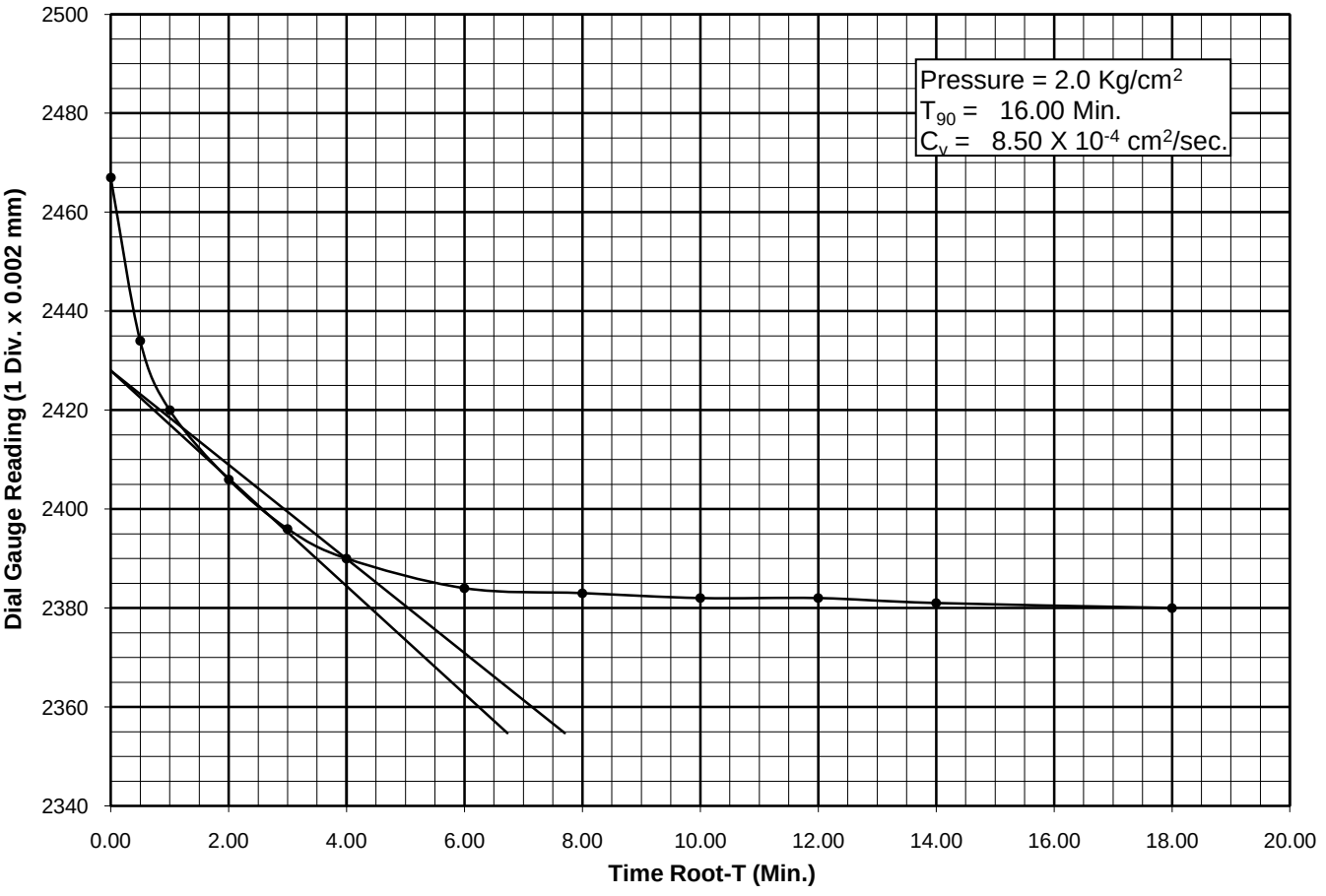
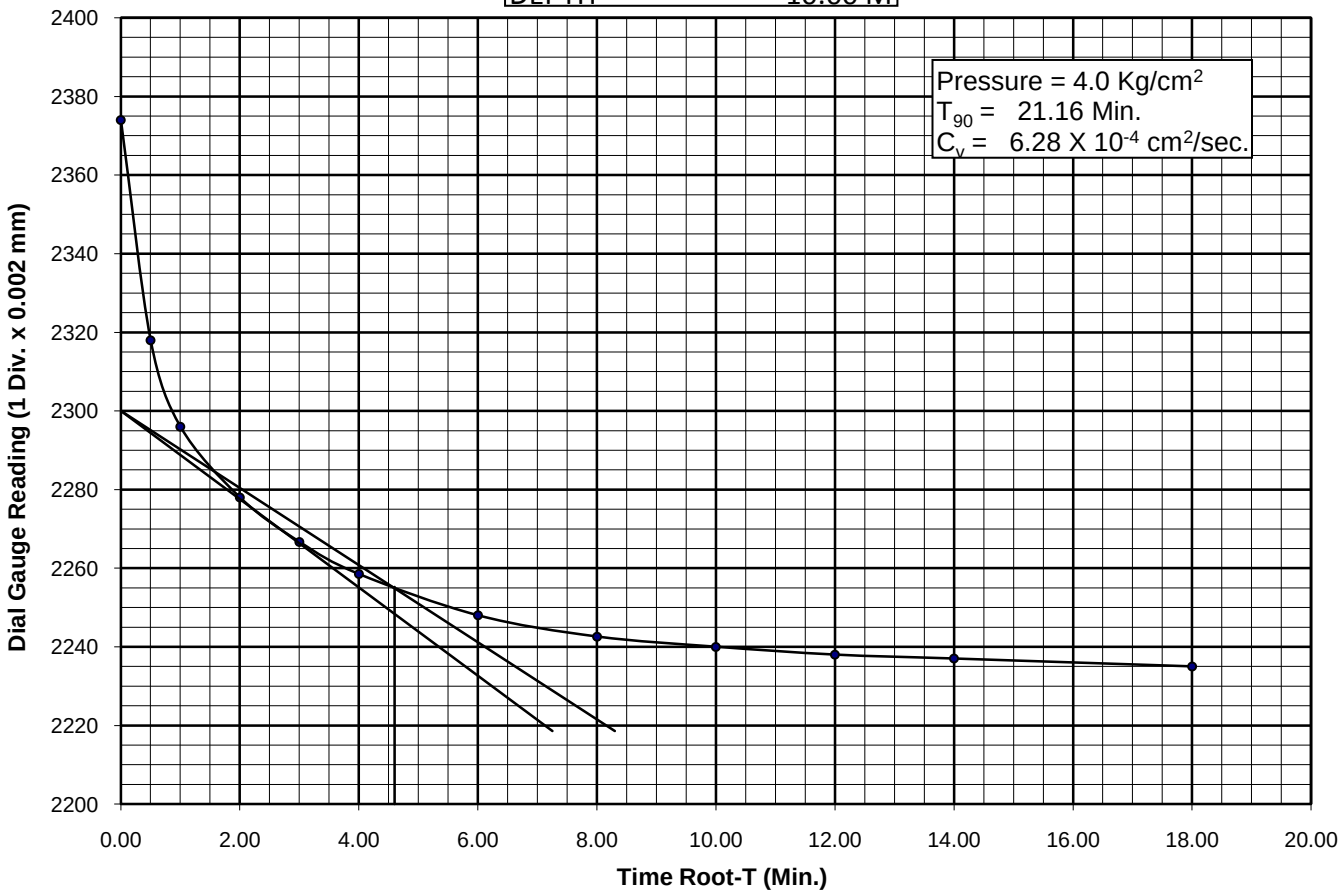


Figure No. -

CHAINAGE = 33+713
BORE HOLE NO. = BH-A2
SAMPLE NO. = UDS-4
DEPTH = 10.00 M



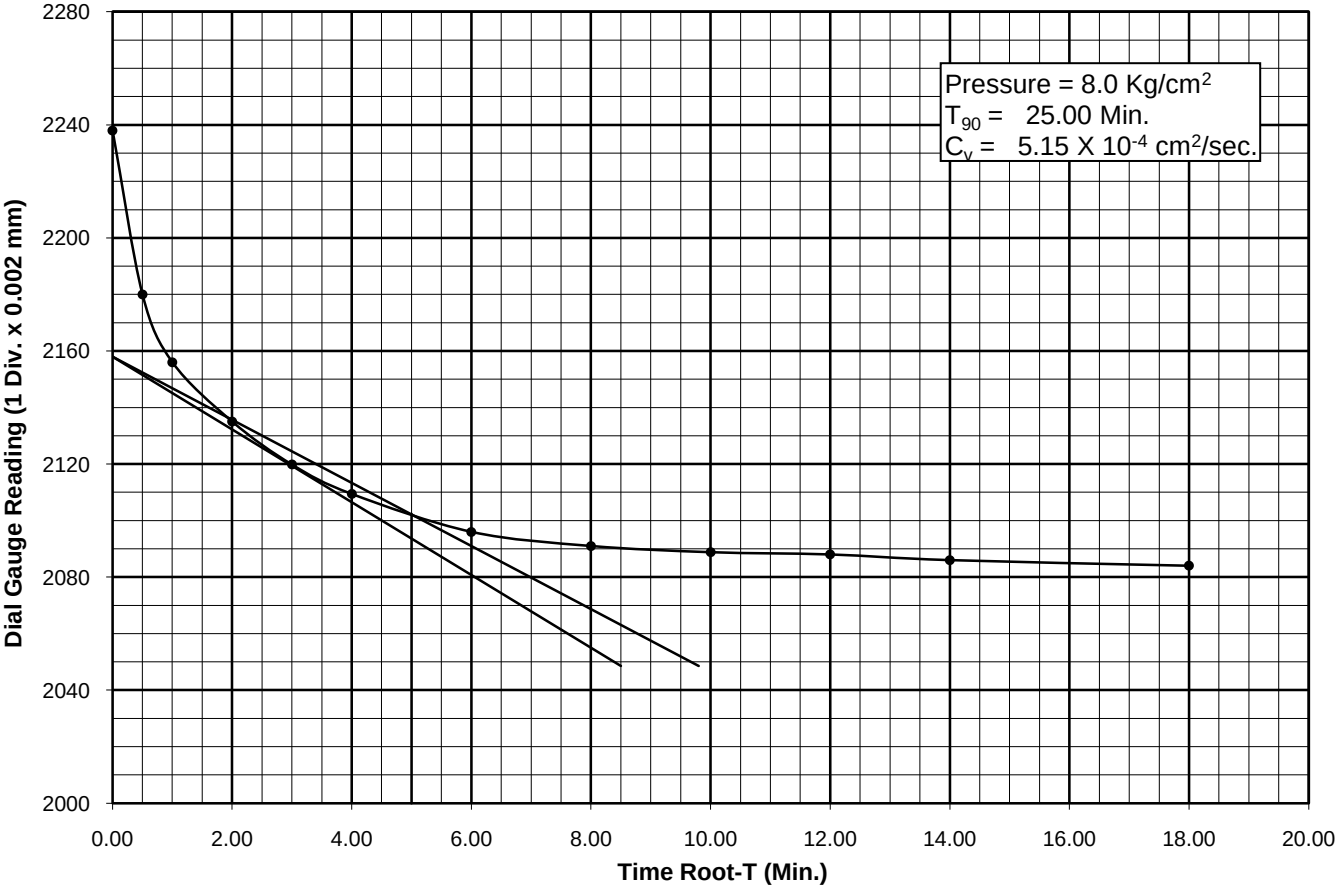
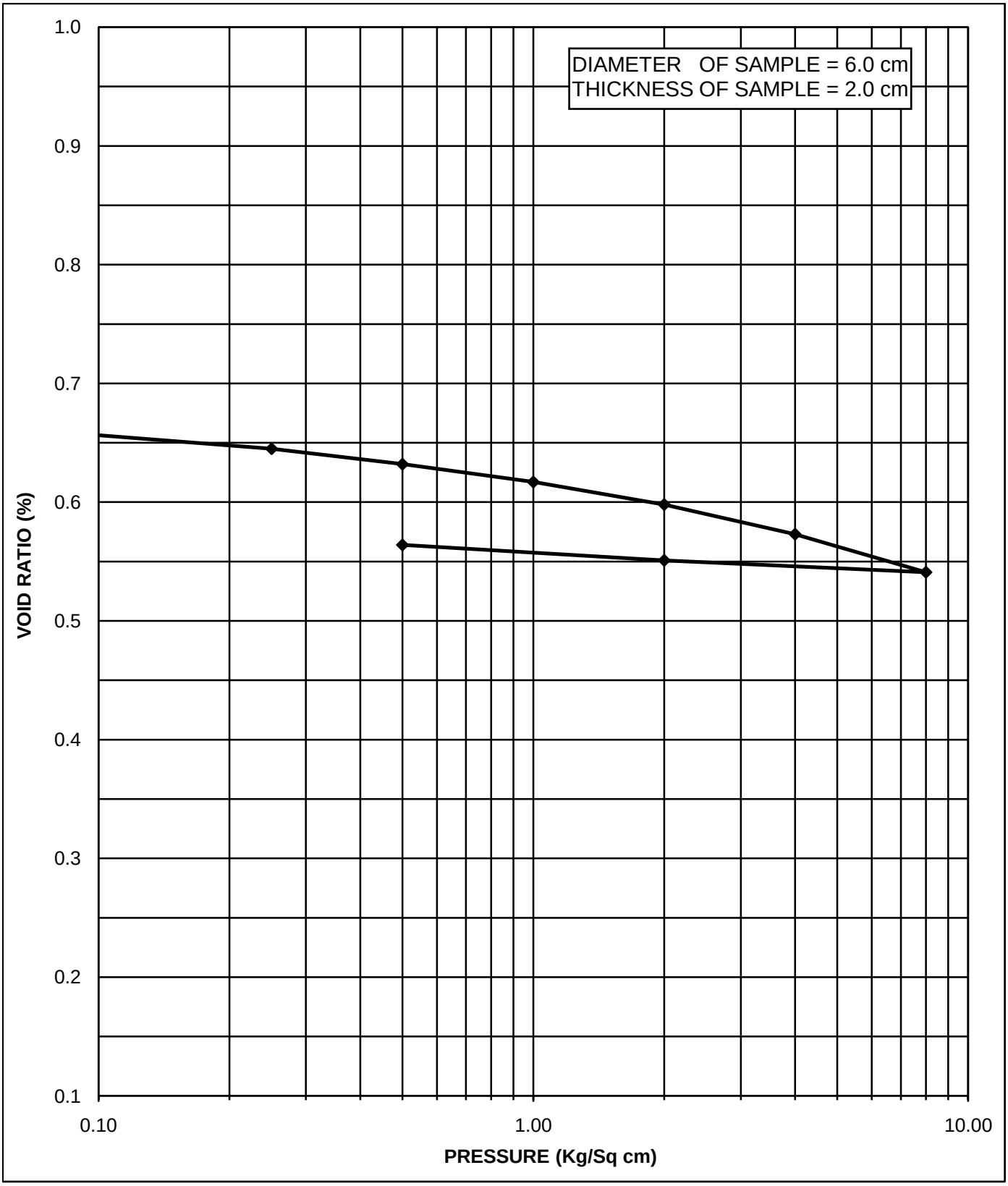


Figure No. -



CHAINAGE: 34+019

BORE HOLE NO. = BH-CL

SAMPLE NO. = UDS-2

DEPTH = 5.50 M

TYPE OF SOIL = CL

INITIAL WATER CONTENT = 15.41 %

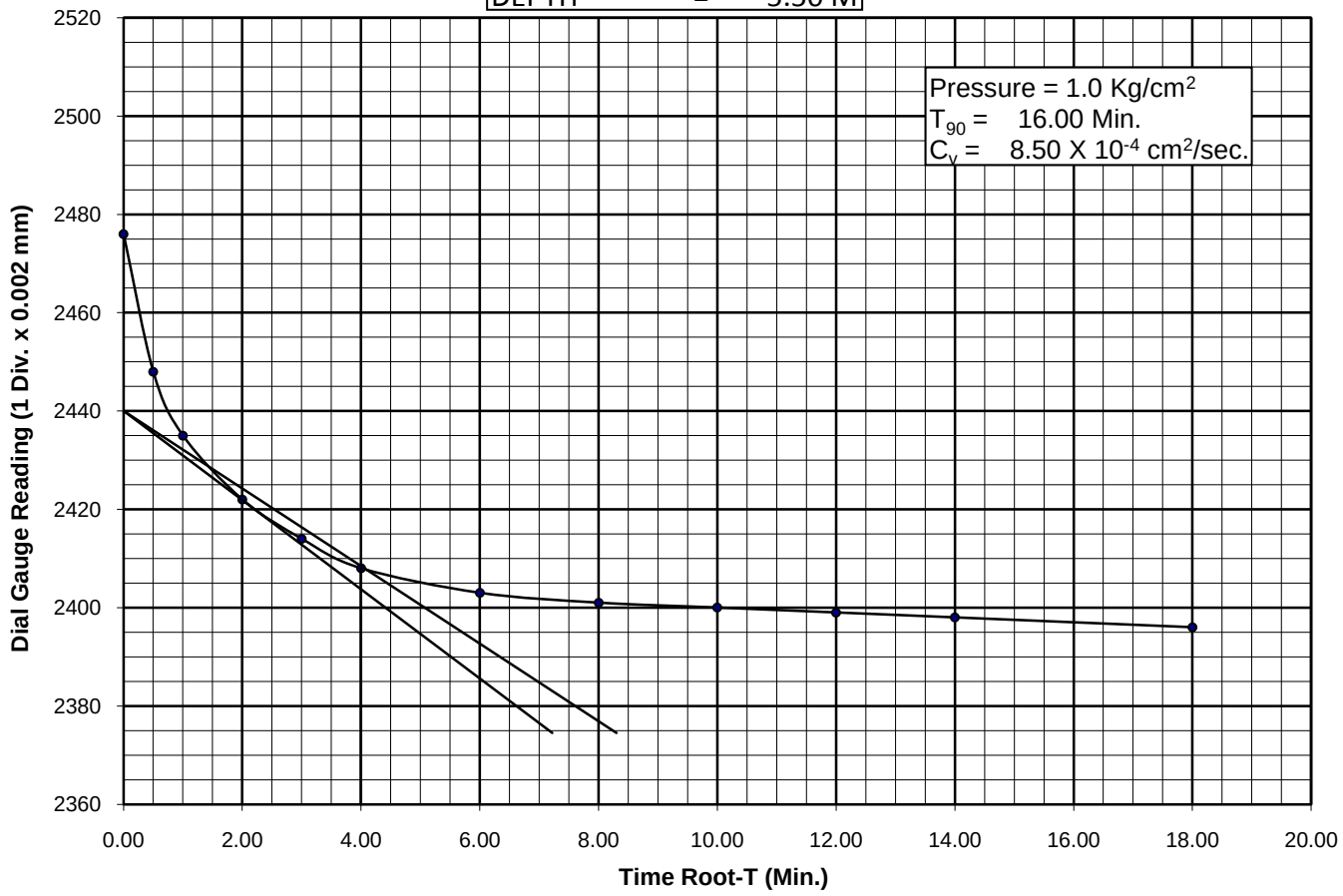
DRY DENSITY = 1.61 gm/cm^3

VOID RATIO (e_o) = 0.655

COMPRESSION INDEX (C_c) = 0.106

FIGURE NO. PRESSURE Vs VOID RATIO CURVE (e-log p)

CHAINAGE: 34+019
BORE HOLE NO. = BH-CL
SAMPLE NO. = UDS-2
DEPTH = 5.50 M



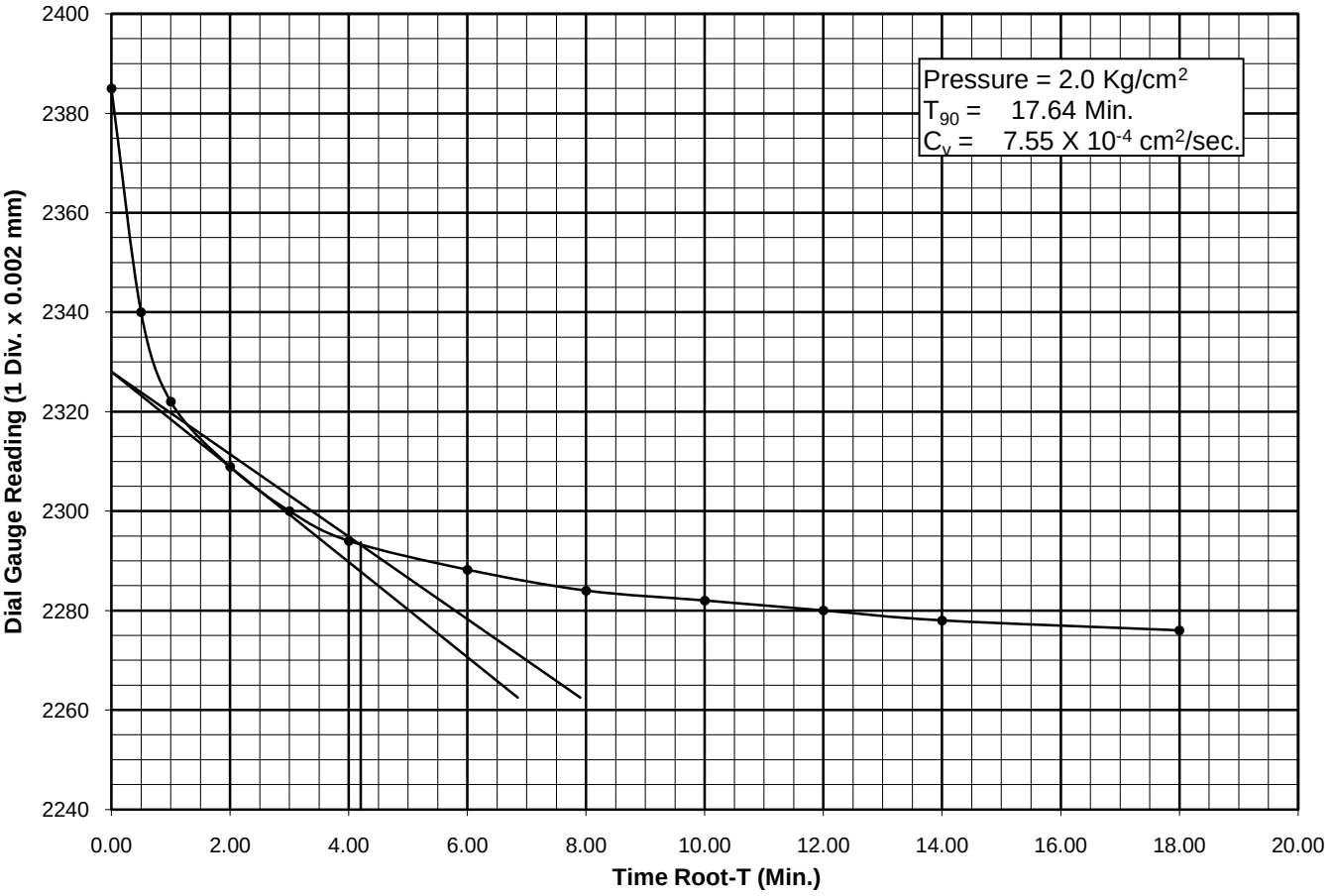
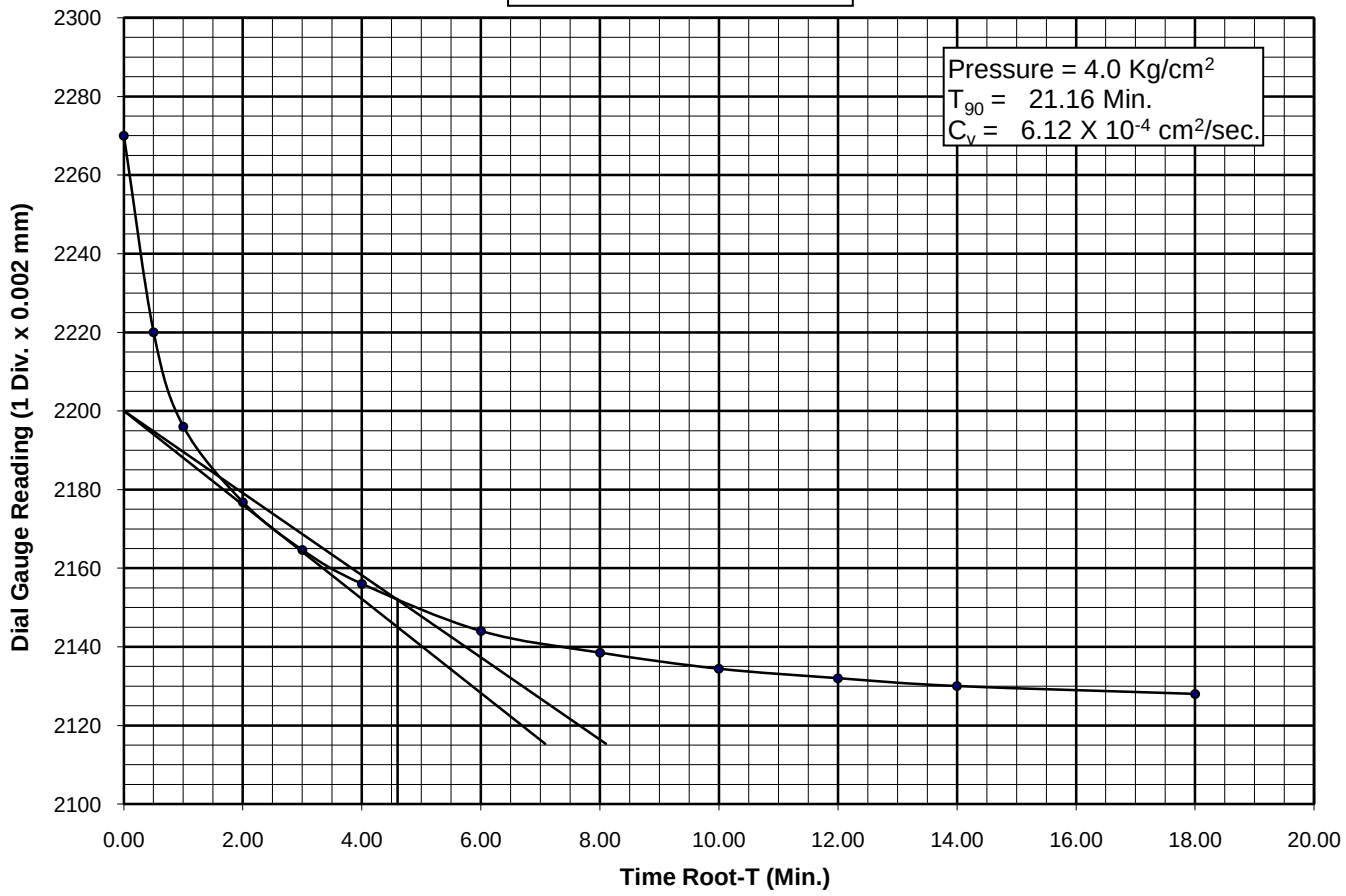


Figure No. -

CHAINAGE: 34+019
BORE HOLE NO. = BH-CL
SAMPLE NO. = UDS-2
DEPTH = 5.50 M



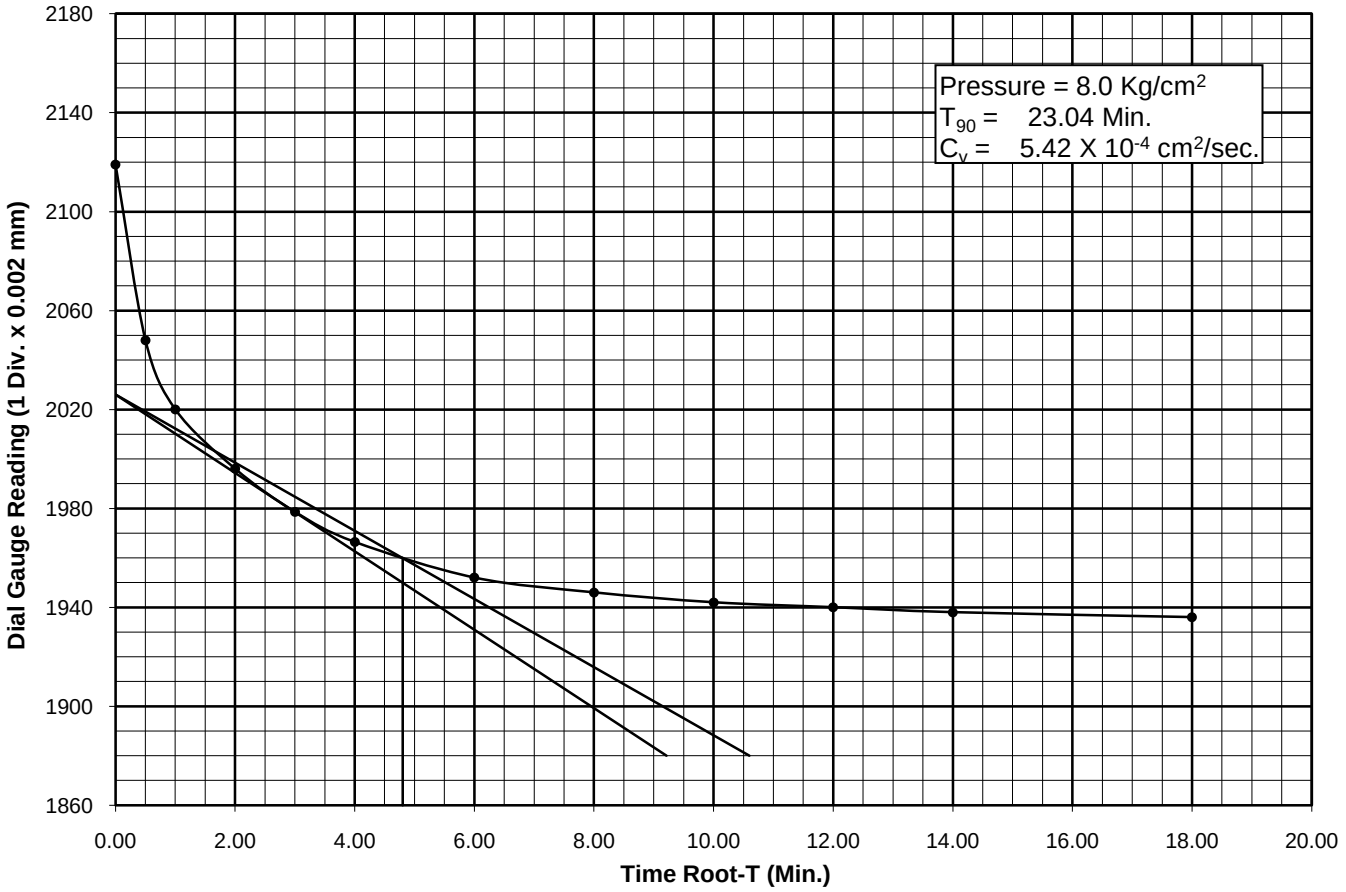
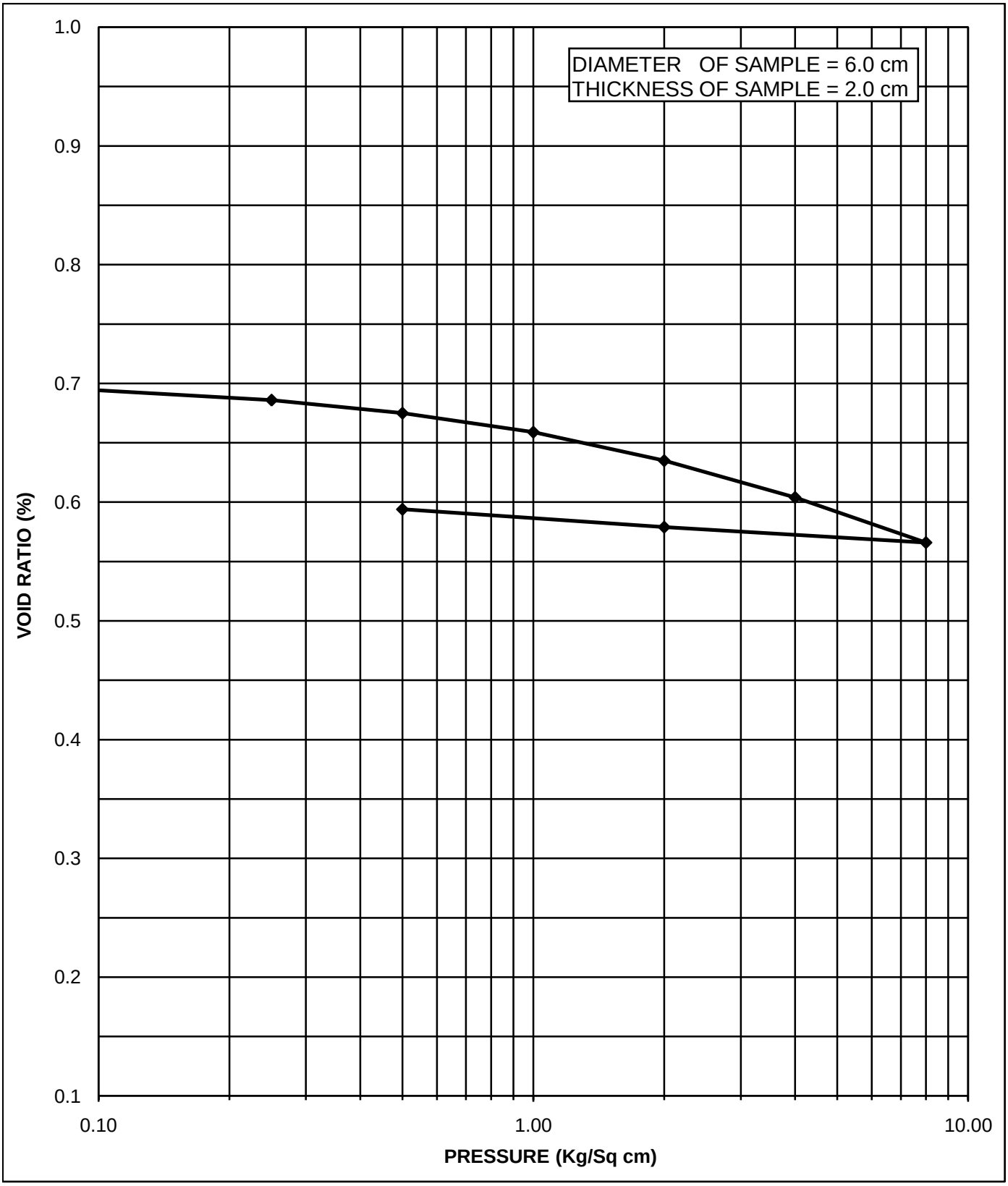


Figure No. -



CHAINAGE: 35+272

BORE HOLE NO. = BH-CL

SAMPLE NO. = UDS-3

DEPTH = 8.50 M

TYPE OF SOIL = CI

INITIAL WATER CONTENT = 14.71 %

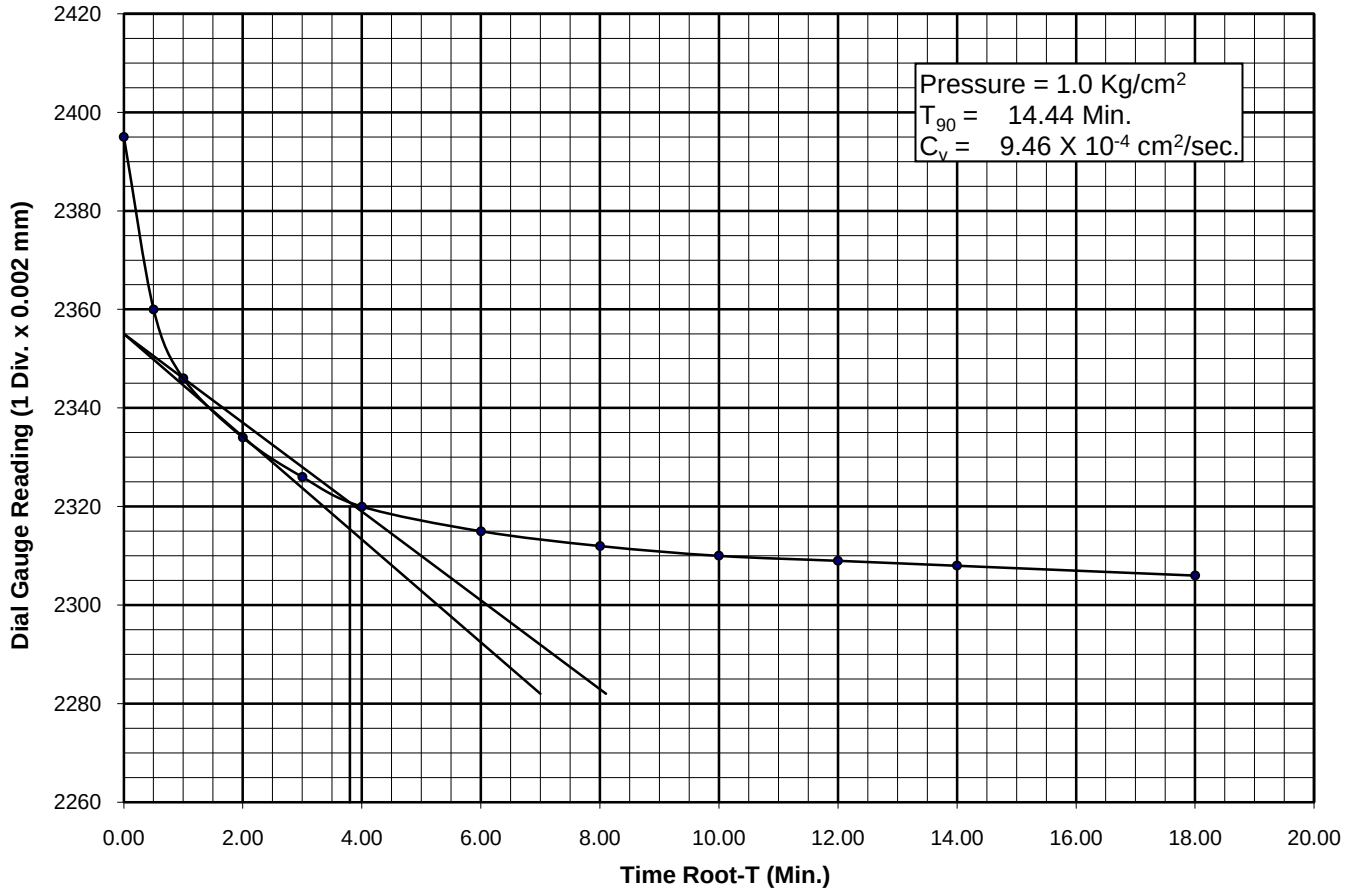
DRY DENSITY = 1.58 gm/cm^3

VOID RATIO (e_o) = 0.695

COMPRESSION INDEX (C_c) = 0.126

FIGURE NO. PRESSURE Vs VOID RATIO CURVE (e-log p)

CHAINAGE	= 35+272
BORE HOLE NO. =	BH-CL
SAMPLE NO. =	UDS-3
DEPTH =	8.50 M



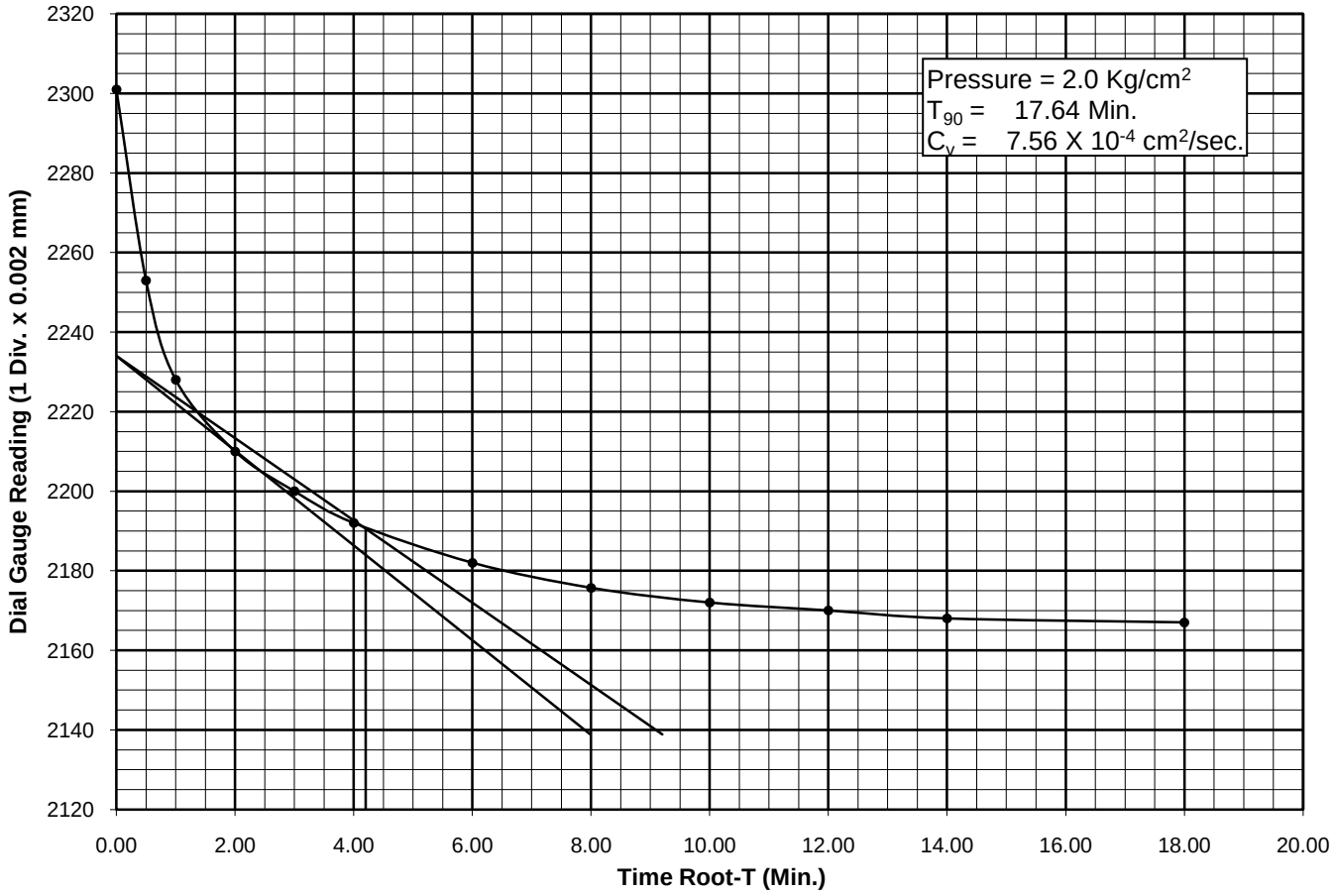
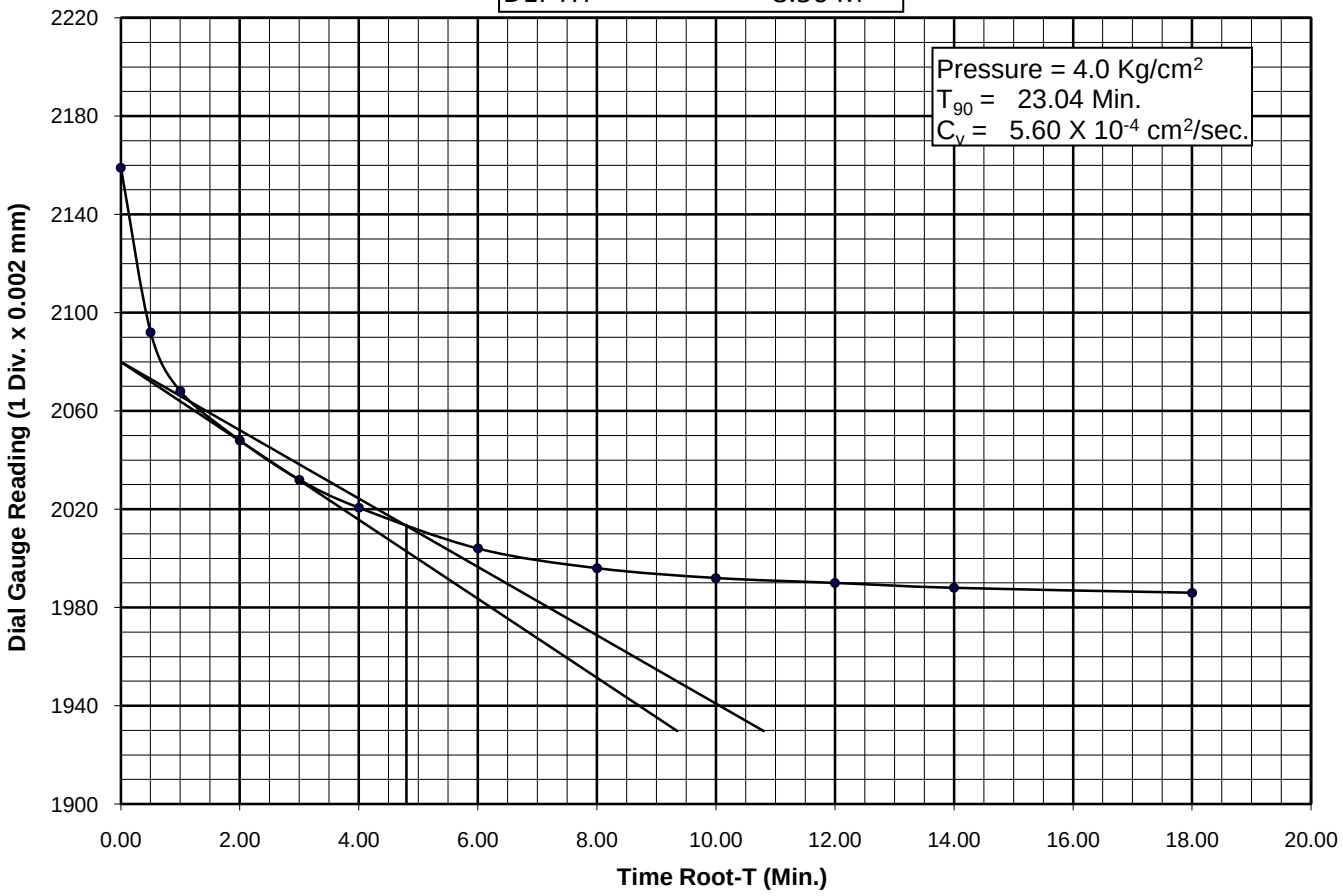


Figure No. -

CHAINAGE = 35+272
BORE HOLE NO. = BH-CL
SAMPLE NO. = UDS-3
DEPTH = 8.50 M



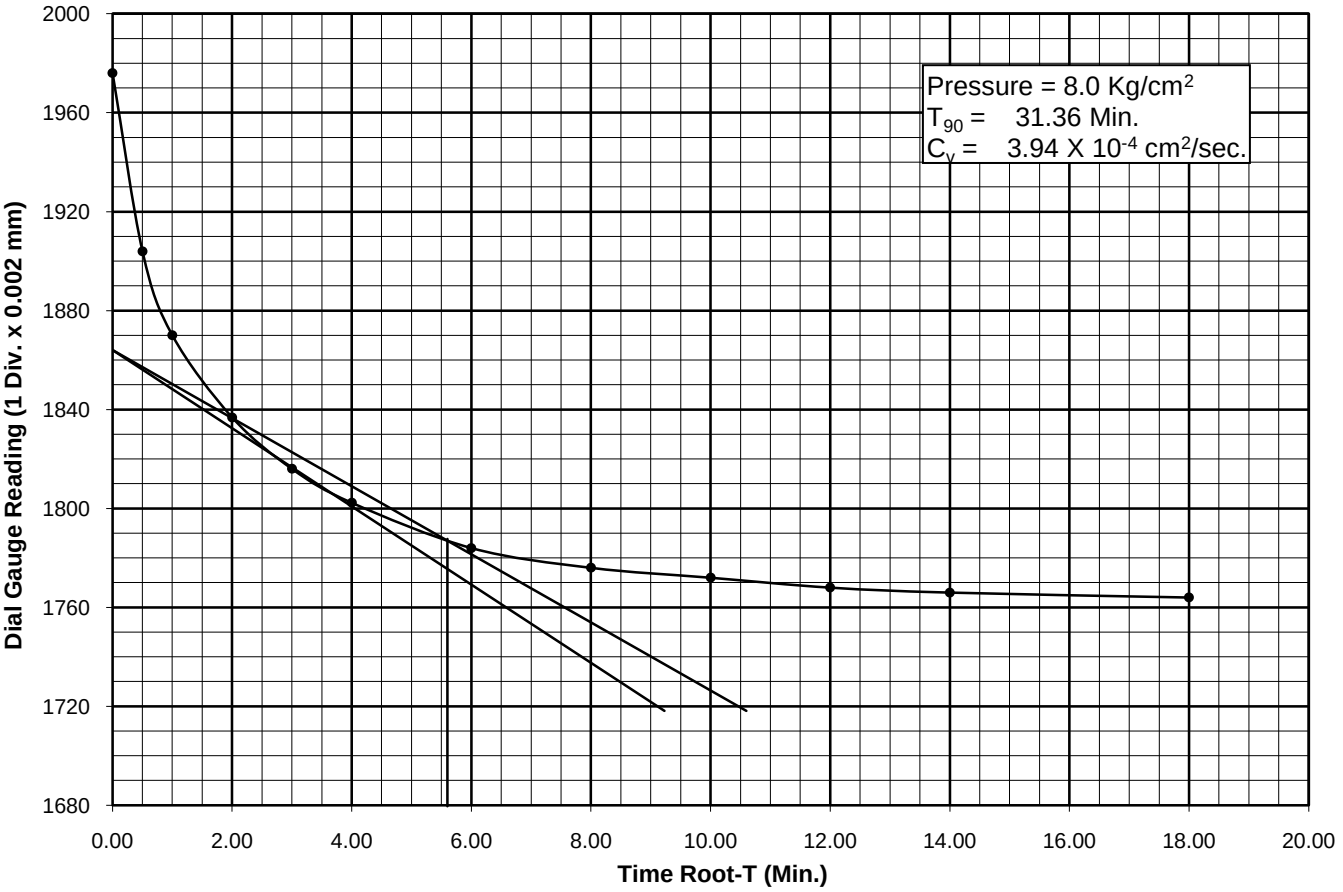
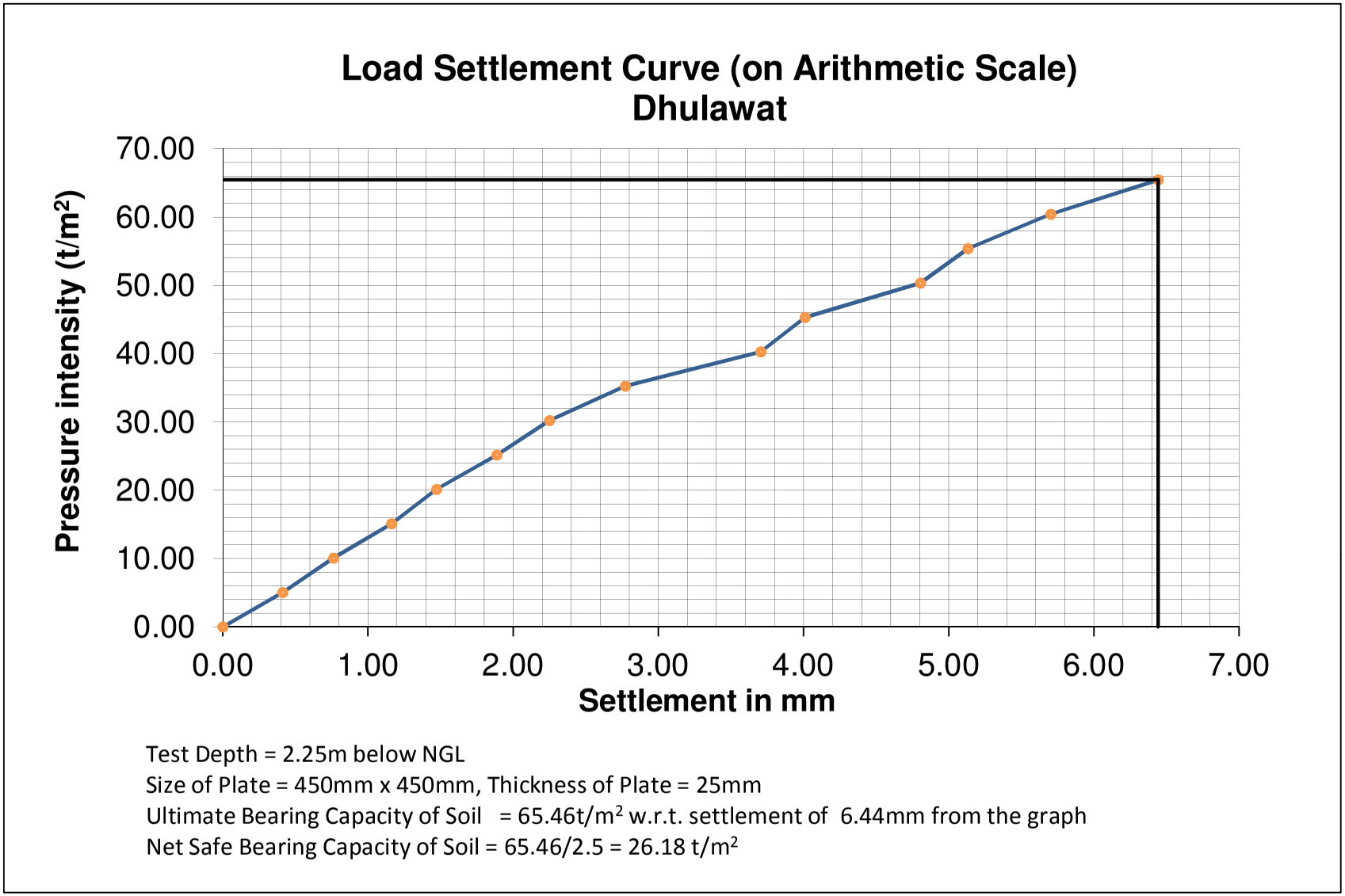


Figure No. -



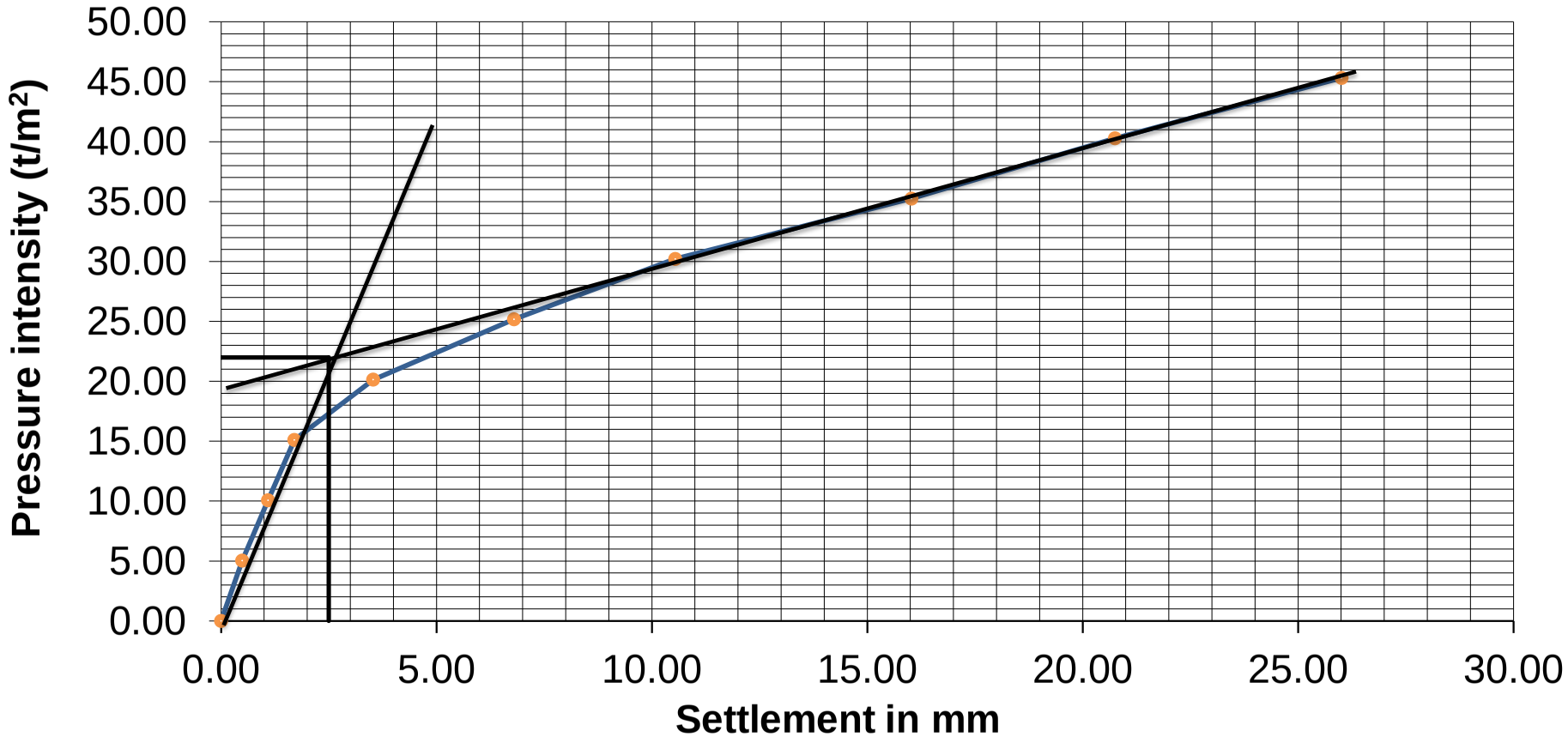
Test Depth = 2.25m below NGL

Size of Plate = 450mm x 450mm, Thickness of Plate = 25mm

Ultimate Bearing Capacity of Soil = 65.46t/m² w.r.t. settlement of 6.44mm from the graph

Net Safe Bearing Capacity of Soil = 65.46/2.5 = 26.18 t/m²

Load Settlement Curve (on Arithmetic Scale)
39+149



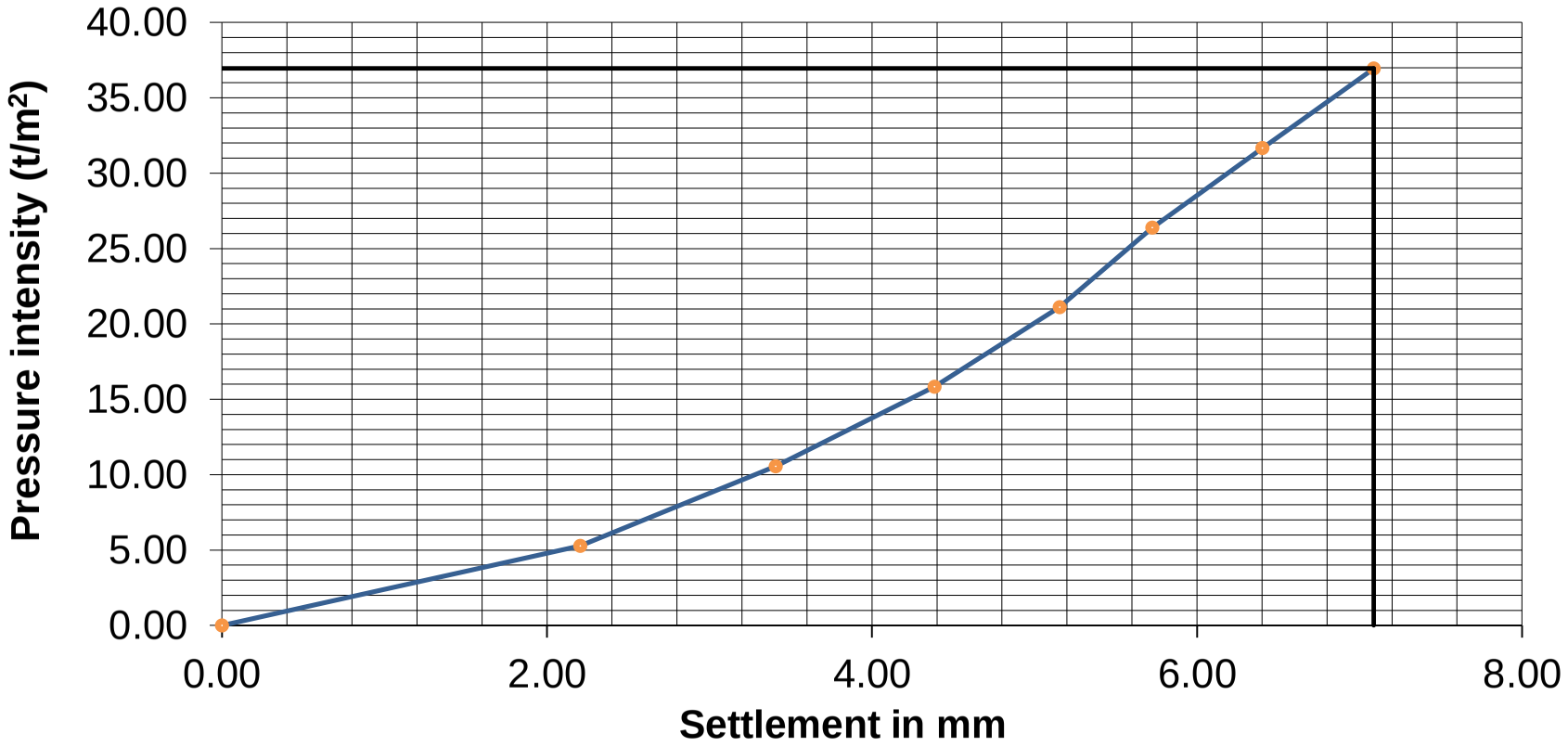
Test Depth = 2.25m below NGL

Size of Plate = 450mm x 450mm, Thickness of Plate = 25mm

Ultimate Bearing Capacity of Soil = 21.98t/m^2 w.r.t. settlement of 2.50mm from the graph

Net Safe Bearing Capacity of Soil = 21.98/2.5 = 8.7 t/m^2

Load Settlement Curve (on Arithmetic Scale)
43+100



Test Depth = 2.50m below NGL
Size of Plate = 600mm x 600mm, Thickness of Plate = 25mm
Ultimate Bearing Capacity of Soil = 36.94t/m^2 w.r.t. settlement of 7.09mm from the graph
Net Safe Bearing Capacity of Soil = 36.94/2.5 = 14.78 t/m^2

APPENDIX – C
(ANALYSIS & RECOMENDATION)

Appendix No.	ITEMS
C-1	SAMPLE CALCULATIONS FOR COMPUTATION OF ALLOWABLE BEARING CAPACITY OF SUB-STRATA FOR SHALLOW FOUNDATION
C-2	SAMPLE CALCULATION FOR COMPUTATION OF SAFE LOAD CARRYING CAPACITY OF NORMAL BORED CAST-IN-SITU RCC PILE IN COMPRESSION & UPLIFT
C-3	SAMPLE CALCULATION FOR COMPUTATION OF SAFE LOAD CARRYING CAPACITY OF NORMAL BORED CAST-IN-SITU RCC PILE IN LATERAL

Calculation of SBC for shallow foundations as per IS : 6403 - 1981

INPUT DATA

CH. (KM) :- 32+160

BH NO. :- BH-CL

Type of footing

1 Continuous Strip
2 Rectangular
3 Square
4 Circular

Square **3**

Angle of internal friction (ϕ^o)	4.00
Cohesion (c in t/m^2)	7.50
Void ratio (e), e = (G.γ_w/γ_d)-1	0.72
Direction of load with vertical (^{o})	0.00
Density of foundation soil (t/m^3) γ_{bulk}	1.77
Depth of water table(m)	NE
Factor of safety	2.50

S.no.	Depth (m) of footing (D_f) below EGL	Width (m)
1	1.00	7.20
2	1.50	7.20
3	2.00	7.20

SHEAR FAILURE CRITERIA

Assumptions and formula used in calculation as per IS:6403-1981 are given below -

NOTE: The type of failure used for bearing capacity analysis depends upon the value of void ratio (see IS 6403 : 1981, Page No. 9, Table No. 3).

The ultimate net bearing capacity in case of general shear failure is given by (from IS 6403 : 1981, page No. 8)

$$q_d = c\,N_c\,s_c\,d_c\,i_c + q\,(N_q-1)\,s_q\,d_q\,i_q + (1/2)\,B\,\gamma\,N_\gamma\,s_\gamma\,d_\gamma\,i_\gamma\,W'$$

The ultimate net bearing capacity in case of local shear failure is given by (from IS 6403 : 1981, page No. 8)

$$q'_d = (2/3)\,c\,N'_c\,s_c\,d_c\,i_c + q\,(N'_q-1)\,s_q\,d_q\,i_q + (1/2)\,B\,\gamma\,N'_\gamma\,s_\gamma\,d_\gamma\,i_\gamma\,W'$$

Where,

$d_c = 1+ 0.2\,(D_f/B)*SQRT(N_\phi)$

$d_q = d_\gamma = 1$ for $\phi < 10^o$

$d_q = d_\gamma = 1 + 0.1\,(D_f/B)*SQRT(N_\phi)$ for $\phi > 10^o$

(from IS 6403 : 1981, page No. 9)

$N_\phi = \tan^2(\pi/4 + \phi/2)$

ϕ' is friction angle for local shear failure = $\tan^{-1}(0.67\tan\phi)$

OUTPUT

The computer aided results for shear failure criteria are tabulated below. The results are interpolated values of bearing capacity obtained from general and local shear failure criteria.

Bearing capacity factors : (from IS 6403 : 1981, page No. 8, Table No. 1)

ϕ	4.00	ϕ'	2.68
N_c	6.19	N'_c	5.81
N_q	1.43	N'_q	1.27
N_γ	0.34	N'_γ	0.21

Shape factors : (from IS 6403 : 1981, page No. 8, Table No. 2)

S.no.	Width(m)	S_c	S_q	S_γ
1	7.20	1.30	1.20	0.80
2	7.20	1.30	1.20	0.80
3	7.20	1.30	1.20	0.80

Depth factors : (from IS 6403 : 1981, page No. 9)

S.no.	Depth(m)	Width(m)	dc	d_q	d_γ
1	1.00	7.20	1.03	1.00	1.00
2	1.50	7.20	1.04	1.00	1.00
3	2.00	7.20	1.06	1.00	1.00

Inclination factors : (from IS 6403 : 1981, page No. 9)

$i_c = (1-\alpha / 90)^2$	$i_q = (1-\alpha / 90)^2$	$i_\gamma = (1- \alpha / \phi)^2$
1.00	1.00	1.00

Water table factor : (from IS 6403 : 1981, page No. 9)

S.no.	Depth(m)	Width(m)	Z_w/B	W'
1	1.00	7.20	4.03	1.00
2	1.50	7.20	3.96	1.00
3	2.00	7.20	3.89	1.00

Safe Bearing Capacity

S.no.	Depth(m)	Width(m)	SBC in (t/m^2)		
			General shear	Local shear	Recommended
1	1.00	7.20	25.90	16.23	17.78
2	1.50	7.20	26.44	16.57	18.15
3	2.00	7.20	26.98	16.91	18.52

SETTLEMENT CALCULATION AS PER 8009 Part-1 1976														CH. (KM): 32+160							BH NO. :- BH-CL			
Layer	Depth below FGL (m)	From (m)	To (m)	Layer Thickness	Stress at Foundation level (Kg/Cm2)	Length (m)	Breadth (m)	Layer Thickness(m)	Dispersed Length (m)	Dispersed Breadth (m)	Stress Increment at top for cohesionless layer & at mid Depth for cohesive layer (kg/Cm2)	Average N-Value	Mvc (Cm^2/Kg)	Consolidation Settlement (mm)	Modulus of Soil (Kg/Cm^2)	H/B	L/B	Influence Factor (I)	Poission's Ratio	Elastic Settlement Si (mm)	Total Settlement (mm)	Depth Factor	Rigidity Factor	Corrected Total Settlement (mm)
Layer 1	1.00	1.00	11.80	10.80	0.65	7.20	7.20	10.80	7.20	7.200	0.654	22	0.0061	42.79	84	3.000	1.000	1.4400	0.45	32.1763	32.18	0.97	0.80	25.00
Layer 1	1.50	1.50	12.30	10.80	0.67	7.20	7.20	10.80	7.20	7.20	0.667	22	0.0091	65.50	84	3.000	1.000	1.4400	0.45	32.8358	32.84	0.95	0.80	25.00
Layer 1	2.00	2.00	12.80	10.80	0.68	7.20	7.20	10.80	7.20	7.20	0.684	22	0.0091	67.17	84	3.000	1.000	1.4400	0.45	33.6735	33.67	0.93	0.80	25.00

SETTLEMENT CALCULATION AS PER 8009 Part-1 1976														CH. (KM): 32+160							BH NO. :- BH-CL			
Layer	Depth below FGL (m)	From (m)	To (m)	Layer Thickness	Stress at Foundation level (Kg/Cm2)	Length (m)	Breadth (m)	Layer Thickness(m)	Dispersed Length (m)	Dispersed Breadth (m)	Stress Increment at top for cohesionless layer & at mid Depth for cohesive layer (kg/Cm2)	Average N-Value	Mvc (Cm^2/Kg)	Consolidation Settlement (mm)	Modulus of Soil (Kg/Cm^2)	H/B	L/B	Influence Factor (I)	Poission's Ratio	Elastic Settlement Si (mm)	Total Settlement (mm)	Depth Factor	Rigidity Factor	Corrected Total Settlement (mm)
Layer 1		1.00	11.80	10.80				10.80	7.20	7.200	1.308	22	0.0061	85.58	84	3.000	1.000	1.4400	0.45	64.3526	64.35			
	1.00				1.31	7.20	7.20															0.97	0.80	50.00
Layer 1		1.50	12.30	10.80				10.80	7.20	7.200	1.334	22	0.0061	87.34	84	3.000	1.000	1.4400	0.45	65.6716	65.67			
	1.50				1.33	7.20	7.20															0.95	0.80	50.00
Layer 1		2.00	12.80	10.80				10.80	7.20	7.200	1.368	22	0.0061	89.57	84	3.000	1.000	1.4400	0.45	67.3469	67.35			
	2.00				1.37	7.20	7.20															0.93	0.80	50.00

Calculation of SBC for shallow foundations as per IS : 6403 - 1981

INPUT DATA

CH. (KM) :- 32+160

BH NO. :- BH-CL

Type of footing

1 Continuous Strip
2 Rectangular
3 Square
4 Circular

Square **3**

Angle of internal friction (ϕ^o)	6.16
Cohesion (c in t/m^2)	6.92
Void ratio (e), e = (G.γ_w/γ_d)-1	0.72
Direction of load with vertical (^{o})	0.00
Density of foundation soil (t/m^3) γ_{bulk}	1.75
Depth of water table(m)	NE
Factor of safety	2.50

S.no.	Depth (m) of footing (D_f) below EGL	Width (m)
1	1.00	7.20
2	1.50	7.20
3	2.00	7.20

SHEAR FAILURE CRITERIA

Assumptions and formula used in calculation as per IS:6403-1981 are given below -

NOTE: The type of failure used for bearing capacity analysis depends upon the value of void ratio (see IS 6403 : 1981, Page No. 9, Table No. 3).

The ultimate net bearing capacity in case of general shear failure is given by (from IS 6403 : 1981, page No. 8)

$$q_d = c\,N_c\,s_c\,d_c\,i_c + q\,(N_q-1)\,s_q\,d_q\,i_q + (1/2)\,B\,\gamma\,N_\gamma\,s_\gamma\,d_\gamma\,i_\gamma\,W'$$

The ultimate net bearing capacity in case of local shear failure is given by (from IS 6403 : 1981, page No. 8)

$$q'_d = (2/3)\,c\,N'_c\,s_c\,d_c\,i_c + q\,(N'_q-1)\,s_q\,d_q\,i_q + (1/2)\,B\,\gamma\,N'_\gamma\,s_\gamma\,d_\gamma\,i_\gamma\,W'$$

Where,

$d_c = 1+ 0.2\,(D_f/B)*SQRT(N_\phi)$

$d_q = d_\gamma = 1$ for $\phi < 10^o$

$d_q = d_\gamma = 1 + 0.1\,(D_f/B)*SQRT(N_\phi)$ for $\phi > 10^o$

(from IS 6403 : 1981, page No. 9)

$N_\phi = \tan^2(\pi/4 + \phi/2)$

ϕ' is friction angle for local shear failure = $\tan^{-1}(0.67\tan\phi)$

OUTPUT

The computer aided results for shear failure criteria are tabulated below. The results are interpolated values of bearing capacity obtained from general and local shear failure criteria.

Bearing capacity factors : (from IS 6403 : 1981, page No. 8, Table No. 1)

ϕ	6.16	ϕ'	4.13
N_c	6.86	N'_c	6.22
N_q	1.74	N'_q	1.45
N_γ	0.59	N'_γ	0.35

Shape factors : (from IS 6403 : 1981, page No. 8, Table No. 2)

S.no.	Width(m)	S_c	S_q	S_γ
1	7.20	1.30	1.20	0.80
2	7.20	1.30	1.20	0.80
3	7.20	1.30	1.20	0.80

Depth factors : (from IS 6403 : 1981, page No. 9)

S.no.	Depth(m)	Width(m)	dc	d_q	d_γ
1	1.00	7.20	1.03	1.00	1.00
2	1.50	7.20	1.05	1.00	1.00
3	2.00	7.20	1.06	1.00	1.00

Inclination factors : (from IS 6403 : 1981, page No. 9)

$i_c = (1-\alpha / 90)^2$	$i_q = (1-\alpha / 90)^2$	$i_\gamma = (1- \alpha / \phi)^2$
1.00	1.00	1.00

Water table factor : (from IS 6403 : 1981, page No. 9)

S.no.	Depth(m)	Width(m)	Z_w/B	W'
1	1.00	7.20	4.03	1.00
2	1.50	7.20	3.96	1.00
3	2.00	7.20	3.89	1.00

Safe Bearing Capacity

S.no.	Depth(m)	Width(m)	SBC in (t/m^2)		
			General shear	Local shear	Recommended
1	1.00	7.20	27.29	16.49	17.99
2	1.50	7.20	27.99	16.91	18.45
3	2.00	7.20	28.68	17.33	18.91

Replacement for 1.0m depth of foundation

SETTLEMENT CALCULATION AS PER 8009 Part-1 1976												CH. (KM): 32+160							BH NO. :- BH-CL			
Layer	Depth below FGL (m)	From (m)	To (m)	Layer Thickness	Stress at Foundation level (Kg/Cm2)	Length (m)	Breadth (m)	Layer Thickness(m)	Stress Increment at top for cohesionless layer & at mid Depth for cohesive layer (kg/Cm2)	Average N-Value	Mvc (Cm^2/Kg)	Consolidation Settlement (mm)	Modulus of Soil (Kg/Cm^2)	Influence Factor (I)	Poission's Ratio	Settlement (mm) for 10 t/m2 (from IS:8009 (Part I), Fig. 9, Page NO. 17)	Settlement in Non-Cohesive Soil Si (mm)	Elastic Settlement Si (mm)	Total Settlement (mm)	Depth Factor	Rigidity Factor	Corrected Total Settlement (mm)
Layer 1		1.00	2.50	1.50				1.50	1.314	25			200		0.30	11.50	3.91		3.91			
Layer 2		2.50	11.80	9.30				9.30	0.382	22	0.0061	21.54	84	0.9016	0.45			21.84	21.84			
	1.00				1.31	7.20	7.20													0.97	1.00	25.00
Layer 1		1.50	2.50	1.00				1.00	1.336	25			200		0.30	11.50	2.71		2.71			
Layer 2		2.50	12.30	9.80				9.80	0.404	22	0.0061	23.97	84	0.9386	0.45			23.56	23.56			
	1.50				1.34	7.20	7.20													0.95	1.00	25.00
Layer 1		2.00	2.50	0.50				0.50	1.364	25			200		0.30	11.50	1.42		1.42			
Layer 2		2.50	12.80	10.30				10.30	0.428	22	0.0061	26.73	84	0.9771	0.45			25.52	25.52			
	2.00				1.36	7.20	7.20													0.93	1.00	25.00

Replacement for 1.0m depth of foundation

SETTLEMENT CALCULATION AS PER 8009 Part-1 1976												CH. (KM): 32+160							BH NO. :- BH-CL			
Layer	Depth below FGL (m)	From (m)	To (m)	Layer Thickness	Stress at Foundation level (Kg/Cm2)	Length (m)	Breadth (m)	Layer Thickness(m)	Stress Increment at top for cohesionless layer & at mid Depth for cohesive layer (kg/Cm2)	Average N-Value	Mvc (Cm^2/Kg)	Consolidation Settlement (mm)	Modulus of Soil (Kg/Cm^2)	Influence Factor (I)	Poission's Ratio	Settlement (mm) for 10 t/m2 (from IS:8009 (Part I), Fig. 9, Page NO. 17)	Settlement in Non-Cohesive Soil Si (mm)	Elastic Settlement Si (mm)	Total Settlement (mm)	Depth Factor	Rigidity Factor	Corrected Total Settlement (mm)
Layer 1		1.00	2.50	1.50				1.50	2.628	25			200		0.30	11.50	7.81		7.81			
Layer 2		2.50	11.80	9.30				9.30	0.764	22	0.0061	43.08	84	0.9016	0.45			43.67	43.67			
	1.00				2.63	7.20	7.20													0.97	1.00	50.00
Layer 1		1.50	2.50	1.00				1.00	2.672	25			200		0.30	11.50	5.43		5.43			
Layer 2		2.50	12.30	9.80				9.80	0.807	22	0.0061	47.94	84	0.9386	0.45			47.11	47.11			
	1.50				2.67	7.20	7.20													0.95	1.00	50.00
Layer 1		2.00	2.50	0.50				0.50	2.728	25			200		0.30	11.50	2.84		2.84			
Layer 2		2.50	12.80	10.30				10.30	0.856	22	0.0061	53.46	84	0.9771	0.45			51.04	51.04			
	2.00				2.73	7.20	7.20													0.93	1.00	50.00

Replacement for 1.5m depth of foundation

SETTLEMENT CALCULATION AS PER 8009 Part-1 1976												CH. (KM): 32+160							BH NO. :- BH-CL			
Layer	Depth below FGL (m)	From (m)	To (m)	Layer Thickness	Stress at Foundation level (Kg/Cm2)	Length (m)	Breadth (m)	Layer Thickness(m)	Stress Increment at top for cohesionless layer & at mid Depth for cohesive layer (kg/Cm2)	Average N-Value	Mvc (Cm^2/Kg)	Consolidation Settlement (mm)	Modulus of Soil (Kg/Cm^2)	Influence Factor (I)	Poission's Ratio	Settlement (mm) for 10 t/m2 (from IS:8009 (Part I), Fig. 9, Page NO. 17)	Settlement in Non-Cohesive Soil Si (mm)	Elastic Settlement Si (mm)	Total Settlement (mm)	Depth Factor	Rigidity Factor	Corrected Total Settlement (mm)
Layer 1		1.00	3.00	2.00				2.00	1.429	25			200		0.30	11.50	5.52		5.52			
Layer 2		3.00	11.80	8.80				8.80	0.400	25	0.0053	18.79	93	0.8659	0.45			20.22	20.22			
	1.00				1.43	7.20	7.20													0.97	1.00	25.00
Layer 1		1.50	3.00	1.50				1.50	1.461	25			200		0.30	11.50	4.34		4.34			
Layer 2		3.00	12.30	9.30				9.30	0.425	25	0.0053	21.07	93	0.9016	0.45			21.93	21.93			
	1.50				1.46	7.20	7.20													0.95	1.00	25.00
Layer 1		2.00	3.00	1.00				1.00	1.500	25			200		0.30	11.50	3.05		3.05			
Layer 2		3.00	12.80	9.80				9.80	0.453	25	0.0053	23.69	93	0.9386	0.45			23.89	23.89			
	2.00				1.50	7.20	7.20													0.93	1.00	25.00

Replacement for 1.5m depth of foundation

SETTLEMENT CALCULATION AS PER 8009 Part-1 1976												CH. (KM): 32+160							BH NO. :- BH-CL			
Layer	Depth below FGL (m)	From (m)	To (m)	Layer Thickness	Stress at Foundation level (Kg/Cm2)	Length (m)	Breadth (m)	Layer Thickness(m)	Stress Increment at top for cohesionless layer & at mid Depth for cohesive layer (kg/Cm2)	Average N-Value	Mvc (Cm^2/Kg)	Consolidation Settlement (mm)	Modulus of Soil (Kg/Cm^2)	Influence Factor (I)	Poission's Ratio	Settlement (mm) for 10 t/m2 (from IS:8009 (Part I), Fig. 9, Page NO. 17)	Settlement in Non-Cohesive Soil Si (mm)	Elastic Settlement Si (mm)	Total Settlement (mm)	Depth Factor	Rigidity Factor	Corrected Total Settlement (mm)
Layer 1		1.00	3.00	2.00				2.00	2.858	25			200		0.30	11.50	11.04		11.04			
Layer 2		3.00	11.80	8.80				8.80	0.801	25	0.0053	37.59	93	0.8659	0.45			40.44	40.44			
	1.00				2.86	7.20	7.20													0.97	1.00	50.00
Layer 1		1.50	3.00	1.50				1.50	2.921	25			200		0.30	11.50	8.68		8.68			
Layer 2		3.00	12.30	9.30				9.30	0.850	25	0.0053	42.15	93	0.9016	0.45			43.85	43.85			
	1.50				2.92	7.20	7.20													0.95	1.00	50.00
Layer 1		2.00	3.00	1.00				1.00	3.000	25			200		0.30	11.50	6.09		6.09			
Layer 2		3.00	12.80	9.80				9.80	0.906	25	0.0053	47.37	93	0.9386	0.45			47.78	47.78			
	2.00				3.00	7.20	7.20													0.93	1.00	50.00

Replacement for 2.0m depth of foundation

SETTLEMENT CALCULATION AS PER 8009 Part-1 1976												CH. (KM): 32+160							BH NO. :- BH-CL			
Layer	Depth below FGL (m)	From (m)	To (m)	Layer Thickness	Stress at Foundation level (Kg/Cm2)	Length (m)	Breadth (m)	Layer Thickness(m)	Stress Increment at top for cohesionless layer & at mid Depth for cohesive layer (kg/Cm2)	Average N-Value	Mvc (Cm^2/Kg)	Consolidation Settlement (mm)	Modulus of Soil (Kg/Cm^2)	Influence Factor (I)	Poission's Ratio	Settlement (mm) for 10 t/m2 (from IS:8009 (Part I), Fig. 9, Page NO. 17)	Settlement in Non-Cohesive Soil Si (mm)	Elastic Settlement Si (mm)	Total Settlement (mm)	Depth Factor	Rigidity Factor	Corrected Total Settlement (mm)
Layer 1		1.00	3.50	2.50				2.50	1.426	25			200		0.30	11.50	6.71		6.71			
Layer 2		3.50	11.80	8.30				8.30	0.385	25	0.0053	17.06	93	0.8315	0.45			19.03	19.03			
	1.00				1.43	7.20	7.20													0.97	1.00	25.00
Layer 1		1.50	3.50	2.00				2.00	1.458	25			200		0.30	11.50	5.64		5.64			
Layer 2		3.50	12.30	8.80				8.80	0.409	25	0.0053	19.18	93	0.8659	0.45			20.63	20.63			
	1.50				1.46	7.20	7.20													0.95	1.00	25.00
Layer 1		2.00	3.50	1.50				1.50	1.498	25			200		0.30	11.50	4.45		4.45			
Layer 2		3.50	12.80	9.30				9.30	0.436	25	0.0053	21.61	93	0.9016	0.45			22.49	22.49			
	2.00				1.50	7.20	7.20													0.93	1.00	25.00

Replacement for 2.0m depth of foundation

SETTLEMENT CALCULATION AS PER 8009 Part-1 1976												CH. (KM): 32+160							BH NO. :- BH-CL			
Layer	Depth below FGL (m)	From (m)	To (m)	Layer Thickness	Stress at Foundation level (Kg/Cm2)	Length (m)	Breadth (m)	Layer Thickness(m)	Stress Increment at top for cohesionless layer & at mid Depth for cohesive layer (kg/Cm2)	Average N-Value	Mvc (Cm^2/Kg)	Consolidation Settlement (mm)	Modulus of Soil (Kg/Cm^2)	Influence Factor (I)	Poission's Ratio	Settlement (mm) for 10 t/m2 (from IS:8009 (Part I), Fig. 9, Page NO. 17)	Settlement in Non-Cohesive Soil Si (mm)	Elastic Settlement Si (mm)	Total Settlement (mm)	Depth Factor	Rigidity Factor	Corrected Total Settlement (mm)
Layer 1		1.00	3.50	2.50				2.50	2.852	25			200		0.30	11.50	13.43		13.43			
Layer 2		3.50	11.80	8.30				8.30	0.771	25	0.0053	34.12	93	0.8315	0.45			38.06	38.06			
	1.00				2.85	7.20	7.20													0.97	1.00	50.00
Layer 1		1.50	3.50	2.00				2.00	2.916	25			200		0.30	11.50	11.27		11.27			
Layer 2		3.50	12.30	8.80				8.80	0.817	25	0.0053	38.36	93	0.8659	0.45			41.27	41.27			
	1.50				2.92	7.20	7.20													0.95	1.00	50.00
Layer 1		2.00	3.50	1.50				1.50	2.996	25			200		0.30	11.50	8.91		8.91			
Layer 2		3.50	12.80	9.30				9.30	0.871	25	0.0053	43.22	93	0.9016	0.45			44.97	44.97			
	2.00				3.00	7.20	7.20													0.93	1.00	50.00

NAME OF PROJECT:- "GTI for designing of bridges and embankment for Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.

Length of Pile below cut of level = 16.00 m **Bore Hole No =** BH-A1 **Ch. (KM)** 30+488 **Dia of pile =** 1.00 m **Cut-off Level =** 2.00 m below EGL

Restricting PD to 15D **Water Table depth considered for analysis =** 30.00 m **Scour Depth =** Non-scourable **Liquefaction Depth =** Non-Liquefiable

Dia. of Pile	Cut-off Depth	Soil layers		Properties of layers/for Skin Friction							For End Bearing										
		from	to	c	Ø	k	α	γeff	ΔL	pd (s.f)	Pd (e.b)	γeff	c	Ø	Nc	Nq	Ny	As/cm	Ap	qs	Qp
(m)	(m)	(m)	(m)	kg/cm^2	deg			gm/cc	cm	kg/cm^2	kg/cm^2	gm/cc	kg/cm^2	deg				cm^2	cm^2	t	t
1.00	2.00	0.00	2.00					1.68	200	0.17											
1.00		2.00	4.00	0.11	30	1.00	1.00	1.68	200	0.50								314.29		25.21	
1.00		4.00	8.50	0.90	5	1.00	0.49	1.81	450	1.08								314.29		76.20	
1.00		8.50	11.50	1.24	4	1.00	0.37	1.85	300	1.76								314.29		54.46	
1.00		11.50	15.00	1.36	4	1.00	0.34	1.87	350	2.37								314.29		69.21	
1.00		15.00	16.00	1.36	4	1.00	0.34	1.87	100	2.70								314.29		20.49	
1.00		16.00	18.00	0.00	32	1.00	1.00	1.88	200	2.70	2.70	1.89	0.22	27	9	13.39	14.47	314.29	7857.14	105.97	310.05
																				351.54	310.05

Qu,comp.= qs + Qp Qu,uplift = Safe Frictional Resistance + Weight of Pile

Qa,comp.= (351.54 + 310.05) / 2.5 Qa,uplift = 351.54 / 3 + 31.42

Qa,comp.= 264.64 T Qa,uplift = 148.60 T

Say **Qa,comp.= 264.00 T** **Qa,uplift = 148.00 T**

*FOS for Vertical Capacity of pile in compression = 2.5

**FOS for Uplift Capacity of pile = 3.0

***Density of Concrete for Weight of Pile = 2.5t/m^3

NAME OF PROJECT:- "GTI for designing of bridges and embankment for Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.

Length of Pile below cut of level = 18.00 m **Bore Hole No =** BH-A1 **Ch. (KM)** 30+488 **Dia of pile =** 1.00 m **Cut-off Level =** 2.00 m below EGL

Restricting PD to 15D **Water Table depth considered for analysis =** 30.00 m **Scour Depth =** Non-scourable **Liquefaction Depth =** Non-Liquefiable

Dia. of Pile	Cut-off Depth	Soil layers		Properties of layers/for Skin Friction							For End Bearing										
		from	to	c	Ø	k	α	γeff	ΔL	pd (s.f)	Pd (e.b)	γeff	c	Ø	Nc	Nq	Ny	As/cm	Ap	qs	Qp
(m)	(m)	(m)	(m)	kg/cm^2	deg			gm/cc	cm	kg/cm^2	kg/cm^2	gm/cc	kg/cm^2	deg				cm^2	cm^2	t	t
1.00	2.00	0.00	2.00					1.68	200	0.17											
1.00		2.00	4.00	0.11	30	1.00	1.00	1.68	200	0.50								314.29		25.21	
1.00		4.00	8.50	0.90	5	1.00	0.49	1.81	450	1.08								314.29		76.20	
1.00		8.50	11.50	1.24	4	1.00	0.37	1.85	300	1.76								314.29		54.46	
1.00		11.50	15.00	1.36	4	1.00	0.34	1.87	350	2.37								314.29		69.21	
1.00		15.00	16.00	1.36	4	1.00	0.34	1.87	100	2.70								314.29		20.49	
1.00		16.00	20.00	0.00	32	1.00	1.00	1.88	400	2.70	2.70	1.89	0.22	27	9	13.39	14.47	314.29	7857.14	211.95	310.05
																				457.51	310.05

Qu,comp.= qs + Qp Qu,uplift = Safe Frictional Resistance + Weight of Pile

Qa,comp.= (457.51 + 310.05) / 2.5 Qa,uplift = 457.51 / 3 + 35.34

Qa,comp.= 307.03 T Qa,uplift = 187.85 T

Say **Qa,comp.= 307.00 T** **Qa,uplift = 187.00 T**

*FOS for Vertical Capacity of pile in compression = 2.5

**FOS for Uplift Capacity of pile = 3.0

***Density of Concrete for Weight of Pile = 2.5t/m^3

NAME OF PROJECT:- "GTI for designing of bridges and embankment for Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.

Length of Pile below cut of level = 20.00 m **Bore Hole No =** BH-A1 **Ch. (KM)** 30+488 **Dia of pile =** 1.00 m **Cut-off Level =** 2.00 m below EGL

Restricting PD to 15D **Water Table depth considered for analysis =** 30.00 m **Scour Depth =** Non-scourable **Liquefaction Depth =** Non-Liquefiable

Dia. of Pile	Cut-off Depth	Soil layers		Properties of layers/for Skin Friction							For End Bearing										
		from	to	c	Ø	k	α	γeff	ΔL	pd (s.f)	Pd (e.b)	γeff	c	Ø	Nc	Nq	Ny	As/cm	Ap	qs	Qp
(m)	(m)	(m)	(m)	kg/cm^2	deg			gm/cc	cm	kg/cm^2	kg/cm^2	gm/cc	kg/cm^2	deg				cm^2	cm^2	t	t
1.00	2.00	0.00	2.00					1.68	200	0.17											
1.00		2.00	4.00	0.11	30	1.00	1.00	1.68	200	0.50								314.29		25.21	
1.00		4.00	8.50	0.90	5	1.00	0.49	1.81	450	1.08								314.29		76.20	
1.00		8.50	11.50	1.24	4	1.00	0.37	1.85	300	1.76								314.29		54.46	
1.00		11.50	15.00	1.36	4	1.00	0.34	1.87	350	2.37								314.29		69.21	
1.00		15.00	16.00	1.36	4	1.00	0.34	1.87	100	2.70								314.29		20.49	
1.00		16.00	20.50	0.00	32	1.00	1.00	1.88	450	2.70								314.29		238.44	
1.00		20.50	22.00	0.22	27	1.00	1.00	1.89	150	2.70	2.70	1.89	0.22	27	9	13.39	14.47	314.29	7857.14	75.18	310.05
																				559.18	310.05

Qu,comp.= qs + Qp Qu,uplift = Safe Frictional Resistance + Weight of Pile

Qa,comp.= (559.18 + 310.05) / 2.5 Qa,uplift = 559.18 / 3 + 39.27

Qa,comp.= 347.69 T Qa,uplift = 225.66 T

Say **Qa,comp.= 347.00 T** **Qa,uplift = 225.00 T**

*FOS for Vertical Capacity of pile in compression = 2.5

**FOS for Uplift Capacity of pile = 3.0

***Density of Concrete for Weight of Pile = 2.5t/m^3

NAME OF PROJECT:- "GTI for designing of bridges and embankment for Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.

Length of Pile below cut of level = 22.00 m **Bore Hole No =** BH-A1 **Ch. (KM)** 30+488 **Dia of pile =** 1.00 m **Cut-off Level =** 2.00 m below EGL

Restricting PD to 15D **Water Table depth considered for analysis =** 30.00 m **Scour Depth =** Non-scourable **Liquefaction Depth =** Non-Liquefiable

Dia. of Pile	Cut-off Depth	Soil layers		Properties of layers/for Skin Friction							For End Bearing										
		from	to	c	Ø	k	α	γeff	ΔL	pd (s.f)	Pd (e.b)	γeff	c	Ø	Nc	Nq	Ny	As/cm	Ap	qs	Qp
(m)	(m)	(m)	(m)	kg/cm^2	deg			gm/cc	cm	kg/cm^2	kg/cm^2	gm/cc	kg/cm^2	deg				cm^2	cm^2	t	t
1.00	2.00	0.00	2.00					1.68	200	0.17											
1.00		2.00	4.00	0.11	30	1.00	1.00	1.68	200	0.50								314.29		25.21	
1.00		4.00	8.50	0.90	5	1.00	0.49	1.81	450	1.08								314.29		76.20	
1.00		8.50	11.50	1.24	4	1.00	0.37	1.85	300	1.76								314.29		54.46	
1.00		11.50	15.00	1.36	4	1.00	0.34	1.87	350	2.37								314.29		69.21	
1.00		15.00	16.00	1.36	4	1.00	0.34	1.87	100	2.70								314.29		20.49	
1.00		16.00	20.50	0.00	32	1.00	1.00	1.88	450	2.70								314.29		238.44	
1.00		20.50	24.00	0.22	27	1.00	1.00	1.89	350	2.70	2.70	1.89	0.22	27	9	13.39	14.47	314.29	7857.14	175.42	310.05
																				659.42	310.05

Qu,comp.= qs + Qp Qu,uplift = Safe Frictional Resistance + Weight of Pile

Qa,comp.= (659.42 + 310.05) / 2.5 Qa,uplift = 659.42 / 3 + 43.2

Qa,comp.= 387.79 T Qa,uplift = 263.00 T

Say **Qa,comp.= 387.00 T** **Qa,uplift = 263.00 T**

*FOS for Vertical Capacity of pile in compression = 2.5

**FOS for Uplift Capacity of pile = 3.0

***Density of Concrete for Weight of Pile = 2.5t/m^3

NAME OF PROJECT:- "GTI for designing of bridges and embankment for Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.

Length of Pile below cut of level = 16.00 m **Bore Hole No =** BH-A1 **Ch. (KM)** 30+488 **Dia of pile =** 1.20 m **Cut-off Level =** 2.00 m below EGL

Restricting PD to 15D **Water Table depth considered for analysis =** 30.00 m **Scour Depth =** Non-scourable **Liquefaction Depth =** Non-Liquefiable

Dia. of Pile	Cut-off Depth	Soil layers		Properties of layers/for Skin Friction							For End Bearing										
		from	to	c	Ø	k	α	γeff	ΔL	pd (s.f)	Pd (e.b)	γeff	c	Ø	Nc	Nq	Ny	As/cm	Ap	qs	Qp
(m)	(m)	(m)	(m)	kg/cm^2	deg			gm/cc	cm	kg/cm^2	kg/cm^2	gm/cc	kg/cm^2	deg				cm^2	cm^2	t	t
1.20	2.00	0.00	2.00					1.68	200	0.17											
1.20		2.00	4.00	0.11	30	1.00	1.00	1.68	200	0.50								377.14		30.25	
1.20		4.00	8.50	0.90	5	1.00	0.49	1.81	450	1.08								377.14		91.44	
1.20		8.50	11.50	1.24	4	1.00	0.37	1.85	300	1.76								377.14		65.35	
1.20		11.50	16.00	1.36	4	1.00	0.34	1.87	450	2.46								377.14		107.88	
1.20		16.00	18.00	0.00	32	1.00	1.00	1.88	200	3.07	3.26	1.89	0.22	27	9	13.39	14.47	377.14	11314.29	144.87	534.99
																				439.79	534.99

Qu,comp.= qs + Qp Qu,uplift = Safe Frictional Resistance + Weight of Pile

Qa,comp.= (439.79 + 534.99) / 2.5 Qa,uplift = 439.79 / 3 + 45.24

Qa,comp.= 389.91 T Qa,uplift = 191.84 T

Say **Qa,comp.= 389.00 T** **Qa,uplift = 191.00 T**

*FOS for Vertical Capacity of pile in compression = 2.5

**FOS for Uplift Capacity of pile = 3.0

***Density of Concrete for Weight of Pile = 2.5t/m^3

NAME OF PROJECT:- "GTI for designing of bridges and embankment for Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.

Length of Pile below cut of level = 18.00 m **Bore Hole No =** BH-A1 **Ch. (KM)** 30+488 **Dia of pile =** 1.20 m **Cut-off Level =** 2.00 m below EGL

Restricting PD to 15D **Water Table depth considered for analysis =** 30.00 m **Scour Depth =** Non-scourable **Liquefaction Depth =** Non-Liquefiable

Dia. of Pile	Cut-off Depth	Soil layers		Properties of layers/for Skin Friction							For End Bearing										
		from	to	c	Ø	k	α	γeff	ΔL	pd (s.f)	Pd (e.b)	γeff	c	Ø	Nc	Nq	Ny	As/cm	Ap	qs	Qp
(m)	(m)	(m)	(m)	kg/cm^2	deg			gm/cc	cm	kg/cm^2	kg/cm^2	gm/cc	kg/cm^2	deg				cm^2	cm^2	t	t
1.20	2.00	0.00	2.00					1.68	200	0.17											
1.20		2.00	4.00	0.11	30	1.00	1.00	1.68	200	0.50								377.14		30.25	
1.20		4.00	8.50	0.90	5	1.00	0.49	1.81	450	1.08								377.14		91.44	
1.20		8.50	11.50	1.24	4	1.00	0.37	1.85	300	1.76								377.14		65.35	
1.20		11.50	16.00	1.36	4	1.00	0.34	1.87	450	2.46								377.14		107.88	
1.20		16.00	18.00	0.00	32	1.00	1.00	1.88	200	3.07								377.14		144.87	
1.20		18.00	20.00	0.00	32	1.00	1.00	1.88	200	3.26	3.26	1.89	0.22	27	9	13.39	14.47	377.14	11314.29	153.75	534.99
																				593.55	534.99

Qu,comp.= qs + Qp Qu,uplift = Safe Frictional Resistance + Weight of Pile

Qa,comp.= (593.55 + 534.99) / 2.5 Qa,uplift = 593.55 / 3 + 50.89

Qa,comp.= 451.41 T Qa,uplift = 248.74 T

Say **Qa,comp.= 451.00 T** **Qa,uplift = 248.00 T**

*FOS for Vertical Capacity of pile in compression = 2.5

**FOS for Uplift Capacity of pile = 3.0

***Density of Concrete for Weight of Pile = 2.5t/m^3

NAME OF PROJECT:- "GTI for designing of bridges and embankment for Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.

Length of Pile below cut of level = 20.00 m **Bore Hole No =** BH-A1 **Ch. (KM)** 30+488 **Dia of pile =** 1.20 m **Cut-off Level =** 2.00 m below EGL

Restricting PD to 15D **Water Table depth considered for analysis =** 30.00 m **Scour Depth =** Non-scourable **Liquefaction Depth =** Non-Liquefiable

Dia. of Pile	Cut-off Depth	Soil layers		Properties of layers/for Skin Friction							For End Bearing										
		from	to	c	Ø	k	α	γeff	ΔL	pd (s.f)	Pd (e.b)	γeff	c	Ø	Nc	Nq	Ny	As/cm	Ap	qs	Qp
(m)	(m)	(m)	(m)	kg/cm^2	deg			gm/cc	cm	kg/cm^2	kg/cm^2	gm/cc	kg/cm^2	deg				cm^2	cm^2	t	t
1.20	2.00	0.00	2.00					1.68	200	0.17											
1.20		2.00	4.00	0.11	30	1.00	1.00	1.68	200	0.50								377.14		30.25	
1.20		4.00	8.50	0.90	5	1.00	0.49	1.81	450	1.08								377.14		91.44	
1.20		8.50	11.50	1.24	4	1.00	0.37	1.85	300	1.76								377.14		65.35	
1.20		11.50	16.00	1.36	4	1.00	0.34	1.87	450	2.46								377.14		107.88	
1.20		16.00	18.00	0.00	32	1.00	1.00	1.88	200	3.07								377.14		144.87	
1.20		18.00	20.50	0.00	32	1.00	1.00	1.88	250	3.26								377.14		192.19	
1.20		20.50	22.00	0.22	27	1.00	1.00	1.89	150	3.26	3.26	1.89	0.22	27	9	13.39	14.47	377.14	11314.29	106.47	534.99
																				738.46	534.99

Qu,comp.= qs + Qp Qu,uplift = Safe Frictional Resistance + Weight of Pile

Qa,comp.= (738.46 + 534.99) / 2.5 Qa,uplift = 738.46 / 3 + 56.55

Qa,comp.= 509.38 T Qa,uplift = 302.70 T

Say **Qa,comp.= 509.00 T** **Qa,uplift = 302.00 T**

*FOS for Vertical Capacity of pile in compression = 2.5

**FOS for Uplift Capacity of pile = 3.0

***Density of Concrete for Weight of Pile = 2.5t/m^3

NAME OF PROJECT:- "GTI for designing of bridges and embankment for Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.

Length of Pile below cut of level = 22.00 m **Bore Hole No =** BH-A1 **Ch. (KM)** 30+488 **Dia of pile =** 1.20 m **Cut-off Level =** 2.00 m below EGL

Restricting PD to 15D **Water Table depth considered for analysis =** 30.00 m **Scour Depth =** Non-scourable **Liquefaction Depth =** Non-Liquefiable

Dia. of Pile	Cut-off Depth	Soil layers		Properties of layers/for Skin Friction							For End Bearing										
		from	to	c	Ø	k	α	γeff	ΔL	pd (s.f)	Pd (e.b)	γeff	c	Ø	Nc	Nq	Ny	As/cm	Ap	qs	Qp
(m)	(m)	(m)	(m)	kg/cm^2	deg			gm/cc	cm	kg/cm^2	kg/cm^2	gm/cc	kg/cm^2	deg				cm^2	cm^2	t	t
1.20	2.00	0.00	2.00					1.68	200	0.17											
1.20		2.00	4.00	0.11	30	1.00	1.00	1.68	200	0.50								377.14		30.25	
1.20		4.00	8.50	0.90	5	1.00	0.49	1.81	450	1.08								377.14		91.44	
1.20		8.50	11.50	1.24	4	1.00	0.37	1.85	300	1.76								377.14		65.35	
1.20		11.50	16.00	1.36	4	1.00	0.34	1.87	450	2.46								377.14		107.88	
1.20		16.00	18.00	0.00	32	1.00	1.00	1.88	200	3.07								377.14		144.87	
1.20		18.00	20.50	0.00	32	1.00	1.00	1.88	250	3.26								377.14		192.19	
1.20		20.50	24.00	0.22	27	1.00	1.00	1.89	350	3.26	3.26	1.89	0.22	27	9	13.39	14.47	377.14	11314.29	248.44	534.99
																				880.42	534.99

Qu,comp.= qs + Qp Qu,uplift = Safe Frictional Resistance + Weight of Pile

Qa,comp.= (880.42 + 534.99) / 2.5 Qa,uplift = 880.42 / 3 + 62.2

Qa,comp.= 566.16 T Qa,uplift = 355.68 T

Say **Qa,comp.= 566.00 T** **Qa,uplift = 355.00 T**

*FOS for Vertical Capacity of pile in compression = 2.5

**FOS for Uplift Capacity of pile = 3.0

***Density of Concrete for Weight of Pile = 2.5t/m^3

Lateral Load capacity of Pile

BH-A1
Ch. (KM): 30+488

Type of Strata = Clayey

Le = Embedded Length of Pile in Meter = 20.000 m **Fck = 35.0 N/mm^2** **D = 100 cm**

Bed level	**0.0 m**
Pile cap bottom level	**-2.0 m**
Liquefaction level	**-2.0 m**

E = Young's Modulus of Pile (Kg/cm^2) = $5000\sqrt{F_{ck}}$ N/mm^2 = 295803.99 Kg/cm^2

I = Moment of Inertia (cm^2) = $\pi x D^4/64$ = 4908738.5 cm^4

c = weighted mean of cohesion along the length of pile from the top of scour depth to bottom of pile = 0.900 Kg/cm^2

q_u = Unconfined Compression Strength = 2 x c = 1.800 Kg/cm^2

k_1 = Modulus of Subgrade Reaction for cohesive soil (from Table 4) = 3.240 kg/cm^3

K = $k_1 x 0.3/(1.5xB)$ = 0.648 kg/cm^3

R, Relative stiffness factor in Preloaded Clay $R = \sqrt[4]{\frac{EI}{KD}}$ = **386.9** cm

For Long Pile If $L_e > 3.5R$

L1 = = **0.000** cm

$\frac{L_1}{R}$ = 0.00

For Fixed Head Pile

$\frac{L_f}{R}$ = **2.000** From Fig. 4

Lf = 773.80 cm

Equivalent length of cantilever $L = L1 + L_F$: 0.00 + 773.80178 = **773.80** cm

Y = Pile Head Deflection (Cm) = $\frac{Q(L_1 + L_F)^3}{12\ EI}$ (for fixed Head pile)

Q = Lateral Load in Kg

Lateral Load For Pile Head Deflection 0.5 cm Q = 18803.38 Kg

= **18.8 T**

Safe Lateral resistance of Pile = Lateral resistance corresponding to deflection 1.0% of Pile Diameter at scour level 1.0 cm

= **37.60 T**

Say 37 T

Lateral Load capacity of Pile

BH-A1
Ch. (KM): 30+488

Type of Strata = Clayey

Le = Embedded Length of Pile in Meter = 20.000 m **Fck = 35.0 N/mm^2** **D = 120 cm**

Bed level	**0.0 m**
Pile cap bottom level	**-2.0 m**
Liquefaction level	**-2.0 m**

E	=	Young's Modulus of Pile (Kg/cm^2)	=	$5000\sqrt{F_{ck}}$ N/mm^2	=	295803.99	Kg/cm^2
I	=	Moment of Inertia (cm^2)	=	$\pi x D^4/64$	=	10178760.2	cm^4
c	=	weighted mean of cohesion along the length of pile from the top of scour depth to bottom of pile			=	0.900	Kg/cm^2
q_u	=	Unconfined Compression Strength	=	2 x c	=	1.800	Kg/cm^2
k_1	=	Modulus of Subgrade Reaction for cohesive soil (from Table 4)			=	3.240	kg/cm^3
K	=		=	$k_1 x 0.3/(1.5xB)$	=	0.540	kg/cm^3
R,		Relative stiffness factor in Preloaded Clay R	=	$\sqrt[4]{EI/KD}$	=	**464.3**	cm

For Long Pile If $L_e > 3.5R$

L1	=	=	**0.000** cm
L_1/R		=	0.00

For Fixed Head Pile

L_f/R	=	**2.000**	From Fig. 4
Lf	=	928.56	cm
Equivalent length of cantilever L= L1+L_F: 0.00 + 928.56214	=	**928.56**	cm

Y = Pile Head Deflection (Cm) = $\frac{Q(L_1 + L_F)^3}{12\ EI}$ (for fixed Head pile)

Q = Lateral Load in Kg

Lateral Load For Pile Head Deflection 0.5 cm Q	=	22564.06	Kg
	=	**22.6**	**T**

Safe Lateral resistance of Pile = Lateral resistance corresponding to deflection 1.0% of Pile Diameter at scour level 1.2 cm

=	**54.15**	**T**
Say	**54**	**T**

Geotechnical Investigation Report

Major Bridge
Old Ch. 42+256 (New Ch: 45+497)

SR NO. : 544_21-22

CONDUCTING GEOTECHNICAL INVESTIGATION, PREPARATION OF GEOTECHNICAL REPORT FOR DESIGNING OF BRIDGES AND FOR EMBANKMENT IN CONNECTION WITH CONSTRUCTION OF HARYANA ORBITAL RAIL CORRIDOR (HORC) PROJECT FROM PALWAL TO HARSANA KALAN INCLUDING CONNECTIVITY TO EXISTING IR NETWORK IN THE STATE OF HARYANA

CLIENT

M/S. HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LTD. (HRIDCL)

PROGRAMME

NOVEMBER - 2022

SR. No.	Report No.	Revision No.	Date
544_21-22	CEGTH/HRIDCL/SR-544/2022-23/1188_(06 BHs)	00	02.12.2022

CEGTH
CEG TEST HOUSE
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CEGTH/HRIDCL/SR-544/2022-23/1188 Date:- 02.12.2022

To,

Haryana Rail Infrastructure Development Corporation Ltd. (HRIDCL)
SCO No.-17-19, 3rd & 4th Floor,
Sector - 17-A,
Chandigarh - 160017
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Subject :- Geotechnical investigation work for Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan in the state of Haryana.

Dear Sir,

We are pleased to submit this report of the subject work based on 06 boreholes carried out at Old Ch. 42+256 (New Ch: 45+497) for Major Bridge for the proposed project site.

The accompanying report presents results of various field tests and laboratory tests conducted on selected soil samples and their interpretation.

Should there be any clarifications regarding the contents please contact us at your most convenient time.

We value the opportunity to participate in this project and look forward a pleasant association on future projects.

Very truly yours,
CEG Test House & Research Centre Pvt. Ltd.

Prepared By:-

Nehal Jain
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Authorized Signatory

Dr. Sarvesh Chandra
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SR. No.	Report Ref. No.	Revision No.	Date
544_21-22	CEGTH/HRIDCL/SR-544/2022-23/1188_(06 BHs)	00	02.12.2022

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LIST OF FIGURES / TABLES

CHAPTER 1 GENERAL

1.0 INTRODUCTION:

The work of conducting "**Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana"** was awarded to "**CEG Test House & Research Centre Pvt. Ltd., Jaipur" by M/S.** "**Haryana Rail Infrastructure Development Corporation Ltd. (HRIDCL)"** as per work order no. HRIDC/ HORC/ GT/ CEG/ 237/ 2021/ 577-M dated 29th July 2021.

Field work including drilling of boreholes, conducting field tests such as Electrical Resistivity Test, & Plate Load Test and sample collection was carried out in the presence of representative of Client. Laboratory tests were conducted on selected soil samples to determine the design parameters, confirming to relevant IS specifications and the guidelines received from time to time from representative of Client.

This report includes the details of Methodology of Investigation, collection of samples of soil, field test results, laboratory test results, analysis of results and recommendations for proposed structure carried out at Old Ch. 42+256 (New Ch: 45+497) based on soil sample collected from the locations of 06 boreholes.

2.0 SITE LOCATION & GENERAL GEOLOGICAL HISTORY:

The details of the site & test locations for the proposed project are shown in location plan attached vide **Appendix A-1**. The site of proposed project is located from Palwal to Harsana Kalan (Sonipat) in the State of Haryana falls in seismic zone – IV (Zone factor=0.24) of India.

Soil of the Haryana Sub-Region have been classified and described under the following major soil types as shown below:-

- Typic Ustochrepts : Soil of old alluvial plains
- Typic Ustipsamments : Soil of Aravali plains
- Typic Ustifluvents : Soil of recent alluvial plains and flood plains
- Typic Torripsamments : Soil of Aeofluvial plains
- Rocky Outcrops : Aravali rocky hills

The district wise details of soil characteristics are described below:-

Panipat: The soils are well drained, Sandy loam to clay loam/silty clay loam in plains and loam to clay loam/ silty/ loose clay loam in relic channels/depressions/basins.

Sonipat: The district comprises of recent flood plains, young meander plains, old meander plains and old alluvial plains. Recent flood plains occur along the Yamuna River and clearly show fluvial features. The soils are loamy sand to sandy loam on the surface and sandy loam to clay loam in the sub surface.

Rohtak: The district mainly comprises of old alluvial plains. The soils are loamy sand to sandy loam on the surface and sandy loam to clay loam in the sub surface. Old meander plains are almost flat with loamy sand to silty clay loam soils. Oldest among all the land forms are old alluvial plains, which cover major areas in the district. These soils are sand to loamy sand/sandy loam (surface) to silt loam/silty clay loam (sub-surface).

Jhajjar: The district mainly comprises of old alluvial plains and some parts of the district also have soil belonging to Aravali plains.

Rewari: The soils of the district fall under Entisols and Inceptisols orders. The surface soil texture varies from sand to fine loamy sand.

Gurgaon: The district comprises of sand dunes, sandy plains, alluvial plains, salt affected areas,

low lands, lakes, hills and pediments. The soil varies from sand to loamy sand in sand dunes and sandy plain areas, sandy loam to clay loam / silty clay loam in alluvial plains, calcareous, loamy sand to loam in salt affected plains, silty loam to loam in low lands and calcareous, loamy sand to loam in hills.

Mewat: The soils of the area are generally sandy loam to loam. In parts of the low-lying areas, they are clayey and saline. The upper hills are mostly barren.

Faridabad and Palwal: The district comprises of recent Yamuna flood plains, low lying plains, depressions, sand dunes and hills. The texture of the soil is sand to loamy sand in recent Yamuna flood plains, sandy loam in plains, sandy loam to clay loam in alluvial plains, sandy loam to loam

(surface), clay loam/silty clay (sub-surface) in low lying plains and depressions.

3.0 SCOPE OF WORK:

The stipulated scope of work involved carrying out the following operations:-

a) Mobilisation of necessary plant equipment, men and materials for the complete Geotechnical investigation work as per specifications, drawings and instructions of the Engineer and to complete the same within the stipulated time schedule and demobilisation after completion of field work.

b) Shifting of Equipments from one structure location to another including Ereaction, installation of rigs at site and dismantling of the same after completion of field work. Shifting of setup for each borehole location and associated preparation for borehole under water

c) Making 150 mm nominal diameter boreholes at various locations in all types of soils except hard rock and large boulders using suitable approved method of boring including chiselling, cleaning, providing casing pipe as required; performing Standard Penetration Test at every 3.0m interval and at change of strata; collection of water samples and disturbed soil samples, observation such as ground water, etc., collection of undisturbed soil samples at every 3.0 m interval and at change of strata; transportation of all the collected samples to the laboratory and back filling of boreholes on completion of the same, complete as per specification and instructions of the Engineer, for depths below natural ground level.

d) Conducting Electrical resistivity tests at various locations all complete as per specification and directions of the Engineer.

e) Conducting plate load test at various locations, all complete as per specification and directions of the Engineer.

f) Drilling of Nx size boreholes (75mm dia.) in all types of hard rock, collection of core samples, maintaining continuous record of core recovery/ RQD, keeping the cores in wooden core boxes, transporting to laboratory, backfilling on completion of the same, all complete as per specification and instructions of the EIC.

g) Conducting various laboratory tests on soil samples at an approved laboratory including preparation of soil samples to determine the following properties of soil, all complete as per specification.

<u>On soil Samples</u>

- Dry density test
- Bulk Density and Moisture Content.
- Sieve Analysis
- Hydrometer Analysis
- Liquid Limit and Plastic Limit
- Specific gravity
- Shrinkage Limit
- Free Swell Index
- Direct Shear Test
- Triaxial Shear Test
- One Dimensional consolidation test
- Chemical Analysis of soil samples (pH, chloride, Sulphate)

h) Conducting laboratory tests on rock samples including preparation of the samples to determine the following properties, all complete as per specification

On Rock Samples

- Moisture content, porosity & Density
- Specific gravity
- Hardness
- Unconfined compression test
- Point load strength index
- Modulus of Elasticity and Poission's Ratio
- Abrasion Test

i) Conducting chemical tests on water samples to determine the Sulphate, chloride and pH value all complete as per specification.

j) Submitting draft report in soft copy including all field records and laboratory test results, graphs, etc., all complete as per specifications.

k) Submitting final report in three hard copies in after the approval of the draft report including all field records and laboratory test results, graphs, etc., all complete as per specifications.

4.0 FIELD INVESTIGATION IN SOIL STRATA:

The investigation was planned to obtain the subsurface stratification in the proposed project site and collect soil / rock core samples for laboratory testing to determine the engineering properties such as shear strength, along with basic engineering classification of the subsurface stratum.

For geotechnical investigation work, required equipements along with rotary drilling rigs and manpower were mobilized at site to carry out various field activities as per the scope of work. These were shifted from one test location to another location during execution of field work and were demobilized on satisfactory completion of field work.

For conducting the field investigations the following practices were followed at site:

- The locations of 06 boreholes carried out at Old Ch. 42+256 (New Ch: 45+497) were marked at site at specified locations. These locations are shown in **Appendix A-1** attached subsequently.

The details of various boreholes along with their coordinates are provided herein below:

Table 1.1: Details of Borehole Locations

S. No.	Chainage Old (km)	Chainage New (km)	Structure	BH.No.	Depth of Water Table below EGL (m)	Depth of Borehole below EGL (m)	Co-ordinates (m)		(+) R.L. (m)
							E	N	
1.	42+256	45+497	MJB	BH-P1	NE*	35.00	685810.000	3133716.000	261.500
2.				BH-P7		35.00	685841.000	3133807.000	263.750
3.				BH-P9		35.00	685867.000	3133938.000	262.750
4.				BH-P10		35.00	685863.000	3133950.000	263.228
5.				BH-P11		35.00	685832.000	3133970.000	264.855
6.				BH-P12		35.00	685794.000	3133961.000	264.325

NE*:-Not Encountered

- In soil, boreholes of 150mm dia. were drilled as per the standard procedure laid in IS: 1892.
- Borehole was properly cleaned before taking any sample in soil.
- Casing was used as per the prevailing soil conditions, to stabilize the borehole.
- Standard Penetration Tests were conducted in bore holes at regular intervals or at every change of strata as per Technical specification.
- Undisturbed were collected wherevery feasible as per the requirements and at specified depths. The same has been discussed in detail in soil characteristics sheets attached with the report.
- Water table was not met in the boreholes.

The detailed procedure adopted for conducting various field tests is given here in below:

(i) Standard Penetration Test:

The Standard Penetration Test was conducted in boreholes as per IS 2131. The test was carried out using the standard split spoon sampler to measure the number of blows 'N'.

Standard split spoon sampler was attached to an 'A' rod. It was driven from borehole bottom to a distance of 45 cm using a standard hammer of 63.5 kg falling freely from a height of 75 cm to the required depth. While driving, the number of blows required to penetrate every 15 cm are recorded. The total number of blows required for the last 30 cm is taken as 'N' value at that particular depth of the borehole. Wherever the total penetration was less than 45cm, the no. of blows & the depth penetrated is recorded in the respective borelog.

SPT 'N' values were correlated with relative density of non-cohesive stratum and with consistency of cohesive stratum as given below:-

Table 1.2: Soil compactness as per SPT N values (cl. 9.7, table 9.3 & 9.4, page 330_text book of V.N.S. Murthy)

Correlation for Clay / Plastic silt		Correlation for Sand / Non-Plastic silt	
Consistency	**SPT "N" Value**	**Compactness**	**SPT "N" Value**
Very Soft	0 - 2	Very Loose	0 - 4
Soft	2 - 4	Loose	4 - 10
Medium	4 - 8	Medium	10 - 30
Stiff	8 - 15	Dense	30 - 50
Very Stiff	15 - 30	Very Dense	> 50
Hard	> 30		

The field SPT N values obtained were further corrected as per the guidelines given in IS: 2131 as follows:

(a) For overburden: - The N value for cohesionless soil is corrected with the help of fig. 1 given in IS-2131.

(b) Due to dilatancy :- Wherever N values observed below water table in fine sand, silty sand or silt was greater than 15, then corrected N values were corrected as under:

$$N' = 15 + \tfrac{1}{2}(N-15)$$

(ii) Undisturbed Sampling (Soil) in boreholes:

Undisturbed samples were collected using MS tubes of suitable diameter and length with Area ratio as per clause 4.1.1 (c) of IS: 1892 (latest) fitted to an adopter with ball and socket arrangement. Before taking any sample, sampling tube was properly greased. Immediately after taking on undisturbed sample in a tube, the adopter head was removed along with the disturbed material. The visible ends of the sample were trimmed off any wet disturbed soil. The ends were coated alternately with four layers of just molten wax. More molten wax was added to give a total thickness of min. 25 mm. The samples were carefully labeled and transported to the laboratory for testing. Undisturbed samples wherever slipped during lifting were duly marked in the field logs as well as in the soil profile.

5.0 LABORATORY TESTS ON SOIL SAMPLES:

The following laboratory tests were conducted on selected soil samples:

Table 1.3: Description of Tests

Description of Test	Reference	Undisturbed (UDS) Soil Samples	Disturbed (DS/SPT) Soil Samples
Grain Size Analysis / Hydrometer	IS: 2720 (Part - 4)	√	-
Natural Moisture Content / Bulk / Dry density	IS : 2720 (Part – 2)	√	-

Description of Test	Reference	Undisturbed (UDS) Soil Samples	Disturbed (DS/SPT) Soil Samples
Atterberg Limits • Liquid Limit • Plastic Limit	 IS: 2720 (Part - 5) IS: 2720 (Part - 5)	 √ √	 √ √
Specific Gravity	IS : 2720 (Part – 3)	√	-
Direct Shear Test	IS : 2720 (Part – 13)	√	-
Triaxial compressive shear test	IS : 2720 (Part – 11 & 12)	√	-
Chemical Analysis of Soil Samples	IS : 2720 (Part – 26, 27)	√	-

Note:- The detailed procedure adopted for conducting various laboratory tests is described in the following paragraphs:

5.1.1 Dry density and Bulk density

For determination of bulk density and dry density, a sample of known volume 'V' was extracted from the undisturbed sampling tube and it's bulk weight 'W' was noted down.Moisture content 'Wn' was determined by oven drying method.

The bulk density and dry density were determined by following equation-

Bulk density (γ_b) = W/V

Dry density (γ_d) = γ_b/ (1+Wn)

5.1.2 Natural water content

For this test, the soil sample of known quantity (Wm) was taken in a container.The container with soil sample was placed into an oven for drying at 105-110°c temperature for 16-24 hours. After drying, the dry sample was again weighted to determine the dry weight of sample (Wd).

The natural water content was computed by the following equation-

Wn = (Wm-Wd)*100/Wd

5.1.3 Grain Size Analysis (IS: 2720- Part-4)

Wet sieve analysis:

For determination of particle sizes finer than 75 micron, wet sieve analysis test was conducted. For this test, oven dried sample of known quantity was taken in a container and soaked with dispersing agent. The soaked soil sample was washed thoroughly over 75 micron IS sieve until the water passing sieve was substantially clean.

Fraction retained on 75 micron IS sieve was carefully collected in a container without any loss in material and placed into oven for drying.

Dry sieve analysis:

For this test, the oven dried soil sample after wet sieving was sieved through the set of IS sieves 20 mm, 10 mm, 4.75 mm, 2.0 mm, 1.0 m , 425 micron , 300 micron, 150 micron and 75micron. The amounts of soil retained on each sieve were noted down. The % retained, cumulative % retained and % passing were computed accordingly. Wherever the soil sample % passing 75 micron sieve was significant, Hydrometer method was used to find the percentage of silt and clay fraction.

Grain size analysis for the fraction passing 75 micron IS Sieve (Hydrometer method)

Calibration of Hydrometer

Hydrometer was calibrated to determine a relationship (an equation) between the effective depth H_R and corresponding hydrometer reading R_h (obtained during test).

50 to 100 gm of soil sample passing through 75 micron IS Sieve was taken. It was mixed with 100 ml of sodium hexametaphesphate solution and the mixture was warmed for about 10 minutes. It was then transferred to the cup of the mechanical mixer and the soil suspension was stirred for 15 minutes. The soil suspension was transferred into 1000 ml measuring cylinder and distilled water was added to make 1000ml solution. This solution was mixed vigorously. The measuring cylinder was then allowed to stand and the stopwatch was started. Hydrometer was immersed in the solution and reading were taken after half, one, two and four minutes. The hydrometer was then removed slowly and kept in distilled water at the same temperature as the soil suspension. Readings were taken after the periods of 8, 15 and 30 minutes, and one, two and four hours. Hydrometer was removed, rinsed and placed in the distilled water after each reading. After 4 hours reading was taken once or twice within 24 hours. Finally a reading was taken at the end of 24 hours. The temperature of the suspension was observed and recorded.

Calculations

Diameter of the particles (D):

$$D = \sqrt{\frac{30\mu}{980(G-1)}} \times \sqrt{\frac{H_R}{t}} = M\sqrt{\frac{H_R}{t}}$$

Where,

D = diameter of particle in suspension, in mm;

μ = co-efficient of viscosity of water at the temperature of the suspension at the time of taking the hydrometer reading, in poise;

G = specific gravity of the soil fraction used in the sedimentations analysis;

H_R = effective depth corresponding to R_n, in cm.

t = time elapsed between the beginning of sedimentation and taking of hydrometer reading in minutes

$M = \sqrt{\frac{30\mu}{980(G-1)}}$ = a constant factor for given values of μ and G at the temperature of the suspension.

Percentage finer than diameter D:

The percentage by mass (w) of particles smaller than corresponding equivalent particle diameters (D) was calculated from the formula:

$$w = \frac{100G_s}{W_b(G_s - 1)} \times R_h$$

Where

w = percentage finer

G_s = specific gravity of soil particle

W_b = weight of soil

R_h = Hydrometer reading

5.1.4 Specific Gravity (IS: 2720-Part-3 Sec-1)

The specific gravity of soil sample was determined by density bottle method. For this test 5-10g oven dried and cooled soil sample was taken in 50ml capacity density bottle and its weight was noted down as W_2 .The soil was covered with distilled water and left for sufficient period for suitable soaking. The entrapped air was removed by vacuum. The bottle with soil was filled fully with water and its weight was noted down (W_3). The mass of empty bottle and bottle filled with distilled water were noted down as W_1 and W_4 respectively.

The Specific Gravity was determined by using following equation :

$G=W_2-W_1/[(W_2-W_1)-(W_3-W_4)]$

5.1.5 Liquid Limit (IS: 2720- Part-5)

By Cone Penetrometer Method

The 'Cone Penetrometer Apparatus' is a variant of the fall-cone and consists of a cone with a smooth polished surface and angle of 30° ± 1/2°. The weight of the cone, together with its associated shaft is 80g ± 0.5g. A support assembly with an automatic cone release mechanism and cone height adjustment mechanism used to hold the cone vertically. The angle and weight of the cone were calibrated at regular intervals, and the sharpness of the cone tip was checked daily.

Distilled water was added and thoroughly mixed with the soil sample to produce a homogeneous paste. The paste was then placed in a cup with a diameter of at least 55mm and a depth of at least 40mm. The surface of the soil was smoothed off level and parallel to the base. The support assembly was used to position the tip of the cone so that it was just touching the top surface of the soil, and the automatic tripping mechanism was released. The cone was allowed to penetrate into the soil for a period of 5 (± 1) s, then the cone was locked off to stop further movement and the penetration was recorded. The cup was refilled and the test was repeated. The two recorded penetrations need to be within 0.5mm of each other, otherwise a third test is performed. when the three test vary by more than 1mm the test was repeated.

Further tests were conducted, at varying water contents, in order to produce a series of cone penetrations (usually 4) in the range 15mm to 25mm. The resulting cone penetrations were plotted verses the water content of the test specimens. The Liquid Limit (W_L) was read off the graph, being the water content at which the line of best fit through the test points crosses 20mm penetration.

5.1.6 Plastic Limit (IS: 2720-Part-5)

For this test, soil sample was prepared in the same way as for liquid limit test. A ball of soil sample weighed about 5 gm was formed. The ball was rolled between the fingers of one hand and the glass plate with pressure sufficient to reduce the mass into a thread of about 3 mm in 5 to 10 complete forward and back movements. When a diameter of 3 mm was reached, soil was again remolded into a ball. The process of rolling and remolding was repeated until the thread started just crumbing at a diameter of 3 mm. The crumbled thread was immediately transferred to an airtight container for determination of its moisture content by oven drying method.

This water content has been termed as plastic limit. (W_P)

5.1.7 Plasticity Index (IS: 2720-Part-5)

The plasticity index Ip was given by

$I_p = W_L - W_P$ (in percent)

5.1.8 Direct Shear Test (IS:2720-Part-13):

For this test shear box test apparatus was used. The prepared specimen from remolded/undisturbed sample was placed carefully in the box. The plain grid was kept on top of the specimen with its directions at right angles to the direction of shear. The upper porous stone was placed on the grid and loading pad on the stone. The box with specimen was gently placed in the container (water jacket). The specimen was submerged with water. The container was mounted with the shear box and the specimen inside, on the shearing machine. The upper part of the box was so adjusted that it

touchéd the proving ring. The jack was brought forward to bear up against the box container. The proving ring dial gauge was set to read zero.

The steel ball was placed in the recess of the loading pad. The loading yoke was set in contact with the steel ball on the loading pad. Vertical displacement dial gauge to read zero in contact with the top of the yoke. The normal load was applied and any change in thickness of specimen was recorded. Shear displacement dial gauge was also set to read zero. The locking screw was now removed and two parts of the shear box were separated by advancing the spacing screws.

The specimen was sheared at constant rate of strain. The readings of the proving ring dial gauge were noted down every 15 seconds for the first one-minute and then every 30 seconds thereafter. The reading of change in the thickness dial gauge and shear displacement dial gauge were also recorded at the same time interval. The test was continued until the specimen fails. The specimen was assumed to fail when the proving ring dial gauge started receding or at shear displacement of approximately 15% of the length took place.

The soil was removed from the box and test was repeated on the identical specimen under increased normal load.

The rate of strain for conducting Direct Shear Test is kept as 0.25 mm/min as per codal/literature provision based on strata.

5.1.9 Triaxial Shear Test_UUT (IS: 2720-Part-11)

For this test, Triaxial Shear Test apparatus was used. The plain disc was placed on the pedestal of the triaxial cell. The specimen was placed centrally on the disc. A correct size rubber membrane was fitted inside the stretcher with ends of membrane folded over those of the stretcher. Vacuum was applied to stretch the membrane to the inside surface of the stretcher which was carefully slipped around the specimen kept on the pedestal. The vacuum on the membrane was released. Its bottom part was rolled down into the pedestal. plain disc was placed on the top of the specimen and then loading pad was placed. The top part of membrane was rolled on to the loading pad. Then the stretcher was removed and ends were sealed with ‘O’ rings. With the properly sealed specimen placed centrally on the pedestal, the cell was assembled, keeping the loading piston initially clear of the loading pad of the specimen, the assembly was placed in the loading frame.

For unconsolidated undrained test, the bottom drainage value (BDV) and top drainage value (TDV) of cell, was closed and air release valve (ARV) was opened. The cell was filled with water through the cell water value CWV. ARV was closed when water begins to escape through it. The cell pressure was raised to the desired value and kept constant till the end of the test.

When the cell pressure was applied, the load piston rises upward, the loading machine was operated at the anticipated rate to bring the load piston slightly above the loading pad of the specimen and the load measuring dial gauge on proving ring was set to zero.

The piston was brought just in contact with loading pad by hand operation of the machine. The

axial compression dial gauge was mounted and set to read zero.

The axial loading was started at 1.25 mm/min rate of strain. Simultaneous readings on the load and compression dial gauges were noted down. The test was continued until a recession of the axial load is observed or 20% of strain.

After failure, the specimen was unloaded by reversing the loading machine, cell pressure was reduced and cell water was drained out through BRV. The cell was dismantled and the specimen was taken out, rubber membrane was removed and weight of the failed sample and its water content was determined. The test was repeated on two more identical specimens with increasing cell pressure.

The rate of strain for conducting UUT is kept as 1.25 mm/min as per codal/literature provision based on strata.

5.1.10 Chemical Testing

Chemical Testing was generally performed in accordance with IS: 2720, but the different parts of method as described below:

a) Total Sulphate Content Of Soil

Samples were tested according to IS 2720 (Part 27). The dried soil was extracted with a 10% solution of hydrochloric acid. The extract was adjusted to slightly alkaline pH with ammonia, and then barium chloride solution was added to precipitate the sulphate. The barium sulphate precipitate was collected by filtration, and it was washed, dried and weighed. The mass of barium sulphate recovered was used to calculate the sulphate content of the original soil.

b) pH Value

Samples were tested according to IS: 2720 (Part 26). The soil sample (30 ± 0.1g) was extracted with 75 ml of distilled water and the pH of the resulting suspension was measured with a calibrated (by means of Standard buffer solution) pH meter.

c) Chloride Content

For the water soluble content, soil samples were extracted with a volume of water equal to twice the mass of the soil. The extract was filtered and acidified with a small amount of nitric acid. Standardized silver nitrate solution was then added to precipitate the chloride as its silver salt. The amount of precipitated silver remaining in solution was then determined by titration.

An acid-soluble version of the test was also available, with the initial extraction being with nitric acid instead of water.

CHAPTER 2 ANALYSIS OF TEST RESULTS AND INTERPRETATION

6.0 STRATIFICATION

From the study of the borehole carried out at Old Ch. 42+256 (New Ch: 45+497), it is revealed that:-

At location of O.C. 42+256 N.C. 45+497:-

The sub strata mainly consist of silty Clay of low plasticity (CL)/Sandy Silt (ML-CL)/Silty sand (SM).

6.1 GROUND WATER TABLE DEPTH

The Ground Water Table was not met in the boreholes as given in Table 1.1. Actual site was located under the shallow water body of around 1 m depth so boreholes were drilled 30 to 40 m away from the actual site location. For the analysis purpose, submerged soil condition has been considered.

6.2 RESULTS OF CHEMICAL ANALYSIS

Results of chemical analysis of soil samples (as per **Appendix – B2**) indicates that the soil sample falls under Class I for sulphates and chlorides concentration (As per IS 456-2000 and CIRIA Sp. Publication No. 31). The results are summarized here in below :-

Summary of chemical analysis of soil samples

Chemical Property	Findings (Min. to Max.)	Remarks (Required limits as per IS 456-2000)
pH	8.24 to 8.36	> 6.0
Sulphite as SO_3^{2-} (%)	0.0018 (%) to 0.0021 (%)	< 0.2% (Class I)
Chlorides as Cl^- (%)	0.0057 (%) to 0.0064 (%)	No limit specified in IS 456. However, a limit of 0.10% specified for class I in CIRIA Sp. Publication No. 31)

Note :- All the chemical contents are within permissible limit hence no special precautions are required.

6.3 COMPUTATION OF LIQUEFACTION POTENTIAL

Liquefaction is the sudden loss of shear strength of the sub soil strata due to earthquake-induced vibration under saturated conditions.

Assessment of liquefaction potential of foundation strata is made by simplified approach proposed as per IS: 1893 (Part-1)-2016, from the SPT data and peak ground acceleration likely to occur at

the site. In this method, cyclic shear stress likely to be induced in the foundation strata by Design Basis Earthquake (DBE) is first evaluated.

Next threshold cyclic shear stress, which is good enough to cause liquefaction, is determined from SPT data and the empirical relations. Finally, comparison of these two stresses is used in the estimation of liquefaction susceptibility of the foundation strata.

Unsaturated soils are not subjected to liquefaction because vibratory forces from earthquakes do not cause any increase in pore water pressure in such soils.

The area of site from Palwal to Harsana Kalan (Sonipat) in the State of Haryana falls in seismic zone – IV of India as per IS: 1893. Further as per the provisions of IS: 1893 in soil deposits consisting of submerged loose sands & soils falling under classification of SP with standard penetration N value less than 15, the shaking caused by earthquake ground motion may cause liquefaction or excessive total and differential settlements.

For the analysis of liquefaction potential, following constant parameters are considered:

EQ Zone	IV
Earthquake Magnitude (Mw)	7.0
Peak Horizontal Ground Acceleration (amax /g)	0.24

For the analysis of liquefaction potential, the water table is considered at groud level. The strata in the boreholes are likely to liquefy tabulated below:-

Table 2.1: Liquefaction Analysis

S. No.	Chainage Old (km)	Chainage New (km)	Structure	BH.No.	Depth of Water Table below EGL (m)	Liquefiable Depth (m)
1.	42+256	45+497	MJB	BH-P1	Not Encountered	8.50
2.				BH-P7	Not Encountered	4.00
3.				BH-P9	Not Encountered	8.50
4.				BH-P10	Not Encountered	7.00
5.				BH-P11	Not Encountered	7.00
6.				BH-P12	Not Encountered	4.00

6.4 INTERPRETATION OF LAB TEST RESULTS

Grain Size Analysis

1. **Clay content:** It generally varies from 6 to 11%.
2. **Silt content:** It generally varies from 22 to 61%.
3. **Sand content:** It generally varies from 23 to 84%.
4. **Gravel content:** It generally varies from 1 to 11%.

Atterberg's Limit

5. **Liquid limit:** The test results of liquid limit of the soil samples reveal that it generally varies from 26 to 28% in ML-CL type of soil, 32 to 32% in CL type of soil.
6. **Plastic Limit*:*** The plastic limit of the soil sample varies from 21 to 22% in ML-CL type of soil, 20 to 23% in CL type of soil. However ML-CL type of soil is considered as non-plastic.
7. **Plasticity index*:*** The plasticity index of the soil samples generally varies from 5 to 7% in ML-CL type of soil, 9 to 11% in CL type of soil whereas ML-CL and SM/ SM-SC/ SC type of soil are non-plastic.

Natural moisture content & Bulk density

The bulk density of soil samples generally varies from 1.81gm/cc to 1.97gm/cc whereas natural moisture content varies from 9.0% to 29.4%.

Direct shear tests:

Direct shear test under drained condition have been conducted in sandy silty (ML-CL) / sandy stratum (SM/ SM-SC/ SC) type of soil.

For Sandy strata (SM/ SM-SC/ SC), the value of angle of internal friction varies from 25^o to 32^o, whereas cohesion varies from 0.00 kg/cm^2 to 0.11 kg/cm^2.

For Silty strata (ML-CL), the value of angle of internal friction varies from 22^o to 27^o, whereas cohesion varies from 0.18 kg/cm^2 to 0.21 kg/cm^2.

Triaxial shear tests:

Triaxial shear test under undrained condition have been conducted in silty clay (CL) type of soil.

For silty clay (CL) strata, the value of angle of internal friction varies from 4^o to 5^o, whereas cohesion varies from 1.41kg/cm^2 to 2.24kg/cm^2.

CHAPTER 3 TYPE AND DEPTH OF FOUNDATION WITH ANALYSIS

7.0 TYPE & DEPTH OF FOUNDATION:

Based on the nature & strength characteristics of the substrata and requirement of the project, the following type of foundation have been analyzed as given below:

Table 3.1 : Shallow Foundation

Type of foundation	Depth of Foundation below E.G.L. (m)	Size of Foundation (m x m)
Shallow Foundation	2.0, 3.0, 4.0	7.2 x 7.2

Table 3.2 : Pile Foundation

Type of foundation	Length of Pile below E.G.L. (m)	Dia. of Pile (m)
Normal Bored Cast in-situ RCC Pile	20.0, 22.0, 24.0, 26.0, 28.0 & 30.0	1.0 & 1.2

The details of foundation analysis are given in the subsequent paragraph.

7.1 ANALYSIS OF SHALLOW FOUNDATION

7.1.1 From Shear Failure Criteria

Net Safe Bearing capacity from Shear Failure consideration has been computed in accordance with IS: 6403-1981, which is based on, modified Terzaghi's classical approach. The weighted average of shear strength parameters for various strata upto depth equal to 0.5*B*Tan (45+Ø/2) (where B = Width of the Foundation, Ø = Angle of internal friction) is used in the analysis. A factor of safety of 2.5 to estimate the net safe bearing capacity from ultimate net bearing capacity.

For soils, containing both coarse grained (gravels & sands) and fine grained (clays), c and Φ are used to determine the soil strength. In case of predominantly fine grained soils, c and Φ are determined by the Triaxial Compression test as per IS: 2720 pt XI. For predominantly coarse grained soils, c and Φ are determined by Direct Shear test as per IS: 2720 pt XIII. These c and Φ values were used for determining the SBC of soil as per shear failure criteria.

The ultimate net bearing capacity in case of general shear failure is given by following expression,

$$q_d = c\,N_c\,s_c\,d_c\,i_c + q\,(N_q-1)\,s_q\,d_q\,i_q + (1/2)\,B\,\gamma\,N_\gamma\,s_\gamma\,d_\gamma\,i_\gamma\,W'$$

The ultimate net bearing capacity in case of local shear failure is given by following expression,

$$q'_d = (2/3)\,c\,N'_c\,s_c\,d_c\,i_c + q\,(N'_q-1)\,s_q\,d_q\,i_q + (1/2)\,B\,\gamma\,N'_\gamma\,s_\gamma\,d_\gamma\,i_\gamma\,W'$$

Where,

$d_c = 1 + 0.2\,(D_f/B)*SQRT(N_\phi)$

$d_q = d_\gamma = 1$ for $\phi < 10^o$

$d_q = d_\gamma = 1 + 0.1\,(D_f/B)*SQRT(N_\phi)$ for $\phi > 10^o$

$N_\phi = \tan^2(\pi/4 + \phi/2)$

ϕ' for local shear failure = $\tan^{-1}$ (0.67 tanϕ)

7.1.2 From Settlement Failure Criteria

Allowable Bearing Pressure from Settlement Failure consideration has been computed in accordance with IS: 8009 (Part-I). The magnitude of settlement, when foundation loads are applied, depends upon the compressibility of the underlying strata and rigidity of the substructure.

The total permissible settlement in cohesion-less soil is estimated using SPT value as per IS: 8009 (Part-I). While using this approach, the N value was corrected, wherever applicable, below the footing base to at least 1.5B below the base to account for the effects of energy ratio, adopted bearing pressure, dilation for submerged silty fine sands / fine sands as well as that due to the overburden pressure.

Further for settlement Calculation in cohesive soil the following equation has been used.

$S_t = \Delta P\ M_v\ H$

Where,

M_v = Coefficient of volume compressibility, cm^2/kg

ΔP = Pressure increment, kg/cm^2

H = Thickness of layers

Note: - Value of Coefficient of volume compressibility (Mv) has been calculated by using the following co-relation [Ref. Stroud and Butler, 1975] :-

Coefficient of Volume Compressibility derived from SPT N-Value (after Stroud and Butler, 1975)

Plasticity Index (%)	Conversion Factor (f_2)	m_v (10^{-3} kPa^{-1}) based on N-Value: $m_v = 1/(f_2N)$				
		N=10	N=20	N=30	N=40	N=50
10	800	0.12	0.06	0.04	0.03	0.02
20	525	0.19	0.09	0.06	0.05	0.04
30	475	0.21	0.10	0.07	0.05	0.04
40	450	0.22	0.11	0.07	0.06	0.04

$Mv = 1/(f_2 N_{corr.})$

Where f_2 = factor based on $N_{corr.}$ Value & plasticity index of soil

$N_{corr.}$ = corrected SPT 'N' value

For analysis of shallow foundation the total permissible settlement has been considered as 25mm, & 50mm as per IS 1904.

Zone of influence below foundation has been considered up to 1.5 times the width of the foundation.

For the determination of the SBC from settlement criteria, the corrected SPT N values within the influence zone are given in the table below.

NOTE:-

- Lower of the two values obtained from settlement and shear criteria is used in arriving at allowable bearing capacity of the soil.
- Structural foundations are designed based on the minimum of Safe Bearing Capacity obtained from Shear Failure Criteria and Allowable Bearing Pressure corresponding to the permissible settlement. The permissible Settlement that can be allowed for the foundation depends on the strata at the location and type of foundation (whether Isolated or Raft).

  Settlement occurs with the application of loads on foundations. It has two components, Immediate Settlement and Long Term Settlement. The immediate settlement takes place immediately as the loading is imposed on the structure and long term settlement arises due to the consolidation of the sub-soil with time under the load. Hence, the total settlement allowed for a foundation is the sum of the immediate and consolidation settlement that is expected to occur. The cohesionless strata (predominantly sandy) is primarily subjected to immediate settlement and cohesive strata (clayey) undergoes settlement in long time with the compression of the strata due to consolidation. Settlement of the foundation is determined from the relation provided in Indian standards (IS: 8009 (part-1) &/or various literatures (Bowles, BM Das, etc.).

  From the Geotechnical investigation conducted on our site along with subsequent laboratory tests on soil samples, it is observed that predominantly the strata is silty with sand (SM/SC/SM-SC/ML-CL i.e. predominantly cohesionless) with the presence of small patches of silty clay of low plasticity (CL). Since the Settlement that takes place in cohesionless strata is mostly immediate, it takes place immediately after the imposing of load, initially during construction with the application of Dead Load and further during Live Load. The live load usually is many times lesser than the dead load, and correspondingly the post construction settlement is very less for live loads. As an example, if dead load is three times that of live load, then the settlement corresponding to live load (i.e. the post construction settlement) will be one-third of the settlement due to dead load which is comparatively lesser than 25mm for permissible settlement of 50mm.

  According to the IS 1904, the permissible settlement for concrete structure having raft foundation is allowed upto 75mm, and the permissible settlement is 25mm post construction as per IRS code (Code of Practice for The Design of Sub-Structures and Foundations of Bridges). As discussed above, the settlement post construction is directly proportional to the allowable settlement. Therefore, given the importance of structure to be constructed and considering mostly cohesionless strata encountered at site, it is recommended that the maximum permissible settlement shall be

restricted to 50mm for the design purpose on conservative side so that the post construction settlement can be constraint to lesser than 25mm.

As per IS- 8009 part 1 clause 9.2.2.1, If the clay layer is sandwitched between cohesionless soil layers, the immediate settlement is zero. Hence, even though the immediate settlement has been calculated during analysis, however it is ignored in the calculation of total settlement.

The sample calculations for computation of allowable bearing capacity of sub-strata for shallow foundation vide **Appendix – C-2.**

7.2 ANALYSIS OF PILE FOUNDATION

(A) DEEP FOUNDATION

The safe Load Carrying Capacity of normal bored cast in-situ RCC pile is determined in compression, uplift and lateral as per IS: 2911 (Part-1/sec-2) – 2010. The axial capacity of a pile depends upon the soil skin friction along the shaft and end bearing at it's tip.

Thus Axial load = Skin Friction + End-bearing

a) For piles in granular soils (using the static formula)

$$\mathbf{Q_u = (0.5*D*\gamma*N_\gamma + P_D*N_q)*A_p + (\Sigma K_i*P_{Di}*\tan\delta_i)*A_{si}}$$

Where,

Q_u = Ultimate load capacity of pile in KN

D = dia. of pile shaft in m

γ = effective unit weight of the soil at pile tip in kN/m^3

N_γ & N_q = bearing capacity factors depending upon the angle of internal friction Φ at pile tip (N_γ from IS 6403 for general shear failure case & N_q from Fig. 1, IS 2911)

P_D = effective overburden pressure at pile tip in kN/m^2 limited to 15-17 times diameter of pile (as per the Phi value at end bearing)

Σ = Summation for layers (1 to n) in which pile is installed and which contribute to (+ve) skin friction

K_i = coefficient of earth pressure applicable for the i^{th} layer

P_{Di} = effective overburden pressure for the i^{th} layer in kN/m^2 limited to 15-17 times diameter of pile (as per the Phi value at end bearing)

δ_i = angle of wall friction between pile and soil for i^{th} layer, and

A_{si} = surface area of pile shaft in the i^{th} layer in m^2

b) For piles in cohesive soils (using the static formula)

$$\mathbf{Q_u = cp*Nc*A_p + \Sigma\alpha_i*c_i*A_{si}}$$

Where,

Q_u = Ultimate load capacity of pile in KN

A_p = cross-sectional area of pile tip in m^2

N_c = bearing capacity factor (= 9)

Σ = Summation for layers (1 to n) in which pile is installed and which contribute to (+ve) skin friction

α_i = adhesion factor for the i^{th} layer depending on the consistency of soil

c_i = average cohesion for i^{th} layer in kN/m^2

A_{si} = surface area for pile shaft in the i^{th} layer in m^2

c) For computation of safe load carrying capacity of pile in lateral, the following equation has been used:

i. Fixed Head Condition

$$Q = (12 * E * I * Y) / (L_1 + L_f)^3$$

ii. Free Head Condition

$$Q = (3 * E * I * Y) / (L_1 + L_f)^3$$

Where,

Q = Lateral Load (in kg)

Y = Permissible lateral deflection taken as 5mm

E = Modulus of Elasticity of concrete

I = Moment of Inertia of the pile cross-section

L_1 = Length of pile above cut-off level

L_f = Length of fixity

The effective length of the pile has been considered below the cut-off level taken as 2.0m below the EGL. Normal Bored cast in-situ RCC piles having stem diameter equal to 100cm & 120cm and of effective length varying from 16.0m to 28.0m were selected.

For the analysis of the pile foundations the soil parameters used for computation of safe load carrying capacity of pile is tabulated below:-

Table 3.3 : Design Soil Parameter

Chainage Old (km)	Chainage New (km)	BH.No.	Layer depth below EGL (m)		Thickness of strata (m)	Strata description	SPT 'N'		Bulk Density (gm/cc)	Cohesion (C) (kg/cm2)	Angle of internal Friction (Φ) (°)
			From	To			Observed	Corrected			
42+256	45+497	BH-P1	0.00	4.00	4.00	Sandy Silt	10	13	1.72	0.13	25
			4.00	7.00	3.00	Sandy Silt	13	16	1.75	0.15	25
			7.00	10.00	3.00	Silty Clay	21	21	1.87	0.77	6

Chainage Old (km)	Chainage New (km)	BH.No.	Layer depth below EGL (m)		Thickness of strata (m)	Strata description	SPT 'N'		Bulk Density (gm/cc)	Cohesion (C) (kg/cm2)	Angle of internal Friction (Φ) (°)
			From	To			Observed	Corrected			
42+256	45+497	BH-P1	10.00	13.00	3.00	Silty Clay	37	37	1.93	1.38	6
			13.00	23.50	10.50	Silty Clay	62	62	1.97	1.71	5
			23.50	28.50	5.00	Sandy Silt	75	38	1.88	0.19	25
			28.50	35.00	6.00	Silty Sand	85	39	1.81	0.00	31
		BH-P7	0.00	5.50	5.50	Silty Clay	16	16	1.80	0.61	5
			5.50	8.50	3.00	Silty Clay	20	20	1.85	0.71	6
			8.50	11.50	3.00	Silty Clay	26	26	1.89	0.99	5
			11.50	14.50	3.00	Silty Clay	22	22	1.86	0.99	5
			14.50	21.00	6.50	Silty Clay	57	57	1.95	1.21	5
			21.00	35.00	13.00	Silty Clay	65	65	2.05	1.98	5
		BH-P9	0.00	4.00	4.00	Sandy Silt	8	10	1.69	0.13	25
			4.00	7.00	3.00	Sandy Silt	11	13	1.72	0.14	26
			7.00	10.00	3.00	Sandy Silt	21	21	1.77	0.15	26
			10.00	13.00	3.00	Sandy Silt	28	24	1.79	0.17	27
			13.00	22.00	9.00	Silty Clay	40	40	1.94	1.51	5
			22.00	35.00	12.50	Silty Clay	74	74	1.97	2.10	5
		BH-P10	0.00	5.50	5.50	Sandy Silt	10	13	1.80	0.44	5
			5.50	8.50	3.00	Silty Clay	24	24	1.82	0.91	6
			8.50	14.50	6.00	Silty Clay	39	39	1.87	1.10	6
			14.50	16.00	1.50	Silty Clay	-	-	1.97	1.19	7
			16.00	20.50	4.50	Sandy Silt	70	47	1.88	0.15	25
			20.50	22.00	1.50	Sandy Silt	-	-	1.90	0.19	26
			22.00	35.00	12.00	Silty Clay	74	74	2.02	2.31	6
		BH-P11	0.00	2.50	2.50	Sandy Silt	-	-	1.68	0.00	31
			2.50	7.00	4.50	Silty Clay	19	19	1.84	0.78	5
			7.00	13.00	6.00	Silty Clay	27	27	1.86	1.02	6
			13.00	14.50	1.50	Silty Clay	-	-	1.89	1.04	6
			14.50	22.00	7.50	Sandy Silt	48	33	1.84	0.16	26
			22.00	25.50	3.50	Sandy Silt	46	25	1.85	0.18	27
			25.50	31.00	5.50	Silty Clay	66	66	2.01	2.68	6
			31.00	35.00	3.50	Silty Clay	74	74	2.02	2.68	6
		BH-P12	0.00	5.50	5.50	Silty Clay	19	19	1.85	0.95	5
			5.50	11.50	6.00	Silty Clay	29	29	1.92	1.14	5
			11.50	14.50	3.00	Silty Clay	24	24	1.89	0.98	6
			14.50	35.00	19.50	Silty Clay	42	42	1.96	1.25	5

Design parameter have been obtain from the laboratory test results however various depth where the shear parameter seems on the lower side with respect to SPT 'N' values those shear parameter

have been judicially improved based on the SPT 'N' for the analysis purpose.

The sample calculation for computation of safe load carrying capacity of normal bored cast-in-situ RCC pile in compression & uplift are attached vide **Appendix C-3.**

The sample calculation for computation of safe load carrying capacity of normal bored cast-in-situ RCC pile in lateral are attached vide **Appendix C-4.**

CHAPTER 4 FOUNDATION RECOMMENDATIONS

8.0 FOUNDATION RECOMMENDATIONS

- Based on the nature & strength characteristics of the substrata and requirement of the project, shallow foundation and normal bored cast in-situ RCC pile foundation have been analyzed.
- Based on the method of analysis & design parameters given under Para 7.1 above, the recommended net allowable bearing capacity values are given in Table 4.1 to 4.4.

Table 4.1: Recommended Net Allowable Bearing Capacity for shallow foundation for allowable settlement 25mm

Chainage Old (km)	Chainage New (km)	BH. No.	Foundation Size (m x m)	Depth of foundation below EGL (m)	Net Safe Bearing Capacity from Shear Failure (t/m^2)	Net Allowable Bearing Pressure from settlement failure (t/m^2)	Recommended Net Allowable Bearing Capacity (t/m^2)
42+256	45+497	BH-P1	7.2 x 7.2	2.0	16.5	7.8	NR
			7.2 x 7.2	3.0	18.7	9.3	NR
			7.2 x 7.2	4.0	21.1	11.5	NR
		BH-P7	7.2 x 7.2	2.0	18.1	8.7	NR
			7.2 x 7.2	3.0	18.8	9.4	NR
			7.2 x 7.2	4.0	19.4	10.6	NR
		BH-P9	7.2 x 7.2	2.0	13.3	4.7	NR
			7.2 x 7.2	3.0	15.2	5.1	NR
			7.2 x 7.2	4.0	17.1	5.2	NR
		BH-P10	7.2 x 7.2	2.0	21.4	14.1	NR
			7.2 x 7.2	3.0	22.2	18.7	NR
			7.2 x 7.2	4.0	23.0	19.8	NR
		BH-P11	7.2 x 7.2	2.0	18.9	11.6	NR
			7.2 x 7.2	3.0	19.6	14.5	NR
			7.2 x 7.2	4.0	20.3	15.4	NR
		BH-P12	7.2 x 7.2	2.0	32.6	14.3	NR
			7.2 x 7.2	3.0	33.7	15.1	NR
			7.2 x 7.2	4.0	34.8	15.9	NR

* The maximum value of recommended net allowable bearing capacity shall be restricted to 30 t/m^2.

Table 4.2: Recommended Net Allowable Bearing Capacity for shallow foundation for allowable settlement 50mm

Chainage Old (km)	Chainage New (km)	BH. No.	Foundation Size (m x m)	Depth of foundation below EGL (m)	Net Safe Bearing Capacity from Shear Failure (t/m^2)	Net Allowable Bearing Pressure from settlement failure (t/m^2)	Recommended Net Allowable Bearing Capacity (t/m^2)
42+256	45+497	BH-P1	7.2 x 7.2	2.0	16.5	15.6	NR
			7.2 x 7.2	3.0	18.7	18.5	NR
			7.2 x 7.2	4.0	21.1	23.0	NR
		BH-P7	7.2 x 7.2	2.0	18.1	17.3	NR
			7.2 x 7.2	3.0	18.8	18.9	NR
			7.2 x 7.2	4.0	19.4	21.2	NR
		BH-P9	7.2 x 7.2	2.0	13.3	9.3	NR
			7.2 x 7.2	3.0	15.2	10.1	NR
			7.2 x 7.2	4.0	17.1	10.4	NR
		BH-P10	7.2 x 7.2	2.0	21.4	28.1	NR
			7.2 x 7.2	3.0	22.2	37.4	NR
			7.2 x 7.2	4.0	23.0	39.5	NR
		BH-P11	7.2 x 7.2	2.0	18.9	23.2	NR
			7.2 x 7.2	3.0	19.6	29.0	NR
			7.2 x 7.2	4.0	20.3	30.7	NR
		BH-P12	7.2 x 7.2	2.0	32.6	28.6	NR
			7.2 x 7.2	3.0	33.7	30.2	NR
			7.2 x 7.2	4.0	34.8	31.9	NR

Table 4.3: Recommended Net Allowable Bearing Capacity for shallow foundation for allowable settlement 25mm (Replaced or Compacted Soil)

Chainage Old (km)	Chainage New (km)	BH. No.	Foundation Size (m x m)	Depth of foundation below EGL (m)	Net Safe Bearing Capacity from Shear Failure (t/m^2)	Net Allowable Bearing Pressure from settlement failure (t/m^2)	*Recommended Net Allowable Bearing Capacity (t/m^2)
42+256	45+497	BH-P7	7.2 x 7.2	2.0	25.4	16.2	16.2
			7.2 x 7.2	3.0	27.2	19.3	19.3
			7.2 x 7.2	4.0	29.1	23.6	23.6
		BH-P12	7.2 x 7.2	2.0	41.3	13.5	13.5
			7.2 x 7.2	3.0	43.8	15.2	15.2
			7.2 x 7.2	4.0	46.3	17.2	17.2

Table 4.4: Recommended Net Allowable Bearing Capacity for shallow foundation for allowable settlement 50mm (Replaced or Compacted Soil)

Chainage Old (km)	Chainage New (km)	BH. No.	Foundation Size (m x m)	Depth of foundation below EGL (m)	Net Safe Bearing Capacity from Shear Failure (t/m^2)	Net Allowable Bearing Pressure from settlement failure (t/m^2)	*Recommended Net Allowable Bearing Capacity (t/m^2)
42+256	45+497	BH-P7	7.2 x 7.2	2.0	25.4	32.4	25.4
			7.2 x 7.2	3.0	27.2	38.6	27.2
			7.2 x 7.2	4.0	29.1	47.2	29.1
		BH-P12	7.2 x 7.2	2.0	41.3	27.1	27.1
			7.2 x 7.2	3.0	43.8	30.4	30.4
			7.2 x 7.2	4.0	46.3	34.4	34.4

Note:- Table 4.1& 4.2 Show that most of the boreholes are liquefiable up to certain depth. Therefore before laying the open foundation it is recommended to replace & compact the soil up to liquefaction depth, Replaced/ Compacted SBC are presented in Table 4.3 & 4.4. However, the stara liquefied more than 4m depth from EGL are not recommended for SBC.

Note:-

- The maximum value of recommended net allowable bearing capacity shall be restricted to 30 t/m^2.
- As per the Morth guidelines the gradation of fill soil shall be as per following limits. The effective angle of friction not less than 30º. The gradation of fill soil shall be as per following limits.

Sieve Size	Percentage Passing
75 mm	100%
425 micron	0-60%
75 micron	less than 15 %
PI	≤6

1. *The density of backfill soil should be more than 95% of proctor density. The replaced /compacted soil should be lay down layer wise for each 300mm.*
2. *The design parameters considered for replaced/compacted Soil for calculating the SBC from shear criteria are as follows;*

C=0, Phi = 32 degree, Sp. Gravity= 2.63 Moisture content= 8%, bulk density= 1.84 g/cc, N = 25.

- Based on the method of analysis given under Para 7.2 above, The values of Safe Load Carrying Capacity of piles in compression, uplift and lateral under static conditions have been tabulated below:-

Table 4.3: Safe Load Carrying Capacity of normal bored cast in-situ RCC Pile in Soil

Chainage Old (km)	Chainage New (km)	BH. No.	Diameter of Pile (m)	Length of piles below cut-off (m)	Cut-off level below EGL (m)	Safe load carrying capacity of single pile (T)		
						In compression	In uplift	In Lateral
								Fixed Head
42+256	45+497	BH-P1	1.0	20.0	2.0	139.0	117.0	5.3
				22.0		154.0	133.0	
				24.0		174.0	153.0	
				26.0		193.0	174.0	
				28.0		212.0	193.0	
				30.0		285.0	213.0	
			1.2	20.0		194.0	151.0	8.3
				22.0		214.0	174.0	
				24.0		241.0	202.0	
				26.0		268.0	231.0	
				28.0		296.0	259.0	
				30.0		422.0	288.0	
		BH-P7	1.0	20.0	2.0	162.0	140.0	12.9
				22.0		200.0	158.0	
				24.0		215.0	175.0	
				26.0		231.0	192.0	
				28.0		247.0	209.0	
				30.0		263.0	226.0	
			1.2	20.0		209.0	180.0	16.9
				22.0		260.0	202.0	
				24.0		279.0	224.0	
				26.0		299.0	246.0	
				28.0		318.0	268.0	
				30.0		338.0	290.0	
		BH-P9	1.0	20.0	2.0	142.0	117.0	4.1
				22.0		175.0	135.0	
				24.0		191.0	152.0	
				26.0		208.0	170.0	
				28.0		224.0	187.0	
				30.0		240.0	205.0	
			1.2	20.0		186.0	152.0	6.2
				22.0		207.0	175.0	
				24.0		251.0	197.0	
				26.0		271.0	220.0	
				28.0		291.0	242.0	
				30.0		312.0	265.0	

Chainage Old (km)	Chainage New (km)	BH. No.	Diameter of Pile (m)	Length of piles below cut-off (m)	Cut-off level below EGL (m)	Safe load carrying capacity of single pile (T)		
						In compression	In uplift	In Lateral Fixed Head
42+256	45+497	BH-P10	1.0	20.0	2.0	164.0	138.0	6.7
				22.0		209.0	157.0	
				24.0		227.0	176.0	
				26.0		246.0	196.0	
				28.0		264.0	215.0	
				30.0		283.0	234.0	
			1.2	20.0		231.0	184.0	9.9
				22.0		267.0	208.0	
				24.0		305.0	233.0	
				26.0		328.0	258.0	
				28.0		351.0	283.0	
				30.0		374.0	308.0	
		BH-P11	1.0	20.0	2.0	173.0	140.0	6.3
				22.0		201.0	161.0	
				24.0		222.0	182.0	
				26.0		266.0	204.0	
				28.0		287.0	225.0	
				30.0		307.0	246.0	
			1.2	20.0		244.0	187.0	9.3
				22.0		272.0	216.0	
				24.0		313.0	245.0	
				26.0		359.0	272.0	
				28.0		385.0	299.0	
				30.0		410.0	326.0	
		BH-P12	1.0	20.0	2.0	146.0	126.0	13.2
				22.0		160.0	142.0	
				24.0		174.0	157.0	
				26.0		189.0	173.0	
				28.0		203.0	189.0	
				30.0		218.0	205.0	
			1.2	20.0		189.0	162.0	17.2
				22.0		207.0	183.0	
				24.0		225.0	203.0	
				26.0		243.0	224.0	
				28.0		261.0	245.0	
				30.0		279.0	265.0	

Notes : -

1. Permissible lateral deflection has been taken 5mm.
2. The self weight of the pile has been taken into account while computing the Safe Load Carrying Capacity of Pile in uplift only and not considered for vertical load capacity in compression.
3. The safe load carrying capacity of piles have been worked out on the basis of IS: 2911 (Part-1/sec-2) – 2010 as per provisions / assumptions provided therein & are only an assessment based on characteristics of the sub-strata obtained at the locations of the above BHs. The safe load carrying capacities as tabulated above will further depend substantially on the piling technique adopted and equipment used for making the piles in the field. However, for the final designs & constructions, the safe/allowable load carrying capacities of these piles should be taken by conducting actual initial load tests on these piles by casting them in the respective areas.
4. While erecting normal bored cast in-situ pile, utmost care should be taken while flushing/cleaning the bottom of pile particularly prior to start of pouring of concrete so as o rest the pile in virgin soil only for obtaining full point bearing as while computing safe load carrying capacity of pile no bottom softening during erection of pile has been considered.
5. Further the pile should have necessary structural strength to transmit / sustain the design load.

***Notes:* -**

All The above recommendations are based on the field and laboratory tests conducted on selected soil/ rock core samples and our experience in this regard. If the actual substrata conditions during excavation for the foundation differ from the observations reported here, the design experts/consultants should be referred for suggestion, further investigations.

REFERENCES

1. IS 2911: Part 1 : Sec 2 : 2010 (Reaffirmed Year : 2020) Design And construction Of pile foundations - Code Of Practice Part 1 Concrete Piles Section 2 Bored Cast In-situ Concrete Piles.
2. IS 2911 : Part 4 : 2013 (Reaffirmed Year : 2018) Design and construction of pile foundations - Code of practice : Part 4 Load test on piles .
3. IS 6403 : 1981 (Reaffirmed Year : 2016), Amd. 2 : 2018 Code of practice for determination of bearing capacity of shallow foundations.
4. IS 8009 : Part 1 : 1976 (Reaffirmed Year : 2018) Code of practice for calculation of settlements of foundations: Part 1 Shallow foundations subjected to symmetrical static vertical loads.
5. IS 8009 : Part 2 : 1980 (Reaffirmed Year : 2020) Code of practice for calculation of settlement of foundations: Part 2 Deep foundations subjected to symmetrical static vertical loading.
6. IS 1893 : Part 1 : 2016 (Reaffirmed Year : 2021) Criteria for Earthquake Resistant Design of Structures - Part 1 : General Provisions and Buildings.
7. IS 1904 : 2021 Draft Indian Standard for General requirements for design and construction of foundations in soils Code of practice third revision of IS 1904.
8. IS 456 : 2000 (Reaffirmed Year : 2021) Plain and Reinforced Concrete - Code of Practice (Including Amendment 1, 2, 3,& 4).
9. BS – 118 : 2015 Final Seismic Design of Bridges.
10. IS 2131 : 1981 (Reaffirmed Year : 2016) Method for standard penetration test for soils.
11. IS 2132 : 1986 (Reaffirmed Year : 2016) Code of practice for thin-walled tube sampling of soils.
12. IS 1892 : 1979 (Reaffirmed Year : 2016) Code of practice for subsurface investigation for foundations.
13. Bowles, J.E., 1982. Foundation design and analysis.
14. IS. 2720 (Part 3)-1980. Determination of Specific Gravity of Soil.
15. IS. 2720 (Part 4). 1985. Methods of Test for Soils: Grain Size Analysis.
16. IS. IS 2131, 1981. Method for standard penetration test for soils.
17. IS: 2720 (Part 11)–(1993). Determination of the shear strength parameters of a specimen tested in unconsolidated undrained triaxial compression without the measurement of pore water pressure.
18. IS: 2720 (Part 13) 1986 Method of test for soils, direct shear test. New Delhi, India.
19. IS: 2720 (Part 3/See 1)–(1980) Methods of test for soils, determination of specific gravity of soil. New Delhi, India.
20. IS: 2720 (Part 5) 1985 Methods of test for soils, determination of liquid and plastic limit of soils. New Delhi, India.

Abbreviations

BH	Borehole
ERT	Electrical Resistivity Test
EGL	Existing Ground Level
GWT	Ground Water Table
IS	Indian Standards
SPT	Standard Penetration Test
DS	Disturbed Soil
R.L.	Reduced Level
m	Metre
sp. gr.	Specific Gravity
%	Percentage
mg /l	Milligram per litre
mg /kg	Milligram per kilogram

APPENDIX – A (FIELD DATA RESULTS)

Appendix No.	ITEMS
A-1	LOCATION PLAN
A-2	FIELD BORE HOLE LOGS
A-3	SUB SOIL PROFILE DIAGRAM


Tea point
Ashok Villa
Rao Harish Hotel
CH-42+256 MJB (BH-P11)
CH-42+256 MJB (BH-P12)
CH-42+256 MJB (BH-P10)
CH-42+256 MJB (BH-P9)
MINI PIZZA HUT
V R HIGH School
KMP Flyover Pachgaon
CH-42+256 MJB (BH-P7)
Akash PG
HDFC Bank
SHRI SHYM COMMUNICATION
CH-42+256 MJB (BH-P1)
Delhi - Jaipur Expy
Shri Ram Optical
Manish Sharma Dhaba
Geeta Garments
Google Earth
N

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*42+256 km	*Northing :*3133716 m	*Easting :*685810 m
Reduced Level (m):(+)261.500	*BH. No. :*BH-P1	*BH Termination Depth (m):*35
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*20-11-2022	*Date of Completion :*21-11-2022	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	UDS-1									
1.5											
2.0											
2.5	2.5	SPT-1	2	4	6	10					
3.0											
3.5							Yellowish brown, Sandy silt of low plasticity	ML-CL			
4.0	4	UDS-2									
4.5											
5.0											
5.5	5.5	SPT-2	3	5	8	13					
6.0											
6.5											
7.0	7	UDS-3									
7.5											
8.0											
8.5	8.5	SPT-3	7	9	12	21	Yellowish brown, Silty clay of low plasticity with gravel	CL			
9.0											
9.5											
10.0	10	UDS-4									

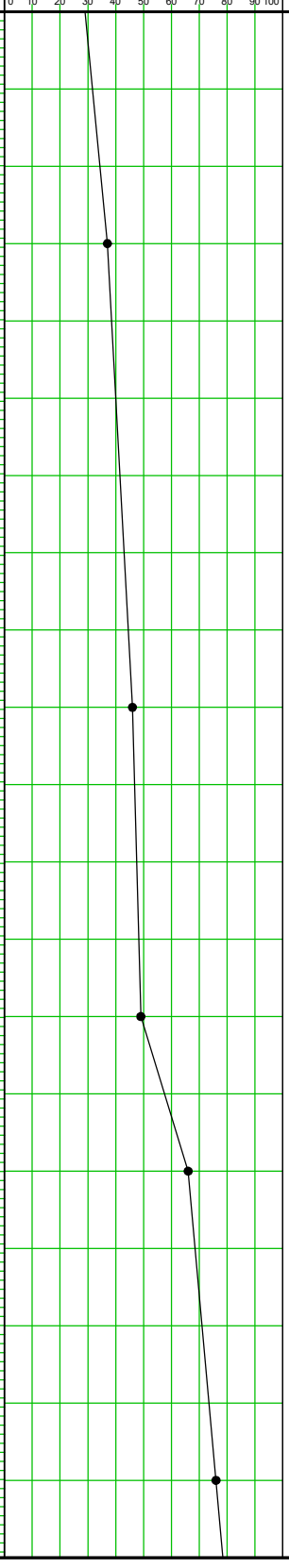
(Depth v/s SPT N Value) axis: 0 10 20 30 40 50 60 70 80 90 100

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*42+256 km	*Northing :*3133716 m	*Easting :*685810 m
Reduced Level (m):(+)261.500	*BH. No. :*BH-P1	*BH Termination Depth (m):*35
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*20-11-2022	*Date of Completion :*21-11-2022	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0											
10.5											
11.0											
11.5	11.5	SPT-4	9	16	21	37					
12.0											
12.5											
13.0	13	UDS-5									
13.5											
14.0											
14.5	14.5	SPT-5	11	19	27	46					
15.0							Yellowish brown, Silty clay of low plasticity with gravel	CL			
15.5											
16.0	16	UDS*									
16.5	16.5	SPT-6	12	17	32	49					
17.0											
17.5	17.5	SPT-7	19	24	42	66					
18.0											
18.5											
19.0											
19.5	19.5	SPT-8	21	27	49	76					
20.0											



UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*42+256 km	*Northing :*3133716 m	*Easting :*685810 m
Reduced Level (m):(+)261.500	*BH. No. :*BH-P1	*BH Termination Depth (m):*35
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*20-11-2022	*Date of Completion :*21-11-2022	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
20.0											
20.5	20.5	SPT-9	24	32	49	81	Yellowish brown, Silty clay of low plasticity with gravel	CL			
21.0											
21.5											
22.0											
22.5	22.5	SPT-10	19	21	34	55					
23.0											
23.5	23.5	SPT-11	25	34	41	75					
24.0											
24.5											
25.0											
25.5	25.5	SPT-12	19	25	37	62	Yellowish brown, Dense to dense, Sandy silt of low plasticity	ML-CL			
26.0											
26.5	26.5	SPT-13	30	39	48	87					
27.0											
27.5											
28.0											
28.5	28.5	SPT-14	31	35	51	86					
29.0											
29.5	29.5	SPT-15	22	41	49	90	Yellowish brown, Silty Sand	SM			
30.0											

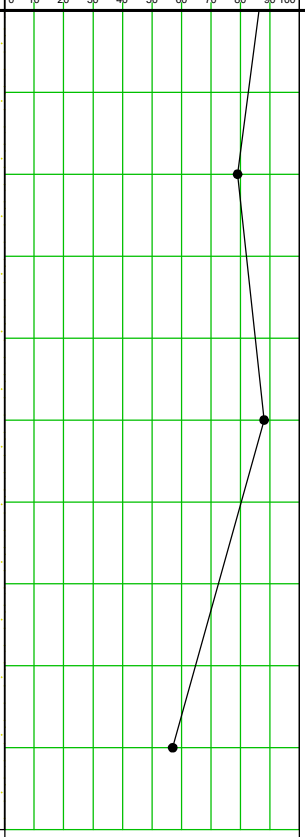
(Depth v/s SPT N Value) axis: 0 10 20 30 40 50 60 70 80 90 100

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*42+256 km	*Northing :*3133716 m	*Easting :*685810 m
Reduced Level (m):(+)261.500	*BH. No. :*BH-P1	*BH Termination Depth (m):*35
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*20-11-2022	*Date of Completion :*21-11-2022	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
30.0											
30.5											
31.0	31	SPT-16	25	34	45	79					
31.5											
32.0											
32.5	32.5	SPT-17	31	39	49	88	Yellowish brown, Silty Sand	SM			
33.0											
33.5											
34.0											
34.5	34.5	SPT-18	20	27	30	57					
35.0											



UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*42+256 km	*Northing :*3133807 m	*Easting :*685841 m
Reduced Level (m):(+)263.750	*BH. No. :*BH-P7	*BH Termination Depth (m):*35
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*19-11-2022	*Date of Completion :*20-11-2022	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	SPT-1	3	7	9	16					
1.5											
2.0											
2.5	2.5	UDS-1									
3.0											
3.5											
4.0	4	SPT-2	4	5	11	16					
4.5											
5.0							Yellowish brown, Silty clay of low plasticity with gravel	CL			
5.5	5.5	UDS-2									
6.0											
6.5											
7.0	7	SPT-3	6	9	11	20					
7.5											
8.0											
8.5	8.5	UDS-3									
9.0											
9.5											
10.0	10	SPT-4	8	11	15	26					

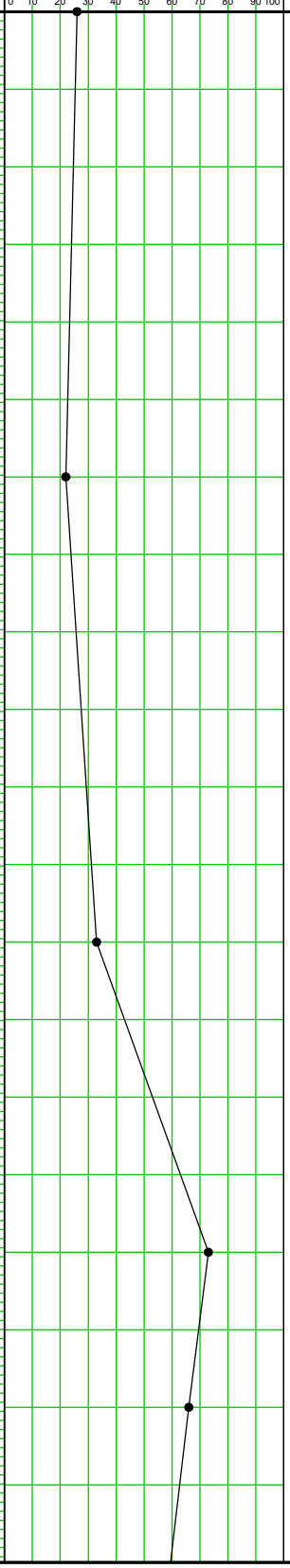
(Depth v/s SPT N Value) axis: 0 10 20 30 40 50 60 70 80 90 100

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*42+256 km	*Northing :*3133807 m	*Easting :*685841 m
Reduced Level (m):(+)263.750	*BH. No. :*BH-P7	*BH Termination Depth (m):*35
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*19-11-2022	*Date of Completion :*20-11-2022	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0											
10.5											
11.0											
11.5	11.5	UDS-4									
12.0											
12.5											
13.0	13	SPT-5	7	9	13	22					
13.5											
14.0											
14.5	14.5	UDS-5									
15.0							Yellowish brown, Silty clay of low plasticity with gravel	CL			
15.5											
16.0	16	SPT-6	11	14	19	33					
16.5											
17.0											
17.5	17.5	UDS*									
18.0	18	SPT-7	17	31	42	73					
18.5											
19.0	19	SPT-8	13	29	37	66					
19.5											
20.0											



UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*42+256 km	*Northing :*3133807 m	*Easting :*685841 m
Reduced Level (m):(+)263.750	*BH. No. :*BH-P7	*BH Termination Depth (m):*35
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*19-11-2022	*Date of Completion :*20-11-2022	

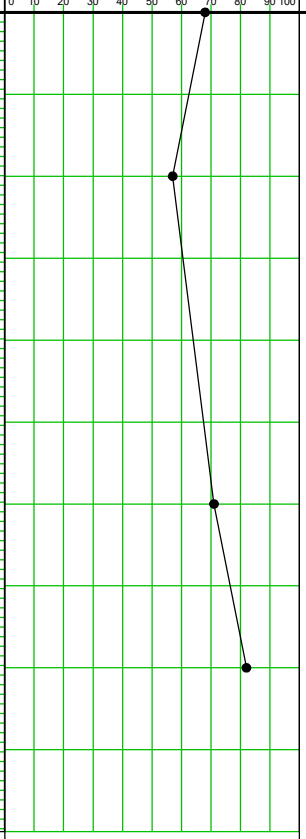
Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
20.0											
20.5	20.5	UDS*									
21.0	21	SPT-9	11	21	32	53					
21.5											
22.0	22	SPT-10	19	26	37	63					
22.5											
23.0											
23.5	23.5	UDS*									
24.0	24	SPT-11	22	31	44	75					
24.5											
25.0	25	SPT-12	25	36	41	77	Yellowish brown, Silty clay of low plasticity with gravel	CL			
25.5											
26.0											
26.5	26.5	UDS*									
27.0	27	SPT-13	19	26	33	59					
27.5											
28.0	28	SPT-14	15	31	36	67					
28.5											
29.0											
29.5	29.5	UDS*									
30.0	30	SPT-15	12	29	39	68					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*42+256 km	*Northing :*3133807 m	*Easting :*685841 m
Reduced Level (m):(+)263.750	*BH. No. :*BH-P7	*BH Termination Depth (m):*35
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*19-11-2022	*Date of Completion :*20-11-2022	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
30.0											
30.5											
31.0	31	SPT-16	19	24	33	57					
31.5											
32.0											
32.5	32.5	UDS*					Yellowish brown, Silty clay of low plasticity with gravel	CL			
33.0	33	SPT-17	24	29	42	71					
33.5											
34.0	34	SPT-18	27	33	49	82					
34.5											
35.0											



UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*42+256 km	*Northing :*3133938 m	*Easting :*685867 m
Reduced Level (m):(+)262.750	*BH. No. :*BH-P9	*BH Termination Depth (m):*35
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*20-11-2022	*Date of Completion :*21-11-2022	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	UDS-1									
1.5											
2.0											
2.5	2.5	SPT-1	2	4	4	8					
3.0											
3.5											
4.0	4	UDS-2									
4.5											
5.0							Yellowish brown, , Sandy silt of low plasticity	ML-CL			
5.5	5.5	SPT-2	4	5	6	11					
6.0											
6.5											
7.0	7	UDS-3									
7.5											
8.0											
8.5	8.5	SPT-3	6	9	12	21					
9.0											
9.5											
10.0	10	UDS-4									

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*42+256 km	*Northing :*3133938 m	*Easting :*685867 m
Reduced Level (m):(+)262.750	*BH. No. :*BH-P9	*BH Termination Depth (m):*35
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*20-11-2022	*Date of Completion :*21-11-2022	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0											
10.5											
11.0											
11.5	11.5	SPT-4	8	13	15	28	Yellowish brown, , Sandy silt of low plasticity	ML-CL			
12.0											
12.5											
13.0	13	UDS*									
13.5	13.5	SPT-5	7	14	17	31					
14.0											
14.5	14.5	SPT-6	6	16	20	36					
15.0											
15.5											
16.0	16	UDS-5									
16.5							Yellowish brown, Silty clay of low plasticity with gravel	CL			
17.0											
17.5	17.5	SPT-7	9	17	22	39					
18.0											
18.5											
19.0	19	UDS*									
19.5	19.5	SPT-8	11	19	25	44					
20.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*42+256 km	*Northing :*3133938 m	*Easting :*685867 m
Reduced Level (m):(+)262.750	*BH. No. :*BH-P9	*BH Termination Depth (m):*35
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*20-11-2022	*Date of Completion :*21-11-2022	

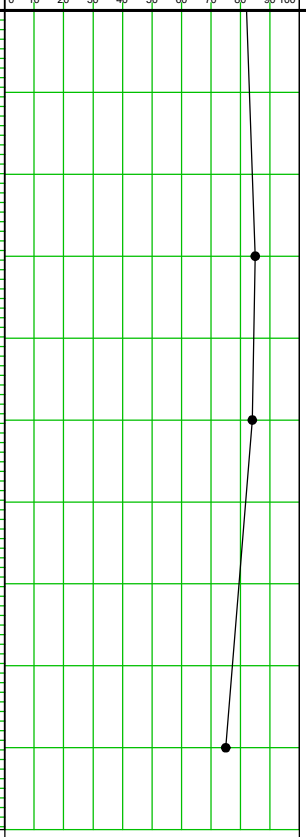
Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
20.0											
20.5	20.5	SPT-9	10	21	27	48					
21.0											
21.5											
22.0	22	UDS-6									
22.5											
23.0											
23.5	23.5	SPT-10	12	24	32	56					
24.0											
24.5											
25.0	25	UDS*					Yellowish brown, Silty clay of low plasticity with gravel	CL			
25.5	25.5	SPT-11	15	30	42	72					
26.0											
26.5	26.5	SPT-12	14	32	43	75					
27.0											
27.5											
28.0											
28.5	28.5	SPT-13	16	31	45	76					
29.0											
29.5	29.5	SPT-14	19	34	47	81					
30.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*42+256 km	*Northing :*3133938 m	*Easting :*685867 m
Reduced Level (m):(+)262.750	*BH. No. :*BH-P9	*BH Termination Depth (m):*35
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*20-11-2022	*Date of Completion :*21-11-2022	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
30.0											
30.5											
31.0											
31.5	31.5	SPT-15	19	36	49	85					
32.0											
32.5	32.5	SPT-16	21	38	46	84	Yellowish brown, Silty clay of low plasticity with gravel	CL			
33.0											
33.5											
34.0											
34.5	34.5	SPT-17	24	35	40	75					
35.0											



UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*42+256 km	*Northing :*3133950 m	*Easting :*685863 m
Reduced Level (m):(+)263.228	*BH. No. :*BH-P10	*BH Termination Depth (m):*35
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary/Shell	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*18-11-2022	*Date of Completion :*17-11-2022	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	SPT-1	2	3	5	8	Yellowish brown, Sandy silt of low plasticity	SM			
1.5											
2.0											
2.5	2.5	UDS-1									
3.0											
3.5											
4.0	4	SPT-2	3	5	7	12					
4.5											
5.0											
5.5	5.5	UDS-2									
6.0											
6.5							Yellowish brown, Silty clay of low plasticity	CL			
7.0	7	SPT-3	6	10	14	24					
7.5											
8.0											
8.5	8.5	UDS-3									
9.0											
9.5											
10.0	10	SPT-4	8	13	17	30					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*42+256 km	*Northing :*3133950 m	*Easting :*685863 m
Reduced Level (m):(+)263.228	*BH. No. :*BH-P10	*BH Termination Depth (m):*35
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary/Shell	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*18-11-2022	*Date of Completion :*17-11-2022	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0											
10.5											
11.0											
11.5	11.5	UDS*									
12.0	12	SPT-5	10	19	24	43					
12.5											
13.0	13	SPT-6	9	16	29	45	Yellowish brown, Silty clay of low plasticity	CL			
13.5											
14.0											
14.5	14.5	UDS-4									
15.0											
15.5											
16.0	16	SPT-7	15	27	39	66					
16.5											
17.0											
17.5	17.5	UDS-5									
18.0	18	SPT-8	17	30	44	74	Yellowish brown,Sandy Silt	ML-CL			
18.5											
19.0											
19.5											
20.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*42+256 km	*Northing :*3133950 m	*Easting :*685863 m
Reduced Level (m):(+)263.228	*BH. No. :*BH-P10	*BH Termination Depth (m):*35
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary/Shell	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*18-11-2022	*Date of Completion :*17-11-2022	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
20.0											
20.5	20.5	UDS-6									
21.0							Yellowish brown,Sandy Silt	ML-CL			
21.5											
22.0	22	SPT-9	11	21	32	53					
22.5											
23.0											
23.5	23.5	UDS*									
24.0	24	SPT-10	14	25	36	61					
24.5											
25.0	25	SPT-11	17	31	42	73					
25.5											
26.0							Yellowish brown, Silty clay of low plasticity	CL			
26.5	26.5	UDS*									
27.0	27	SPT-12	15	33	44	77					
27.5											
28.0	28	SPT-13	19	38	49	87					
28.5											
29.0											
29.5	29.5	UDS*									
30.0	30	SPT-14	17	31	46	77					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*42+256 km	*Northing :*3133950 m	*Easting :*685863 m
Reduced Level (m):(+)263.228	*BH. No. :*BH-P10	*BH Termination Depth (m):*35
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary/Shell	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*18-11-2022	*Date of Completion :*17-11-2022	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
30.0										0 10 20 30 40 50 60 70 80 90 100	
30.5											
31.0	31	SPT-15	15	37	51	88					
31.5											
32.0											
32.5	32.5	UDS*					Yellowish brown, Silty clay of low plasticity	CL			
33.0	33	SPT-16	22	42	55	97					
33.5											
34.0	34	SPT-17	19	39	42	81					
34.5											
35.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*42+256 km	*Northing :*3133970 m	*Easting :*685832 m
Reduced Level (m):(+)264.855	*BH. No. :*BH-P11	*BH Termination Depth (m):*35
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*16-11-2022	*Date of Completion :*17-11-2022	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	UDS-1					Yellowish brown, Sandy silt of low plasticity	SM			
1.5											
2.0											
2.5	2.5	SPT-1	6	7	9	16					
3.0											
3.5											
4.0	4	UDS-2									
4.5											
5.0											
5.5	5.5	SPT-2	5	9	12	21					
6.0							Yellowish brown, Silty clay of low plasticity	CL			
6.5											
7.0	7	UDS-3									
7.5											
8.0											
8.5	8.5	SPT-3	7	11	16	27					
9.0											
9.5											
10.0	10	UDS*									

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*42+256 km	*Northing :*3133970 m	*Easting :*685832 m
Reduced Level (m):(+)264.855	*BH. No. :*BH-P11	*BH Termination Depth (m):*35
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*16-11-2022	*Date of Completion :*17-11-2022	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0											
10.5	10.5	SPT-4	6	9	12	21					
11.0											
11.5	11.5	SPT-5	7	14	19	33					
12.0							Yellowish brown, Silty clay of low plasticity	CL			
12.5											
13.0	13	UDS-4									
13.5											
14.0											
14.5	14.5	SPT-6	6	16	21	37					
15.0											
15.5											
16.0	16	UDS*					Yellowish brown, Sandy silt of low plasticity	SM			
16.5	16.5	SPT-7	7	21	29	50					
17.0											
17.5	17.5	SPT-8	12	27	35	62					
18.0											
18.5											
19.0	19	UDS-5					Yellowish brown,Sandy Silt	ML-CL			
19.5											
20.0											

(Depth v/s SPT N Value) axis: 0 10 20 30 40 50 60 70 80 90 100

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*42+256 km	*Northing :*3133970 m	*Easting :*685832 m
Reduced Level (m):(+)264.855	*BH. No. :*BH-P11	*BH Termination Depth (m):*35
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*16-11-2022	*Date of Completion :*17-11-2022	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
20.0											
20.5	20.5	SPT-9	11	16	27	43					
21.0											
21.5											
22.0	22	UDS-6									
22.5											
23.0							Yellowish brown,Sandy Silt	ML-CL			
23.5	23.5	SPT-10	14	17	29	46					
24.0											
24.5											
25.0	25	UDS*									
25.5	25.5	SPT-11	11	24	34	58					
26.0											
26.5	26.5	SPT-12	15	27	41	68					
27.0											
27.5											
28.0	28	UDS-7					Yellowish brown, Silty clay of low plasticity	CL			
28.5											
29.0											
29.5	29.5	SPT-13	14	31	42	73					
30.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*42+256 km	*Northing :*3133970 m	*Easting :*685832 m
Reduced Level (m):(+)264.855	*BH. No. :*BH-P11	*BH Termination Depth (m):*35
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*16-11-2022	*Date of Completion :*17-11-2022	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
30.0										0 10 20 30 40 50 60 70 80 90 100	
30.5											
31.0	31	UDS-8									
31.5											
32.0											
32.5	32.5	SPT-14	16	28	46	74	Yellowish brown, Silty clay of low plasticity	CL			
33.0											
33.5											
34.0											
34.5	34.5	SPT-15	19	31	42	73					
35.0											

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*42+256 km	*Northing :*3133961 m	*Easting :*685794 m
Reduced Level (m):(+)264.325	*BH. No. :*BH-P12	*BH Termination Depth (m):*35
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*14-11-2022	*Date of Completion :*15-11-2022	

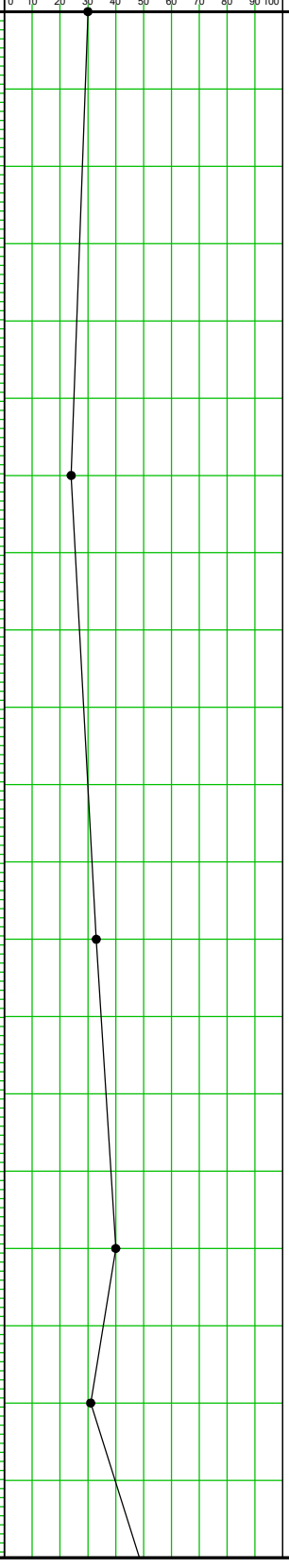
Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5											
1.0	1	SPT-1	3	5	8	13					
1.5											
2.0											
2.5	2.5	UDS-1									
3.0											
3.5											
4.0	4	SPT-2	5	10	15	25					
4.5											
5.0							Yellowish brown, Silty clay of low plasticity	CL			
5.5	5.5	UDS-2									
6.0											
6.5											
7.0	7	SPT-3	4	12	18	30					
7.5											
8.0											
8.5	8.5	UDS*									
9.0	9	SPT-4	6	10	16	26					
9.5											
10.0	10	SPT-5	5	14	16	30					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*42+256 km	*Northing :*3133961 m	*Easting :*685794 m
Reduced Level (m):(+)264.325	*BH. No. :*BH-P12	*BH Termination Depth (m):*35
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*14-11-2022	*Date of Completion :*15-11-2022	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
10.0											
10.5											
11.0											
11.5	11.5	UDS-3									
12.0											
12.5											
13.0	13	SPT-6	6	9	15	24					
13.5											
14.0											
14.5	14.5	UDS-4									
15.0							Yellowish brown, Silty clay of low plasticity	CL			
15.5											
16.0	16	SPT-7	11	14	19	33					
16.5											
17.0											
17.5	17.5	UDS*									
18.0	18	SPT-8	9	16	24	40					
18.5											
19.0	19	SPT-9	10	14	17	31					
19.5											
20.0											



UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*42+256 km	*Northing :*3133961 m	*Easting :*685794 m
Reduced Level (m):(+)264.325	*BH. No. :*BH-P12	*BH Termination Depth (m):*35
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*14-11-2022	*Date of Completion :*15-11-2022	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
20.0											
20.5	20.5	UDS*									
21.0	21	SPT-10	15	25	41	66					
21.5											
22.0	22	SPT-11	20	27	38	65					
22.5											
23.0											
23.5	23.5	UDS*									
24.0	24	SPT-12	5	12	17	29					
24.5											
25.0	25	SPT-13	8	16	19	35	Yellowish brown, Silty clay of low plasticity	CL			
25.5											
26.0											
26.5	26.5	UDS*									
27.0	27	SPT-14	14	19	24	43					
27.5											
28.0	28	SPT-15	12	17	23	40					
28.5											
29.0											
29.5	29.5	UDS*									
30.0	30	SPT-16	11	16	29	45					

UDS*-UDS not recovered

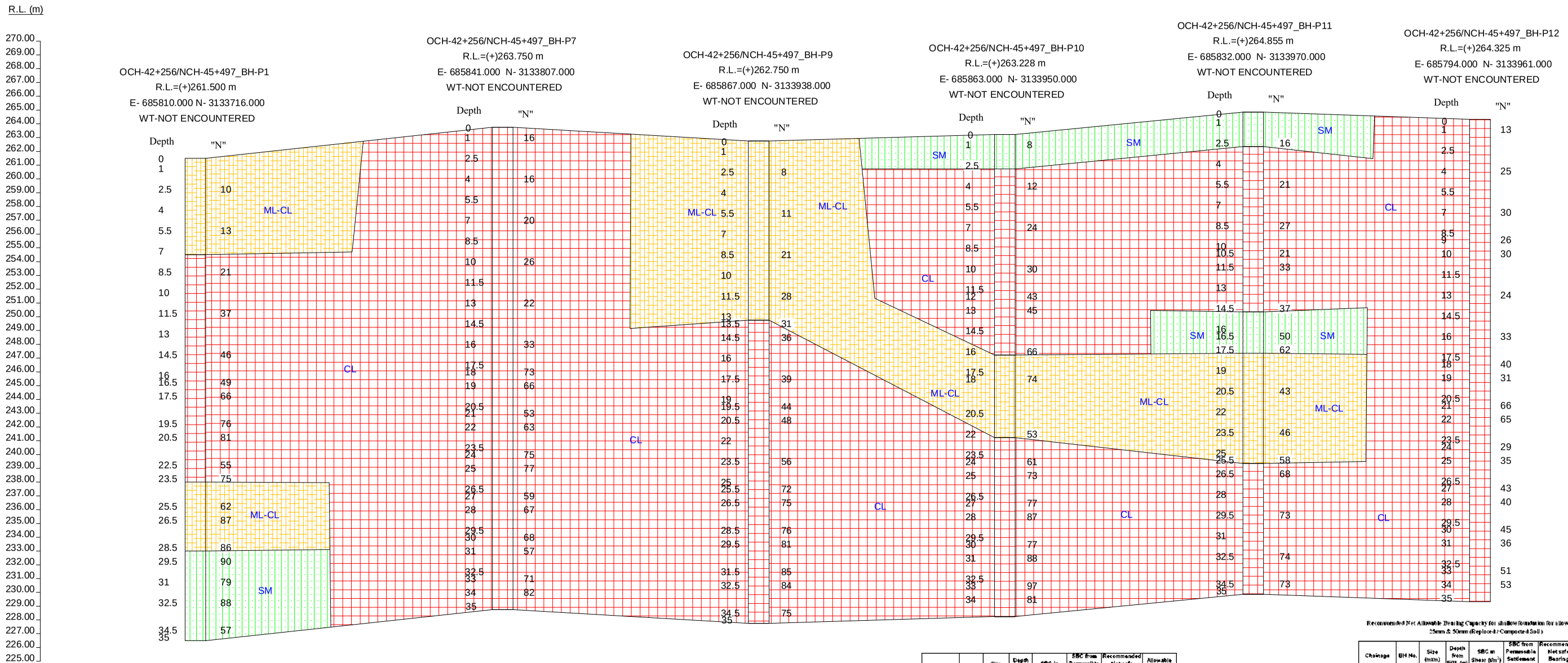
FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*42+256 km	*Northing :*3133961 m	*Easting :*685794 m
Reduced Level (m):(+)264.325	*BH. No. :*BH-P12	*BH Termination Depth (m):*35
*Proposed / Existing Structure :*Major Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Shell & Auger	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*14-11-2022	*Date of Completion :*15-11-2022	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
30.0											
30.5											
31.0	31	SPT-17	9	17	19	36					
31.5											
32.0											
32.5	32.5	UDS*					Yellowish brown, Silty clay of low plasticity	CL			
33.0	33	SPT-18	18	22	29	51					
33.5											
34.0	34	SPT-19	15	22	31	53					
34.5											
35.0											

UDS*-UDS not recovered

CONDUCTING GEOTECHNICAL INVESTIGATION, PREPARATION OF GEOTECHNICAL REPORT FOR DESIGNING OF BRIDGES AND FOR EMBANKMENT IN CONNECTION WITH CONSTRUCTION OF HARYANA ORBITAL RAIL CORRIDOR (HORC) PROJECT FROM PALWAL TO HARSANA KALAN INCLUDING CONNECTIVITY TO EXISTING IR NETWORK IN THE STATE OF HARYANA.



Note:-

The suitable Soil Improvement Methods (SSM) are recommended for those boreholes which are liquefiable more than 4.0mtr depth.

Chainage	BH No.	Size (mxm)	Depth from EGL (m)	SBC in Shear (t/m²)	SBC from Permissible Settlement (t/m²)	Recommended Net safe Bearing Capacity (t/m²)	Allowable Settlement (mm)
OCH-42+256 NCH-45+497	BH-P1	7.2 x 7.2	2.0	26.5	9.8	SSM	25
		7.2 x 7.2	3.0	38.7	9.5	SSM	
		7.2 x 7.2	4.0	21.1	13.5	SSM	
OCH-42+256 NCH-45+497	BH-P1	7.2 x 7.2	2.0	26.5	15.6	SSM	50
		7.2 x 7.2	3.0	38.7	18.5	SSM	
		7.2 x 7.2	4.0	21.1	23.0	SSM	

Recommended Net Allowable Bearing Capacity for shallow foundation for allowable settlement 25mm & 50mm (Replaced / Compacted Soil)

Chainage	BH No.	Size (mxm)	Depth from EGL (m)	SBC in Shear (t/m²)	SBC from Permissible Settlement (t/m²)	Recommended Net safe Bearing Capacity (t/m²)	Allowable Settlement (mm)
OCH-42+256 NCH-45+497	BH-P7	7.2 x 7.2	2.0	25.4	16.3	26.2	25
		7.2 x 7.2	3.0	25.2	18.3	29.3	
		7.2 x 7.2	4.0	29.1	23.6	23.6	
OCH-42+256 NCH-45+497	BH-P7	7.2 x 7.2	2.0	25.4	32.4	25.4	50
		7.2 x 7.2	3.0	27.2	38.6	27.2	
		7.2 x 7.2	4.0	29.1	47.2	29.1	

Chainage	BH No	Size (mxm)	Depth from EGL (m)	SBC in Shear (t/m²)	SBC from Permissible Settlement (t/m²)	Recommended Net safe Bearing Capacity (t/m²)	Allowable Settlement (mm)
OCH-42+256 NCH-45+497	BH-P9	3.2 × 3.2	2.0	23.3	4.3	SSM	25
		3.2 × 3.2	3.0	25.2	5.1	SSM	
		3.2 × 3.2	4.0	27.1	5.2	SSM	
OCH-42+256 NCH-45+497	BH-P9	7.2 × 7.2	2.0	23.3	9.3	SSM	50
		7.2 × 7.2	3.0	25.2	10.1	SSM	
		7.2 × 7.2	4.0	27.1	10.2	SSM	
OCH-42+256 NCH-45+497	BH-P10	3.2 × 3.2	2.0	21.4	14.2	SSM	25
		3.2 × 3.2	3.0	23.2	18.7	SSM	
		3.2 × 3.2	4.0	25.0	19.8	SSM	
OCH-42+256 NCH-45+497	BH-P10	7.2 × 7.2	2.0	21.4	28.3	SSM	50
		7.2 × 7.2	3.0	23.2	37.2	SSM	
		7.2 × 7.2	4.0	25.0	39.5	SSM	
OCH-42+256 NCH-45+497	BH-PL1	7.2 × 7.2	2.0	20.9	13.4	SSM	25
		7.2 × 7.2	3.0	19.6	14.5	SSM	
		7.2 × 7.2	4.0	20.3	15.2	SSM	
OCH-42+256 NCH-45+497	BH-PL1	3.2 × 3.2	2.0	20.9	33.2	SSM	50
		3.2 × 3.2	3.0	19.6	28.0	SSM	
		3.2 × 3.2	4.0	20.3	30.7	SSM	

Recommended Net Allowable Bearing Capacity for shallow foundation for allowable settlement 25mm & 50mm (Replaced / Compacted Soil)

Chainage	BH No.	Size (mxm)	Depth from EGL (m)	SBC in Shear (t/m²)	SBC from Permissible Settlement (t/m²)	Recommended Net safe Bearing Capacity (t/m²)	Allowable Settlement (mm)
OCH-42+256 NCH-45+497	BH-P12	7.2 x 7.2	2.0	23.3	13.5		25
		7.2 X 7.2	3.0	25.8	25.2	25.2	
		7.2 X 7.2	4.0	26.2	27.2	27.2	
OCH-42+256 NCH-45+497	BH-P12	7.2 x 7.2	2.0	23.3	27.1	27.1	50
		7.2 X 7.2	3.0	25.8	30.4	30.0	
		7.2 X 7.2	4.0	26.2	33.4	30.0	

SYMBOL	DESCRIPTION
	SM- Silty Sand (Having fines Less Than 50% and no plasticity or below A-line)
	ML-CL -Sandy with clay (Having fines greater than 50% and in the hatched zone (LL<35 & 4<PI<7)
	CL-Silty Clay of low plasticity (Above A-line, LL<35)
Note:- Fines= Percentage of Silty + Clay A-line=.73(wl-20)	WATER TABLE

APPENDIX – B (LAB TEST RESULTS)

Appendix No.	ITEMS
B-1	SOIL CHARACTERISTICS SHEETS
B-2	RESULT OF CHEMICAL ANALYSIS OF SOIL SAMPLES
B-3	GSD CURVES
B-4	SHEAR CURVES

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.					Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
						20-11-2022	to	21-11-2022	42+256 Major Bridge	BH-P1	Not Encountered	35.00 m	685810.000 m	3133716.000 m	(+)261.500 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																			
DS	0.00	-	-	Yellowish brown, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	1.00	-	-		ML-CL		6	53	32	4	0	5	0	26	21	5	-	1.72	13.40	1.52	2.66	DST	0.13	24	-	-	-	-	-	-	-	-	-
SPT-1	2.50	10	13		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	4.00	-	-		ML-CL		6	47	36	5	0	6	0	28	22	6	-	1.75	14.10	1.53	2.66	DST	0.15	24	-	-	-	-	-	-	-	-	-
SPT-2	5.50	13	16		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	7.00	-	-	Yellowish brown, Silty clay of low plasticity with gravel	CL		8	62	26	3	0	1	0	32	21	11	-	1.87	19.60	1.56	2.68	UUT	0.77	6	-	-	-	-	-	-	-	-	-
SPT-3	8.50	21	21		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	10.00	-	-		CL		8	61	27	2	0	2	0	33	22	11	-	1.93	20.40	1.60	2.68	UUT	1.38	6	-	-	-	-	-	-	-	-	-
SPT-4	11.50	37	37		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-5	13.00	-	-		CL		10	56	31	2	0	1	0	33	20	13	-	1.97	21.10	1.63	2.67	UUT	1.71	5	-	-	-	-	-	-	-	-	-
SPT-5	14.50	46	46		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	16.00	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-6	16.50	49	49		CL		11	59	27	1	0	2	0	31	21	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-7	17.50	66	66		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	19.50	76	76		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-9	20.50	81	81		CL		10	58	28	2	0	2	0	32	22	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-10	22.50	55	55		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-11	23.50	75	40	Yellowish brown, Dense to dense, Sandy silt of low plasticity	ML-CL		7	49	33	7	4	0	0	29	23	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-12	25.50	62	31		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-13	26.50	87	43		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEGTH
CEG TEST HOUSE
AND RESEARCH CENTRE PVT LTD

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		20-11-2022	to	21-11-2022	42+256 Major Bridge	BH-P1	Not Encountered	35.00 m	685810.000 m	3133716.000 m	(+)261.500 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
SPT-14	28.50	86	40	Yellowish brown, Silty Sand	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-15	29.50	90	41		SM		0	20	78	2	0	0	0	-	NIL	NP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-16	31.00	79	36		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-17	32.50	88	40		SM		0	18	79	3	0	0	0	-	NIL	NP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-18	34.50	57	26		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEGTH
CEG TEST HOUSE
AND RESEARCH CENTRE PVT LTD

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		19-11-2022	to	20-11-2022	42+256 Major Bridge	BH-P7	Not Encountered	35.00 m	685841.000 m	3133807.000 m	(+)263.750 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	1.00	16	16		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.50	-	-		CL		9	61	26	4	0	0	0	31	21	10	-	1.80	19.40	1.51	2.68	UUT	0.61	5	-	-	-	-	-	-	-	-	-
SPT-2	4.00	16	16		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	5.50	-	-		CL		8	61	28	3	0	0	0	33	21	12	-	1.85	19.60	1.55	2.68	UUT	0.71	6	-	-	-	-	-	-	-	-	-
SPT-3	7.00	20	20		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	8.50	-	-		CL		11	54	31	4	0	0	0	33	22	11	-	1.89	20.10	1.57	2.68	UUT	0.99	5	-	-	-	-	-	-	-	-	-
SPT-4	10.00	26	26		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	11.50	-	-		CL		10	55	32	3	0	0	0	34	22	12	-	1.86	21.10	1.54	2.68	-	-	-	-	-	-	-	-	-	-	-	-
SPT-5	13.00	22	22		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-5	14.50	-	-	Yellowish brown, Silty clay of low plasticity with gravel	CL		10	54	25	3	0	8	0	32	21	11	-	1.95	21.40	1.61	2.68	UUT	1.21	5	-	-	-	-	-	-	-	-	-
SPT-6	16.00	33	33		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	17.50	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-7	18.00	73	73		CL		9	54	26	3	0	8	0	33	21	12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	19.00	66	66		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	20.50	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-9	21.00	53	53		CL		8	56	25	3	0	8	0	32	21	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-10	22.00	63	63		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	23.50	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-11	24.00	75	75		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEGTH
CEG TEST HOUSE
AND RESEARCH CENTRE PVT LTD

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.						Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
							19-11-2022	to	20-11-2022	42+256 Major Bridge	BH-P7	Not Encountered	35.00 m	685841.000 m	3133807.000 m	(+)263.750 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
SPT-12	25.00	77	77	Yellowish brown, Silty clay of low plasticity with gravel	CL		13	64	21	2	0	0	0	34	22	12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	26.50	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-13	27.00	59	59		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-14	28.00	67	67		CL		11	64	23	2	0	0	0	33	22	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	29.50	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-15	30.00	68	68		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-16	31.00	57	57		CL		10	64	24	2	0	0	0	33	22	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	32.50	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-17	33.00	71	71		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-18	34.00	82	38		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEGTH
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SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		20-11-2022	to	21-11-2022	42+256 Major Bridge	BH-P9	Not Encountered	35.00 m	685867.000 m	3133938.000 m	(+)262.750 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Yellowish brown, , Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	1.00	-	-		ML-CL		6	57	32	5	0	0	0	28	21	7	-	1.69	13.20	1.49	2.66	DST	0.13	24	-	-	-	-	-	-	-	-	-
SPT-1	2.50	8	10		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	4.00	-	-		ML-CL		6	49	36	7	0	2	0	28	22	6	-	1.72	13.40	1.52	2.66	DST	0.14	25	-	-	-	-	-	-	-	-	-
SPT-2	5.50	11	13		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	7.00	-	-		ML-CL		7	46	37	8	0	2	0	28	21	7	-	1.77	14.10	1.55	2.66	DST	0.15	25	-	-	-	-	-	-	-	-	-
SPT-3	8.50	21	21		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	10.00	-	-		ML-CL		6	45	38	9	0	2	0	29	22	7	-	1.79	14.60	1.56	2.67	DST	0.17	26	-	-	-	-	-	-	-	-	-
SPT-4	11.50	28	24		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	13.00	-	-	Yellowish brown, Silty clay of low plasticity with gravel	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-5	13.50	31	31		CL		6	66	18	2	0	8	0	32	21	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-6	14.50	36	36		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-5	16.00	-	-		CL		6	64	18	3	0	9	0	33	21	12	-	1.94	19.60	1.62	2.63	UUT	1.51	5	-	-	-	-	-	-	-	-	-
SPT-7	17.50	39	39		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	19.00	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	19.50	44	44		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-9	20.50	48	48		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-6	22.00	-	-		CL		12	69	18	1	0	0	0	33	22	11	-	1.97	20.10	1.64	2.66	UUT	2.10	5	-	-	-	-	-	-	-	-	-
SPT-10	23.50	56	56		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	25.00	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

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SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		20-11-2022	to	21-11-2022	42+256 Major Bridge	BH-P9	Not Encountered	35.00 m	685867.000 m	3133938.000 m	(+)262.750 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
SPT-11	25.50	72	72	Yellowish brown, Silty clay of low plasticity with gravel	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-12	26.50	75	75		CL		11	70	18	1	0	0	0	33	22	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-13	28.50	76	76		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-14	29.50	81	81		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-15	31.50	85	85		CL		13	68	18	1	0	0	0	34	22	12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-16	32.50	84	84		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-17	34.50	75	75		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

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Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		18-11-2022	to	17-11-2022	42+256 Major Bridge	BH-P10	Not Encountered	35.00 m	685863.000 m	3133950.000 m	(+)263.228 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Yellowish brown, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	1.00	8	13		SM		0	21	78	1	0	0	0	-	NIL	NP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.50	-	-	Yellowish brown, Silty clay of low plasticity	CL		10	65	25	0	0	0	0	32	21	11	-	1.80	19.40	1.51	2.68	UUT	0.44	5	-	-	-	-	-	-	-	-	-
SPT-2	4.00	12	12		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	5.50	-	-		CL		10	64	26	0	0	0	0	33	21	12	-	1.82	19.70	1.52	2.68	UUT	0.91	6	-	-	-	-	-	-	-	-	-
SPT-3	7.00	24	24		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	8.50	-	-		CL		11	62	27	0	0	0	0	33	21	12	-	1.87	20.10	1.56	2.67	UUT	1.10	6	-	-	-	-	-	-	-	-	-
SPT-4	10.00	30	30		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	11.50	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-5	12.00	43	43		CL		10	62	28	0	0	0	0	32	21	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-6	13.00	45	45		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	14.50	-	-		CL		10	63	27	0	0	0	0	32	21	11	-	1.97	21.10	1.63	2.68	UUT	1.19	7	-	-	-	-	-	-	-	-	-
SPT-7	16.00	66	46	Yellowish brown,Sandy Silt	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-5	17.50	-	-		ML-CL		6	51	32	7	4	0	0	29	23	6	-	1.88	15.40	1.63	2.66	DST	0.15	24	-	-	-	-	-	-	-	-	-
SPT-8	18.00	74	48		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-6	20.50	-	-		ML-CL		6	50	33	7	4	0	0	29	23	6	-	1.90	15.80	1.64	2.66	DST	0.19	25	-	-	-	-	-	-	-	-	-
SPT-9	22.00	53	30	Yellowish brown, Silty clay of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	23.50	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-10	24.00	61	61		CL		12	66	21	1	0	0	0	33	22	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-11	25.00	73	73		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEGTH
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SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.						Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
							18-11-2022	to	17-11-2022	42+256 Major Bridge	BH-P10	Not Encountered	35.00 m	685863.000 m	3133950.000 m	(+)263.228 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
UDS*	26.50	-	-	Yellowish brown, Silty clay of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-12	27.00	77	77		CL		10	67	22	1	0	0	0	34	22	12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-13	28.00	87	87		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	29.50	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-14	30.00	77	77		CL		11	65	23	1	0	0	0	33	22	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-15	31.00	88	88		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	32.50	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-16	33.00	97	97		CL		10	67	22	1	0	0	0	34	22	12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-17	34.00	81	81		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
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		16-11-2022	to	17-11-2022	42+256 Major Bridge	BH-P11	Not Encountered	35.00 m	685832.000 m	3133970.000 m	(+)264.855 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Yellowish brown, Sandy silt of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	1.00	-	-		SM		0	21	78	1	0	0	0	-	NIL	NP	-	1.68	9.70	1.53	2.63	DST	0.00	30	-	-	-	-	-	-	-	-	-
SPT-1	2.50	16	20	Yellowish brown, Silty clay of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	4.00	-	-		CL		8	60	29	2	1	0	0	30	21	9	-	1.84	18.70	1.55	2.68	UUT	0.78	5	-	-	-	-	-	-	-	-	-
SPT-2	5.50	21	21		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	7.00	-	-		CL		8	54	36	2	0	0	0	32	22	10	-	1.86	19.20	1.56	2.68	UUT	1.02	6	-	-	-	-	-	-	-	-	-
SPT-3	8.50	27	27		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	10.00	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-4	10.50	21	21		CL		9	58	31	2	0	0	0	32	22	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-5	11.50	33	33		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	13.00	-	-		CL		8	59	31	2	0	0	0	32	22	10	-	1.89	20.10	1.57	2.70	UUT	1.04	6	-	-	-	-	-	-	-	-	-
SPT-6	14.50	37	28	Yellowish brown, Sandy silt of low plasticity	SM		0	24	71	3	2	0	0	-	NIL	NP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	16.00	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-7	16.50	50	35		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	17.50	62	41	Yellowish brown,Sandy Silt	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-5	19.00	-	-		ML-CL		7	48	35	7	3	0	0	30	23	7	-	1.84	16.40	1.58	2.66	DST	0.16	25	-	-	-	-	-	-	-	-	-
SPT-9	20.50	43	26		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-6	22.00	-	-		ML-CL		6	48	36	7	3	0	0	29	23	6	-	1.85	17.10	1.58	2.66	DST	0.18	26	-	-	-	-	-	-	-	-	-
SPT-10	23.50	46	25		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	25.00	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
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Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (km.)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		16-11-2022	to	17-11-2022	42+256 Major Bridge	BH-P11	Not Encountered	35.00 m	685832.000 m	3133970.000 m	(+)264.855 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
SPT-11	25.50	58	58	Yellowish brown, Silty clay of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-12	26.50	68	68		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-7	28.00	-	-		CL		6	67	27	0	0	0	0	33	21	12	-	2.01	19.40	1.68	2.68	UUT	2.68	6	-	-	-	-	-	-	-	-	-
SPT-13	29.50	73	73		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-8	31.00	-	-		CL		7	64	29	0	0	0	0	32	21	11	-	2.02	20.10	1.68	2.68	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-14	32.50	74	74		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-15	34.50	73	73		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

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Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	1.00	13	13		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.50	-	-		CL		8	60	27	4	1	0	0	31	21	10	-	1.85	18.60	1.56	2.68	UUT	0.95	5	-	-	-	-	-	-	-	-	-
SPT-2	4.00	25	25		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	5.50	-	-		CL		9	59	27	4	1	0	0	30	21	9	-	1.92	19.10	1.61	2.68	UUT	1.14	5	-	-	-	-	-	-	-	-	-
SPT-3	7.00	30	30		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	8.50	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-4	9.00	26	26		CL		8	62	29	1	0	0	0	33	21	12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-5	10.00	30	30		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	11.50	-	-	Yellowish brown, Silty clay of low plasticity	CL		6	59	32	1	0	2	0	33	21	12	-	1.89	19.60	1.58	2.68	UUT	0.98	6	-	-	-	-	-	-	-	-	-
SPT-6	13.00	24	24		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-4	14.50	-	-		CL		7	64	28	1	0	0	0	33	21	12	-	1.96	20.10	1.63	2.68	UUT	1.25	5	-	-	-	-	-	-	-	-	-
SPT-7	16.00	33	33		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	17.50	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	18.00	40	40		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-9	19.00	31	31		CL		6	65	24	3	2	0	0	32	22	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	20.50	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-10	21.00	66	66				-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-11	22.00	65	65		CL		7	62	28	2	1	0	0	33	22	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	23.50	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

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							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
SPT-12	24.00	29	29	Yellowish brown, Silty clay of low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-13	25.00	35	35		CL		6	63	28	2	1	0	0	32	22	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	26.50	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-14	27.00	43	43		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-15	28.00	40	40		CL		7	64	27	1	1	0	0	33	22	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	29.50	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-16	30.00	45	45		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-17	31.00	36	36		CL		6	65	27	1	1	0	0	33	22	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS*	32.50	-	-		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-18	33.00	51	51		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-19	34.00	53	53		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

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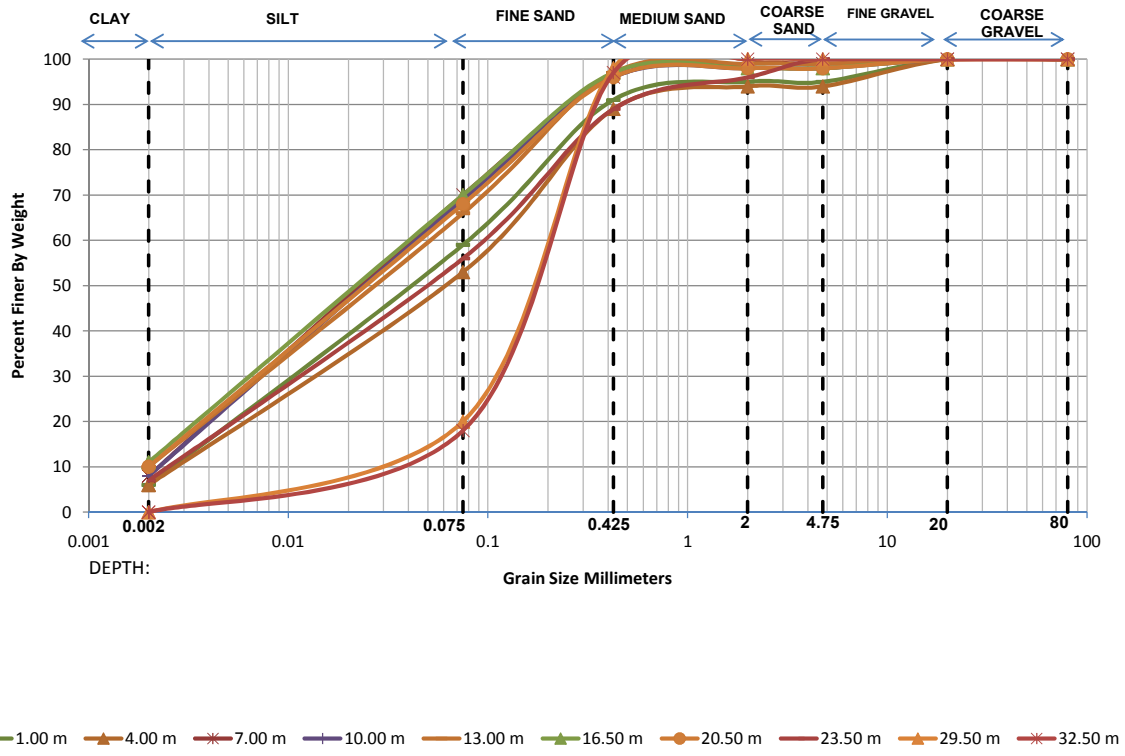
AND RESEARCH CENTRE PVT LTD

RESULT OF CHEMICAL ANALYSIS OF SOIL SAMPLES

Sr. No	Chainage Old (km)	Chainage New (km)	BH No.	Depth of collected sample (m)	pH	Chlorides (Cl^-)		Sulphate (SO_3^{2-})	
						(mg/kg)	(%)	(mg/kg)	(%)
1.	42+256	45+497	BH-P1	4.00	8.24	57.14	0.0057	17.52	0.0018
			BH-P10	20.50	8.36	63.71	0.0064	21.34	0.0021

GRAIN SIZE DISTRIBUTION CURVES

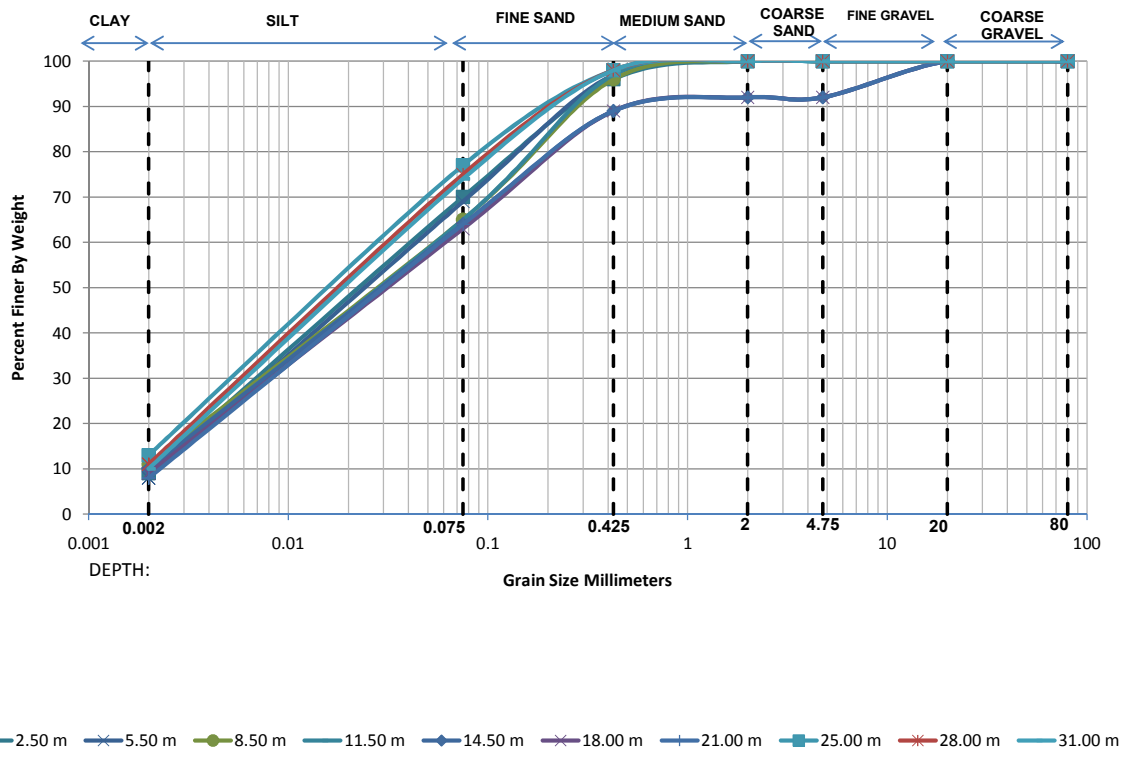
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	42+256 Major Bridge
B.H. No.	BH-P1



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
1.00 m	6.00	53.00	32.00	4.00	0.00	5.00	0.00	0.0043	0.0227	0.0777	17.91	1.52
4.00 m	6.00	47.00	36.00	5.00	0.00	6.00	0.00	0.0045	0.0268	0.1010	22.45	1.57
7.00 m	8.00	62.00	26.00	3.00	0.00	1.00	0.00	0.0029	0.0159	0.0552	19.31	1.60
10.00 m	8.00	61.00	27.00	2.00	0.00	2.00	0.00	0.0029	0.0162	0.0568	19.84	1.62
13.00 m	10.00	56.00	31.00	2.00	0.00	1.00	0.00	0.0020	0.0154	0.0617	30.84	1.93
16.50 m	11.00	59.00	27.00	1.00	0.00	2.00	0.00	-	0.0132	0.0543	-	-
20.50 m	10.00	58.00	28.00	2.00	0.00	2.00	0.00	0.0020	0.0147	0.0579	28.97	1.86
23.50 m	7.00	49.00	33.00	7.00	4.00	0.00	0.00	0.0036	0.0233	0.0886	24.59	1.70
29.50 m	0.00	20.00	78.00	2.00	0.00	0.00	0.00	0.0284	0.1114	0.2058	7.24	2.12
32.50 m	0.00	18.00	79.00	3.00	0.00	0.00	0.00	0.0341	0.1197	0.2137	6.27	1.97

GRAIN SIZE DISTRIBUTION CURVES

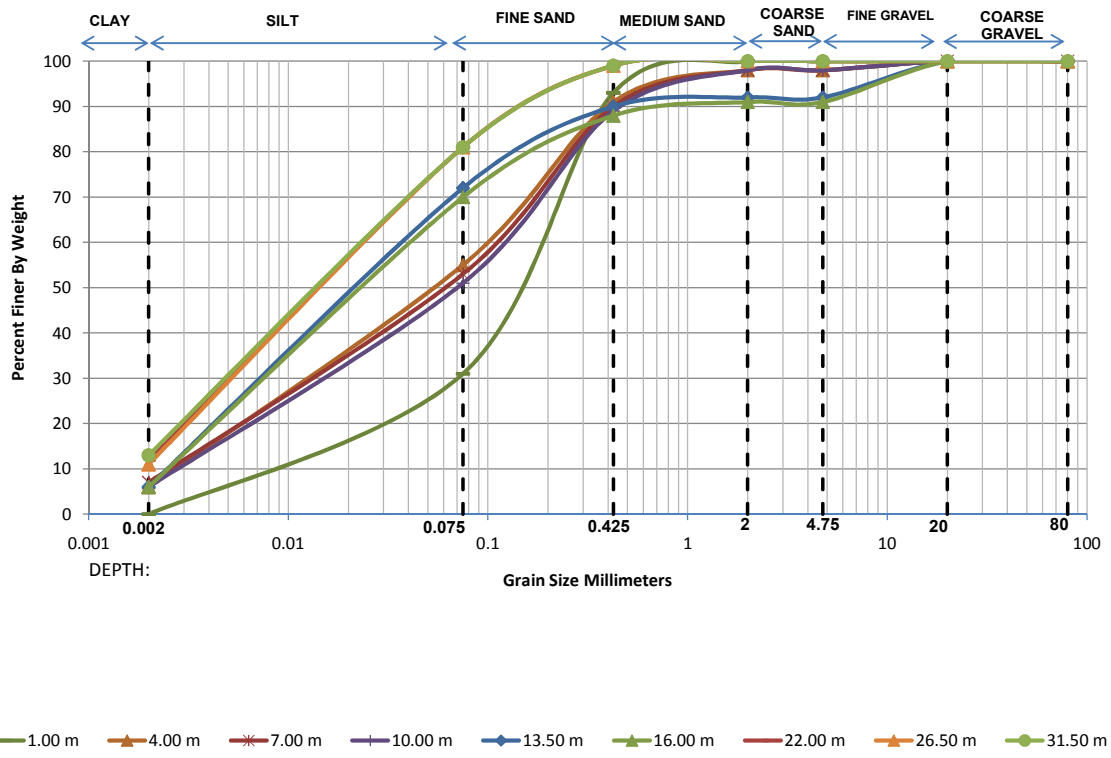
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	42+256 Major Bridge
B.H. No.	BH-P7



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
2.50 m	9.00	61.00	26.00	4.00	0.00	0.00	0.00	0.0024	0.0150	0.0549	23.02	1.71
5.50 m	8.00	61.00	28.00	3.00	0.00	0.00	0.00	0.0029	0.0163	0.0569	19.85	1.63
8.50 m	11.00	54.00	31.00	4.00	0.00	0.00	0.00	-	0.0148	0.0634	-	-
11.50 m	10.00	55.00	32.00	3.00	0.00	0.00	0.00	0.0020	0.0158	0.0637	31.83	1.96
14.50 m	10.00	54.00	25.00	3.00	0.00	8.00	0.00	0.0020	0.0159	0.0655	32.75	1.93
18.00 m	9.00	54.00	26.00	3.00	0.00	8.00	0.00	0.0024	0.0173	0.0678	28.30	1.83
21.00 m	8.00	56.00	25.00	3.00	0.00	8.00	0.00	0.0029	0.0178	0.0658	22.79	1.67
25.00 m	13.00	64.00	21.00	2.00	0.00	0.00	0.00	-	0.0101	0.0436	-	-
28.00 m	11.00	64.00	23.00	2.00	0.00	0.00	0.00	-	0.0120	0.0470	-	-
31.00 m	10.00	64.00	24.00	2.00	0.00	0.00	0.00	0.0020	0.0131	0.0488	24.39	1.75

GRAIN SIZE DISTRIBUTION CURVES

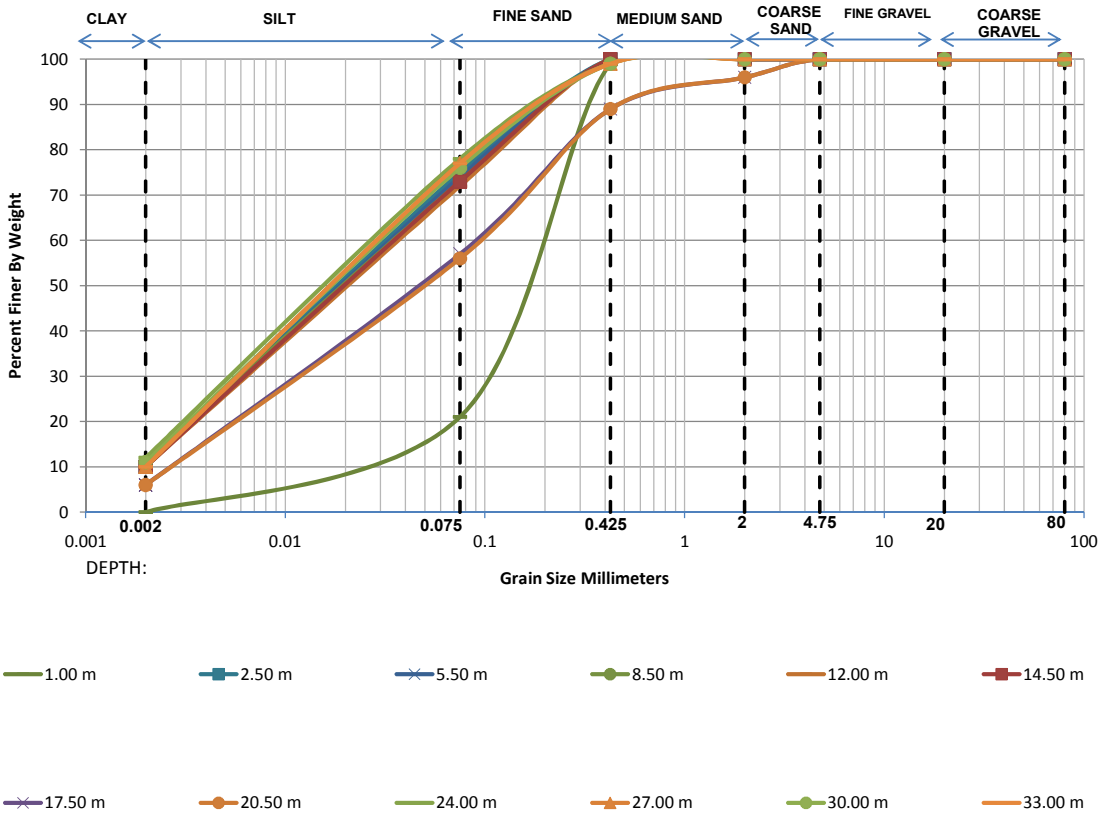
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	42+256 Major Bridge
B.H. No.	BH-P9



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
1.00 m	0.00	31.00	62.00	7.00	0.00	0.00	0.00	0.0126	0.0717	0.1809	14.33	2.25
4.00 m	6.00	49.00	36.00	7.00	0.00	2.00	0.00	0.0044	0.0253	0.0918	20.66	1.57
7.00 m	7.00	46.00	37.00	8.00	0.00	2.00	0.00	0.0037	0.0257	0.1010	27.56	1.78
10.00 m	6.00	45.00	38.00	9.00	0.00	2.00	0.00	0.0046	0.0286	0.1106	24.20	1.61
13.50 m	6.00	66.00	18.00	2.00	0.00	8.00	0.00	0.0041	0.0173	0.0527	12.85	1.38
16.00 m	6.00	64.00	18.00	3.00	0.00	9.00	0.00	0.0041	0.0178	0.0555	13.46	1.38
22.00 m	12.00	69.00	18.00	1.00	0.00	0.00	0.00	-	0.0102	0.0397	-	-
26.50 m	11.00	70.00	18.00	1.00	0.00	0.00	0.00	-	0.0109	0.0402	-	-
31.50 m	13.00	68.00	18.00	1.00	0.00	0.00	0.00	-	0.0095	0.0392	-	-

GRAIN SIZE DISTRIBUTION CURVES

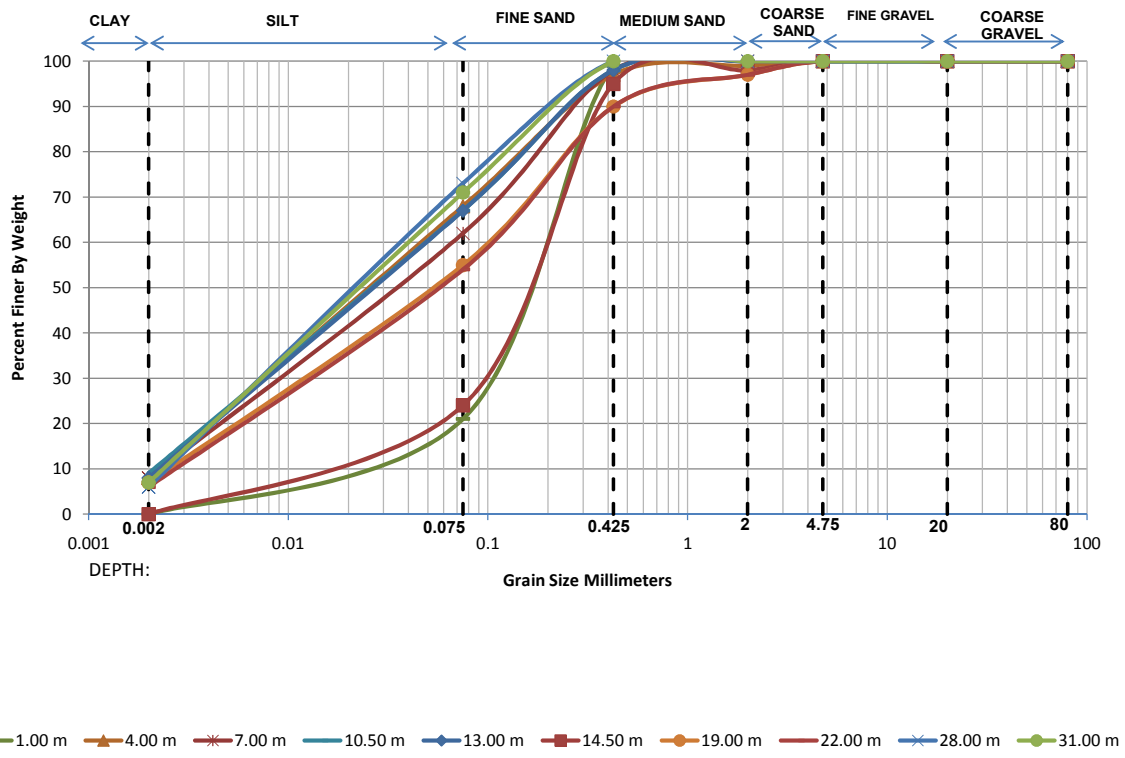
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	42+256 Major Bridge
B.H. No.	BH-P10



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
1.00 m	0.00	21.00	78.00	1.00	0.00	0.00	0.00	0.0261	0.1073	0.2009	7.69	2.19
2.50 m	10.00	65.00	25.00	0.00	0.00	0.00	0.00	0.0020	0.0129	0.0476	23.79	1.74
5.50 m	10.00	64.00	26.00	0.00	0.00	0.00	0.00	0.0020	0.0131	0.0489	24.45	1.76
8.50 m	11.00	62.00	27.00	0.00	0.00	0.00	0.00	-	0.0125	0.0499	-	-
12.00 m	10.00	62.00	28.00	0.00	0.00	0.00	0.00	0.0020	0.0136	0.0517	25.85	1.79
14.50 m	10.00	63.00	27.00	0.00	0.00	0.00	0.00	0.0020	0.0134	0.0503	25.13	1.78
17.50 m	6.00	51.00	32.00	7.00	4.00	0.00	0.00	0.0044	0.0238	0.0846	19.30	1.53
20.50 m	6.00	50.00	33.00	7.00	4.00	0.00	0.00	0.0044	0.0245	0.0885	20.07	1.53
24.00 m	12.00	66.00	21.00	1.00	0.00	0.00	0.00	-	0.0107	0.0430	-	-
27.00 m	10.00	67.00	22.00	1.00	0.00	0.00	0.00	0.0020	0.0124	0.0451	22.53	1.71
30.00 m	11.00	65.00	23.00	1.00	0.00	0.00	0.00	-	0.0118	0.0458	-	-
33.00 m	10.00	67.00	22.00	1.00	0.00	0.00	0.00	0.0020	0.0124	0.0451	22.53	1.71

GRAIN SIZE DISTRIBUTION CURVES

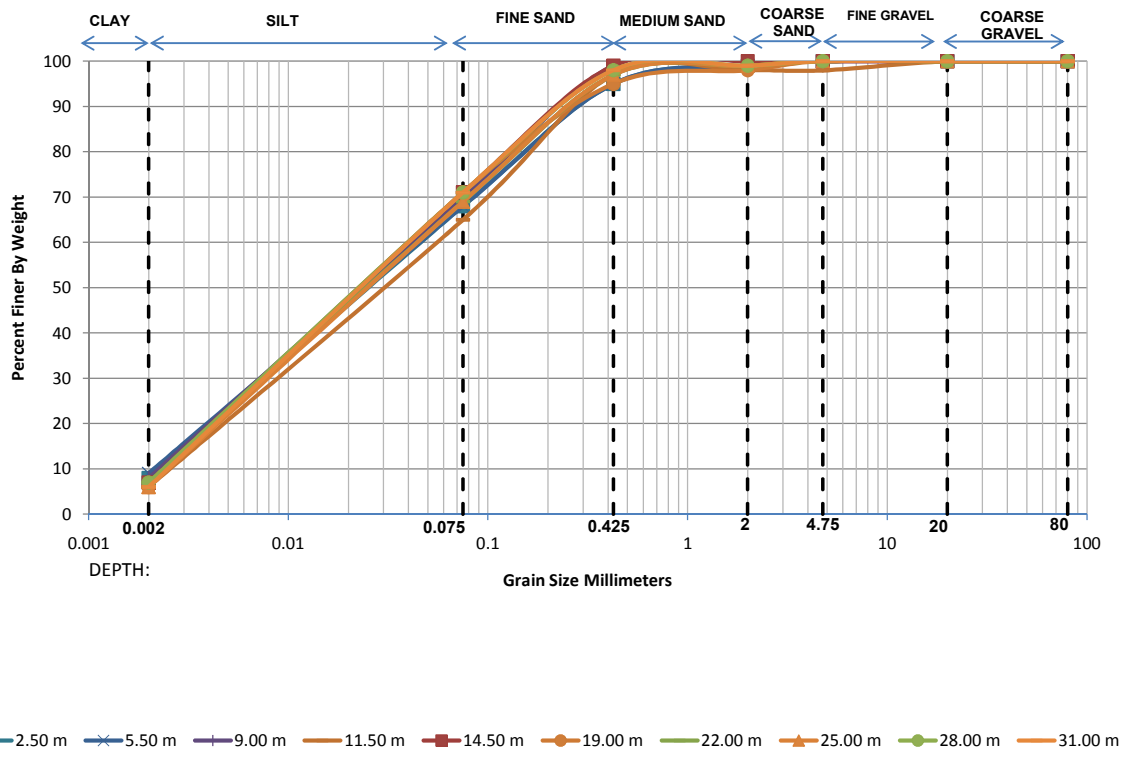
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	42+256 Major Bridge
B.H. No.	BH-P11



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
1.00 m	0.00	21.00	78.00	1.00	0.00	0.00	0.00	0.0261	0.1073	0.2009	7.69	2.19
4.00 m	8.00	60.00	29.00	2.00	1.00	0.00	0.00	0.0029	0.0166	0.0586	20.40	1.64
7.00 m	8.00	54.00	36.00	2.00	0.00	0.00	0.00	0.0029	0.0191	0.0703	24.20	1.79
10.50 m	9.00	58.00	31.00	2.00	0.00	0.00	0.00	0.0024	0.0160	0.0601	25.13	1.79
13.00 m	8.00	59.00	31.00	2.00	0.00	0.00	0.00	0.0029	0.0170	0.0603	20.98	1.67
14.50 m	0.00	24.00	71.00	3.00	2.00	0.00	0.00	0.0203	0.0965	0.1987	9.78	2.30
19.00 m	7.00	48.00	35.00	7.00	3.00	0.00	0.00	0.0036	0.0241	0.0924	25.49	1.73
22.00 m	6.00	48.00	36.00	7.00	3.00	0.00	0.00	0.0045	0.0260	0.0964	21.55	1.57
28.00 m	6.00	67.00	27.00	0.00	0.00	0.00	0.00	0.0041	0.0173	0.0519	12.64	1.41
31.00 m	7.00	64.00	29.00	0.00	0.00	0.00	0.00	0.0034	0.0168	0.0543	15.81	1.51

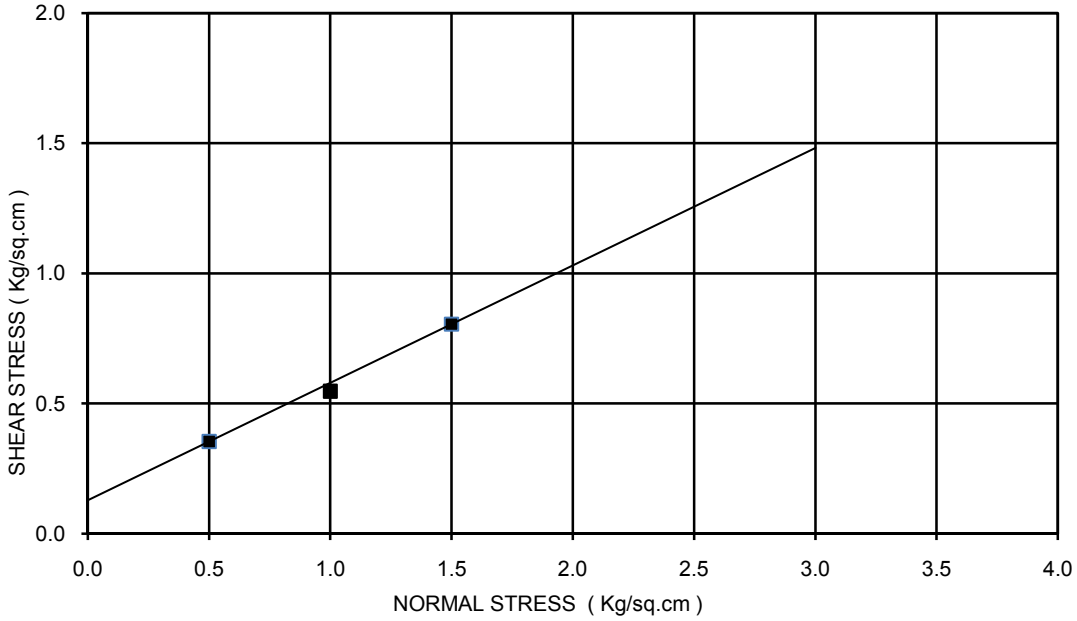
GRAIN SIZE DISTRIBUTION CURVES

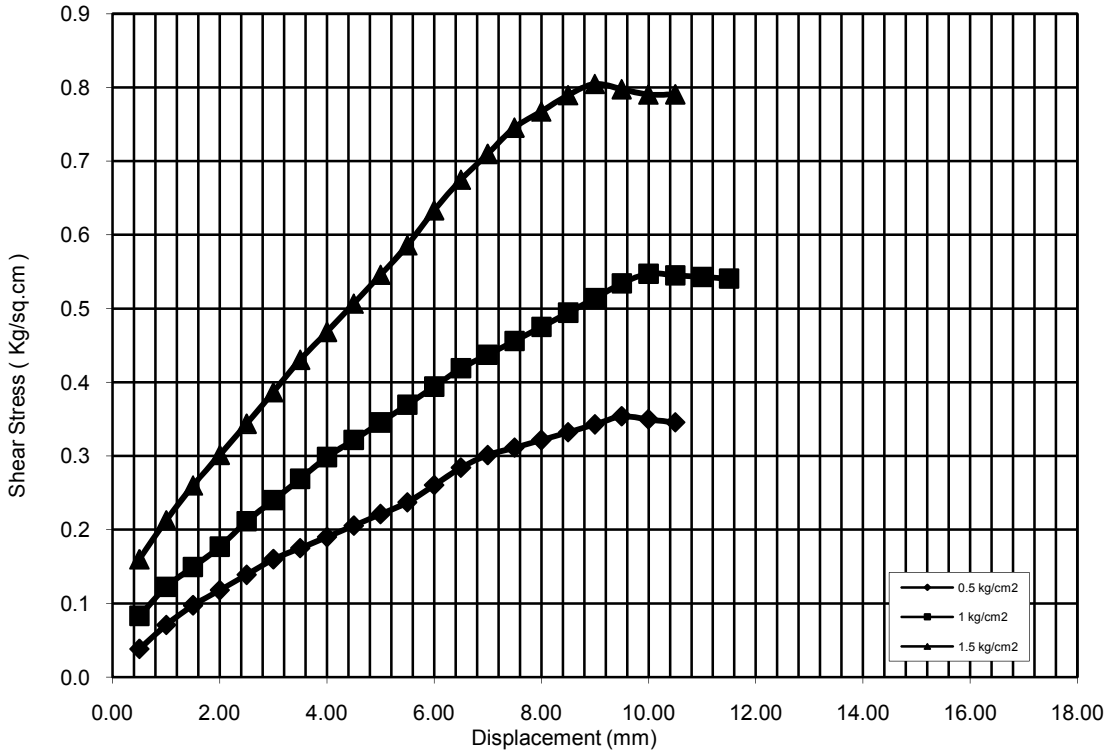
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	42+256 Major Bridge
B.H. No.	BH-P12



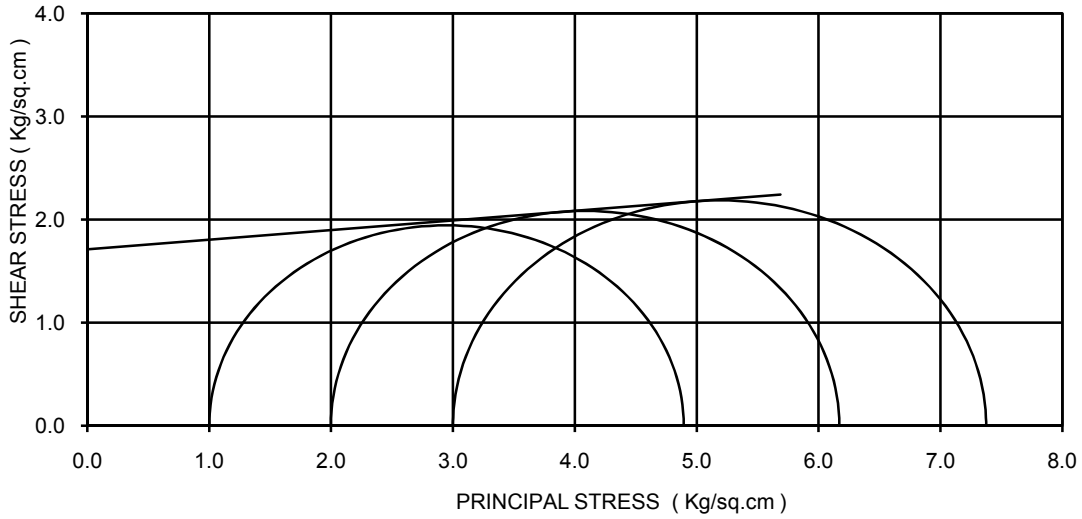
Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
2.50 m	8.00	60.00	27.00	4.00	1.00	0.00	0.00	0.0029	0.0165	0.0585	20.37	1.63
5.50 m	9.00	59.00	27.00	4.00	1.00	0.00	0.00	0.0024	0.0156	0.0582	24.36	1.74
9.00 m	8.00	62.00	29.00	1.00	0.00	0.00	0.00	0.0029	0.0160	0.0554	19.35	1.62
11.50 m	6.00	59.00	32.00	1.00	0.00	2.00	0.00	0.0042	0.0200	0.0644	15.25	1.47
14.50 m	7.00	64.00	28.00	1.00	0.00	0.00	0.00	0.0034	0.0168	0.0542	15.80	1.51
19.00 m	6.00	65.00	24.00	3.00	2.00	0.00	0.00	0.0041	0.0178	0.0544	13.19	1.41
22.00 m	7.00	62.00	28.00	2.00	1.00	0.00	0.00	0.0034	0.0173	0.0572	16.59	1.52
25.00 m	6.00	63.00	28.00	2.00	1.00	0.00	0.00	0.0042	0.0185	0.0575	13.83	1.43
28.00 m	7.00	64.00	27.00	1.00	1.00	0.00	0.00	0.0034	0.0167	0.0542	15.79	1.50
31.00 m	6.00	65.00	27.00	1.00	1.00	0.00	0.00	0.0041	0.0179	0.0545	13.21	1.42

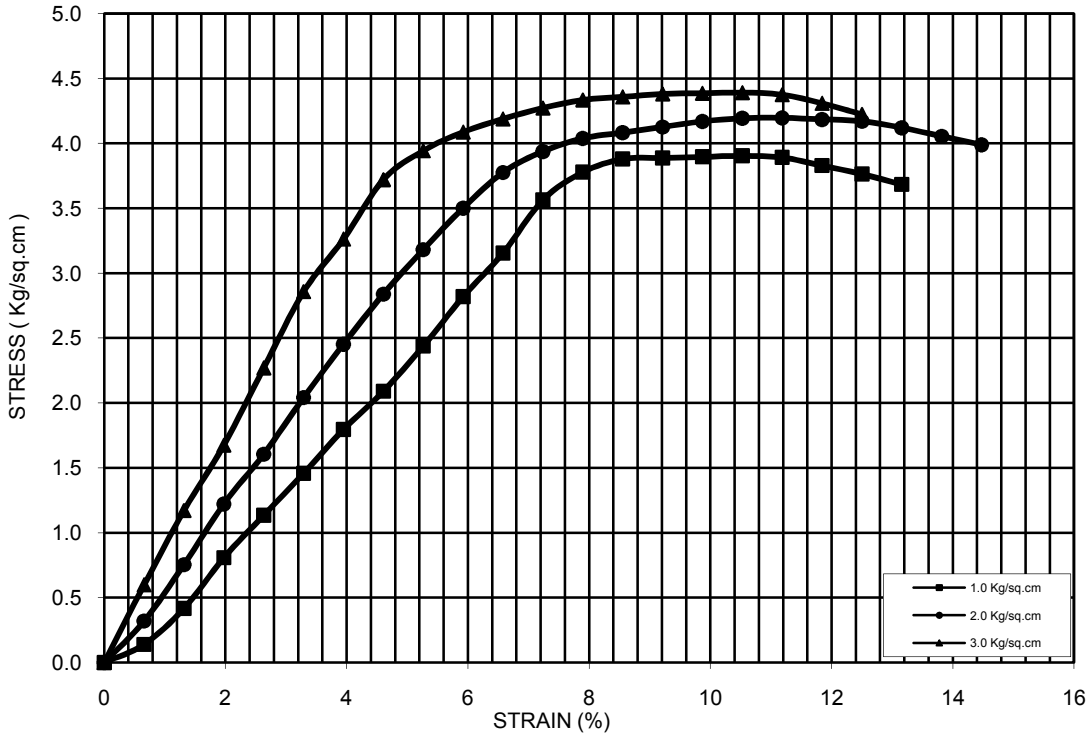
BORE HOLE NO: BH-P1
CH.-42+256
SAMPLE NO.: UDS-1
DEPTH: 1.00 m
COHESION(C)= 0.13 kg/sq.cm
ANGLE OF FRICTION(Phi): 24 deg
TYPE OF THE TEST: DST



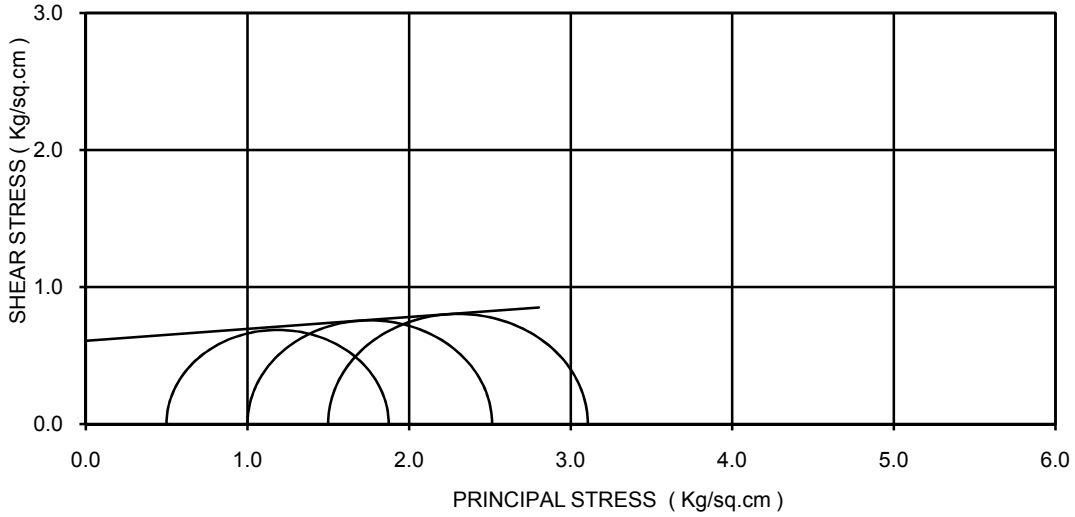


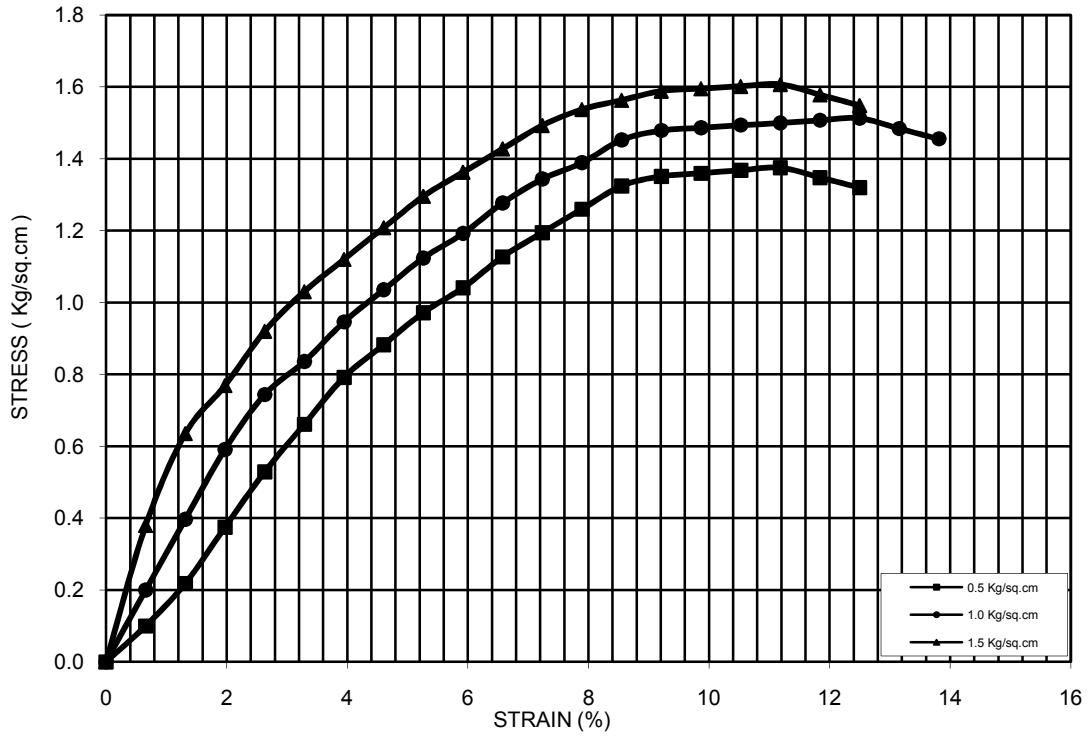
BORE HOLE NO: BH-P1
CHAINAGE : 42+256
SAMPLE NO.:-UDS-5
DEPTH: 13.00 m
COHESION(C)= 1.71 kg/sq.cm
ANGLE OF FRICTION(Phi): 5 deg
TYPE OF THE TEST: UUT



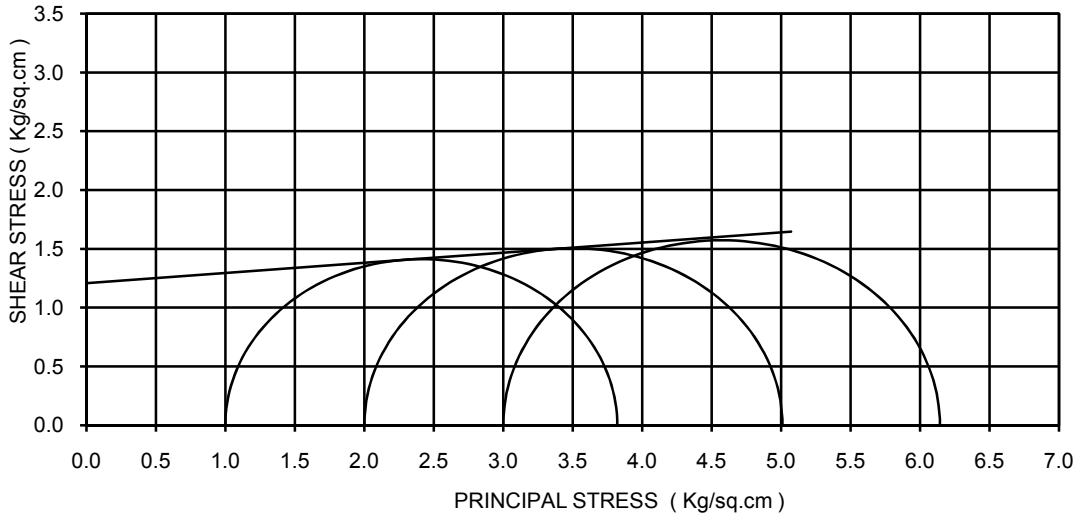


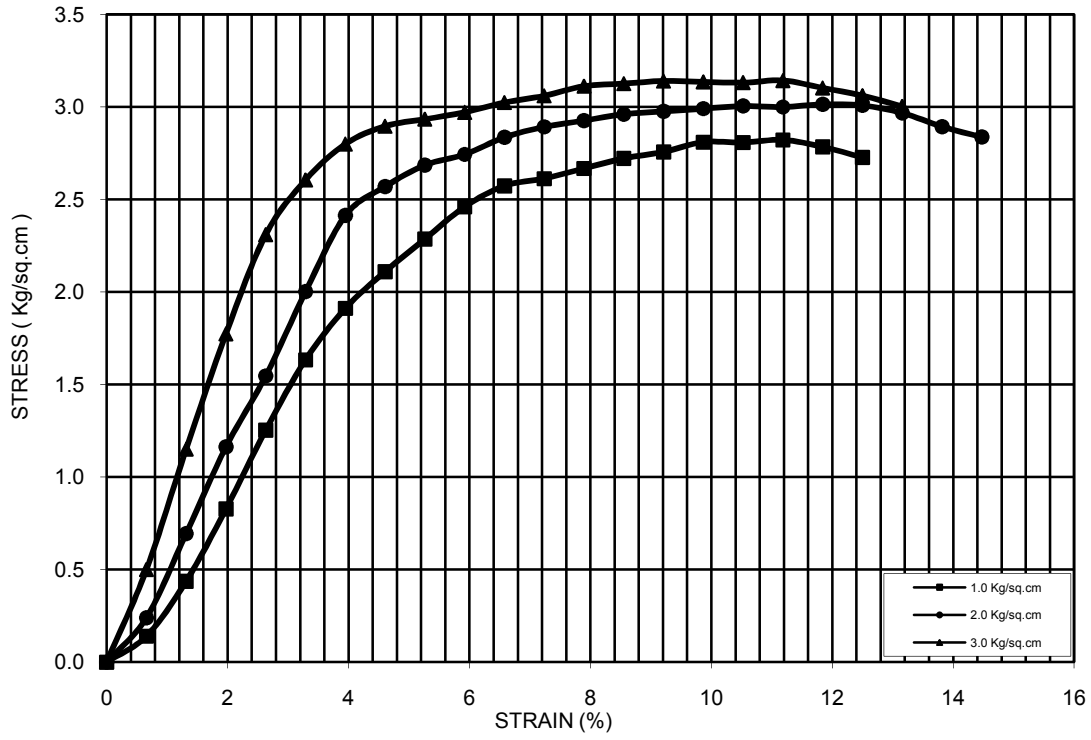
BORE HOLE NO: BH-P7
CHAINAGE = 42+256
SAMPLE NO.: UDS-1
DEPTH: 2.50m
COHESION(C)= 0.61 kg/sq.cm
ANGLE OF FRICTION(Phi): 5deg
TYPE OF THE TEST: UUT



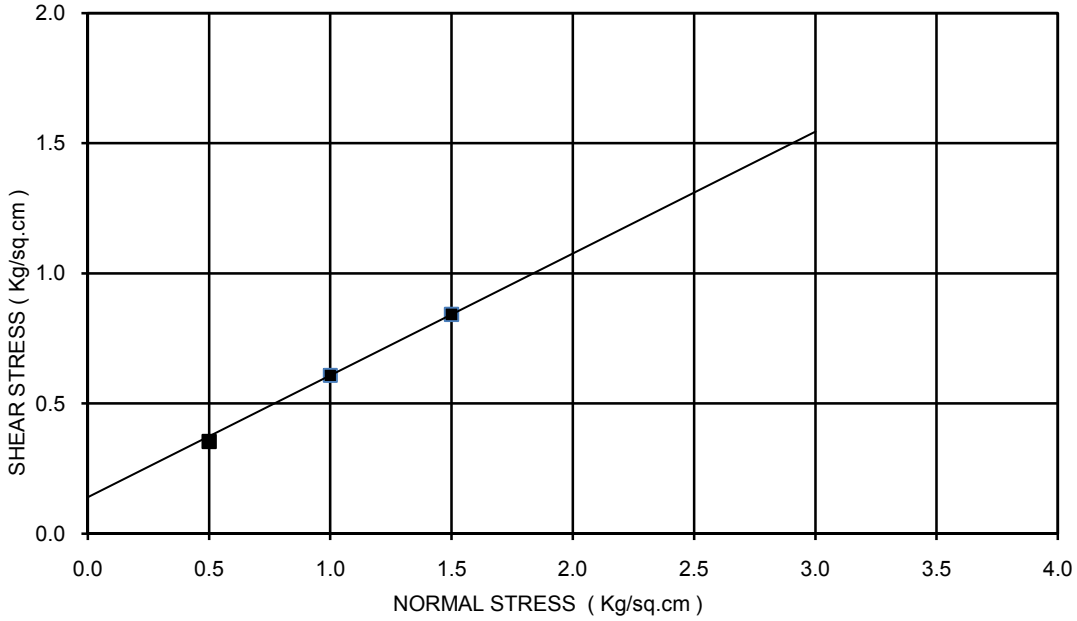


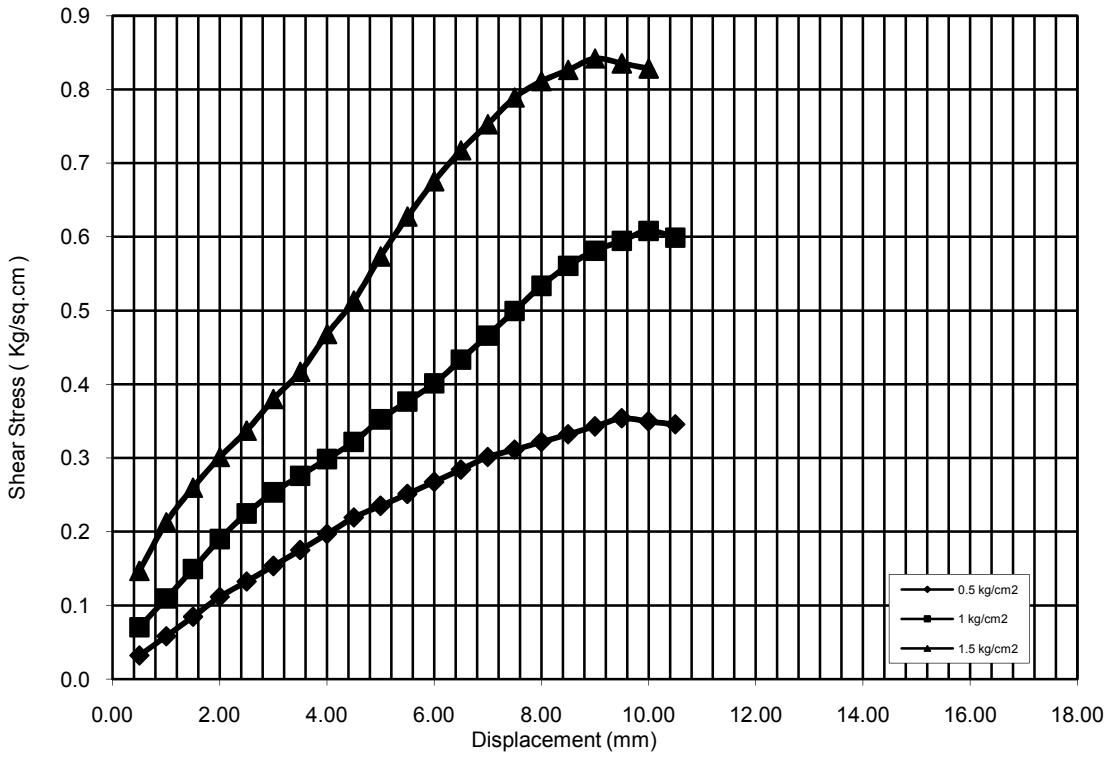
BORE HOLE NO: BH-P7
CHAINAGE = 42+256
SAMPLE NO.: UDS-5
DEPTH: 14.50 m
COHESION(C)= 1.21 kg/sq.cm
ANGLE OF FRICTION(Phi): 5 deg
TYPE OF THE TEST: UUT



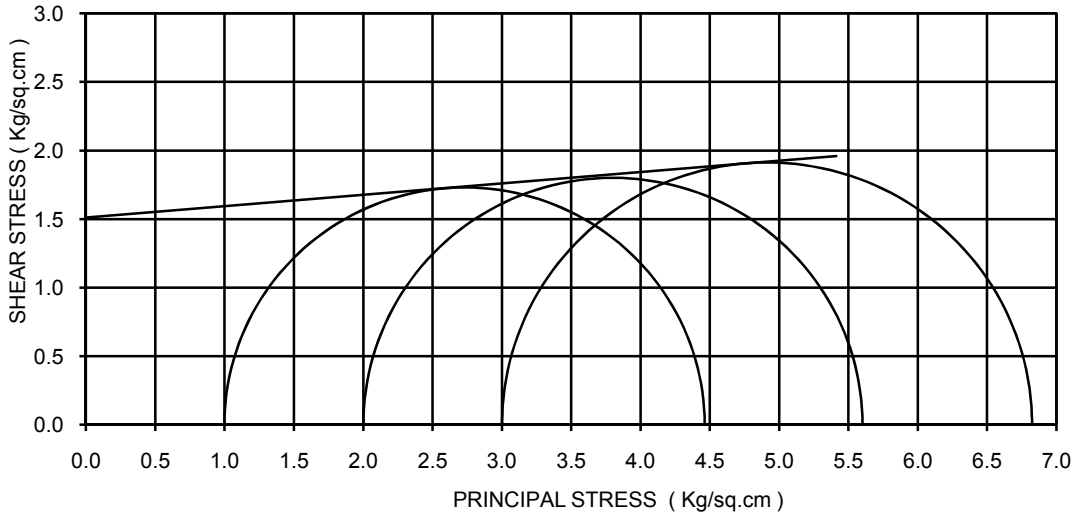


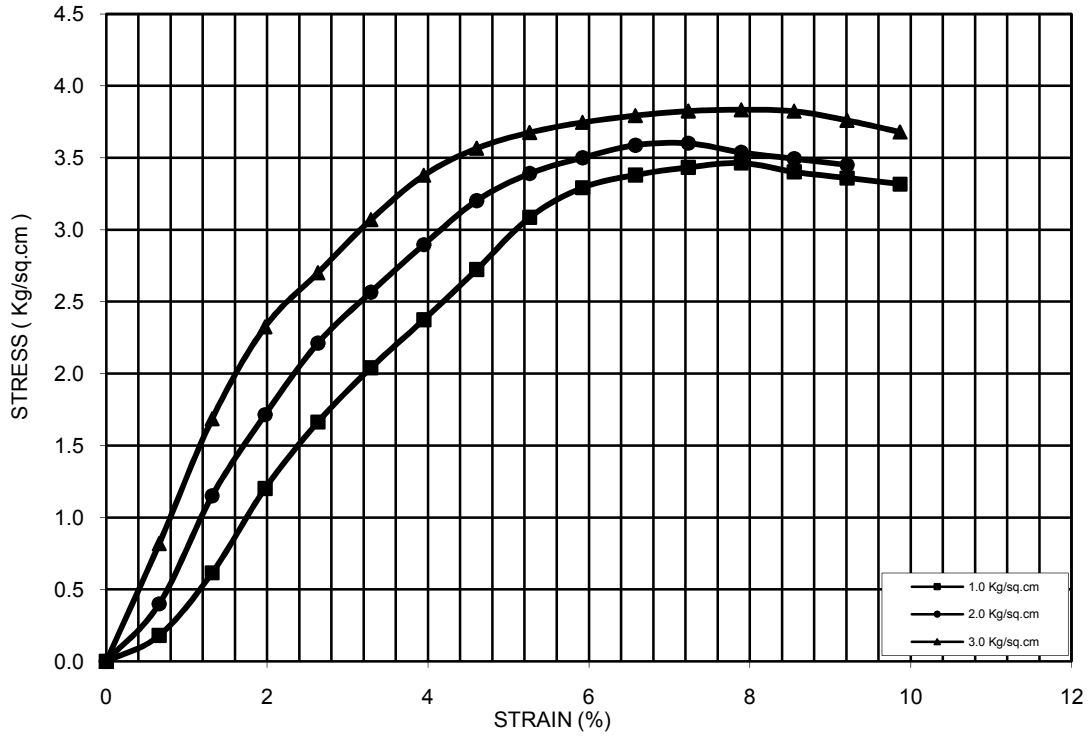
BORE HOLE NO: BH-P9
CHAINAGE : 42+256
SAMPLE NO.: UDS-2
DEPTH: 4.00 m
COHESION(C)= 0.14 kg/sq.cm
ANGLE OF FRICTION(Phi): 25 deg
TYPE OF THE TEST: DST



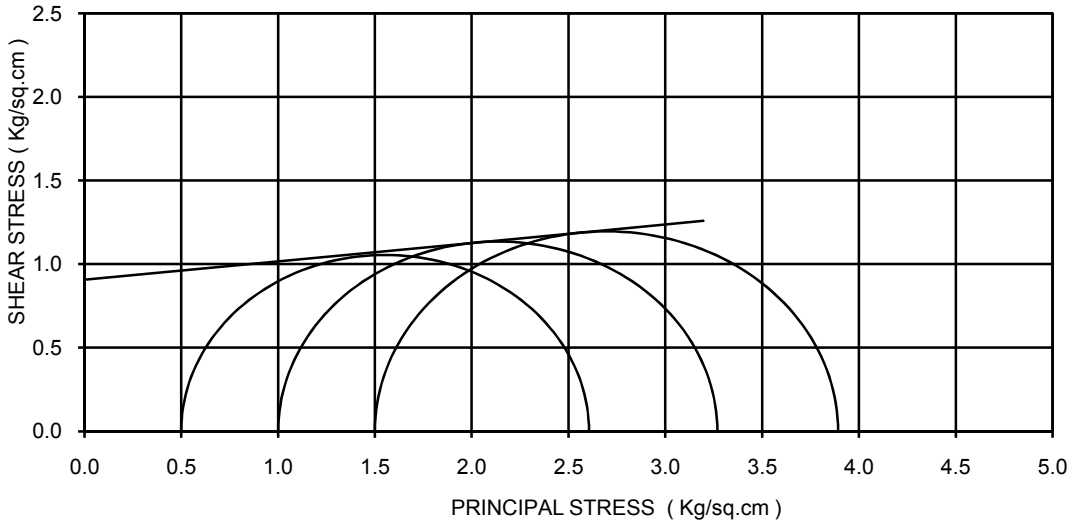


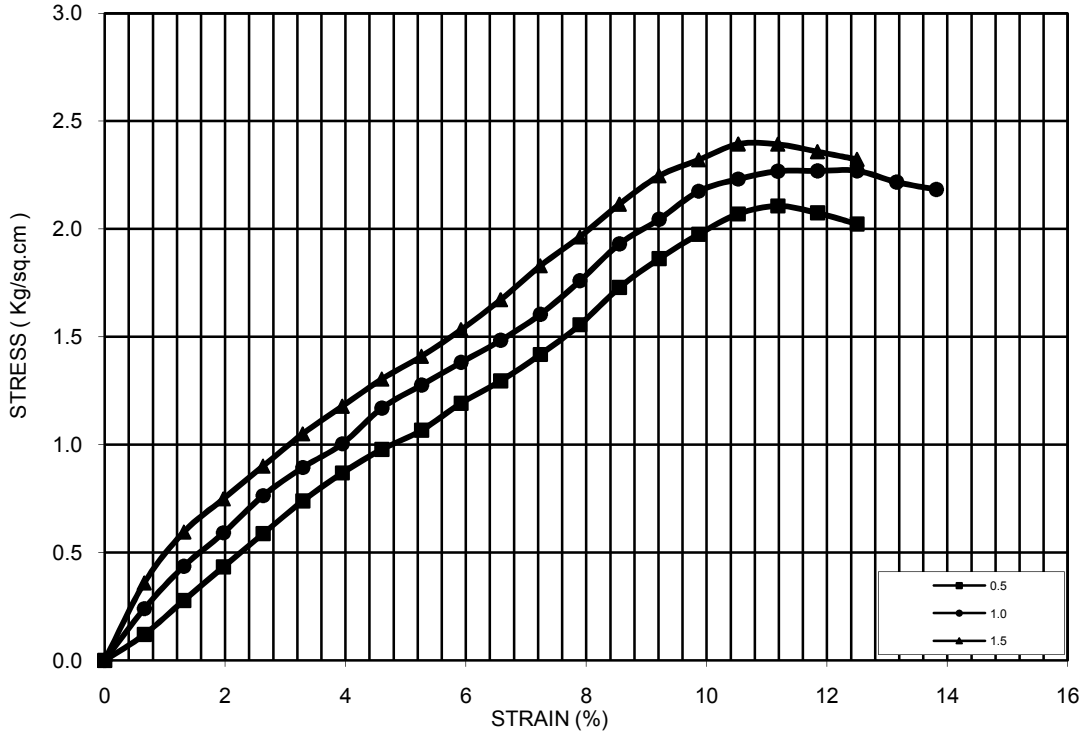
BORE HOLE NO: BH-P9
CHAINAGE : 42+256
BORE HOLE NO: UDS-5
DEPTH: 16.00
COHESION(C)= 1.51 kg/sq.cm
ANGLE OF FRICTION(Phi): 5 deg
TYPE OF THE TEST: UUT



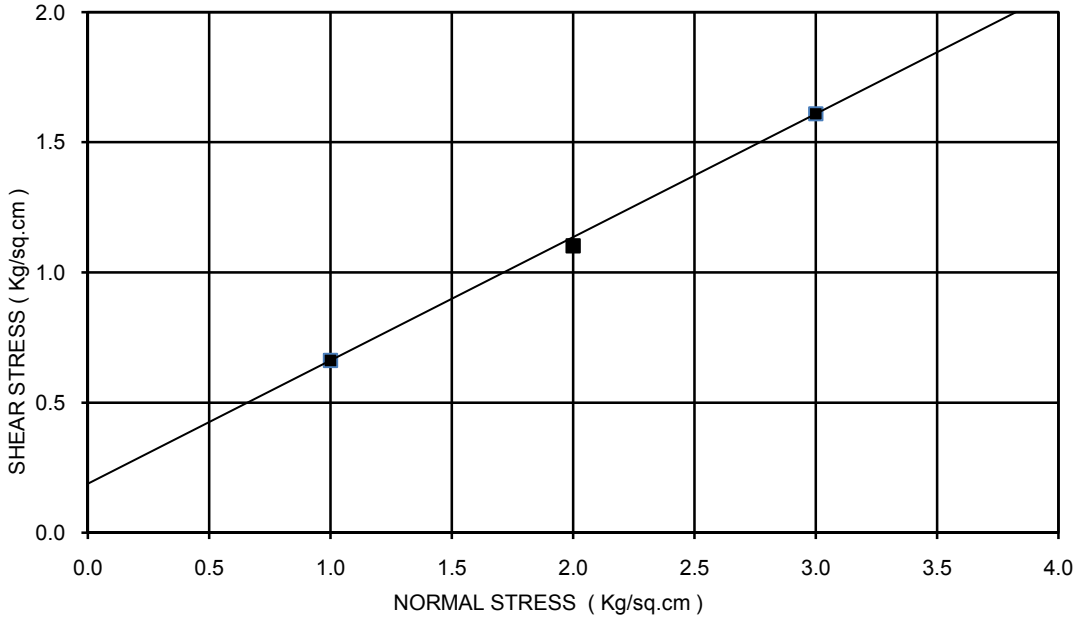


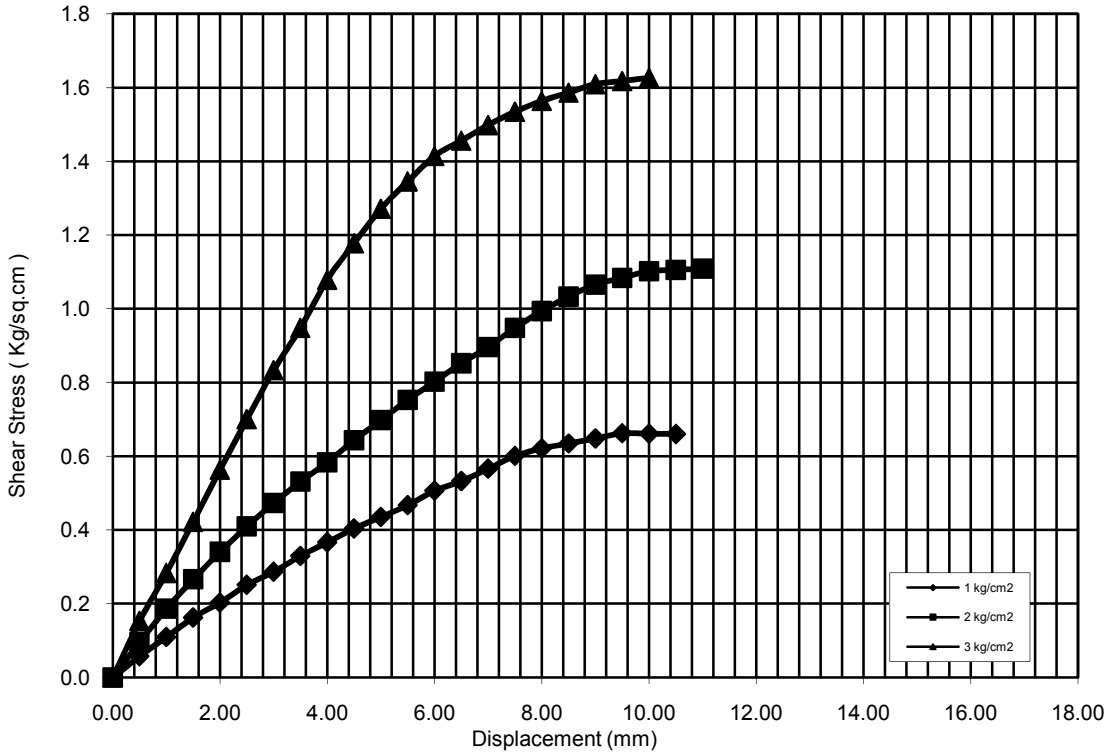
BORE HOLE NO: BH-P10
CHAINAGE = 42+256
SAMPLE NO.: UDS-2
DEPTH: 5.50 m
COHESION(C)= 0.91 kg/sq.cm
ANGLE OF FRICTION(Phi): 5 deg
TYPE OF THE TEST: UUT



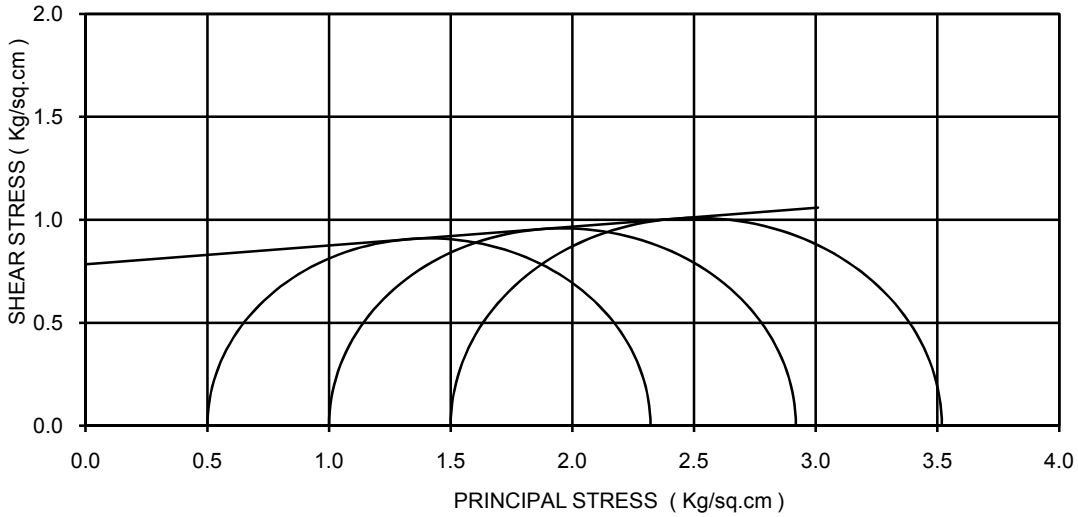


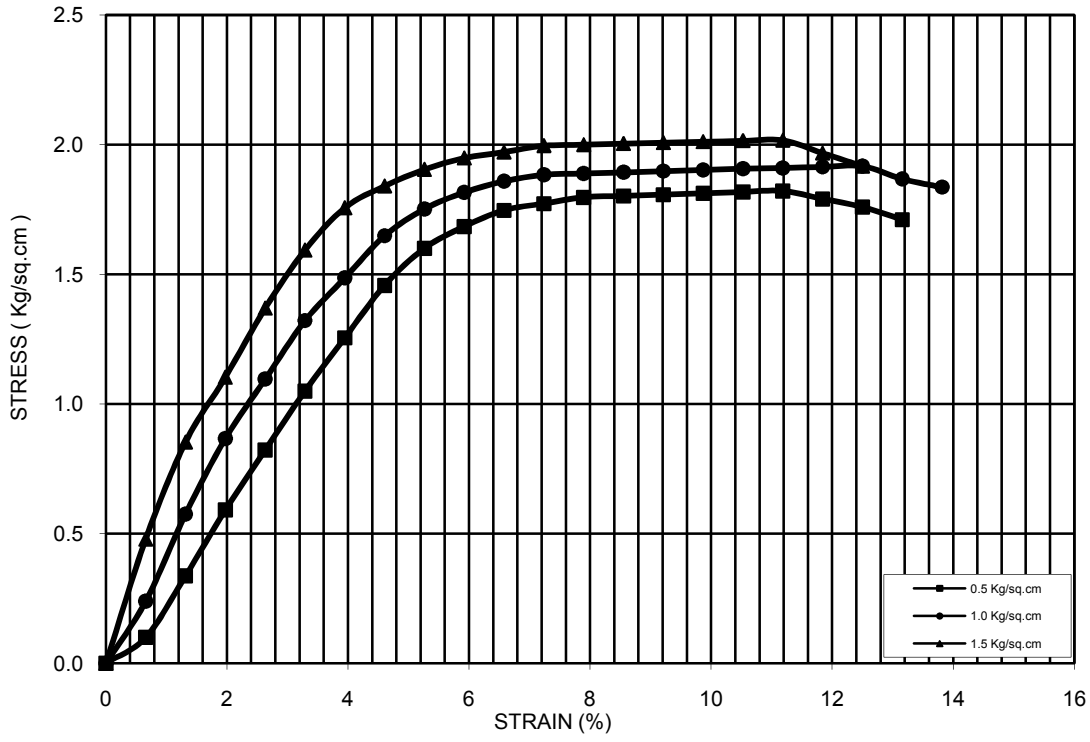
BORE HOLE NO: BH-P10
CHAINAGE= 42+256
SAMPLE NO.: UDS-6
DEPTH: 20.50 m
COHESION(C)= 0.19 kg/sq.cm
ANGLE OF FRICTION(Phi): 25 deg
TYPE OF THE TEST: DST



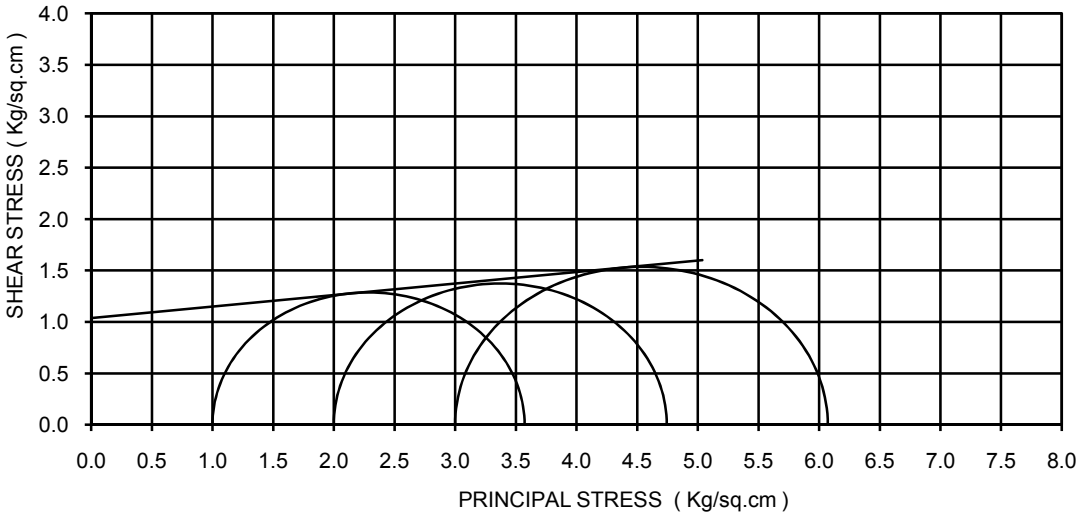


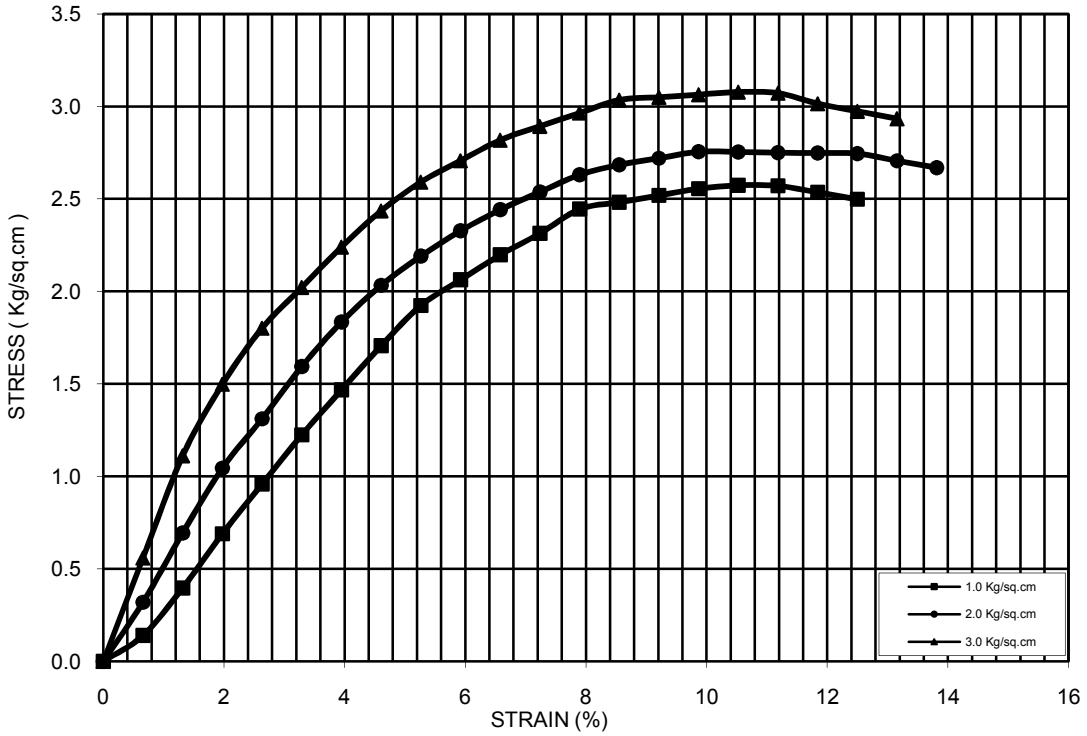
BORE HOLE NO:BH-P11
CH.-42+256
SAMPLE NO.: UDS-2
DEPTH: 4.00 m
COHESION(C)= 0.78 kg/sq.cm
ANGLE OF FRICTION(Phi): 5 deg
TYPE OF THE TEST: UUT



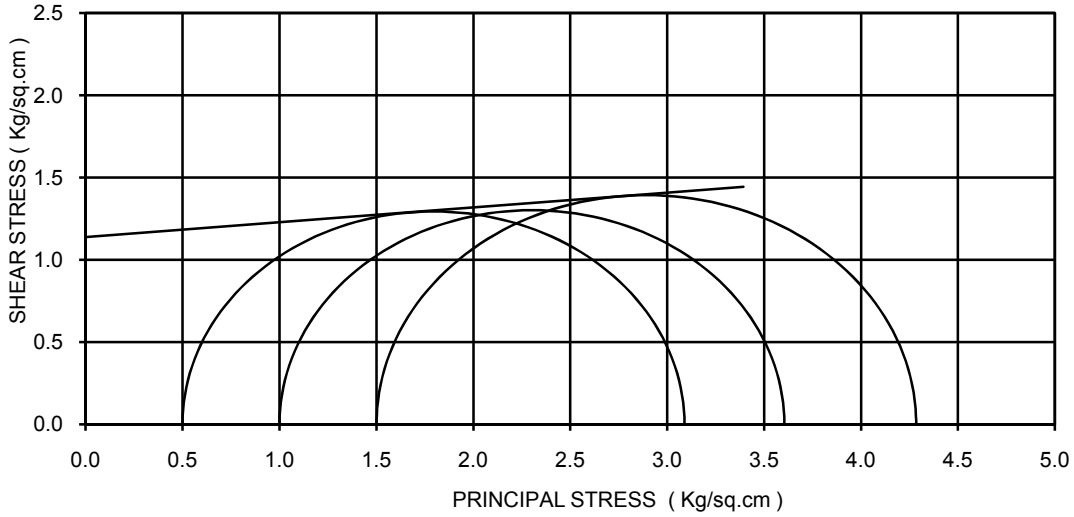


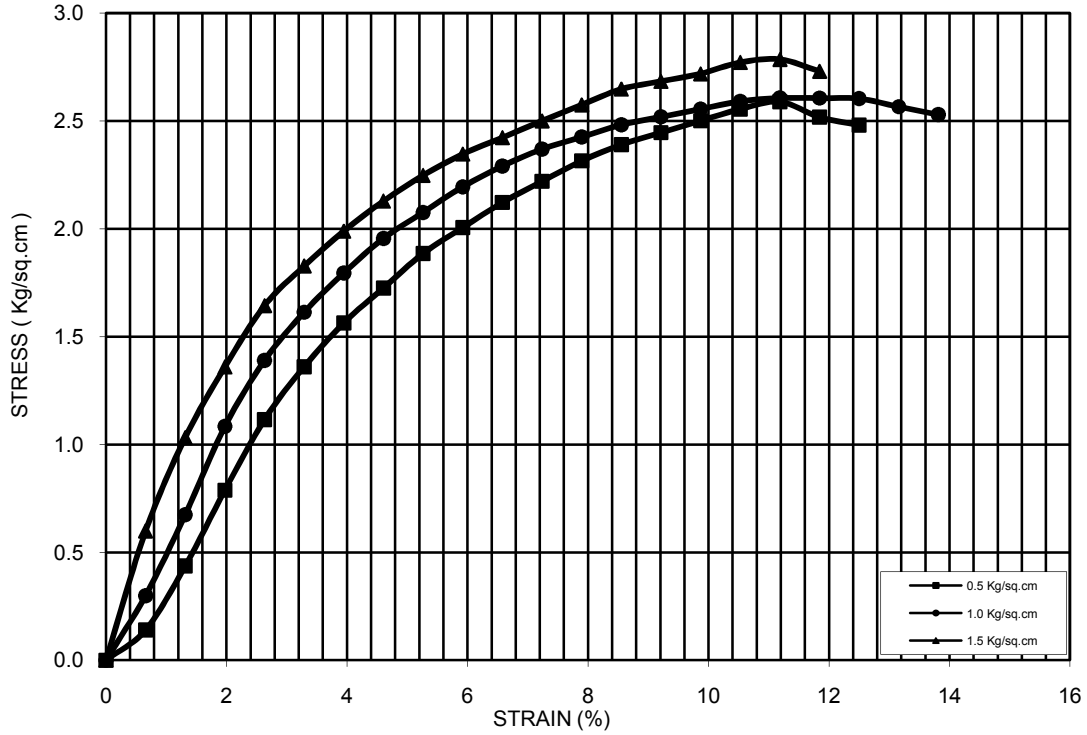
BORE HOLE NO: BH-P11
CHAINAGE : 42+256
SAMPLE NO.: UDS-4
DEPTH: 13.00 m
COHESION(C)= 1.04 kg/sq.cm
ANGLE OF FRICTION(Phi): 6 deg
TYPE OF THE TEST: UUT



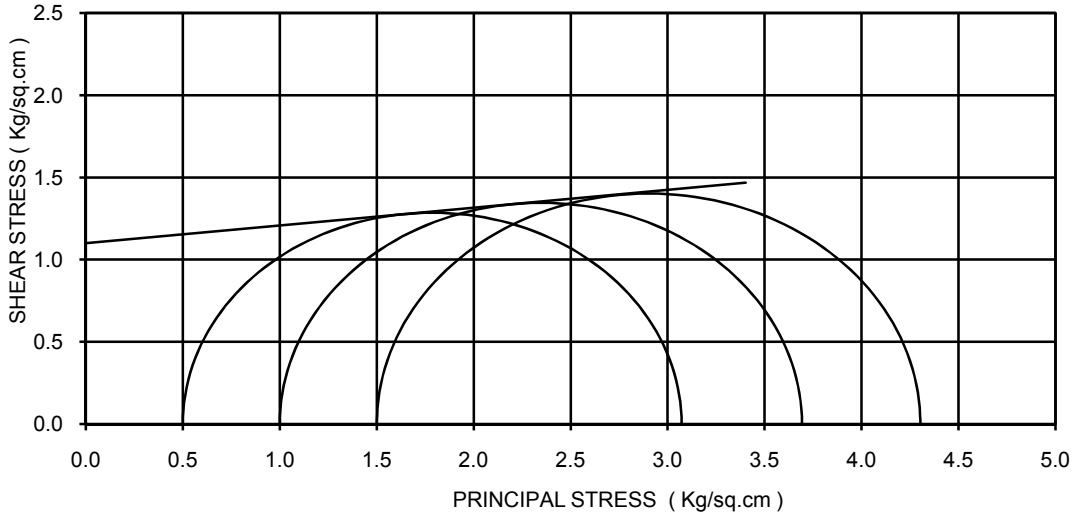


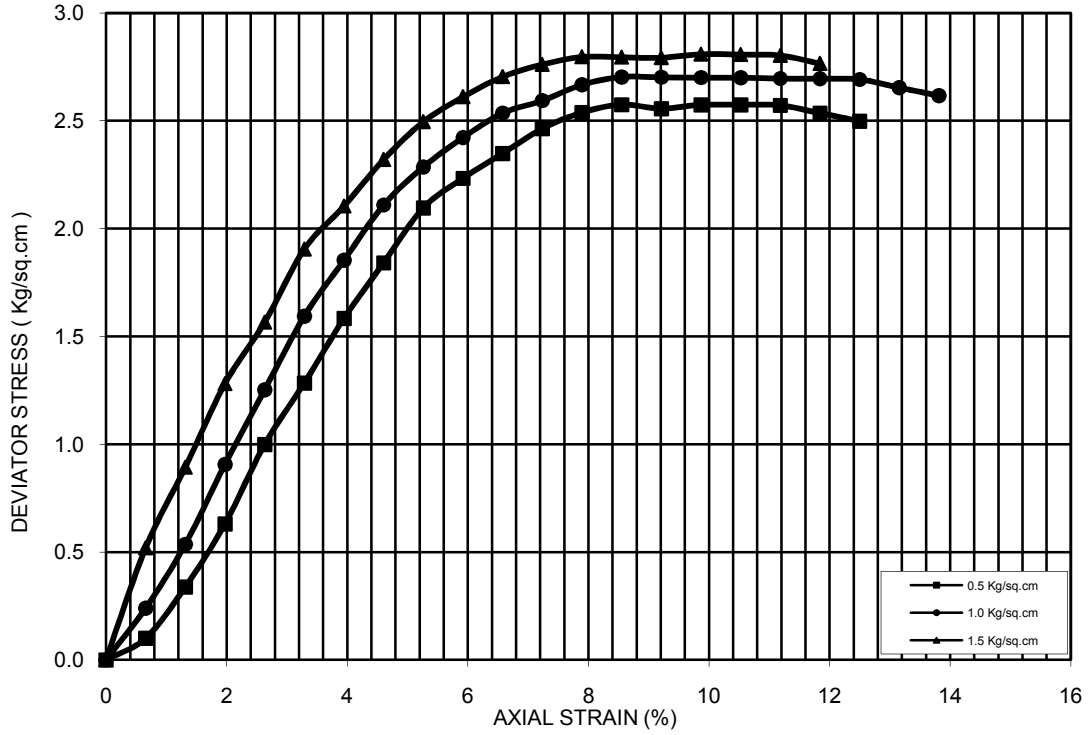
BORE HOLE NO: BH-P12
CHAINAGE : 42+256
SAMPLE NO.: UDS-2
DEPTH: 5.50 m
COHESION(C)= 1.14 kg/sq.cm
ANGLE OF FRICTION(Phi): 5 deg
TYPE OF THE TEST: UUT





BORE HOLE NO: BH-P12
CHAINAGE= 42+256
SAMPLE NO.: UDS-3
DEPTH: 8.50 m
COHESION(C)= 1.10 kg/sq.cm
ANGLE OF FRICTION(Phi): 6 deg
TYPE OF THE TEST: UUT





APPENDIX – C
(ANALYSIS & RECOMENDATION)

Appendix No.	ITEMS
C-1	SAMPLE CALCULATION SHEET OF LIQUEFACTION ANALYSIS RESULTS
C-2	SAMPLE CALCULATIONS FOR COMPUTATION OF ALLOWABLE BEARING CAPACITY OF SUB-STRATA FOR SHALLOW FOUNDATION
C-3	SAMPLE CALCULATION FOR COMPUTATION OF SAFE LOAD CARRYING CAPACITY OF NORMAL BORED CAST-IN-SITU RCC PILE IN COMPRESSION & UPLIFT
C-4	SAMPLE CALCULATION FOR COMPUTATION OF SAFE LOAD CARRYING CAPACITY OF NORMAL BORED CAST-IN-SITU RCC PILE IN LATERAL

Liquefaction Analysis as per IRC:75-2015, IS: 1893 (Part-1)-2016 & RDSO BS-118

Chainage (Km)	42+256	BH No.:-	BH-P1	Liquefiable upto=	8.50m	Water Table depth considered for analysis (m):-	0.00

Depth Below G.L. (z) in m	Observed SPT Value	Saturated Density (t/m^3)	Submerged Density (t/m^3)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Moisture Content @ 100% saturation	Strata Type	Liquefaction Check for Cohesive Strata	Fine Content (%)	Stress Reduction Coefficient (rd)	Total Overburden Press (σ_v), t/m^2	Effective Overburden (σ'_v), t/m^2	Critical Stress Ratio (CSR)	C_{HT}	C_{HW}	C_{SS}	C_{RL}	C_{BD}	C_{60}	Stress Normalization Factor(C_N)	SPT Corrected $(N1)_{60}$	α	β	$(N1)_{60CS}$	$CRR_{M=7.5}$	K_M	Kα	Kσ	CRR_{Mw}	FOS	Conclusion
2.50	10	1.95	0.95	26.00	21.00	5.00	28.20	Cohesive	Liquefiable	59	0.981	4.50	2.00	0.344	0.75	0.986	1.00	0.75	1.05	0.582	1.70	9.9	5.00	1.20	16.88	0.180	1.19	1	1.00	0.214	0.62	Liquefiable
5.50	13	1.95	0.95	28.00	22.00	6.00	27.77	Cohesive	Liquefiable	53	0.958	10.35	4.85	0.319	0.75	0.986	1.00	0.85	1.05	0.660	1.42	12.2	5.00	1.20	19.64	0.211	1.19	1	1.00	0.252	0.79	Liquefiable
8.50	21	1.98	0.98	32.00	21.00	11.00	26.79	Cohesive	Liquefiable	70	0.935	16.21	7.71	0.307	0.75	0.986	1.00	0.95	1.05	0.738	1.13	17.5	5.00	1.20	25.95	0.312	1.19	1	1.00	0.372	1.21	Non Liquefiable
11.50	37	2.00	1.00	33.00	22.00	11.00	25.19	Cohesive	Non-Liquefiable	-	0.867	22.14	10.64	0.281	0.75	0.986	1.00	1.00	1.05	0.776	-	-	-	-	-	-	-	-	-	-	>1	Non Liquefiable
14.50	46	2.02	1.02	33.00	20.00	13.00	23.90	Cohesive	Non-Liquefiable	-	0.787	28.15	13.65	0.253	0.75	0.986	1.00	1.00	1.05	0.776	-	-	-	-	-	-	-	-	-	-	>1	Non Liquefiable
16.50	49	2.02	1.02	31.00	21.00	10.00	23.90	Cohesive	Non-Liquefiable	-	0.733	32.19	15.69	0.235	0.75	0.986	1.00	1.00	1.05	0.776	-	-	-	-	-	-	-	-	-	-	>1	Non Liquefiable
17.50	66	2.02	1.02	31.00	21.00	10.00	23.90	Cohesive	Non-Liquefiable	-	0.707	34.21	16.71	0.226	0.75	0.986	1.00	1.00	1.05	0.776	-	-	-	-	-	-	-	-	-	-	>1	Non Liquefiable
19.50	76	2.02	1.02	31.00	21.00	10.00	23.90	Cohesive	Non-Liquefiable	-	0.653	38.25	18.75	0.208	0.75	0.986	1.00	1.00	1.05	0.776	-	-	-	-	-	-	-	-	-	-	>1	Non Liquefiable
20.50	81	2.02	1.02	32.00	22.00	10.00	23.90	Cohesive	Non-Liquefiable	-	0.627	40.27	19.77	0.199	0.75	0.986	1.00	1.00	1.05	0.776	-	-	-	-	-	-	-	-	-	-	>1	Non Liquefiable
22.50	55	2.02	1.02	32.00	22.00	10.00	23.90	Cohesive	Non-Liquefiable	-	0.573	44.31	21.81	0.182	0.75	0.986	1.00	1.00	1.05	0.776	-	-	-	-	-	-	-	-	-	-	>1	Non Liquefiable

Calculation of SBC for shallow foundations as per IS : 6403 - 1981

INPUT DATA

CH. (KM) :- 42+256

BH NO. :- BH-P1

Type of footing

1 Continuous Strip
2 Rectangular
3 Square
4 Circular

Square **3**

Angle of internal friction (ϕ^o)	26.00
Cohesion (c in t/m^2)	1.50
Void ratio (e), $e = (G.\gamma_w/\gamma_d)-1$	0.74
Direction of load with vertical (^{o})	0.00
Density of foundation soil (t/m^3) γ_{bulk}	1.75
Depth of water table(m)	0.00
Factor of safety	2.50

S.no.	Depth (m) of footing (D_f) below EGL	Width (m)
1	2.00	7.20
2	3.00	7.20
3	4.00	7.20

SHEAR FAILURE CRITERIA

Assumptions and formula used in calculation as per IS:6403-1981 are given below -

NOTE: The type of failure used for bearing capacity analysis depends upon the value of void ratio (see IS 6403 : 1981, Page No. 9, Table No. 3).

The ultimate net bearing capacity in case of general shear failure is given by (from IS 6403 : 1981, page No. 8)

$$q_d = c\,N_c\,s_c\,d_c\,i_c + q\,(N_q-1)\,s_q\,d_q\,i_q + (1/2)\,B\,\gamma\,N_\gamma\,s_\gamma\,d_\gamma\,i_\gamma\,W'$$

The ultimate net bearing capacity in case of local shear failure is given by (from IS 6403 : 1981, page No. 8)

$$q'_d = (2/3)\,c\,N'_c\,s_c\,d_c\,i_c + q\,(N'_q-1)\,s_q\,d_q\,i_q + (1/2)\,B\,\gamma\,N'_\gamma\,s_\gamma\,d_\gamma\,i_\gamma\,W'$$

Where,

$d_c = 1+ 0.2\,(D_f/B)*SQRT(N_\phi)$

$d_q = d_\gamma = 1$ for $\phi < 10^o$

$d_q = d_\gamma = 1 + 0.1\,(D_f/B)*SQRT(N_\phi)$ for $\phi > 10^o$

(from IS 6403 : 1981, page No. 9)

$N_\phi = \tan^2(\pi/4 + \phi/2)$

ϕ' is friction angle for local shear failure = $\tan^{-1}(0.67\tan\phi)$

OUTPUT

The computer aided results for shear failure criteria are tabulated below. The results are interpolated values of bearing capacity obtained from general and local shear failure criteria.

Bearing capacity factors : (from IS 6403 : 1981, page No. 8, Table No. 1)

ϕ	26.00	ϕ'	18.10
N_c	22.25	N'_c	13.18
N_q	11.85	N'_q	5.31
N_γ	12.54	N'_γ	4.12

Shape factors : (from IS 6403 : 1981, page No. 8, Table No. 2)

S.no.	Width(m)	S_c	S_q	S_γ
1	7.20	1.30	1.20	0.80
2	7.20	1.30	1.20	0.80
3	7.20	1.30	1.20	0.80
		1.30	1.20	0.80
		1.30	1.20	0.80
		1.30	1.20	0.80

Depth factors : (from IS 6403 : 1981, page No. 9)

S.no.	Depth(m)	Width(m)	dc	d_q	d_γ
1	2.00	7.20	1.09	1.04	1.04
2	3.00	7.20	1.13	1.07	1.07
3	4.00	7.20	1.18	1.09	1.09

Inclination factors : (from IS 6403 : 1981, page No. 9)

$i_c = (1-\alpha / 90)^2$	$i_q = (1-\alpha / 90)^2$	$i_\gamma = (1-\alpha / \phi)^2$
1.00	1.00	1.00

Water table factor : (from IS 6403 : 1981, page No. 9)

S.no.	Depth(m)	Width(m)	Z_w/B	W'
1	2.00	7.20	-0.28	0.50
2	3.00	7.20	-0.42	0.50
3	4.00	7.20	-0.56	0.50

Safe Bearing Capacity

S.no.	Depth(m)	Width(m)	SBC in (t/m^2)		
			General shear	Local shear	Recommended
1	2.00	7.20	40.19	15.01	16.45
2	3.00	7.20	45.56	17.12	18.75
3	4.00	7.20	51.10	19.30	21.12

SETTLEMENT CALCULATION AS PER 8009 Part-1 1976														CH. (KM): 42+256				BH NO. :- BH-P1		
Layer	Depth below FGL (m)	From (m)	To (m)	Layer Thickness	Stress at Foundation level (Kg/Cm2)	Length (m)	Breadth (m)	Layer Thickness(m)	Dispersed Length (m)	Dispersed Breadth (m)	Stress Increment at top for cohesionless layer & at mid Depth for cohesive layer (kg/Cm2)	Average N-Value	Mvc (Cm^2/Kg)	Consolidation Settlement (mm)	Settlement (mm) for 10 t/m2 (from IS:8009 (Part I), Fig. 9, Page NO. 17)	Settlement in Non-Cohesive Soil Si (mm)	Total Settlement (mm)	Depth Factor	Rigidity Factor	Corrected Total Settlement (mm)
Layer 1		2.00	7.00	5.00				5.00	7.20	7.200	0.779	15			22.00	24.40	24.40			
Layer 2		7.00	12.80	5.80				5.80	15.100	15.100	0.177	54	0.0025	2.54			2.54			
	2.00				0.78	7.20	7.20											0.93	1.00	25.00
Layer 1		3.00	7.00	4.00				4.00	7.20	7.200	0.927	15			22.00	24.61	24.61			
Layer 2		7.00	13.80	6.80				6.80	14.600	14.600	0.225	54	0.0025	3.78			3.78			
	3.00				0.93	7.20	7.20											0.88	1.00	25.00
Layer 1		4.00	7.00	3.00				3.00	7.20	7.200	1.150	15			22.00	24.21	24.21			
Layer 2		7.00	14.80	7.80				7.80	14.100	14.100	0.300	54	0.0025	5.78			5.78			
	4.00				1.15	7.20	7.20											0.83	1.00	25.00

SETTLEMENT CALCULATION AS PER 8009 Part-1 1976														CH. (KM): 42+256				BH NO. :- BH-P1		
Layer	Depth below FGL (m)	From (m)	To (m)	Layer Thickness	Stress at Foundation level (Kg/Cm2)	Length (m)	Breadth (m)	Layer Thickness(m)	Dispersed Length (m)	Dispersed Breadth (m)	Stress Increment at top for cohesionless layer & at mid Depth for cohesive layer (kg/Cm2)	Average N-Value	Mvc (Cm^2/Kg)	Consolidation Settlement (mm)	Settlement (mm) for 10 t/m2 (from IS:8009 (Part I), Fig. 9, Page NO. 17)	Settlement in Non-Cohesive Soil Si (mm)	Total Settlement (mm)	Depth Factor	Rigidity Factor	Corrected Total Settlement (mm)
Layer 1		2.00	7.00	5.00				5.00	7.20	7.200	1.559	15			22.00	48.80	48.80			
Layer 2		7.00	12.80	5.80				5.80	15.100	15.100	0.354	54	0.0025	5.08			5.08			
	2.00				1.56	7.20	7.20											0.93	1.00	50.00
Layer 1		3.00	7.00	4.00				4.00	7.20	7.200	1.854	15			22.00	49.23	49.23			
Layer 2		7.00	13.80	6.80				6.80	14.600	14.600	0.451	54	0.0025	7.57			7.57			
	3.00				1.85	7.20	7.20											0.88	1.00	50.00
Layer 1		4.00	7.00	3.00				3.00	7.20	7.200	2.301	15			22.00	48.43	48.43			
Layer 2		7.00	14.80	7.80				7.80	14.100	14.100	0.600	54	0.0025	11.55			11.55			
	4.00				2.30	7.20	7.20											0.83	1.00	50.00

NAME OF PROJECT:- "GTI for designing of bridges and embankment for Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.

Length of Pile below cut of level = 20.00 m **Bore Hole No =** BH-P1 **Ch. (KM)** 101+830 **Dia of pile =** 1.00 m **Cut-off Level =** 2.00 m below EGL

Restricting PD to 15D **Water Table depth considered for analysis =** 0.00 m **Scour Depth =** Non-scourable **Liquefaction Depth =** 8.50 m

Dia. of Pile	Cut-off Depth	Soil layers		Properties of layers/for Skin Friction							For End Bearing										
		from	to	c	Ø	k	α	γeff	ΔL	pd (s.f)	Pd (e.b)	γeff	c	Ø	Nc	Nq	Ny	As/cm	Ap	qs	Qp
(m)	(m)	(m)	(m)	kg/cm^2	deg			gm/cc	cm	kg/cm^2	kg/cm^2	gm/cc	kg/cm^2	deg				cm^2	cm^2	t	t
1.00	2.00	0.00	2.00					0.72	200	0.07											
1.00		2.00	4.00	0.13	25	1.00	1.00	0.72	200	0.22								314.29		0.00	
1.00		4.00	7.00	0.15	25	1.00	1.00	0.75	300	0.40								314.29		0.00	
1.00		7.00	8.50	0.77	6	1.00	0.59	0.87	150	0.58								314.29		0.00	
1.00		8.50	10.00	0.77	6	1.00	0.59	0.87	150	0.71								314.29		24.95	
1.00		10.00	13.00	1.38	6	1.00	0.34	0.93	300	0.91								314.29		52.78	
1.00		13.00	15.00	1.71	5	1.00	0.26	0.97	200	1.15								314.29		34.26	
1.00		15.00	22.00	1.71	5	1.00	0.26	0.97	700	1.25	1.25	0.88	0.19	25	9	10.00	10.88	314.29	7857.14	121.80	115.08
																				233.79	115.08

Qu,comp.= qs + Qp Qu,uplift = Safe Frictional Resistance + Weight of Pile

Qa,comp.= (233.79 + 115.08) / 2.5 Qa,uplift = 233.79 / 3 + 39.27

Qa,comp.= 139.55 T Qa,uplift = 117.20 T

Say **Qa,comp.= 139.00 T** **Qa,uplift = 117.00 T**

*FOS for Vertical Capacity of pile in compression = 2.5

**FOS for Uplift Capacity of pile = 3.0

CEGTH CEG TEST HOUSE AND RESEARCH CENTRE PVT. LTD.

NAME OF PROJECT:- "GTI for designing of bridges and embankment for Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.

Length of Pile below cut of level = 22.00 m **Bore Hole No =** BH-P1 **Ch. (KM)** 42+256 **Dia of pile =** 1.00 m **Cut-off Level =** 2.00 m below EGL

Restricting PD to 15D **Water Table depth considered for analysis =** 0.00 m **Scour Depth =** Non-scourable **Liquefaction Depth =** 8.50 m

Dia. of Pile	Cut-off Depth	Soil layers		Properties of layers/for Skin Friction							For End Bearing										
		from	to	c	Ø	k	α	γeff	ΔL	pd (s.f)	Pd (e.b)	γeff	c	Ø	Nc	Nq	Ny	As/cm	Ap	qs	Qp
(m)	(m)	(m)	(m)	kg/cm^2	deg			gm/cc	cm	kg/cm^2	kg/cm^2	gm/cc	kg/cm^2	deg				cm^2	cm^2	t	t
1.00	2.00	0.00	2.00					0.72	200	0.07											
1.00		2.00	4.00	0.13	25	1.00	1.00	0.72	200	0.22								314.29		0.00	
1.00		4.00	7.00	0.15	25	1.00	1.00	0.75	300	0.40								314.29		0.00	
1.00		7.00	8.50	0.77	6	1.00	0.59	0.87	150	0.58								314.29		0.00	
1.00		8.50	10.00	0.77	6	1.00	0.59	0.87	150	0.71								314.29		24.95	
1.00		10.00	13.00	1.38	6	1.00	0.34	0.93	300	0.91								314.29		52.78	
1.00		13.00	15.00	1.71	5	1.00	0.26	0.97	200	1.15								314.29		34.26	
1.00		15.00	23.50	1.71	5	1.00	0.26	0.97	850	1.25								314.29		147.90	
1.00		23.50	24.00	0.19	25	1.00	1.00	0.88	50	1.25	1.25	0.88	0.19	25	9	10.00	10.88	314.29	7857.14	12.12	115.08
																				272.01	115.08

Qu,comp.= qs + Qp Qu,uplift = Safe Frictional Resistance + Weight of Pile

Qa,comp.= (272.01 + 115.08) / 2.5 Qa,uplift = 272.01 / 3 + 43.2

Qa,comp.= 154.84 T Qa,uplift = 133.87 T

Say **Qa,comp.= 154.00 T** **Qa,uplift = 133.00 T**

*FOS for Vertical Capacity of pile in compression = 2.5

**FOS for Uplift Capacity of pile = 3.0

NAME OF PROJECT:- "GTI for designing of bridges and embankment for Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.

Length of Pile below cut of level = 24.00 m **Bore Hole No =** BH-P1 **Ch. (KM)** 42+256 **Dia of pile =** 1.00 m **Cut-off Level =** 2.00 m below EGL

Restricting PD to 15D **Water Table depth considered for analysis =** 0.00 m **Scour Depth =** Non-scourable **Liquefaction Depth =** 8.50 m

Dia. of Pile	Cut-off Depth	Soil layers		Properties of layers/for Skin Friction							For End Bearing										
		from	to	c	Ø	k	α	γeff	ΔL	pd (s.f)	Pd (e.b)	γeff	c	Ø	Nc	Nq	Ny	As/cm	Ap	qs	Qp
(m)	(m)	(m)	(m)	kg/cm^2	deg			gm/cc	cm	kg/cm^2	kg/cm^2	gm/cc	kg/cm^2	deg				cm^2	cm^2	t	t
1.00	2.00	0.00	2.00					0.72	200	0.07											
1.00		2.00	4.00	0.13	25	1.00	1.00	0.72	200	0.22								314.29		0.00	
1.00		4.00	7.00	0.15	25	1.00	1.00	0.75	300	0.40								314.29		0.00	
1.00		7.00	8.50	0.77	6	1.00	0.59	0.87	150	0.58								314.29		0.00	
1.00		8.50	10.00	0.77	6	1.00	0.59	0.87	150	0.71								314.29		24.95	
1.00		10.00	13.00	1.38	6	1.00	0.34	0.93	300	0.91								314.29		52.78	
1.00		13.00	15.00	1.71	5	1.00	0.26	0.97	200	1.15								314.29		34.26	
1.00		15.00	23.50	1.71	5	1.00	0.26	0.97	850	1.25								314.29		147.90	
1.00		23.50	26.00	0.19	25	1.00	1.00	0.88	250	1.25	1.25	0.88	0.19	25	9	10.00	10.88	314.29	7857.14	60.59	115.08
																				320.48	115.08

Qu,comp.= qs + Qp Qu,uplift = Safe Frictional Resistance + Weight of Pile

Qa,comp.= (320.48 + 115.08) / 2.5 Qa,uplift = 320.48 / 3 + 47.12

Qa,comp.= 174.22 T Qa,uplift = 153.95 T

Say **Qa,comp.= 174.00 T** **Qa,uplift = 153.00 T**

*FOS for Vertical Capacity of pile in compression = 2.5

**FOS for Uplift Capacity of pile = 3.0

CEGTH CEG TEST HOUSE AND RESEARCH CENTRE PVT. LTD.

NAME OF PROJECT:- "GTI for designing of bridges and embankment for Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.

Length of Pile below cut of level = 26.00 m **Bore Hole No =** BH-P1 **Ch. (KM)** 42+256 **Dia of pile =** 1.00 m **Cut-off Level =** 2.00 m below EGL

Restricting PD to 15D **Water Table depth considered for analysis =** 0.00 m **Scour Depth =** Non-scourable **Liquefaction Depth =** 8.50 m

Dia. of Pile	Cut-off Depth	Soil layers		Properties of layers/for Skin Friction							For End Bearing										
		from	to	c	Ø	k	α	γeff	ΔL	pd (s.f)	Pd (e.b)	γeff	c	Ø	Nc	Nq	Ny	As/cm	Ap	qs	Qp
(m)	(m)	(m)	(m)	kg/cm^2	deg			gm/cc	cm	kg/cm^2	kg/cm^2	gm/cc	kg/cm^2	deg				cm^2	cm^2	t	t
1.00	2.00	0.00	2.00					0.72	200	0.07											
1.00		2.00	4.00	0.13	25	1.00	1.00	0.72	200	0.22								314.29		0.00	
1.00		4.00	7.00	0.15	25	1.00	1.00	0.75	300	0.40								314.29		0.00	
1.00		7.00	8.50	0.77	6	1.00	0.59	0.87	150	0.58								314.29		0.00	
1.00		8.50	10.00	0.77	6	1.00	0.59	0.87	150	0.71								314.29		24.95	
1.00		10.00	13.00	1.38	6	1.00	0.34	0.93	300	0.91								314.29		52.78	
1.00		13.00	15.00	1.71	5	1.00	0.26	0.97	200	1.15								314.29		34.26	
1.00		15.00	23.50	1.71	5	1.00	0.26	0.97	850	1.25								314.29		147.90	
1.00		23.50	28.00	0.19	25	1.00	1.00	0.88	450	1.25	1.25	0.88	0.19	25	9	10.00	10.88	314.29	7857.14	109.06	115.08
																				368.95	115.08

Qu,comp.= qs + Qp Qu,uplift = Safe Frictional Resistance + Weight of Pile

Qa,comp.= (368.95 + 115.08) / 2.5 Qa,uplift = 368.95 / 3 + 51.05

Qa,comp.= 193.61 T Qa,uplift = 174.03 T

Say **Qa,comp.= 193.00 T** **Qa,uplift = 174.00 T**

*FOS for Vertical Capacity of pile in compression = 2.5

**FOS for Uplift Capacity of pile = 3.0

CEGTH CEG TEST HOUSE AND RESEARCH CENTRE PVT. LTD.

NAME OF PROJECT:- "GTI for designing of bridges and embankment for Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.

Length of Pile below cut of level = 28.00 m **Bore Hole No =** BH-P1 **Ch. (KM)** 42+256 **Dia of pile =** 1.00 m **Cut-off Level =** 2.00 m below EGL

Restricting PD to 15D **Water Table depth considered for analysis =** 0.00 m **Scour Depth =** Non-scourable **Liquefaction Depth =** 8.50 m

Dia. of Pile	Cut-off Depth	Soil layers		Properties of layers/for Skin Friction							For End Bearing										
		from	to	c	Ø	k	α	γeff	ΔL	pd (s.f)	Pd (e.b)	γeff	c	Ø	Nc	Nq	Ny	As/cm	Ap	qs	Qp
(m)	(m)	(m)	(m)	kg/cm^2	deg			gm/cc	cm	kg/cm^2	kg/cm^2	gm/cc	kg/cm^2	deg				cm^2	cm^2	t	t
1.00	2.00	0.00	2.00					0.72	200	0.07											
1.00		2.00	4.00	0.13	25	1.00	1.00	0.72	200	0.22								314.29		0.00	
1.00		4.00	7.00	0.15	25	1.00	1.00	0.75	300	0.40								314.29		0.00	
1.00		7.00	8.50	0.77	6	1.00	0.59	0.87	150	0.58								314.29		0.00	
1.00		8.50	10.00	0.77	6	1.00	0.59	0.87	150	0.71								314.29		24.95	
1.00		10.00	13.00	1.38	6	1.00	0.34	0.93	300	0.91								314.29		52.78	
1.00		13.00	15.00	1.71	5	1.00	0.26	0.97	200	1.15								314.29		34.26	
1.00		15.00	23.50	1.71	5	1.00	0.26	0.97	850	1.25								314.29		147.90	
1.00		23.50	28.50	0.19	25	1.00	1.00	0.88	500	1.25								314.29		121.17	
1.00		28.50	30.00	0.00	31	1.00	1.00	0.81	150	1.25	1.25	0.88	0.19	25	9	10.00	10.88	314.29	7857.14	35.30	115.08
																				416.36	115.08

Qu,comp.= qs + Qp Qu,uplift = Safe Frictional Resistance + Weight of Pile

Qa,comp.= (416.36 + 115.08) / 2.5 Qa,uplift = 416.36 / 3 + 54.98

Qa,comp.= 212.58 T Qa,uplift = 193.77 T

Say **Qa,comp.= 212.00 T** **Qa,uplift = 193.00 T**

*FOS for Vertical Capacity of pile in compression = 2.5

**FOS for Uplift Capacity of pile = 3.0

CEGTH CEG TEST HOUSE AND RESEARCH CENTRE PVT. LTD.

NAME OF PROJECT:- "GTI for designing of bridges and embankment for Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.

Length of Pile below cut of level = 30.00 m **Bore Hole No =** BH-P1 **Ch. (KM)** 42+256 **Dia of pile =** 1.00 m **Cut-off Level =** 2.00 m below EGL

Restricting PD to 15D **Water Table depth considered for analysis =** 0.00 m **Scour Depth =** Non-scourable **Liquefaction Depth =** 8.50 m

Dia. of Pile	Cut-off Depth	Soil layers		Properties of layers/for Skin Friction							For End Bearing										
		from	to	c	Ø	k	α	γeff	ΔL	pd (s.f)	Pd (e.b)	γeff	c	Ø	Nc	Nq	Ny	As/cm	Ap	qs	Qp
(m)	(m)	(m)	(m)	kg/cm^2	deg			gm/cc	cm	kg/cm^2	kg/cm^2	gm/cc	kg/cm^2	deg				cm^2	cm^2	t	t
1.00	2.00	0.00	2.00					0.72	200	0.07											
1.00		2.00	4.00	0.13	25	1.00	1.00	0.72	200	0.22								314.29		0.00	
1.00		4.00	7.00	0.15	25	1.00	1.00	0.75	300	0.40								314.29		0.00	
1.00		7.00	8.50	0.77	6	1.00	0.59	0.87	150	0.58								314.29		0.00	
1.00		8.50	10.00	0.77	6	1.00	0.59	0.87	150	0.71								314.29		24.95	
1.00		10.00	13.00	1.38	6	1.00	0.34	0.93	300	0.91								314.29		52.78	
1.00		13.00	15.00	1.71	5	1.00	0.26	0.97	200	1.15								314.29		34.26	
1.00		15.00	23.50	1.71	5	1.00	0.26	0.97	850	1.25								314.29		147.90	
1.00		23.50	28.50	0.19	25	1.00	1.00	0.88	500	1.25								314.29		121.17	
1.00		28.50	32.00	0.00	31	1.00	1.00	0.81	350	1.25	1.25	0.81	0.00	31	9	24.74	25.99	314.29	7857.14	82.37	250.42
																				463.43	250.42

Qu,comp.= qs + Qp Qu,uplift = Safe Frictional Resistance + Weight of Pile

Qa,comp.= (463.43 + 250.42) / 2.5 Qa,uplift = 463.43 / 3 + 58.9

Qa,comp.= 285.54 T Qa,uplift = 213.38 T

Say **Qa,comp.= 285.00 T** **Qa,uplift = 213.00 T**

*FOS for Vertical Capacity of pile in compression = 2.5

**FOS for Uplift Capacity of pile = 3.0

CEGTH CEG TEST HOUSE AND RESEARCH CENTRE PVT. LTD.

NAME OF PROJECT:- "GTI for designing of bridges and embankment for Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.

Length of Pile below cut of level = 20.00 m **Bore Hole No =** BH-P1 **Ch. (KM)** 42+256 **Dia of pile =** 1.20 m **Cut-off Level =** 2.00 m below EGL

Restricting PD to 15D **Water Table depth considered for analysis =** 0.00 m **Scour Depth =** Non-scourable **Liquefaction Depth =** 8.50 m

Dia. of Pile	Cut-off Depth	Soil layers		Properties of layers/for Skin Friction							For End Bearing										
		from	to	c	Ø	k	α	γeff	ΔL	pd (s.f)	Pd (e.b)	γeff	c	Ø	Nc	Nq	Ny	As/cm	Ap	qs	Qp
(m)	(m)	(m)	(m)	kg/cm^2	deg			gm/cc	cm	kg/cm^2	kg/cm^2	gm/cc	kg/cm^2	deg				cm^2	cm^2	t	t
1.20	2.00	0.00	2.00					0.72	200	0.07											
1.20		2.00	4.00	0.13	25	1.00	1.00	0.72	200	0.22								377.14		0.00	
1.20		4.00	7.00	0.15	25	1.00	1.00	0.75	300	0.40								377.14		0.00	
1.20		7.00	8.50	0.77	6	1.00	0.59	0.87	150	0.58								377.14		0.00	
1.20		8.50	10.00	0.77	6	1.00	0.59	0.87	150	0.71								377.14		29.94	
1.20		10.00	13.00	1.38	6	1.00	0.34	0.93	300	0.91								377.14		63.33	
1.20		13.00	18.00	1.71	5	1.00	0.26	0.97	500	1.29								377.14		105.20	
1.20		18.00	22.00	1.71	5	1.00	0.26	0.97	400	1.54	1.54	0.88	0.19	25	9	10.00	10.88	377.14	11314.29	87.38	199.87
																				285.85	199.87

Qu,comp.= qs + Qp Qu,uplift = Safe Frictional Resistance + Weight of Pile

Qa,comp.= (285.85 + 199.87) / 2.5 Qa,uplift = 285.85 / 3 + 56.55

Qa,comp.= 194.29 T Qa,uplift = 151.83 T

Say **Qa,comp.= 194.00 T** **Qa,uplift = 151.00 T**

*FOS for Vertical Capacity of pile in compression = 2.5

**FOS for Uplift Capacity of pile = 3.0

CEGTH CEG TEST HOUSE AND RESEARCH CENTRE PVT. LTD.

NAME OF PROJECT:- "GTI for designing of bridges and embankment for Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.

Length of Pile below cut of level = 22.00 m **Bore Hole No =** BH-P1 **Ch. (KM)** 42+256 **Dia of pile =** 1.20 m **Cut-off Level =** 2.00 m below EGL

Restricting PD to 15D **Water Table depth considered for analysis =** 0.00 m **Scour Depth =** Non-scourable **Liquefaction Depth =** 8.50 m

Dia. of Pile	Cut-off Depth	Soil layers		Properties of layers/for Skin Friction							For End Bearing										
		from	to	c	Ø	k	α	γeff	ΔL	pd (s.f)	Pd (e.b)	γeff	c	Ø	Nc	Nq	Ny	As/cm	Ap	qs	Qp
(m)	(m)	(m)	(m)	kg/cm^2	deg			gm/cc	cm	kg/cm^2	kg/cm^2	gm/cc	kg/cm^2	deg				cm^2	cm^2	t	t
1.20	2.00	0.00	2.00					0.72	200	0.07											
1.20		2.00	4.00	0.13	25	1.00	1.00	0.72	200	0.22								377.14		0.00	
1.20		4.00	7.00	0.15	25	1.00	1.00	0.75	300	0.40								377.14		0.00	
1.20		7.00	8.50	0.77	6	1.00	0.59	0.87	150	0.58								377.14		0.00	
1.20		8.50	10.00	0.77	6	1.00	0.59	0.87	150	0.71								377.14		29.94	
1.20		10.00	13.00	1.38	6	1.00	0.34	0.93	300	0.91								377.14		63.33	
1.20		13.00	18.00	1.71	5	1.00	0.26	0.97	500	1.29								377.14		105.20	
1.20		18.00	23.50	1.71	5	1.00	0.26	0.97	550	1.54								377.14		120.14	
1.20		23.50	24.00	0.19	25	1.00	1.00	0.88	50	1.54	1.54	0.88	0.19	25	9	10.00	10.88	377.14	11314.29	17.11	199.87
																				335.73	199.87

Qu,comp.= qs + Qp Qu,uplift = Safe Frictional Resistance + Weight of Pile

Qa,comp.= (335.73 + 199.87) / 2.5 Qa,uplift = 335.73 / 3 + 62.2

Qa,comp.= 214.24 T Qa,uplift = 174.11 T

Say **Qa,comp.= 214.00 T** **Qa,uplift = 174.00 T**

*FOS for Vertical Capacity of pile in compression = 2.5

**FOS for Uplift Capacity of pile = 3.0

CEGTH CEG TEST HOUSE AND RESEARCH CENTRE PVT. LTD.

NAME OF PROJECT:- "GTI for designing of bridges and embankment for Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.

Length of Pile below cut of level = 24.00 m **Bore Hole No =** BH-P1 **Ch. (KM)** 42+256 **Dia of pile =** 1.20 m **Cut-off Level =** 2.00 m below EGL

Restricting PD to 15D **Water Table depth considered for analysis =** 0.00 m **Scour Depth =** Non-scourable **Liquefaction Depth =** 8.50 m

Dia. of Pile	Cut-off Depth	Soil layers		Properties of layers/for Skin Friction							For End Bearing										
		from	to	c	Ø	k	α	γeff	ΔL	pd (s.f)	Pd (e.b)	γeff	c	Ø	Nc	Nq	Ny	As/cm	Ap	qs	Qp
(m)	(m)	(m)	(m)	kg/cm^2	deg			gm/cc	cm	kg/cm^2	kg/cm^2	gm/cc	kg/cm^2	deg				cm^2	cm^2	t	t
1.20	2.00	0.00	2.00					0.72	200	0.07											
1.20		2.00	4.00	0.13	25	1.00	1.00	0.72	200	0.22								377.14		0.00	
1.20		4.00	7.00	0.15	25	1.00	1.00	0.75	300	0.40								377.14		0.00	
1.20		7.00	8.50	0.77	6	1.00	0.59	0.87	150	0.58								377.14		0.00	
1.20		8.50	10.00	0.77	6	1.00	0.59	0.87	150	0.71								377.14		29.94	
1.20		10.00	13.00	1.38	6	1.00	0.34	0.93	300	0.91								377.14		63.33	
1.20		13.00	18.00	1.71	5	1.00	0.26	0.97	500	1.29								377.14		105.20	
1.20		18.00	23.50	1.71	5	1.00	0.26	0.97	550	1.54								377.14		120.14	
1.20		23.50	26.00	0.19	25	1.00	1.00	0.88	250	1.54	1.54	0.88	0.19	25	9	10.00	10.88	377.14	11314.29	85.56	199.87
																				404.17	199.87

Qu,comp.= qs + Qp Qu,uplift = Safe Frictional Resistance + Weight of Pile

Qa,comp.= (404.17 + 199.87) / 2.5 Qa,uplift = 404.17 / 3 + 67.86

Qa,comp.= 241.62 T Qa,uplift = 202.58 T

Say **Qa,comp.= 241.00 T** **Qa,uplift = 202.00 T**

*FOS for Vertical Capacity of pile in compression = 2.5

**FOS for Uplift Capacity of pile = 3.0

CEGTH CEG TEST HOUSE AND RESEARCH CENTRE PVT. LTD.

NAME OF PROJECT:- "GTI for designing of bridges and embankment for Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.

Length of Pile below cut of level = 26.00 m **Bore Hole No =** BH-P1 **Ch. (KM)** 42+256 **Dia of pile =** 1.20 m **Cut-off Level =** 2.00 m below EGL

Restricting PD to 15D **Water Table depth considered for analysis =** 0.00 m **Scour Depth =** Non-scourable **Liquefaction Depth =** 8.50 m

Dia. of Pile	Cut-off Depth	Soil layers		Properties of layers/for Skin Friction							For End Bearing										
		from	to	c	Ø	k	α	γeff	ΔL	pd (s.f)	Pd (e.b)	γeff	c	Ø	Nc	Nq	Ny	As/cm	Ap	qs	Qp
(m)	(m)	(m)	(m)	kg/cm^2	deg			gm/cc	cm	kg/cm^2	kg/cm^2	gm/cc	kg/cm^2	deg				cm^2	cm^2	t	t
1.20	2.00	0.00	2.00					0.72	200	0.07											
1.20		2.00	4.00	0.13	25	1.00	1.00	0.72	200	0.22								377.14		0.00	
1.20		4.00	7.00	0.15	25	1.00	1.00	0.75	300	0.40								377.14		0.00	
1.20		7.00	8.50	0.77	6	1.00	0.59	0.87	150	0.58								377.14		0.00	
1.20		8.50	10.00	0.77	6	1.00	0.59	0.87	150	0.71								377.14		29.94	
1.20		10.00	13.00	1.38	6	1.00	0.34	0.93	300	0.91								377.14		63.33	
1.20		13.00	18.00	1.71	5	1.00	0.26	0.97	500	1.29								377.14		105.20	
1.20		18.00	23.50	1.71	5	1.00	0.26	0.97	550	1.54								377.14		120.14	
1.20		23.50	28.00	0.19	25	1.00	1.00	0.88	450	1.54	1.54	0.88	0.19	25	9	10.00	10.88	377.14	11314.29	154.00	199.87
																				472.62	199.87

Qu,comp.= qs + Qp Qu,uplift = Safe Frictional Resistance + Weight of Pile

Qa,comp.= (472.62 + 199.87) / 2.5 Qa,uplift = 472.62 / 3 + 73.51

Qa,comp.= 268.99 T Qa,uplift = 231.05 T

Say **Qa,comp.= 268.00 T** **Qa,uplift = 231.00 T**

*FOS for Vertical Capacity of pile in compression = 2.5

**FOS for Uplift Capacity of pile = 3.0

CEGTH CEG TEST HOUSE AND RESEARCH CENTRE PVT. LTD.

NAME OF PROJECT:- "GTI for designing of bridges and embankment for Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.

Length of Pile below cut of level = 28.00 m **Bore Hole No =** BH-P1 **Ch. (KM)** 42+256 **Dia of pile =** 1.20 m **Cut-off Level =** 2.00 m below EGL

Restricting PD to 15D **Water Table depth considered for analysis =** 0.00 m **Scour Depth =** Non-scourable **Liquefaction Depth =** 8.50 m

Dia. of Pile	Cut-off Depth	Soil layers		Properties of layers/for Skin Friction							For End Bearing										
		from	to	c	Ø	k	α	γeff	ΔL	pd (s.f)	Pd (e.b)	γeff	c	Ø	Nc	Nq	Ny	As/cm	Ap	qs	Qp
(m)	(m)	(m)	(m)	kg/cm^2	deg			gm/cc	cm	kg/cm^2	kg/cm^2	gm/cc	kg/cm^2	deg				cm^2	cm^2	t	t
1.20	2.00	0.00	2.00					0.72	200	0.07											
1.20		2.00	4.00	0.13	25	1.00	1.00	0.72	200	0.22								377.14		0.00	
1.20		4.00	7.00	0.15	25	1.00	1.00	0.75	300	0.40								377.14		0.00	
1.20		7.00	8.50	0.77	6	1.00	0.59	0.87	150	0.58								377.14		0.00	
1.20		8.50	10.00	0.77	6	1.00	0.59	0.87	150	0.71								377.14		29.94	
1.20		10.00	13.00	1.38	6	1.00	0.34	0.93	300	0.91								377.14		63.33	
1.20		13.00	18.00	1.71	5	1.00	0.26	0.97	500	1.29								377.14		105.20	
1.20		18.00	23.50	1.71	5	1.00	0.26	0.97	550	1.54								377.14		120.14	
1.20		23.50	28.50	0.19	25	1.00	1.00	0.88	500	1.54								377.14		171.11	
1.20		28.50	30.00	0.00	31	1.00	1.00	0.81	150	1.54	1.54	0.88	0.19	25	9	10.00	10.88	377.14	11314.29	52.30	199.87
																				542.03	199.87

Qu,comp.= qs + Qp Qu,uplift = Safe Frictional Resistance + Weight of Pile

Qa,comp.= (542.03 + 199.87) / 2.5 Qa,uplift = 542.03 / 3 + 79.17

Qa,comp.= 296.76 T Qa,uplift = 259.84 T

Say **Qa,comp.= 296.00 T** **Qa,uplift = 259.00 T**

*FOS for Vertical Capacity of pile in compression = 2.5

**FOS for Uplift Capacity of pile = 3.0

CEGTH CEG TEST HOUSE AND RESEARCH CENTRE PVT. LTD.

NAME OF PROJECT:- "GTI for designing of bridges and embankment for Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.

Length of Pile below cut of level = 30.00 m **Bore Hole No =** BH-P1 **Ch. (KM)** 42+256 **Dia of pile =** 1.20 m **Cut-off Level =** 2.00 m below EGL

Restricting PD to 15D **Water Table depth considered for analysis =** 0.00 m **Scour Depth =** Non-scourable **Liquefaction Depth =** 8.50 m

Dia. of Pile	Cut-off Depth	Soil layers		Properties of layers/for Skin Friction							For End Bearing										
		from	to	c	Ø	k	α	γeff	ΔL	pd (s.f)	Pd (e.b)	γeff	c	Ø	Nc	Nq	Ny	As/cm	Ap	qs	Qp
(m)	(m)	(m)	(m)	kg/cm^2	deg			gm/cc	cm	kg/cm^2	kg/cm^2	gm/cc	kg/cm^2	deg				cm^2	cm^2	t	t
1.20	2.00	0.00	2.00					0.72	200	0.07											
1.20		2.00	4.00	0.13	25	1.00	1.00	0.72	200	0.22								377.14		0.00	
1.20		4.00	7.00	0.15	25	1.00	1.00	0.75	300	0.40								377.14		0.00	
1.20		7.00	8.50	0.77	6	1.00	0.59	0.87	150	0.58								377.14		0.00	
1.20		8.50	10.00	0.77	6	1.00	0.59	0.87	150	0.71								377.14		29.94	
1.20		10.00	13.00	1.38	6	1.00	0.34	0.93	300	0.91								377.14		63.33	
1.20		13.00	18.00	1.71	5	1.00	0.26	0.97	500	1.29								377.14		105.20	
1.20		18.00	23.50	1.71	5	1.00	0.26	0.97	550	1.54								377.14		120.14	
1.20		23.50	28.50	0.19	25	1.00	1.00	0.88	500	1.54								377.14		171.11	
1.20		28.50	32.00	0.00	31	1.00	1.00	0.81	350	1.54	1.54	0.81	0.00	31	9	24.74	25.99	377.14	11314.29	122.03	444.78
																				611.76	444.78

Qu,comp.= qs + Qp Qu,uplift = Safe Frictional Resistance + Weight of Pile

Qa,comp.= (611.76 + 444.78) / 2.5 Qa,uplift = 611.76 / 3 + 84.82

Qa,comp.= 422.62 T Qa,uplift = 288.74 T

Say **Qa,comp.= 422.00 T** **Qa,uplift = 288.00 T**

*FOS for Vertical Capacity of pile in compression = 2.5

**FOS for Uplift Capacity of pile = 3.0

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Lateral Load capacity of Pile

BH-P1
Ch. (KM): 42+256

Type of Strata = Clayey

Le = Embedded Length of Pile in Meter = 20.000 m **Fck = 35.0 N/mm^2** **D = 100 cm**

Bed level 0.0 m

Pile cap bottom level -2.0 m

E =	Young's Modulus of Pile (Kg/cm^2)	=	$5000\sqrt{F_{ck}}$ N/mm^2	=	295803.99	Kg/cm^2
I =	Moment of Inertia (cm^2)	=	$\pi xD^4/64$	=	4908738.5	cm^4
c =	weighted mean of cohesion along the length of pile from the top of scour depth to bottom of pile			=	1.550	Kg/cm^2
q_u =	Unconfined Compression Strength	=	2 x c	=	3.100	Kg/cm^2
k_1 =	Modulus of Subgrade Reaction for cohesive soil (from Table 4)			=	5.580	kg/cm^3
K =		=	$k_1 x 0.3/(1.5xB)$	=	1.116	kg/cm^3
R,	Relative stiffness factor in Preloaded Clay R =		$\sqrt[4]{EI/KD}$	=	**337.7**	cm

For Long Pile If $L_e > 3.5R$

L1 =	=	**650.000**	cm
L_1/R	=	1.92	

For Fixed Head Pile

L_f/R	=	**1.569**	From Fig. 4
Lf	=	529.76	cm
Equivalent length of cantilever L= $L1+L_F$: 650.00 + 529.75864	=	**1179.76**	cm

Y = Pile Head Deflection (Cm) = $\frac{Q(L_1 + L_F)^3}{12\ EI}$ (for fixed Head pile)

Q = Lateral Load in Kg

Lateral Load For Pile Head Deflection 0.5 cm Q	=	5305.736	Kg
	=	**5.3**	**T**

Lateral Load capacity of Pile

BH-P1
Ch. (KM): 42+256

Type of Strata = Clayey

Le = Embedded Length of Pile in Meter = 20.000 m **Fck = 35.0 N/mm^2** **D = 120 cm**

Bed level 0.0 m

Pile cap bottom level -2.0 m

E =	Young's Modulus of Pile (Kg/cm^2)	=	$5000\sqrt{F_{ck}}$ N/mm^2	=	295803.99	Kg/cm^2
I =	Moment of Inertia (cm^2)	=	$\pi xD^4/64$	=	10178760.2	cm^4
c =	weighted mean of cohesion along the length of pile from the top of scour depth to bottom of pile			=	1.550	Kg/cm^2
q_u =	Unconfined Compression Strength	=	2 x c	=	3.100	Kg/cm^2
k_1 =	Modulus of Subgrade Reaction for cohesive soil (from Table 4)			=	5.580	kg/cm^3
K =		=	$k_1 x 0.3/(1.5xB)$	=	0.930	kg/cm^3
R,	Relative stiffness factor in Preloaded Clay R =		$\sqrt[4]{EI/KD}$	=	**405.3**	cm

For Long Pile If $L_e > 3.5R$

L1 =	=	**650.000**	cm
L_1/R	=	1.60	

For Fixed Head Pile

L_f/R	=	**1.598**	From Fig. 4
Lf	=	647.44	cm
Equivalent length of cantilever L= $L1+L_F$: 650.00 + 647.4427	=	**1297.44**	cm

Y = Pile Head Deflection (Cm) = $\frac{Q(L_1 + L_F)^3}{12\ EI}$ (for fixed Head pile)

Q = Lateral Load in Kg

Lateral Load For Pile Head Deflection 0.5 cm Q	=	8271.525	Kg
	=	**8.3**	**T**

Geotechnical Investigation Report

Old Ch. 898.787 New Ch. 1046.562 (Minor Bridge), Old Ch. 1153.187 New Ch. 1277.958 (Minor Bridge), Old Ch. 1859.918 New Ch. 1986.847 (Minor Bridge), Old Ch. 2391.105 New Ch. 2518.489 (Minor Bridge) m & Old Ch. 2560.493 New Ch. 2687.006 (Minor Bridge) m

PATLI TO NEW PATLI

SR NO. : 544_21-22

CONDUCTING GEOTECHNICAL INVESTIGATION, PREPARATION OF GEOTECHNICAL REPORT FOR DESIGNING OF BRIDGES AND FOR EMBANKMENT IN CONNECTION WITH CONSTRUCTION OF HARYANA ORBITAL RAIL CORRIDOR (HORC) PROJECT FROM PALWAL TO HARSANA KALAN INCLUDING CONNECTIVITY TO EXISTING IR NETWORK IN THE STATE OF HARYANA

CLIENT

M/S. HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LTD. (HRIDCL)

PROGRAMME

JULY - 2022

SR. No.	Report No.	Revision No.	Date
544_21-22	CEGTH/HRIDCL/SR-544/2022-23/864_(05 BHs)	01	22.09.2022
544_21-22	CEGTH/HRIDCL/SR-544/2022-23/666_(05 BHs)	00	29.07.2022

CEGTH
CEG TEST HOUSE
AND RESEARCH CENTRE PVT LTD

B-11(G), Malviya Industrial Area, Jaipur-302017
Tel. : 91-141-4046599, Fax : 91-141-2751806
E-mail : info@cegtesthouse.com., www.cegtesthouse.com

CEGTH/HRIDCL/SR-544/2022-23/864 Date:- 22.09.2022

To,

Haryana Rail Infrastructure Development Corporation Ltd. (HRIDCL)
SCO No.-17-19, 3rd & 4th Floor,
Sector - 17-A,
Chandigarh - 160017
Tele:- 0172-2715644
Email: hridc2017@gmail.com

Subject :- Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.

Dear Sir,

We are pleased to submit this report of the subject work based on 05 boreholes carried out at Ch. 898.787m to Ch. 2560.493m (OLD) - Ch. 1046.562m to Ch. 2687.006m (NEW) for Minor Bridge for the proposed project site.

The accompanying report presents results of various field tests and laboratory tests conducted on selected soil samples and their interpretation.

Should there be any clarifications regarding the contents please contact us at your most convenient time.

We value the opportunity to participate in this project and look forward a pleasant association on future projects.

Very truly yours,
CEG Test House & Research Centre Pvt. Ltd.

Nehal Jain
General Manager - Geotechnical
Authorized Signatory

Prepared By:-

Dr. Ankur Mudgal
Senior Manager

SR. No.	Report Ref. No.	Revision No.	Date
544_21-22	CEGTH/HRIDCL/SR-544/2022-23/864_(05 BHs)	01	22.09.2022
544_21-22	CEGTH/HRIDCL/SR-544/2022-23/666_(05 BHs)	00	29.07.2022

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CHAPTER 1 GENERAL

1.0 INTRODUCTION:

The work of conducting "**Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana"** was awarded to "**CEG Test House & Research Centre Pvt. Ltd., Jaipur" by M/S.** "**Haryana Rail Infrastructure Development Corporation Ltd. (HRIDCL)"** as per work order no. HRIDC/ HORC/ GT/ CEG/ 237/ 2021/ 577-M dated 29th Ju;y 2021.

Field work including drilling of boreholes, conducting field tests such as Electrical Resistivity Test, & Plate Load Test and sample collection was carried out in the presence of representative of Client. Laboratory tests were conducted on selected soil samples to determine the design parameters, confirming to relevant IS specifications and the guidelines received from time to time from representative of Client.

This report includes the details of Methodology of Investigation, collection of samples (soil/ rock), field test results, laboratory test results, analysis of results and recommendations for results for proposed structures based on soil sample collected from the locations of boreholes.

2.0 SITE LOCATION & GENERAL GEOLOGICAL HISTORY:

The details of the site & test locations for the proposed project are shown in location plan attached vide **Appendix A-1**. The site of proposed project is located from Palwal to Harsana Kalan (Sonipat) in the State of Haryana falls in seismic zone – IV (Zone factor=0.24) of India.

Soil of the Haryana Sub-Region have been classified and described under the following major soil types as shown below:-

- Typic Ustochrepts : Soil of old alluvial plains
- Typic Ustipsamments : Soil of Aravali plains
- Typic Ustifluvents : Soil of recent alluvial plains and flood plains
- Typic Torripsamments : Soil of Aeofluvial plains
- Rocky Outcrops : Aravali rocky hills

The district wise details of soil characteristics are described below:-

Panipat: The soils are well drained, Sandy loam to clay loam/silty clay loam in plains and loam to clay loam/ silty/ loose clay loam in relic channels/depressions/basins.

Sonipat: The district comprises of recent flood plains, young meander plains, old meander plains and old alluvial plains. Recent flood plains occur along the Yamuna River and clearly show fluvial features. The soils are loamy sand to sandy loam on the surface and sandy loam to clay loam in the sub surface.

Rohtak: The district mainly comprises of old alluvial plains. The soils are loamy sand to sandy loam on the surface and sandy loam to clay loam in the sub surface. Old meander plains are almost flat with loamy sand to silty clay loam soils. Oldest among all the land forms are old alluvial plains, which cover major areas in the district. These soils are sand to loamy sand/sandy loam (surface) to silt loam/silty clay loam (sub-surface).

Jhajjar: The district mainly comprises of old alluvial plains and some parts of the district also have soil belonging to Aravali plains.

Rewari: The soils of the district fall under Entisols and Inceptisols orders. The surface soil texture varies from sand to fine loamy sand.

Gurgaon: The district comprises of sand dunes, sandy plains, alluvial plains, salt affected areas,

low lands, lakes, hills and pediments. The soil varies from sand to loamy sand in sand dunes and sandy plain areas, sandy loam to clay loam / silty clay loam in alluvial plains, calcareous, loamy sand to loam in salt affected plains, silty loam to loam in low lands and calcareous, loamy sand to loam in hills.

Mewat: The soils of the area are generally sandy loam to loam. In parts of the low-lying areas, they are clayey and saline. The upper hills are mostly barren.

Faridabad and Palwal: The district comprises of recent Yamuna flood plains, low lying plains, depressions, sand dunes and hills. The texture of the soil is sand to loamy sand in recent Yamuna flood plains, sandy loam in plains, sandy loam to clay loam in alluvial plains, sandy loam to loam

(surface), clay loam/silty clay (sub-surface) in low lying plains and depressions.

3.0 SCOPE OF WORK:

The stipulated scope of work involved carrying out the following operations:-

a) Mobilisation of necessary plant equipment, men and materials for the complete Geotechnical investigation work as per specifications, drawings and instructions of the Engineer and to complete the same within the stipulated time schedule and demobilisation after completion of field work.

b) Shifting of Equipments from one structure location to another including Ereaction, installation of rigs at site and dismantling of the same after completion of field work. Shifting of setup for each borehole location and associated preparation for borehole under water

c) Making 150 mm nominal diameter boreholes at various locations in all types of soils except hard rock and large boulders using suitable approved method of boring including chiselling, cleaning, providing casing pipe as required; performing Standard Penetration Test at every 3.0m interval and at change of strata; collection of water samples and disturbed soil samples, observation such as ground water, etc., collection of undisturbed soil samples at every 3.0 m interval and at change of strata; transportation of all the collected samples to the laboratory and back filling of boreholes on completion of the same, complete as per specification and instructions of the Engineer, for depths below natural ground level.

d) Conducting Electrical resistivity tests at various locations all complete as per specification and directions of the Engineer.

e) Conducting plate load test at various locations, all complete as per specification and directions of the Engineer.

f) Drilling of Nx size boreholes (75mm dia.) in all types of hard rock, collection of core samples, maintaining continuous record of core recovery/ RQD, keeping the cores in wooden core boxes, transporting to laboratory, backfilling on completion of the same, all complete as per specification and instructions of the EIC.

g) Conducting various laboratory tests on soil samples at an approved laboratory including preparation of soil samples to determine the following properties of soil, all complete as per specification.

<u>On soil Samples</u>

- Dry density test
- Bulk Density and Moisture Content.
- Sieve Analysis
- Hydrometer Analysis
- Liquid Limit and Plastic Limit
- Specific gravity
- Shrinkage Limit

- Free Swell Index
- Direct Shear Test
- Triaxial Shear Test
- One Dimensional consolidation test
- Chemical Analysis of soil samples (pH, chloride, Sulphate)

h) Conducting laboratory tests on rock samples including preparation of the samples to determine the following properties, all complete as per specification

<u>On Rock Samples</u>

- Moisture content, porosity & Density
- Specific gravity
- Hardness
- Unconfined compression test
- Point load strength index
- Modulus of Elasticity and Poission's Ratio
- Abrasion Test

i) Conducting chemical tests on water samples to determine the Sulphate, chloride and pH value all complete as per specification.

j) Submitting draft report in soft copy including all field records and laboratory test results, graphs, etc., all complete as per specifications.

k) Submitting final report in three hard copies in after the approval of the draft report including all field records and laboratory test results, graphs, etc., all complete as per specifications.

4.0 FIELD INVESTIGATION IN SOIL STRATA:

The investigation was planned to obtain the subsurface stratification in the proposed project site and collect soil / rock core samples for laboratory testing to determine the engineering properties such as shear strength, along with basic engineering classification of the subsurface stratum.

For geotechnical investigation work, required equipements along with rotary drilling rigs and manpower were mobilized at site to carry out various field activities as per the scope of work. These were shifted from one test location to another location during execution of field work and were demobilized on satisfactory completion of field work.

For conducting the field investigations the following practices were followed at site:

- The locations of 05 boreholes were marked at site at specified locations. These locations are shown in **Appendix A-1** attached subsequently.

The details of various boreholes along with their coordinates are provided herein below:

Table 1.1: Details of Borehole Locations

S. No.	Old Chainage/ Structure (m)	New Chainage/ Structure (m)	BH. No.	Depth of Water Table below EGL (m)	Depth of Borehole below EGL (m)	Co-ordinates (m)		+R.L
						E	N	
1.	898.787	1046.562	BH-03	Not Encountered	10.00	682976.604	3145159.097	216.537
2.	1153.187	1277.958	BH-04		10.00	683182.833	3145010.076	218.023
3.	1859.918	1986.847	BH-05		10.00	683610.917	3144481.635	218.551
4.	2391.105	2518.489	BH-06		10.00	683460.537	3143989.172	220.462
5.	2560.493	2687.006	BH-07		10.00	683330.410	3143881.578	221.172

- In soil, boreholes of 150mm dia. were drilled as per the standard procedure laid in IS: 1892.
- Borehole was properly cleaned before taking any sample in soil.
- Casing was used as per the prevailing soil conditions, to stabilize the borehole.
- Standard Penetration Tests were conducted in bore holes at regular intervals or at every change of strata as per Technical specification.
- Undisturbed were collected wherevery feasible as per the requirements and at specified depths. The same has been discussed in detail in soil characteristics sheets attached with the report.

- Water table was not encountered in the boreholes.
- The detailed procedure adopted for conducting various field tests is given here in below:

(i) Standard Penetration Test:

The Standard Penetration Test was conducted in boreholes as per IS 2131. The test was carried out using the standard split spoon sampler to measure the number of blows 'N'.

Standard split spoon sampler was attached to an 'A' rod. It was driven from borehole bottom to a distance of 45 cm using a standard hammer of 63.5 kg falling freely from a height of 75 cm to the required depth. While driving, the number of blows required to penetrate every 15 cm are recorded. The total number of blows required for the last 30 cm is taken as 'N' value at that particular depth of the borehole. Wherever the total penetration was less than 45cm, the no. of blows & the depth penetrated is recorded in the respective borelog.

SPT 'N' values were correlated with relative density of non-cohesive stratum and with consistency of cohesive stratum as given below:-

Table 1.2: Soil compactness as per SPT N values (cl. 9.7, table 9.3 & 9.4, page 330_text book of V.N.S. Murthy)

Correlation for Clay / Plastic silt		Correlation for Sand / Non-Plastic silt	
Consistency	**SPT "N" Value**	**Compactness**	**SPT "N" Value**
Very Soft	0 - 2	Very Loose	0 - 4
Soft	2 - 4	Loose	4 - 10
Medium	4 - 8	Medium	10 - 30
Stiff	8 - 15	Dense	30 - 50
Very Stiff	15 - 30	Very Dense	> 50
Hard	> 30		

The field SPT N values obtained were further corrected as per the guidelines given in IS: 2131 as follows:

(a) For overburden: - The N value for cohesionless soil is corrected with the help of fig. 1 given in IS-2131.

(b) Due to dilatancy :- Wherever N values observed below water table in fine sand, silty sand or silt was greater than 15, then corrected N values were corrected as under:

$$N' = 15 + \tfrac{1}{2}(N-15)$$

(ii) Undisturbed Sampling (Soil) in boreholes:

Undisturbed samples were collected using MS tubes of suitable diameter and length with Area ratio as per clause 4.1.1 (c) of IS: 1892 (latest) fitted to an adopter with ball and socket arrangement. Before taking any sample, sampling tube was properly greased. Immediately after taking on undisturbed sample in a tube, the adopter head was removed along with the disturbed material. The visible ends of the sample were trimmed off any wet disturbed soil. The ends were coated alternately with four layers of just molten wax. More molten wax was added to give a total thickness of min. 25 mm. The samples were carefully labeled and transported to the laboratory for testing. Undisturbed samples wherever slipped during lifting were duly marked in the field logs as well as in the soil profile.

(iii) Collection of Ground Water Samples from bore holes:

Water table was not encountered in the boreholes during the site investigation.

5.0 LABORATORY TESTS ON SOIL SAMPLES:

The following laboratory tests were conducted on selected soil samples:

Table 1.3: Description of Tests

Description of Test	Reference	Undisturbed (UDS) Soil Samples	Disturbed (DS/SPT) Soil Samples
Grain Size Analysis / Hydrometer	IS: 2720 (Part - 4)	√	√
Natural Moisture Content / Bulk / Dry density	IS : 2720 (Part – 2)	√	√
Atterberg Limits • Liquid Limit • Plastic Limit	 IS: 2720 (Part - 5) IS: 2720 (Part - 5)	 √ √	√
Specific Gravity	IS : 2720 (Part – 3)	√	√
Direct Shear Test	IS : 2720 (Part – 13)	√	√
Triaxial compressive shear test	IS : 2720 (Part – 11 & 12)	√	√
Chemical Analysis of Soil Samples	IS : 2720 (Part – 26, 27)	√	-

Note:- The detailed procedure adopted for conducting various laboratory tests is described in the following paragraphs:

5.1.1 Dry density and Bulk density

For determination of bulk density and dry density, a sample of known volume 'V' was extracted from the undisturbed sampling tube and it's bulk weight 'W' was noted down.Moisture content 'Wn' was determined by oven drying method.

The bulk density and dry density were determined by following equation-

Bulk density (γ_b) = W/V

Dry density (γ_d) = γ_b/ (1+Wn)

5.1.2 Natural water content

For this test, the soil sample of known quantity (Wm) was taken in a container.The container with soil sample was placed into an oven for drying at 105-110°c temperature for 16-24 hours. After drying, the dry sample was again weighted to determine the dry weight of sample (Wd).

The natural water content was computed by the following equation-

Wn = (Wm-Wd)*100/Wd

5.1.3 Grain Size Analysis (IS: 2720- Part-4)

Wet sieve analysis:

For determination of particle sizes finer than 75 micron, wet sieve analysis test was conducted. For this test, oven dried sample of known quantity was taken in a container and soaked with dispersing

agent. The soaked soil sample was washed thoroughly over 75 micron IS sieve until the water passing sieve was substantially clean.

Fraction retained on 75 micron IS sieve was carefully collected in a container without any loss in material and placed into oven for drying.

Dry sieve analysis:

For this test, the oven dried soil sample after wet sieving was sieved through the set of IS sieves 20 mm, 10 mm, 4.75 mm, 2.0 mm, 1.0 m , 425 micron , 300 micron, 150 micron and 75micron. The amounts of soil retained on each sieve were noted down. The % retained, cumulative % retained and % passing were computed accordingly. Wherever the soil sample % passing 75 micron sieve was significant, Hydrometer method was used to find the percentage of silt and clay fraction.

Grain size analysis for the fraction passing 75 micron IS Sieve (Hydrometer method)

Calibration of Hydrometer

Hydrometer was calibrated to determine a relationship (an equation) between the effective depth H_R and corresponding hydrometer reading R_h (obtained during test).

50 to 100 gm of soil sample passing through 75 micron IS Sieve was taken. It was mixed with 100 ml of sodium hexametaphesphate solution and the mixture was warmed for about 10 minutes. It was then transferred to the cup of the mechanical mixer and the soil suspension was stirred for 15 minutes. The soil suspension was transferred into 1000 ml measuring cylinder and distilled water was added to make 1000ml solution. This solution was mixed vigorously. The measuring cylinder was then allowed to stand and the stopwatch was started. Hydrometer was immersed in the solution and reading were taken after half, one, two and four minutes. The hydrometer was then removed slowly and kept in distilled water at the same temperature as the soil suspension. Readings were taken after the periods of 8, 15 and 30 minutes, and one, two and four hours. Hydrometer was removed, rinsed and placed in the distilled water after each reading. After 4 hours reading was taken once or twice within 24 hours. Finally a reading was taken at the end of 24 hours. The temperature of the suspension was observed and recorded.

Calculations

Diameter of the particles (D):

$$D = \sqrt{\frac{30\mu}{980(G-1)}} \times \sqrt{\frac{H_R}{t}} = M\sqrt{\frac{H_R}{t}}$$

Where,

D = diameter of particle in suspension, in mm;

μ = co-efficient of viscosity of water at the temperature of the suspension at the time of taking the hydrometer reading, in poise;

G = specific gravity of the soil fraction used in the sedimentations analysis;

H_R = effective depth corresponding to R_n, in cm.

t = time elapsed between the beginning of sedimentation and taking of hydrometer reading in minutes

$M = \sqrt{\frac{30\mu}{980(G-1)}}$ = a constant factor for given values of μ and G at the temperature of the suspension.

Percentage finer than diameter D:

The percentage by mass (w) of particles smaller than corresponding equivalent particle diameters (D) was calculated from the formula:

$$w = \frac{100G_s}{W_b(G_s-1)} \times R_h$$

Where

w = percentage finer

G_s = specific gravity of soil particle

W_b = weight of soil

R_h = Hydrometer reading

5.1.4 Specific Gravity (IS: 2720-Part-3 Sec-1)

The specific gravity of soil sample was determined by density bottle method. For this test 5-10g oven dried and cooled soil sample was taken in 50ml capacity density bottle and its weight was noted down as W_2 .The soil was covered with distilled water and left for sufficient period for suitable soaking. The entrapped air was removed by vacuum. The bottle with soil was filled fully with water and its weight was noted down (W_3). The mass of empty bottle and bottle filled with distilled water were noted down as W_1 and W_4 respectively.

The Specific Gravity was determined by using following equation :

$G=W_2-W_1/[(W_2-W_1)-(W_3-W_4)]$

5.1.5 Liquid Limit (IS: 2720- Part-5)

By Cone Penetrometer Method

The 'Cone Penetrometer Apparatus' is a variant of the fall-cone and consists of a cone with a smooth polished surface and angle of 30° ± 1/2°. The weight of the cone, together with its

associated shaft is 80g ± 0.5g. A support assembly with an automatic cone release mechanism and cone height adjustment mechanism used to hold the cone vertically. The angle and weight of the cone were calibrated at regular intervals, and the sharpness of the cone tip was checked daily.

Distilled water was added and thoroughly mixed with the soil sample to produce a homogeneous paste. The paste was then placed in a cup with a diameter of at least 55mm and a depth of at least 40mm. The surface of the soil was smoothed off level and parallel to the base. The support assembly was used to position the tip of the cone so that it was just touching the top surface of the soil, and the automatic tripping mechanism was released. The cone was allowed to penetrate into the soil for a period of 5 (± 1) s, then the cone was locked off to stop further movement and the penetration was recorded. The cup was refilled and the test was repeated. The two recorded penetrations need to be within 0.5mm of each other, otherwise a third test is performed. when the three test vary by more than 1mm the test was repeated.

Further tests were conducted, at varying water contents, in order to produce a series of cone penetrations (usually 4) in the range 15mm to 25mm. The resulting cone penetrations were plotted verses the water content of the test specimens. The Liquid Limit (W_L) was read off the graph, being the water content at which the line of best fit through the test points crosses 20mm penetration.

5.1.6 Plastic Limit (IS: 2720-Part-5)

For this test, soil sample was prepared in the same way as for liquid limit test. A ball of soil sample weighed about 5 gm was formed. The ball was rolled between the fingers of one hand and the glass plate with pressure sufficient to reduce the mass into a thread of about 3 mm in 5 to 10 complete forward and back movements. When a diameter of 3 mm was reached, soil was again remolded into a ball. The process of rolling and remolding was repeated until the thread started just crumbing at a diameter of 3 mm. The crumbled thread was immediately transferred to an airtight container for determination of its moisture content by oven drying method.

This water content has been termed as plastic limit. (W_P)

5.1.7 Plasticity Index (IS: 2720-Part-5)

The plasticity index Ip was given by

$I_p=W_L-W_P$ (in percent)

5.1.8 Direct Shear Test (IS:2720-Part-13):

For this test shear box test apparatus was used. The prepared specimen from remolded/undisturbed sample was placed carefully in the box. The plain grid was kept on top of the specimen with its directions at right angles to the direction of shear. The upper porous stone was placed on the grid and loading pad on the stone. The box with specimen was gently placed in the container (water

jacket). The specimen was submerged with water. The container was mounted with the shear box and the specimen inside, on the shearing machine. The upper part of the box was so adjusted that it touchéd the proving ring. The jack was brought forward to bear up against the box container. The proving ring dial gauge was set to read zero.

The steel ball was placed in the recess of the loading pad. The loading yoke was set in contact with the steel ball on the loading pad. Vertical displacement dial gauge to read zero in contact with the top of the yoke. The normal load was applied and any change in thickness of specimen was recorded. Shear displacement dial gauge was also set to read zero. The locking screw was now removed and two parts of the shear box were separated by advancing the spacing screws.

The specimen was sheared at constant rate of strain. The readings of the proving ring dial gauge were noted down every 15 seconds for the first one-minute and then every 30 seconds thereafter. The reading of change in the thickness dial gauge and shear displacement dial gauge were also recorded at the same time interval. The test was continued until the specimen fails. The specimen was assumed to fail when the proving ring dial gauge started receding or at shear displacement of approximately 15% of the length took place.

The soil was removed from the box and test was repeated on the identical specimen under increased normal load.

5.1.9 Triaxial Shear Test_UUT (IS: 2720-Part-11)

For this test, Triaxial Shear Test apparatus was used. The plain disc was placed on the pedestal of the triaxial cell. The specimen was placed centrally on the disc. A correct size rubber membrane was fitted inside the stretcher with ends of membrane folded over those of the stretcher. Vacuum was applied to stretch the membrane to the inside surface of the stretcher which was carefully slipped around the specimen kept on the pedestal. The vacuum on the membrane was released. Its bottom part was rolled down into the pedestal. plain disc was placed on the top of the specimen and then loading pad was placed. The top part of membrane was rolled on to the loading pad. Then the stretcher was removed and ends were sealed with ‘O’ rings. With the properly sealed specimen placed centrally on the pedestal, the cell was assembled, keeping the loading piston initially clear of the loading pad of the specimen, the assembly was placed in the loading frame.

For unconsolidated undrained test, the bottom drainage value (BDV) and top drainage value (TDV) of cell, was closed and air release valve (ARV) was opened. The cell was filled with water through the cell water value CWV. ARV was closed when water begins to escape through it. The cell pressure was raised to the desired value and kept constant till the end of the test.

When the cell pressure was applied, the load piston rises upward, the loading machine was operated at the anticipated rate to bring the load piston slightly above the loading pad of the specimen and the load measuring dial gauge on proving ring was set to zero.

The piston was brought just in contact with loading pad by hand operation of the machine. The

axial compression dial gauge was mounted and set to read zero.

The axial loading was started at 1.25 mm/min rate of strain. Simultaneous readings on the load and compression dial gauges were noted down. The test was continued until a recession of the axial load is observed or 20% of strain.

After failure, the specimen was unloaded by reversing the loading machine, cell pressure was reduced and cell water was drained out through BRV. The cell was dismantled and the specimen was taken out, rubber membrane was removed and weight of the failed sample and its water content was determined. The test was repeated on two more identical specimens with increasing cell pressure.

CHAPTER 2 ANALYSIS OF TEST RESULTS AND INTERPRETATION

6.0 STRATIFICATION

From the study of the borehole logs, it is revealed that the sub strata mainly consist of silty sand (SM),sandy silt of low plasticity (ML-CL) and silty clay of low plasticity(CL).

However,

At the location of (OLD) CH.898.787 (BH-3):-

a) From EGL to 10.00m depth consists of fine grained strata i.e. silty clay of low plasticity (CL).

At the location of (OLD) CH.1153.187 (BH-4):-

a) From EGL to 1.50m depth consists of coarse grained strata i.e silty sand (SM).

b) From 1.50m to 10.00m depth consists of fine grained strata i.e. silty clay of low plasticity (CL).

At the location of (OLD) CH.1859.918 (BH-5):-

a) From EGL to 3.00m depth consists of coarse grained strata i.e sandy silt of low plasticity (ML-CL)

b) From 3.00m to 6.00m depth consists of coarse grained strata i.e silty sand (SM).

c) From 6.00m to 10.00m depth consists of fine grained strata i.e. silty clay of low plasticity (CL).

At the location of (OLD) CH.2391.105 (BH-6):-

a) From EGL to 4.50m depth consists of coarse grained strata i.e silty sand (SM).

b) From 4.50m to 10.00m depth consists of fine grained strata i.e. silty clay of low plasticity (CL).

At the location of (OLD) CH.2560.493 (BH-7):-

a) From EGL to 3.00m depth consists of coarse grained strata i.e silty sand with clay of low plasticity (SM-SC).

b) From 3.00m to 10.00m depth consists of fine grained strata i.e. silty clay of low plasticity (CL) and silty clay of intermediate plasticity(CI).

6.1 GROUND WATER TABLE DEPTH

The Ground Water Table at all the bore hole locations was not encountered during the site investigation.

6.2 RESULTS OF CHEMICAL ANALYSIS

Results of chemical analysis of soil samples (as per **Appendix – B2**) indicates that the soil sample falls under Class I for sulphates and chlorides concentration (As per IS 456-2000 and CIRIA Sp. Publication No. 31). The results are summarized here in below :-

Summary of chemical analysis of soil samples

Chemical Property	Findings (Min. to Max.)	Remarks (Required limits as per IS 456-200)
pH	7.20 to 7.91	> 6.0
Sulphite as SO_3^{2-} (%)	0.0012 to 0.0025(%)	< 0.2% (Class I)
Chlorides as Cl^- (%)	0.0029 to 0.0065 (%)	No limit specified in IS 456. However, a limit of 0.10% specified for class I in CIRIA Sp. Publication No. 31)

Note :- All the chemical contents are within permissible limit hence no special precautions are required.

CHAPTER 3 TYPE AND DEPTH OF FOUNDATION WITH ANALYSIS

7.0 TYPE & DEPTH OF FOUNDATION:

Based on the nature & strength characteristics of the substrata and requirement of the project, the following type of foundation have been analyzed as given below:

Chainage (Old) (m)	BH No.	Type of foundation	Depth of foundation below E.G.L. (m)	Length x Width (m)	Remarks
898.787	BH-03	Shallow Foundation	1.00	5.0 x 5.0	-
			1.50		
			2.00		
1153.187	BH-04		1.00	2.0 x 2.0	
			1.50		
			2.00		
1859.910	BH-05		1.00	4.0 x 4.0	
			1.50		
			2.00		
2391.105	BH-06		1.00	5.0 x 5.0	
			1.50		
			2.00		
2560.493	BH-07		1.00	2.5 x 2.5	
			1.50		
			2.00		

The details of foundation analysis are given in the subsequent paragraph.

7.1 ANALYSIS OF SHALLOW FOUNDATION

7.1.1 From Shear Failure Criteria

Net Safe Bearing capacity from Shear Failure consideration has been computed in accordance with IS: 6403-1981, which is based on, modified Terzaghi's classical approach. The weighted average of shear strength parameters for various strata upto depth equal to 0.5*B*Tan (45+Ø/2) (where B = Width of the Foundation, Ø = Angle of internal friction) is used in the analysis. A factor of safety of 2.5 to estimate the net safe bearing capacity from ultimate net bearing capacity.

For soils, containing both coarse grained (gravels & sands) and fine grained (clays), c and Φ are used to determine the soil strength. In case of predominantly fine grained soils, c and Φ are determined by the Triaxial Compression test as per IS: 2720 pt XI. For predominantly coarse grained soils, c and Φ are determined by Direct Shear test as per IS: 2720 pt XIII. These c and Φ values were used for determining the SBC of soil as per shear failure criteria.

The ultimate net bearing capacity in case of general shear failure is given by following expression,

$q_d = c\ N_c\ s_c\ d_c\ i_c + q\ (N_q\text{-}1)\ s_q\ d_q\ i_q + (1/2)\ B\ \gamma\ N_\gamma\ s_\gamma\ d_\gamma\ i_\gamma\ W'$

The ultimate net bearing capacity in case of local shear failure is given by following expression,

$q'_d = (2/3)\ c\ N'_c\ s_c\ d_c\ i_c + q\ (N'_q\text{-}1)\ s_q\ d_q\ i_q + (1/2)\ B\ \gamma\ N'_\gamma\ s_\gamma\ d_\gamma\ i_\gamma\ W'$

Where,

$d_c = 1 + 0.2\ (D_f/B)*SQRT(N_\phi)$

$d_q = d_\gamma = 1$ for $\phi < 10^o$

$d_q = d_\gamma = 1 + 0.1\ (D_f/B)*SQRT(N_\phi)$ for $\phi > 10^o$

$N_\phi = \tan^2(\pi/4 + \phi/2)$

ϕ' for local shear failure $= \tan^{-1}(0.67 \tan\phi)$

7.1.2 From Settlement Failure Criteria

Allowable Bearing Pressure from Settlement Failure consideration has been computed in accordance with IS: 8009 (Part-I). The magnitude of settlement, when foundation loads are applied, depends upon the compressibility of the underlying strata and rigidity of the substructure.

The total permissible settlement in cohesion-less soil is estimated using SPT value as per IS: 8009 (Part-I). While using this approach, the N value was corrected, wherever applicable, below the footing base to at least 1.5B below the base to account for the effects of energy ratio, adopted bearing pressure, dilation for submerged silty fine sands / fine sands as well as that due to the overburden pressure.

Further for settlement Calculation in cohesive soil the following equation has been used.

$S_t = \Delta P\ M_v\ H$

Where,

M_v = Coefficient of volume compressibility, cm^2/kg

ΔP = Pressure increment, kg/cm^2

H = Thickness of layers

CHAPTER 4 FOUNDATION RECOMMENDATIONS

8.0 FOUNDATION RECOMMENDATIONS

- Based on the nature & strength characteristics of the substrata and requirement of the project, shallow foundation have been analyzed.
- The recommended net allowable bearing capacity values are given in Table 4.1 to 4.2.

Table 4.1: Recommended Net Allowable Bearing Capacity for shallow foundation for allowable settlement 25mm

Chainage Old (m)	Chainage New (m)	BH. No.	Foundation Size (m x m)	Depth of foundation below EGL (m)	Net Safe Bearing Capacity from Shear Failure (t/m^2)	Net Allowable Bearing Pressure from settlement failure (t/m^2)	Recommended Net Allowable Bearing Capacity (t/m^2)
898.787	1046.562	BH-03	5.0 x 5.0	1.00	37.76	13.61	13.61
				1.50	38.69	14.11	14.11
				2.00	39.62	14.66	14.66
1153.187	1277.958	BH-04	2.0 x 2.0	1.00	10.90	23.86	10.90
				1.50	19.53	33.54	19.53
				2.00	20.57	35.43	20.57
1859.918	1986.847	BH-05	4.0 x 4.0	1.00	18.53	12.91	12.91
				1.50	21.11	13.47	13.47
				2.00	23.77	14.26	14.26
2391.105	2518.489	BH-06	5.0 x 5.0	1.00	25.76	16.85	16.85
				1.50	30.60	16.96	16.96
				2.00	35.59	17.07	17.07
2560.493	2687.006	BH-07	2.5 x 2.5	1.00	23.18	11.11	11.11
				1.50	27.81	13.40	13.40
				2.00	32.67	16.54	16.54

Table 4.2: Recommended Net Allowable Bearing Capacity for shallow foundation for allowable settlement 50mm

Chainage Old (m)	Chainage New (m)	BH. No.	Foundation Size (m x m)	Depth of foundation below EGL (m)	Net Safe Bearing Capacity from Shear Failure (t/m^2)	Net Allowable Bearing Pressure from settlement failure (t/m^2)	Recommended Net Allowable Bearing Capacity (t/m^2)
898.787	1046.562	BH-03	5.0 x 5.0	1.00	37.76	27.22	27.22
				1.50	38.69	28.22	28.22
				2.00	39.62	29.31	29.31
1153.187	1277.958	BH-04	2.0 x 2.0	1.00	10.90	47.72	10.90
				1.50	19.53	67.08	19.53
				2.00	20.57	70.85	20.57

Chainage Old (m)	Chainage New (m)	BH. No.	Foundation Size (m x m)	Depth of foundation below EGL (m)	Net Safe Bearing Capacity from Shear Failure (t/m^2)	Net Allowable Bearing Pressure from settlement failure (t/m^2)	Recommended Net Allowable Bearing Capacity (t/m^2)
1859.918	1986.847	BH-05	4.0 x 4.0	1.00	18.53	25.83	18.53
				1.50	21.11	26.95	21.11
				2.00	23.77	28.52	23.77
2391.105	2518.489	BH-06	5.0 x 5.0	1.00	25.76	33.71	25.76
				1.50	30.60	33.91	30.60
				2.00	35.59	34.14	34.14
2560.493	2687.006	BH-07	2.5 x 2.5	1.00	23.18	22.22	22.22
				1.50	27.81	26.81	26.81
				2.00	32.67	33.07	32.67

Notes: **-**

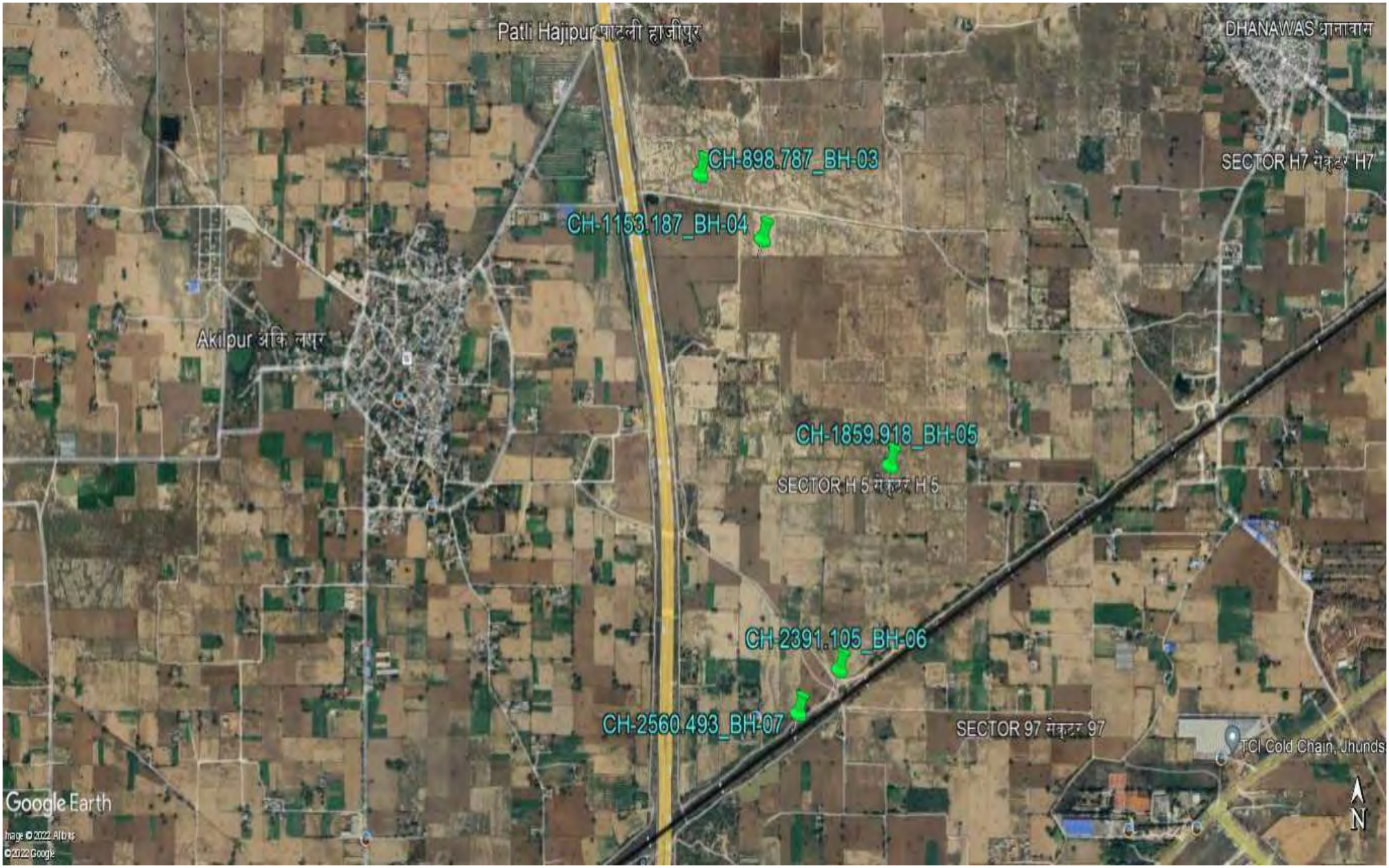
All The above recommendations are based on the field and laboratory tests conducted on selected soil/ rock core samples and our experience in this regard. If the actual substrata conditions during excavation for the foundation differ from the observations reported here, the design experts/consultants should be referred for suggestion, further investigations.

Abbreviations

BH	Borehole
ERT	Electrical Resistivity Test
EGL	Existing Ground Level
GWT	Ground Water Table
IS	Indian Standards
SPT	Standard Penetration Test
DS	Disturbed Soil
R.L.	Reduced Level
m	Metre
sp. gr.	Specific Gravity
%	Percentage
mg /l	Milligram per litre
mg /kg	Milligram per kilogram

APPENDIX – A (FIELD DATA RESULTS)

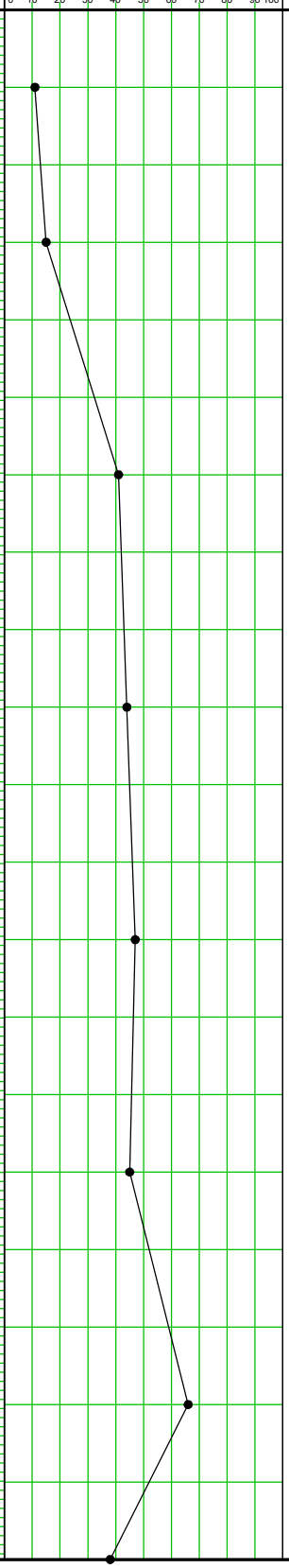
Appendix No.	ITEMS
A-1	LOCATION PLAN
A-2	FIELD BORE HOLE LOGS
A-3	SUB SOIL PROFILE DIAGRAM


Patli Hajipur पाटली हाजीपुर
DHANAWAS धानावास
CH-898.787_BH-03
SECTOR H7 सेक्टर H7
CH-1153.187_BH-04
Akilpur अकिलपुर
CH-1859.918_BH-05
SECTOR H 5 सेक्टर H 5
CH 2391.105_BH-06
CH-2560.493_BH-07
SECTOR 97 सेक्टर 97
TCI Cold Chain, Jhunds
Google Earth
N

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*898.787m	*Northing :*3145159.097 m	*Easting :*682976.604 m
Reduced Level (m):(+)216.537	*BH. No. :*BH-03	*BH Termination Depth (m):*10
*Proposed / Existing Structure :*Minor Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*08-06-2022	*Date of Completion :*08-06-2022	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5	0.5	SPT-1	3	5	6	11					
1.0											
1.5	1.5	SPT-2	4	7	8	15					
2.0											
	2.25	UDS-1									
2.5											
3.0	3	SPT-3	15	19	22	41					
3.5											
4.0											
4.5	4.5	SPT-4	15	21	23	44					
5.0							Stiff to Hard, Brownish, Silty Clay of low Plasticity	CL			
	5.25	UDS-2									
5.5											
6.0	6	SPT-5	19	22	25	47					
6.5											
7.0											
7.5	7.5	SPT-6	17	21	24	45					
8.0											
	8.25	UDS-3									
8.5											
9.0	9	SPT-7	21	28	38	66					
9.5											
10.0	10	SPT-8	15	18	20	38					



UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*1153.187m	*Northing :*3145010.076 m	*Easting :*683182.833 m
Reduced Level (m):(+)-218.023	*BH. No. :*BH-04	*BH Termination Depth (m):*10
*Proposed / Existing Structure :*Minor Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*09-06-2022	*Date of Completion :*09-06-2022	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5	0.5	SPT-1	2	3	5	8	Loose, Brownish, Silty Sand	SM			
1.0											
1.5	1.5	SPT-2	3	5	7	12					
2.0											
	2.25	UDS-1									
2.5											
3.0	3	SPT-3	7	9	11	20					
3.5											
4.0											
4.5	4.5	SPT-4	8	10	12	22					
5.0											
	5.25	UDS-2									
5.5							Stiff to Hard, Brownish, Silty Clay of Low Plasticity	CL			
6.0	6	SPT-5	11	16	18	34					
6.5											
7.0											
7.5	7.5	SPT-6	13	17	21	38					
8.0											
	8.25	UDS-3									
8.5											
9.0	9	SPT-7	12	18	24	42					
9.5											
10.0	10	SPT-8	11	16	32	48					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*1859.918m	*Northing :*3144481.635 m	*Easting :*683610.917 m
Reduced Level (m):(+)218.551	*BH. No. :*BH-05	*BH Termination Depth (m):*10
*Proposed / Existing Structure :*Minor Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*10-06-2022	*Date of Completion :*10-06-2022	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5	0.5	SPT-1	2	3	3	6					
1.0											
1.5	1.5	SPT-2	5	6	6	12	Medium dense, Brownish, Sandy Silt of low Plasticity	ML-CL			
2.0											
	2.25	UDS-1									
2.5											
3.0	3	SPT-3	4	6	7	13					
3.5											
4.0											
4.5	4.5	SPT-4	6	8	9	17	Medium dense, Brownish, Silty Sand	SM			
5.0											
	5.25	UDS-2									
5.5											
6.0	6	SPT-5	9	13	14	27					
6.5											
7.0											
7.5	7.5	SPT-6	10	14	16	30					
8.0							Hard, Brownish, Silty Clay of low Plasticity	CL			
	8.25	UDS-3									
8.5											
9.0	9	SPT-7	12	17	21	38					
9.5											
10.0	10	SPT-8	14	19	23	42					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*2391.105m	*Northing :*3143989.172 m	*Easting :*683460.538 m
Reduced Level (m):(+)220.462	*BH. No. :*BH-06	*BH Termination Depth (m):*10
*Proposed / Existing Structure :*Minor Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*11-06-2022	*Date of Completion :*11-06-2022	

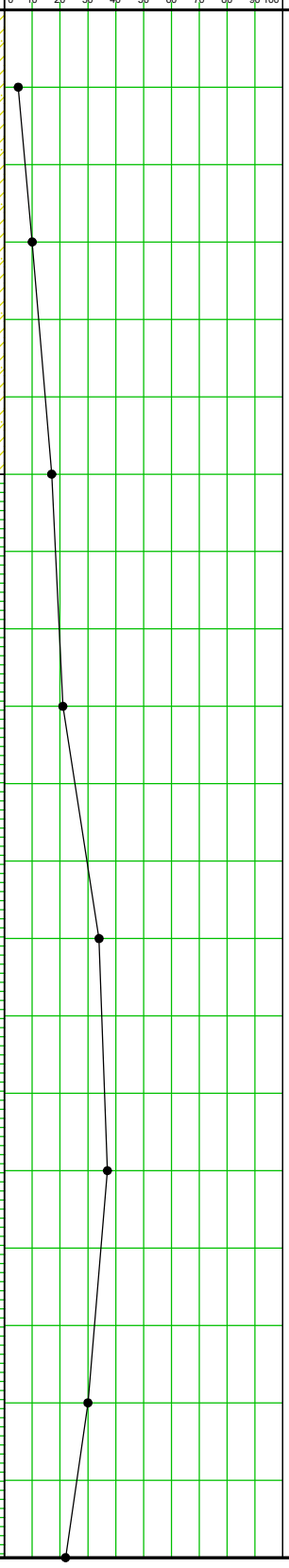
Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5	0.5	SPT-1	5	7	9	16					
1.0											
1.5	1.5	SPT-2	7	9	11	20					
2.0											
2.5	2.25	UDS-1					Medium dense, Brownish, Silty Sand	SM			
3.0	3	SPT-3	6	8	9	17					
3.5											
4.0											
4.5	4.5	SPT-4	5	9	11	20					
5.0											
5.5	5.25	UDS-2									
6.0	6	SPT-5	9	12	14	26					
6.5											
7.0											
7.5	7.5	SPT-6	9	13	15	28	Very Stiff to Hard, Brownish, Silty Clay of Low plasticity	CL			
8.0											
8.5	8.25	UDS-3									
9.0	9	SPT-7	10	15	20	35					
9.5											
10.0	10	SPT-8	12	16	23	39					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*2560.493m	*Northing :*3143881.578 m	*Easting :*683330.41 m
Reduced Level (m):(+)-221.172	*BH. No. :*BH-07	*BH Termination Depth (m):*10
*Proposed / Existing Structure :*Minor Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*12-06-2022	*Date of Completion :*12-06-2022	

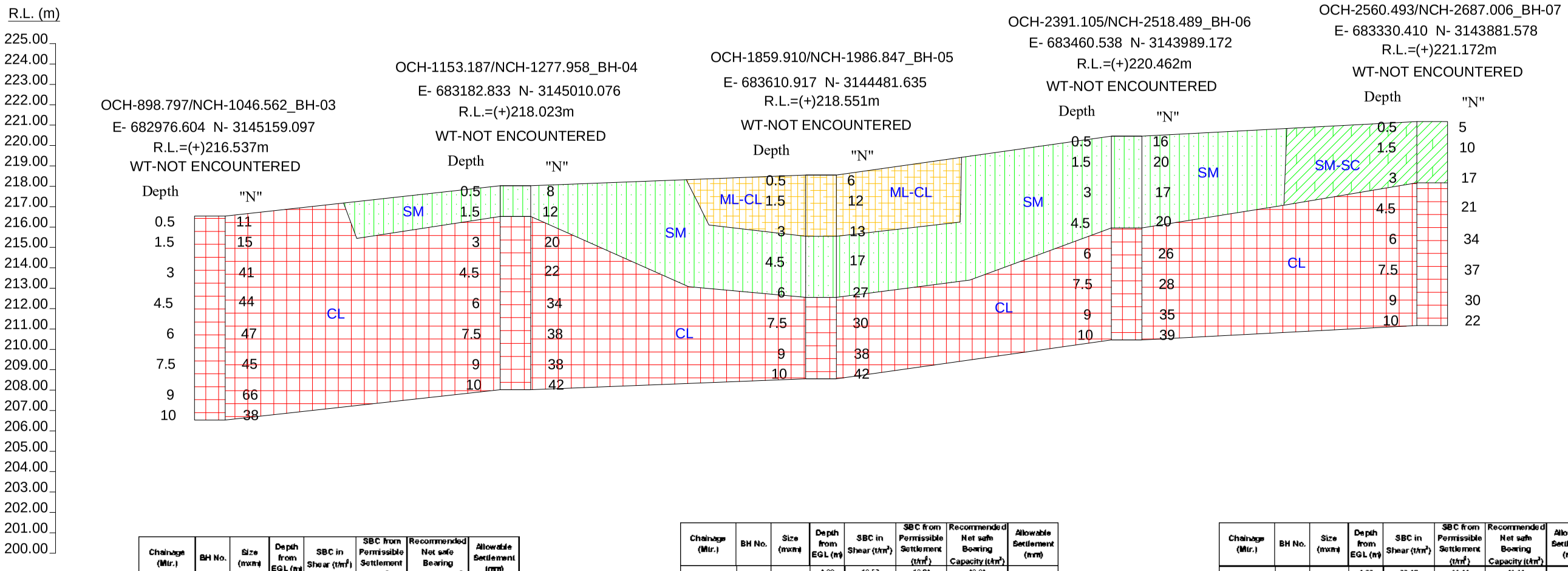
Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5	0.5	SPT-1	1	2	3	5					
1.0											
1.5	1.5	SPT-2	3	4	6	10	Loose, Brownish, Silty Sand with Clay	SM-SC			
2.0											
	2.25	UDS-1									
2.5											
3.0	3	SPT-3	4	8	9	17					
3.5											
4.0											
4.5	4.5	SPT-4	7	9	12	21					
5.0											
	5.25	UDS-2									
5.5											
6.0	6	SPT-5	12	16	18	34					
6.5							Very Stiff to Hard, Brownish, Silty Clay of Low Plasticity	CL			
7.0											
7.5	7.5	SPT-6	13	17	20	37					
8.0											
	8.25	UDS-3									
8.5											
9.0	9	SPT-7	12	14	16	30					
9.5											
10.0	10	SPT-8	8	10	12	22					



UDS*-UDS not recovered

CONDUCTING GEOTECHNICAL INVESTIGATION, PREPARATION OF GEOTECHNICAL REPORT FOR DESIGNING OF BRIDGES AND FOR EMBANKMENT IN CONNECTION WITH CONSTRUCTION OF HARYANA ORBITAL RAIL CORRIDOR (HORC) PROJECT FROM PALWAL TO HARSANA KALAN INCLUDING CONNECTIVITY TO EXISTING IR NETWORK IN THE STATE OF HARYANA.

Patli To New Patli



Chainage (Mtr.)	BH No.	Size (mxm)	Depth from EGL (m)	SBC in Shear (t/m²)	SBC from Permissible Settlement (t/m²)	Recommended Net safe Bearing Capacity (t/m²)	Allowable Settlement (mm)
OCH-898.797/ NCH-1046.562	BH-03	5 X 5	1.00	37.76	13.61	13.61	25
			1.50	38.69	14.11	14.11	
			2.00	39.62	14.66	14.66	
OCH-898.797/ NCH-1046.562	BH-03	5 X 5	1.00	37.76	27.22	27.22	50
			1.50	38.69	28.22	28.22	
			2.00	39.62	29.31	29.31	

Chainage (Mtr.)	BH No.	Size (mxm)	Depth from EGL (m)	SBC in Shear (t/m²)	SBC from Permissible Settlement (t/m²)	Recommended Net safe Bearing Capacity (t/m²)	Allowable Settlement (mm)
OCH-1859.910/ NCH-1986.847	BH-05	4 X 4	1.00	18.53	12.91	12.91	25
			1.50	21.11	13.47	13.47	
			2.00	23.77	14.26	14.26	
OCH-1859.910/ NCH-1986.847	BH-05	4 X 4	1.00	18.50	25.80	18.50	50
			1.50	21.10	26.90	21.10	
			2.00	23.80	28.50	23.80	

Chainage (Mtr.)	BH No.	Size (mxm)	Depth from EGL (m)	SBC in Shear (t/m²)	SBC from Permissible Settlement (t/m²)	Recommended Net safe Bearing Capacity (t/m²)	Allowable Settlement (mm)
OCH-2560.493/ NCH-2687.006	BH-07	2.5X 2.5	1.00	23.18	11.11	11.11	25
			1.50	27.81	13.40	13.40	
			2.00	32.67	16.54	16.54	
OCH-2560.493/ NCH-2687.006	BH-07	2.5X 2.5	1.00	23.18	22.22	22.22	50
			1.50	27.81	26.81	26.81	
			2.00	32.67	33.07	30.00	

Chainage (Mtr.)	BH No.	Size (mxm)	Depth from EGL (m)	SBC in Shear (t/m²)	SBC from Permissible Settlement (t/m²)	Recommended Net safe Bearing Capacity (t/m²)	Allowable Settlement (mm)
OCH-1153.187/ NCH-1277.958	BH-04	2 X 2	1.00	10.90	23.86	10.90	25
			1.50	19.53	33.54	19.53	
			2.00	20.57	35.43	20.57	
OCH-1153.187/ NCH-1277.958	BH-04	2 X 2	1.00	10.90	47.72	10.90	50
			1.50	19.53	67.08	19.53	
			2.00	20.57	70.85	20.57	

Chainage (Mtr.)	BH No.	Size (mxm)	Depth from EGL (m)	SBC in Shear (t/m²)	SBC from Permissible Settlement (t/m²)	Recommended Net safe Bearing Capacity (t/m²)	Allowable Settlement (mm)
OCH-2391.105/ NCH-2518.489	BH-06	5 X 5	1.00	25.76	16.85	16.85	25
			1.50	30.60	16.96	16.96	
			2.00	35.59	17.07	17.07	
OCH-2391.105/ NCH-2518.489	BH-06	5 X 5	1.00	25.76	33.71	25.76	50
			1.50	30.60	33.91	30.00	
			2.00	35.59	34.14	30.00	

SYMBOL	DESCRIPTION
	FILLED UP STRATA
	SM- Silty Sand (Having fines Less Than 50% and no plasticity or below A-line)
	SM-SC -Clayey Sand (Having fines Less Than 50% and in the hatched zone (4<PI<7)
	ML-CL -Sandy with clay (Having fines greater than 50% and in the hatched zone (LL<35 & 4<PI<7)
	CL-Silty Clay of low plasticity (Above A-line, LL<35) — WATER TABLE

Note:- Fines= Percentage of Silty + Clay A-line=.73(wl-20)

APPENDIX – B (LAB TEST RESULTS)

Appendix No.	ITEMS
B-1	SOIL CHARACTERISTICS SHEETS
B-2	RESULT OF CHEMICAL ANALYSIS OF SOIL SAMPLES
B-3	GSD CURVES

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (m)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		08-06-2022	to	08-06-2022	898.787	BH-03	Not Encountered	10.00 m	682976.604 m	3145159.097 m	(+)216.537 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction ($\varphi°$)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00		-	Stiff to Hard, Brownish, Silty Clay of low Plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	0.50	11	11		CL		16	43	33	7	1	0	0	30	21	9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-2	1.50	15	15		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.25	-	-		CL		15	46	28	9	1	1	0	33	22	11	-	1.91	17.40	1.63	2.67	UUT	1.32	4	-	-	-	-	-	-	-	-	-
SPT-3	3.00	41	41		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-4	4.50	44	44		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	5.25	-	-		CL		16	39	36	8	1	0	0	28	20	8	-	1.95	17.90	1.65	2.68	UUT	1.38	5	-	-	-	-	-	-	-	-	-
SPT-5	6.00	47	47		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-6	7.50	45	45		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	8.25	-	-		CL		17	39	32	8	3	1	0	30	22	8	-	1.96	16.40	1.68	2.68	UUT	1.61	6	-	-	-	-	-	-	-	-	-
SPT-7	9.00	66	66		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	10.00	38	38		CL		18	44	30	7	1	0	0	31	21	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

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AND RESEARCH CENTRE PVT LTD

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.						Date of Boring			Chainage (m)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
							09-06-2022	to	09-06-2022	1153.187	BH-04	Not Encountered	10.00 m	683182.833 m	3145010.076 m	(+)218.023 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00		-	Loose, Brownish, Silty Sand	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	0.50	8	15		SM		0	13	78	7	2	0	0	-	NIL	NP	-	1.66	9.50	1.52	2.63	DST+	0.00	29	-	-	-	-	-	-	-	-	-
SPT-2	1.50	12	18	Stiff to Hard, Brownish, Silty Clay of Low Plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.25	-	-		CL		16	46	29	8	1	0	0	33	21	12	-	1.79	15.40	1.55	2.67	UUT	0.72	5	-	-	-	-	-	-	-	-	-
SPT-3	3.00	20	20		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-4	4.50	22	22		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	5.25	-	-		CL		9	47	37	6	0	1	0	28	20	8	-	1.85	15.20	1.61	2.68	UUT	1.09	6	-	-	-	-	-	-	-	-	-
SPT-5	6.00	34	34		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-6	7.50	38	38		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	8.25	-	-		CL		8	53	26	10	3	0	0	31	22	9	-	1.89	15.70	1.63	2..67	UUT	1.11	6	-	-	-	-	-	-	-	-	-
SPT-7	9.00	42	42		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	10.00	48	48		CI		14	55	21	6	1	3	0	37	24	13	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

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SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (m)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		10-06-2022	to	10-06-2022	1859.918	BH-05	Not Encountered	10.00 m	683610.917 m	3144481.635 m	(+)218.551 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00		-	Medium dense, Brownish, Sandy Silt of low Plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	0.50	6	11		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-2	1.50	12	17		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.25	-	-		ML-CL		11	42	37	9	1	0	0	27	20	7	-	1.70	12.14	1.52	2.66	DST	0.18	23	-	-	-	-	-	-	-	-
SPT-3	3.00	13	16	Medium dense, Brownish, Silty Sand	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-4	4.50	17	18		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	5.25	-	-		SM		0	14	78	6	2	0	0	-	NIL	NP	-	1.75	10.51	1.58	2.63	DST	0.00	30	-	-	-	-	-	-	-	-
SPT-5	6.00	27	27	Hard, Brownish, Silty Clay of low Plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-6	7.50	30	27		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	8.25	-	-		CL		7	49	34	8	1	1	0	29	21	8	-	1.90	15.90	1.64	2.67	UUT	1.13	5	-	-	-	-	-	-	-	-
SPT-7	9.00	38	38		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	10.00	42	42		CL		9	56	27	5	1	2	0	32	22	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

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SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.					Date of Boring			Chainage (m)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
						11-06-2022	to	11-06-2022	2391.105	BH-06	Not Encountered	10.00 m	683460.538 m	3143989.172 m	(+)220.462 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00		-	Medium dense, Brownish, Silty Sand	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	0.50	16	29		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-2	1.50	20	29		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.25	-	-		SM		0	15	83	2	0	0	0	-	NIL	NP	-	1.72	10.40	1.56	2.62	DST	0.00	29	-	-	-	-	-	-	-	-	-
SPT-3	3.00	17	21		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-4	4.50	20	22	Very Stiff to Hard, Brownish, Silty Clay of Low plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	5.25	-	-		CL		8	47	36	7	1	1	0	28	20	8	-	1.83	15.60	1.58	2.67	DST	0.85	5	-	-	-	-	-	-	-	-	-
SPT-5	6.00	26	26		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-6	7.50	28	28		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	8.25	-	-		CL		11	53	29	5	1	1	0	34	22	12	-	1.88	16.10	1.62	2.68	DST	0.91	6	-	-	-	-	-	-	-	-	-
SPT-7	9.00	35	35		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	10.00	39	39		CL		11	52	28	8	1	0	0	30	20	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

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SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (m)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		12-06-2022	to	12-06-2022	2560.493	BH-07	Not Encountered	10.00 m	683330.410 m	3143881.578 m	(+)221.172 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00	-	-	Loose, Brownish, Silty Sand with Clay	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	0.50	5	9		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-2	1.50	10	14		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.25	-	-		SM-SC		10	36	44	10	0	0	0	27	20	7	-	1.72	12.30	1.53	2.63	DST	0.12	27	-	-	-	-	-	-	-	-
SPT-3	3.00	17	21	Very Stiff to Hard, Brownish, Silty Clay of Low Plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-4	4.50	21	23		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	5.25	-	-		CL		11	42	37	8	1	1	0	29	21	8	-	1.86	15.60	1.61	2.67	UUT	1.08	5	-	-	-	-	-	-	-	-
SPT-5	6.00	34	34		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-6	7.50	37	37		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	8.25	-	-		CL		9	53	30	7	1	0	0	32	22	10	-	1.85	15.90	1.60	2.68	UUT	0.95	4	-	-	-	-	-	-	-	-
SPT-7	9.00	30	30		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	10.00	22	22		CI		15	59	20	4	0	2	0	39	23	16	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEGTH
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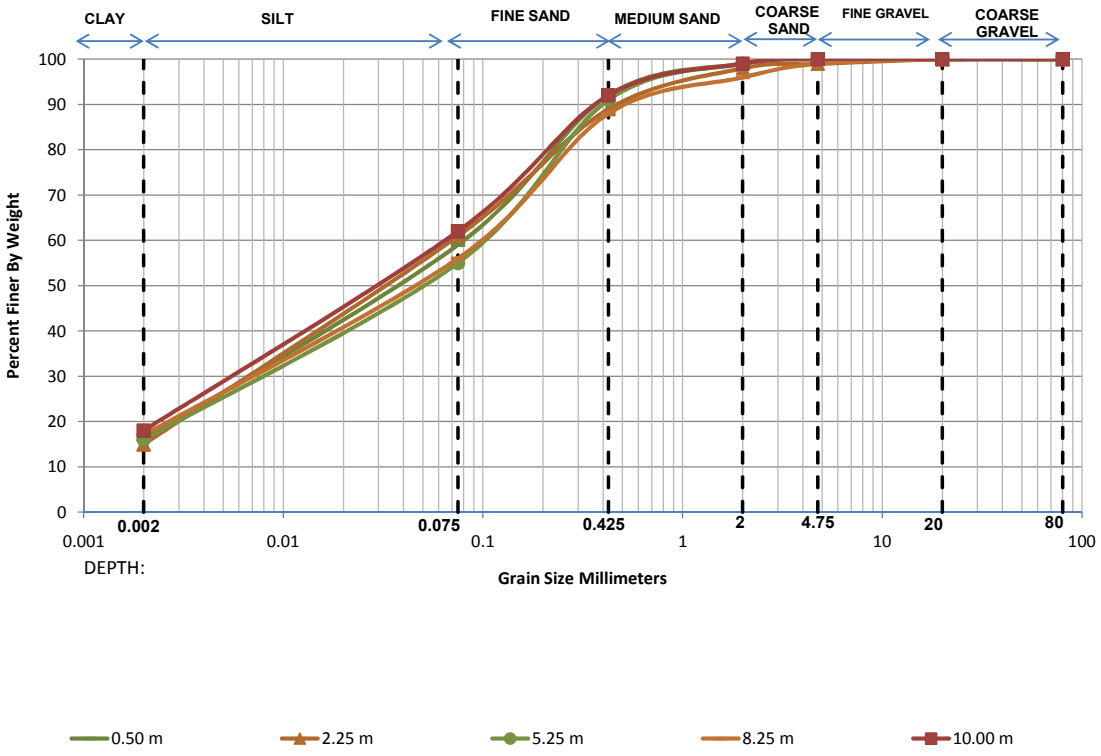
RESULT OF CHEMICAL ANALYSIS OF SOIL SAMPLES

Sr. No	Chainage/ Structure (m)	BH No.	Depth (m)	pH	Chlorides (Cl^-)		Sulphate (SO_3^{2-})	
					(mg/kg)	(%)	(mg/kg)	(%)
1.	898.787 (Minor Bridge)	BH-03	2.25	7.55	65.50	0.0065	25.32	0.0025
2.	2391.105 (Minor Bridge)	BH-06	2.25	7.80	55.55	0.0055	21.23	0.0021

GRAIN SIZE DISTRIBUTION CURVES

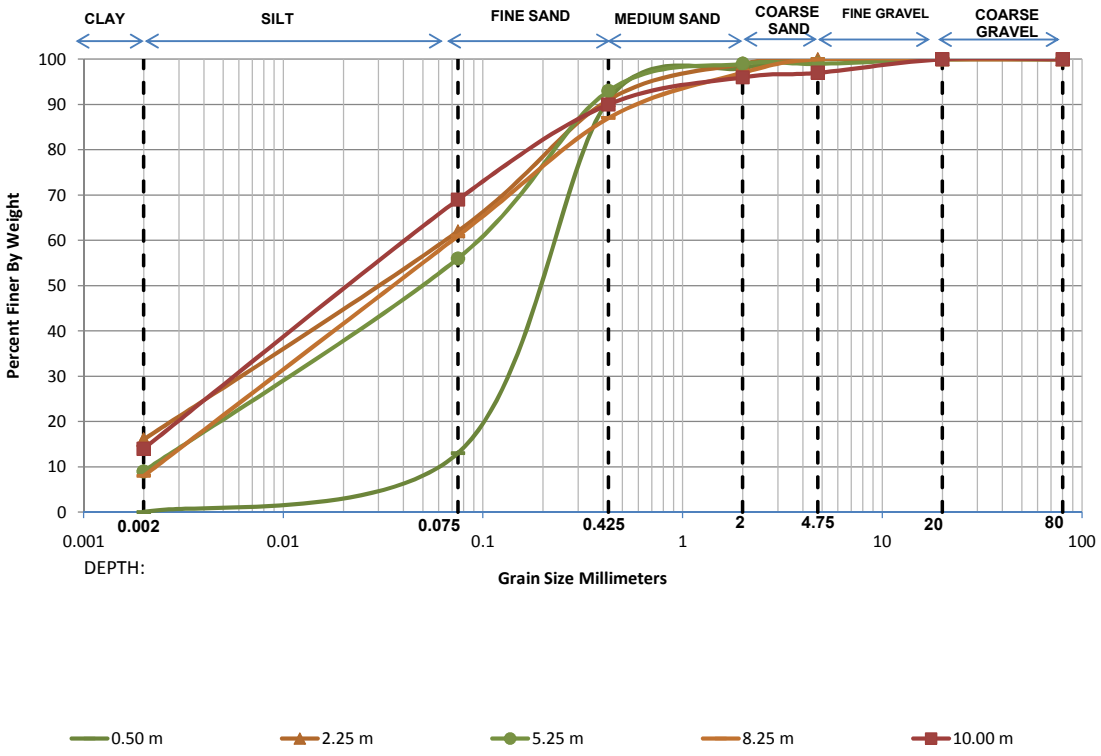
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	898.787
B.H. No.	BH-03



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
0.50 m	16.00	43.00	33.00	7.00	1.00	0.00	0.00	-	0.0127	0.0781	-	-
2.25 m	15.00	46.00	28.00	9.00	1.00	1.00	0.00	-	0.0126	0.0722	-	-
5.25 m	16.00	39.00	36.00	8.00	1.00	0.00	0.00	-	0.0147	0.0939	-	-
8.25 m	17.00	39.00	32.00	8.00	3.00	1.00	0.00	-	0.0130	0.0908	-	-
10.00 m	18.00	44.00	30.00	7.00	1.00	0.00	0.00	-	0.0097	0.0693	-	-

GRAIN SIZE DISTRIBUTION CURVES

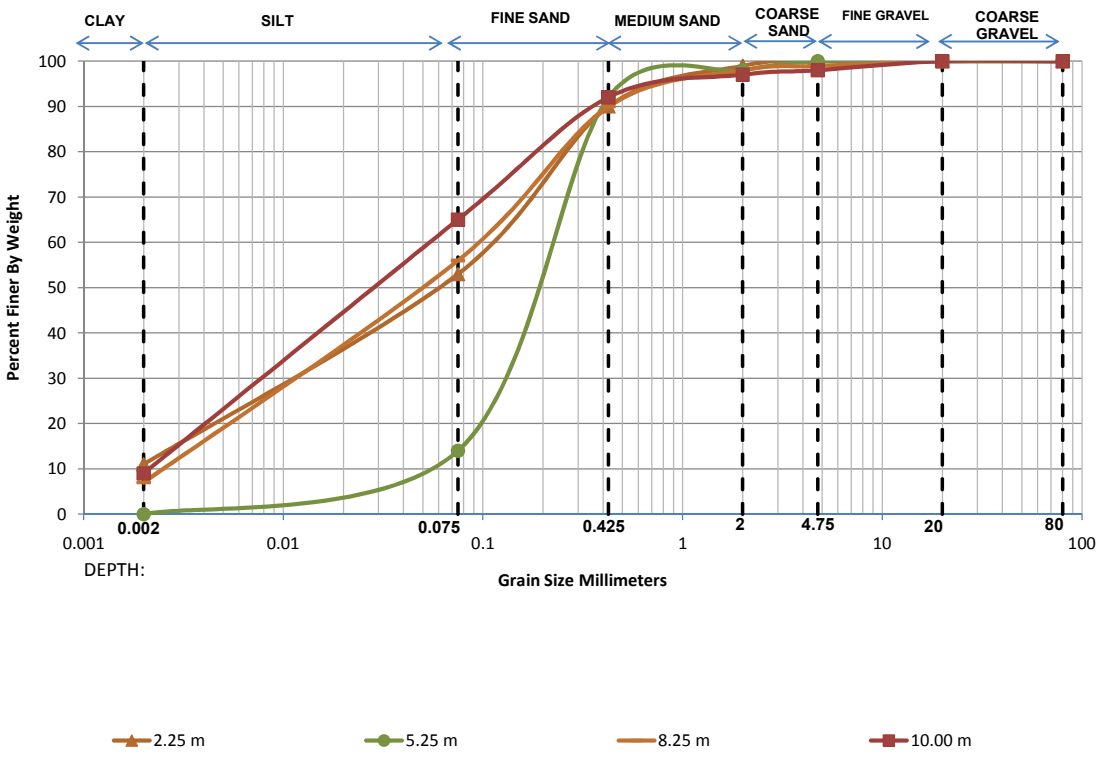
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	1153.187
B.H. No.	BH-04



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
0.50 m	0.00	13.00	78.00	7.00	2.00	0.00	0.00	0.0563	0.1440	0.2411	4.28	1.53
2.25 m	16.00	46.00	29.00	8.00	1.00	0.00	0.00	-	0.0114	0.0695	-	-
5.25 m	9.00	47.00	37.00	6.00	0.00	1.00	0.00	0.0024	0.0213	0.0878	36.38	2.15
8.25 m	8.00	53.00	26.00	10.00	3.00	0.00	0.00	0.0029	0.0191	0.0725	24.96	1.74
10.00 m	14.00	55.00	21.00	6.00	1.00	3.00	0.00	-	0.0109	0.0546	-	-

GRAIN SIZE DISTRIBUTION CURVES

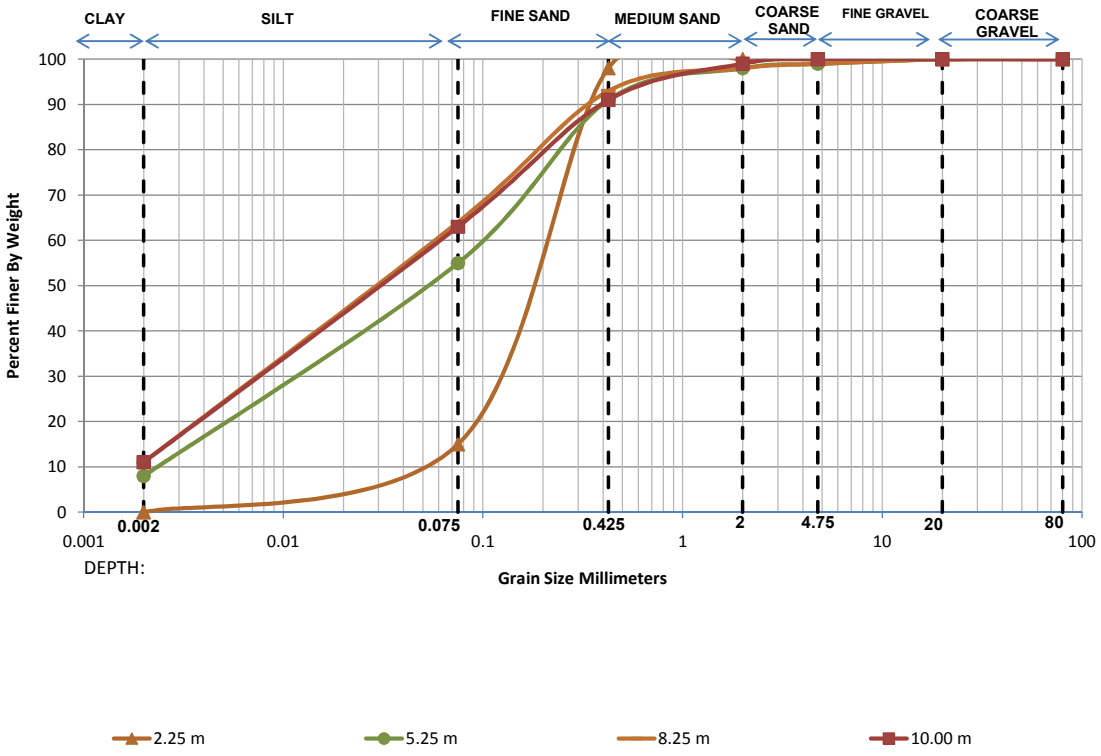
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	1859.918
B.H. No.	BH-05



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
2.25 m	11.00	42.00	37.00	9.00	1.00	0.00	0.00	-	0.0214	0.1021	-	-
5.25 m	0.00	14.00	78.00	6.00	2.00	0.00	0.00	0.0507	0.1389	0.2358	4.65	1.61
8.25 m	7.00	49.00	34.00	8.00	1.00	1.00	0.00	0.0036	0.0233	0.0884	24.51	1.71
10.00 m	9.00	56.00	27.00	5.00	1.00	2.00	0.00	0.0024	0.0166	0.0637	26.61	1.80

GRAIN SIZE DISTRIBUTION CURVES

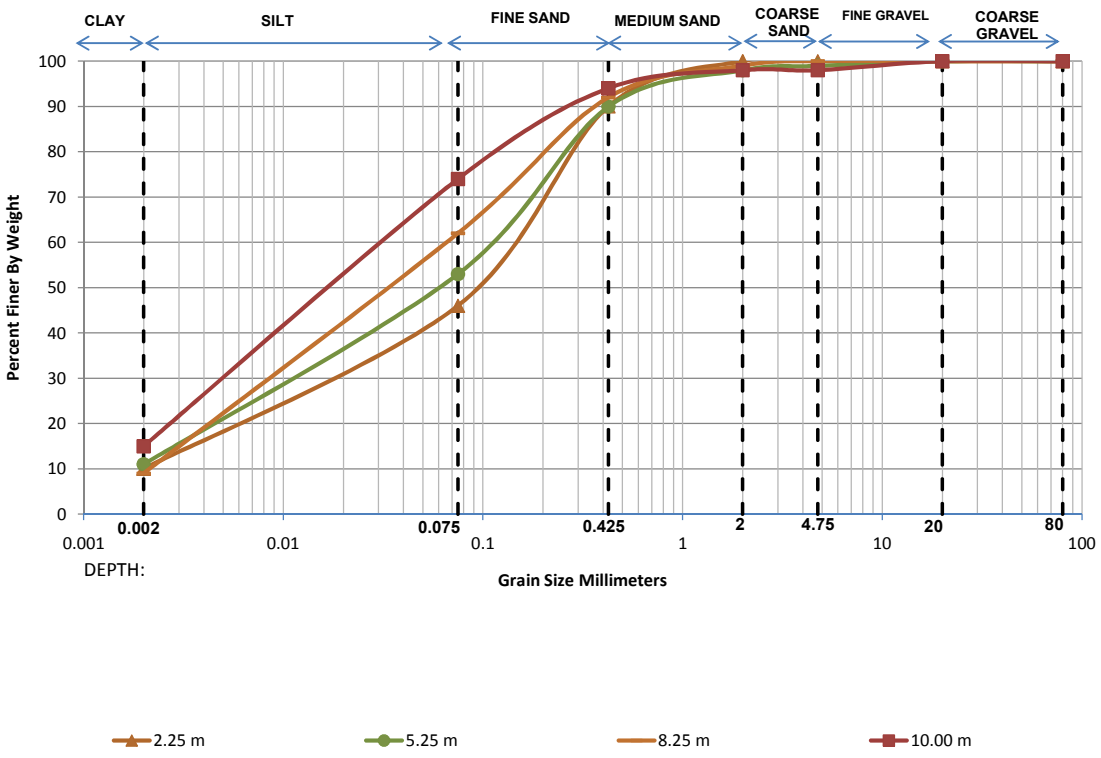
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	2391.105
B.H. No.	BH-06



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
2.25 m	0.00	15.00	83.00	2.00	0.00	0.00	0.00	0.0460	0.1320	0.2210	4.80	1.71
5.25 m	8.00	47.00	36.00	7.00	1.00	1.00	0.00	0.0030	0.0230	0.0922	31.17	1.94
8.25 m	11.00	53.00	29.00	5.00	1.00	1.00	0.00	-	0.0151	0.0655	-	-
10.00 m	11.00	52.00	28.00	8.00	1.00	0.00	0.00	-	0.0155	0.0676	-	-

GRAIN SIZE DISTRIBUTION CURVES

Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	2560.493
B.H. No.	BH-07



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
2.25 m	10.00	36.00	44.00	10.00	0.00	0.00	0.00	0.0020	0.0300	0.1338	66.89	3.37
5.25 m	11.00	42.00	37.00	8.00	1.00	1.00	0.00	-	0.0214	0.1020	-	-
8.25 m	9.00	53.00	30.00	7.00	1.00	0.00	0.00	0.0024	0.0179	0.0702	29.24	1.89
10.00 m	15.00	59.00	20.00	4.00	0.00	2.00	0.00	-	0.0092	0.0464	-	-

APPENDIX – C
(ANALYSIS & RECOMENDATION)

Appendix No.	ITEMS
C-1	SAMPLE CALCULATIONS FOR COMPUTATION OF ALLOWABLE BEARING CAPACITY OF SUB-STRATA FOR SHALLOW FOUNDATION

Calculation of SBC for shallow foundations as per IS : 6403 - 1981

INPUT DATA

CH. (m) :- 898.787

BH NO. :- BH-03

Type of footing

1	Continuous Strip		
2	Rectangular	***Square***	**3**
3	Square		
4	Circular		

Angle of internal friction (ϕ^o)	4.00
Cohesion (c in t/m^2)	13.20
Void ratio (e), e = (G.γ_w/γ_d)-1	0.64
Direction of load with vertical (^{o})	0.00
Density of foundation soil (t/m^3) γ_{bulk}	1.91
Depth of water table(m)	NE
Factor of safety	2.50

S.no.	Depth (m) of footing (D_f) below EGL	Width (m)
1	1.00	5.00
2	1.50	5.00
3	2.00	5.00

SHEAR FAILURE CRITERIA

Assumptions and formula used in calculation as per IS:6403-1981 are given below -

NOTE: The type of failure used for bearing capacity analysis depends upon the value of void ratio (see IS 6403 : 1981, Page No. 9, Table No. 3).

The ultimate net bearing capacity in case of general shear failure is given by (from IS 6403 : 1981, page No. 8)

$$q_d = c\,N_c\,s_c\,d_c\,i_c + q\,(N_q-1)\,s_q\,d_q\,i_q + (1/2)\,B\,\gamma\,N_\gamma\,s_\gamma\,d_\gamma\,i_\gamma\,W'$$

The ultimate net bearing capacity in case of local shear failure is given by (from IS 6403 : 1981, page No. 8)

$$q'_d = (2/3)\,c\,N'_c\,s_c\,d_c\,i_c + q\,(N'_q-1)\,s_q\,d_q\,i_q + (1/2)\,B\,\gamma\,N'_\gamma\,s_\gamma\,d_\gamma\,i_\gamma\,W'$$

Where,

$d_c = 1+ 0.2\,(D_f/B)*SQRT(N_\phi)$

$d_q = d_\gamma = 1$ for $\phi < 10^o$

$d_q = d_\gamma = 1 + 0.1\,(D_f/B)*SQRT(N_\phi)$ for $\phi > 10^o$

(from IS 6403 : 1981, page No. 9)

$N_\phi = \tan^2(\pi/4 + \phi/2)$

ϕ' is friction angle for local shear failure = $\tan^{-1}(0.67\tan\phi)$

OUTPUT

The computer aided results for shear failure criteria are tabulated below. The results are interpolated values of bearing capacity obtained from general and local shear failure criteria.

Bearing capacity factors : (from IS 6403 : 1981, page No. 8, Table No. 1)

ϕ	4.00	ϕ'	2.68
N_c	6.19	N'_c	5.81
N_q	1.43	N'_q	1.27
N_γ	0.34	N'_γ	0.21

Shape factors : (from IS 6403 : 1981, page No. 8, Table No. 2)

S.no.	Width(m)	S_c	S_q	S_γ
1	5.00	1.30	1.20	0.80
2	5.00	1.30	1.20	0.80
3	5.00	1.30	1.20	0.80

Depth factors : (from IS 6403 : 1981, page No. 9)

S.no.	Depth(m)	Width(m)	dc	d_q	d_γ
1	1.00	5.00	1.04	1.00	1.00
2	1.50	5.00	1.06	1.00	1.00
3	2.00	5.00	1.09	1.00	1.00

Inclination factors : (from IS 6403 : 1981, page No. 9)

$i_c = (1-\alpha / 90)^2$	$i_q = (1-\alpha / 90)^2$	$i_\gamma = (1-\alpha / \phi)^2$
1.00	1.00	1.00

Water table factor : (from IS 6403 : 1981, page No. 9)

S.no.	Depth(m)	Width(m)	Z_w/B	W'
1	1.00	5.00	5.80	1.00
2	1.50	5.00	5.70	1.00
3	2.00	5.00	5.60	1.00

Safe Bearing Capacity

S.no.	Depth(m)	Width(m)	SBC in (t/m^2)		
			General shear	Local shear	Recommended
1	1.00	5.00	45.19	28.32	37.76
2	1.50	5.00	46.30	29.01	38.69
3	2.00	5.00	47.41	29.71	39.62

SETTLEMENT CALCULATION AS PER 8009 Part-1 1976														CH. (m): 898.787							BH NO. :- BH-03			
Layer	Depth below FGL (m)	From (m)	To (m)	Layer Thickness	Stress at Foundation level (Kg/Cm2)	Length (m)	Breadth (m)	Layer Thickness(m)	Dispersed Length (m)	Dispersed Breadth (m)	Stress Increment at top for cohesionless layer & at mid Depth for cohesive layer (kg/Cm2)	Average N-Value	Mvc (Cm^2/Kg)	Consolidation Settlement (mm)	Modulus of Soil (Kg/Cm^2)	Influence Factor (I)	Poission's Ratio	Settlement (mm) for 10 t/m2 (from IS:8009 (Part I), Fig. 9, Page NO. 17)	Settlement in Non-Cohesive Soil Si (mm)	Elastic Settlement Si (mm)	Total Settlement (mm)	Depth Factor	Rigidity Factor	Corrected Total Settlement (mm)
Layer 1	1.00	1.00	8.50	7.50	1.36	5.00	5.00	7.50	8.75	8.750	0.444	38	0.0035	11.69	132	0.6171	0.45			14.50	26.19	0.95	1.00	25.00
Layer 1	1.50	1.50	9.00	7.50	1.41	5.00	5.00	7.50	8.75	8.750	0.461	38	0.0035	12.13	132	0.6171	0.45			15.03	27.16	0.92	1.00	25.00
Layer 1	2.00	2.00	9.50	7.50	1.47	5.00	5.00	7.50	8.75	8.750	0.479	38	0.0035	12.59	132	0.6171	0.45			15.61	28.21	0.89	1.00	25.00

SETTLEMENT CALCULATION AS PER 8009 Part-1 1976														CH. (m): 898.787							BH NO. :- BH-03			
Layer	Depth below FGL (m)	From (m)	To (m)	Layer Thickness	Stress at Foundation level (Kg/Cm2)	Length (m)	Breadth (m)	Layer Thickness(m)	Dispersed Length (m)	Dispersed Breadth (m)	Stress Increment at top for cohesionless layer & at mid Depth for cohesive layer (kg/Cm2)	Average N-Value	Mvc (Cm^2/Kg)	Consolidation Settlement (mm)	Modulus of Soil (Kg/Cm^2)	Influence Factor (I)	Poission's Ratio	Settlement (mm) for 10 t/m2 (from IS:8009 (Part I), Fig. 9, Page NO. 17)	Settlement in Non-Cohesive Soil Si (mm)	Elastic Settlement Si (mm)	Total Settlement (mm)	Depth Factor	Rigidity Factor	Corrected Total Settlement (mm)
Layer 1		1.00	8.50	7.50				7.50	8.75	8.750	0.889	38	0.0035	23.39	132	0.6171	0.45			28.99	52.38			
	1.00				2.72	5.00	5.00															0.95	1.00	50.00
Layer 1		1.50	9.00	7.50				7.50	8.75	8.750	0.922	38	0.0035	24.25	132	0.6171	0.45			30.07	54.32			
	1.50				2.82	5.00	5.00															0.92	1.00	50.00
Layer 1		2.00	9.50	7.50				7.50	8.75	8.750	0.957	38	0.0035	25.19	132	0.6171	0.45			31.22	56.41			
	2.00				2.93	5.00	5.00															0.89	1.00	50.00

Geotechnical Investigation Report

Old Ch. 1698.053 New Ch. 1548.996 (Minor Bridge), Old Ch. 1912.700 New Ch. 1767.989 (Minor Bridge), Old Ch. 2807.817 New Ch. 2189.831 (Minor Bridge) & Old Ch. 2972.708 New Ch. 2823.679 (Minor Bridge) m

NEW PATLI TO SULTANPUR

SR NO. : 544_21-22

CONDUCTING GEOTECHNICAL INVESTIGATION, PREPARATION OF GEOTECHNICAL REPORT FOR DESIGNING OF BRIDGES AND FOR EMBANKMENT IN CONNECTION WITH CONSTRUCTION OF HARYANA ORBITAL RAIL CORRIDOR (HORC) PROJECT FROM PALWAL TO HARSANA KALAN INCLUDING CONNECTIVITY TO EXISTING IR NETWORK IN THE STATE OF HARYANA

CLIENT

M/S. HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LTD. (HRIDCL)

PROGRAMME

JULY - 2022

SR. No.	Report No.	Revision No.	Date
544_21-22	CEGTH/HRIDCL/SR-544/2022-23/863_(04 BHs)	01	22.09.2022
544_21-22	CEGTH/HRIDCL/SR-544/2022-23/665_(04 BHs)	00	29.07.2022

CEGTH
CEG TEST HOUSE
AND RESEARCH CENTRE PVT LTD

B-11(G), Malviya Industrial Area, Jaipur-302017
Tel. : 91-141-4046599, Fax : 91-141-2751806
E-mail : info@cegtesthouse.com., www.cegtesthouse.com

CEGTH/HRIDCL/SR-544/2022-23/863 Date:- 22.09.2022

To,

Haryana Rail Infrastructure Development Corporation Ltd. (HRIDCL)
SCO No.-17-19, 3rd & 4th Floor,
Sector - 17-A,
Chandigarh - 160017
Tele:- 0172-2715644
Email: hridc2017@gmail.com

Subject :- Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.

Dear Sir,

We are pleased to submit this report of the subject work based on 04 boreholes carried out at Ch. 1698.053m to Ch. 2972.708m (OLD) - Ch. 1548.996m to Ch. 2823.679m (NEW) for Minor Bridge for the proposed project site.

The accompanying report presents results of various field tests and laboratory tests conducted on selected soil samples and their interpretation.

Should there be any clarifications regarding the contents please contact us at your most convenient time.

We value the opportunity to participate in this project and look forward a pleasant association on future projects.

Very truly yours,
CEG Test House & Research Centre Pvt. Ltd.

Nehal Jain
General Manager - Geotechnical
Authorized Signatory

Prepared By:-

Dr. Ankur Mudgal
Senior Manager

SR. No.	Report Ref. No.	Revision No.	Date
544_21-22	CEGTH/HRIDCL/SR-544/2022-23/863_(04 BHs)	01	22.09.2022
544_21-22	CEGTH/HRIDCL/SR-544/2022-23/665_(04 BHs)	00	29.07.2022

CONTENTS

LIST OF FIGURES / TABLES

CHAPTER 1 GENERAL

1.0 INTRODUCTION:

The work of conducting "**Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana"** was awarded to "**CEG Test House & Research Centre Pvt. Ltd., Jaipur" by M/S.** "**Haryana Rail Infrastructure Development Corporation Ltd. (HRIDCL)"** as per work order no. HRIDC/ HORC/ GT/ CEG/ 237/ 2021/ 577-M dated 29th Ju;y 2021.

Field work including drilling of boreholes, conducting field tests such as Electrical Resistivity Test, & Plate Load Test and sample collection was carried out in the presence of representative of Client. Laboratory tests were conducted on selected soil samples to determine the design parameters, confirming to relevant IS specifications and the guidelines received from time to time from representative of Client.

This report includes the details of Methodology of Investigation, collection of samples (soil/ rock), field test results, laboratory test results, analysis of results and recommendations for results for proposed structures based on soil sample collected from the locations of boreholes.

2.0 SITE LOCATION & GENERAL GEOLOGICAL HISTORY:

The details of the site & test locations for the proposed project are shown in location plan attached vide **Appendix A-1**. The site of proposed project is located from Palwal to Harsana Kalan (Sonipat) in the State of Haryana falls in seismic zone – IV (Zone factor=0.24) of India.

Soil of the Haryana Sub-Region have been classified and described under the following major soil types as shown below:-

- Typic Ustochrepts : Soil of old alluvial plains
- Typic Ustipsamments : Soil of Aravali plains
- Typic Ustifluvents : Soil of recent alluvial plains and flood plains
- Typic Torripsamments : Soil of Aeofluvial plains
- Rocky Outcrops : Aravali rocky hills

The district wise details of soil characteristics are described below:-

Panipat: The soils are well drained, Sandy loam to clay loam/silty clay loam in plains and loam to clay loam/ silty/ loose clay loam in relic channels/depressions/basins.

Sonipat: The district comprises of recent flood plains, young meander plains, old meander plains and old alluvial plains. Recent flood plains occur along the Yamuna River and clearly show fluvial features. The soils are loamy sand to sandy loam on the surface and sandy loam to clay loam in the sub surface.

Rohtak: The district mainly comprises of old alluvial plains. The soils are loamy sand to sandy loam on the surface and sandy loam to clay loam in the sub surface. Old meander plains are almost flat with loamy sand to silty clay loam soils. Oldest among all the land forms are old alluvial plains, which cover major areas in the district. These soils are sand to loamy sand/sandy loam (surface) to silt loam/silty clay loam (sub-surface).

Jhajjar: The district mainly comprises of old alluvial plains and some parts of the district also have soil belonging to Aravali plains.

Rewari: The soils of the district fall under Entisols and Inceptisols orders. The surface soil texture varies from sand to fine loamy sand.

Gurgaon: The district comprises of sand dunes, sandy plains, alluvial plains, salt affected areas,

low lands, lakes, hills and pediments. The soil varies from sand to loamy sand in sand dunes and sandy plain areas, sandy loam to clay loam / silty clay loam in alluvial plains, calcareous, loamy sand to loam in salt affected plains, silty loam to loam in low lands and calcareous, loamy sand to loam in hills.

Mewat: The soils of the area are generally sandy loam to loam. In parts of the low-lying areas, they are clayey and saline. The upper hills are mostly barren.

Faridabad and Palwal: The district comprises of recent Yamuna flood plains, low lying plains, depressions, sand dunes and hills. The texture of the soil is sand to loamy sand in recent Yamuna flood plains, sandy loam in plains, sandy loam to clay loam in alluvial plains, sandy loam to loam

(surface), clay loam/silty clay (sub-surface) in low lying plains and depressions.

3.0 SCOPE OF WORK:

The stipulated scope of work involved carrying out the following operations:-

a) Mobilisation of necessary plant equipment, men and materials for the complete Geotechnical investigation work as per specifications, drawings and instructions of the Engineer and to complete the same within the stipulated time schedule and demobilisation after completion of field work.

b) Shifting of Equipments from one structure location to another including Ereaction, installation of rigs at site and dismantling of the same after completion of field work. Shifting of setup for each borehole location and associated preparation for borehole under water

c) Making 150 mm nominal diameter boreholes at various locations in all types of soils except hard rock and large boulders using suitable approved method of boring including chiselling, cleaning, providing casing pipe as required; performing Standard Penetration Test at every 3.0m interval and at change of strata; collection of water samples and disturbed soil samples, observation such as ground water, etc., collection of undisturbed soil samples at every 3.0 m interval and at change of strata; transportation of all the collected samples to the laboratory and back filling of boreholes on completion of the same, complete as per specification and instructions of the Engineer, for depths below natural ground level.

d) Conducting Electrical resistivity tests at various locations all complete as per specification and directions of the Engineer.

e) Conducting plate load test at various locations, all complete as per specification and directions of the Engineer.

f) Drilling of Nx size boreholes (75mm dia.) in all types of hard rock, collection of core samples, maintaining continuous record of core recovery/ RQD, keeping the cores in wooden core boxes, transporting to laboratory, backfilling on completion of the same, all complete as per specification and instructions of the EIC.

g) Conducting various laboratory tests on soil samples at an approved laboratory including preparation of soil samples to determine the following properties of soil, all complete as per specification.

<u>On soil Samples</u>

- Dry density test
- Bulk Density and Moisture Content.
- Sieve Analysis
- Hydrometer Analysis
- Liquid Limit and Plastic Limit
- Specific gravity
- Shrinkage Limit

- Free Swell Index
- Direct Shear Test
- Triaxial Shear Test
- One Dimensional consolidation test
- Chemical Analysis of soil samples (pH, chloride, Sulphate)

h) Conducting laboratory tests on rock samples including preparation of the samples to determine the following properties, all complete as per specification

<u>On Rock Samples</u>

- Moisture content, porosity & Density
- Specific gravity
- Hardness
- Unconfined compression test
- Point load strength index
- Modulus of Elasticity and Poission's Ratio
- Abrasion Test

i) Conducting chemical tests on water samples to determine the Sulphate, chloride and pH value all complete as per specification.

j) Submitting draft report in soft copy including all field records and laboratory test results, graphs, etc., all complete as per specifications.

k) Submitting final report in three hard copies in after the approval of the draft report including all field records and laboratory test results, graphs, etc., all complete as per specifications.

4.0 FIELD INVESTIGATION IN SOIL STRATA:

The investigation was planned to obtain the subsurface stratification in the proposed project site and collect soil / rock core samples for laboratory testing to determine the engineering properties such as shear strength, along with basic engineering classification of the subsurface stratum.

For geotechnical investigation work, required equipements along with rotary drilling rigs and manpower were mobilized at site to carry out various field activities as per the scope of work. These were shifted from one test location to another location during execution of field work and were demobilized on satisfactory completion of field work.

For conducting the field investigations the following practices were followed at site:

- The locations of 04 boreholes were marked at site at specified locations. These locations are shown in **Appendix A-1** attached subsequently.

The details of various boreholes along with their coordinates are provided herein below:

Table 1.1: Details of Borehole Locations

S. No.	Old Chainage/ Structure (m)	New Chainage/ Structure (m)	BH. No.	Depth of Water Table below EGL (m)	Depth of Borehole below EGL (m)	Co-ordinates (m)		(+) R.L (m)
						E	N	
1.	1698.053	1548.996	BH-01	Not Encountered	10.00	682480.212	3147693.121	213.913
2.	1912.700	1767.989	BH-02		10.00	682529.013	3147832.270	214.395
3.	2807.817	2189.831	BH-03		10.00	682734.079	3148703.655	212.675
4.	2972.708	2823.679	BH-04		10.00	682770.474	3148864.480	213.976

- In soil, boreholes of 150mm dia. were drilled as per the standard procedure laid in IS: 1892.
- Borehole was properly cleaned before taking any sample in soil.
- Casing was used as per the prevailing soil conditions, to stabilize the borehole.
- Standard Penetration Tests were conducted in bore holes at regular intervals or at every change of strata as per Technical specification.
- Undisturbed were collected wherevery feasible as per the requirements and at specified depths. The same has been discussed in detail in soil characteristics sheets attached with the report.
- Water table was not encountered in the boreholes.
- The detailed procedure adopted for conducting various field tests is given here in below:

(i) Standard Penetration Test:

The Standard Penetration Test was conducted in boreholes as per IS 2131. The test was carried out using the standard split spoon sampler to measure the number of blows 'N'.

Standard split spoon sampler was attached to an 'A' rod. It was driven from borehole bottom to a distance of 45 cm using a standard hammer of 63.5 kg falling freely from a height of 75 cm to the required depth. While driving, the number of blows required to penetrate every 15 cm are recorded. The total number of blows required for the last 30 cm is taken as 'N' value at that particular depth of the borehole. Wherever the total penetration was less than 45cm, the no. of blows & the depth penetrated is recorded in the respective borelog.

SPT 'N' values were correlated with relative density of non-cohesive stratum and with consistency of cohesive stratum as given below:-

Table 1.2: Soil compactness as per SPT N values (cl. 9.7, table 9.3 & 9.4, page 330_text book of V.N.S. Murthy)

Correlation for Clay / Plastic silt		Correlation for Sand / Non-Plastic silt	
Consistency	**SPT "N" Value**	**Compactness**	**SPT "N" Value**
Very Soft	0 - 2	Very Loose	0 - 4
Soft	2 - 4	Loose	4 - 10
Medium	4 - 8	Medium	10 - 30
Stiff	8 - 15	Dense	30 - 50
Very Stiff	15 - 30	Very Dense	> 50
Hard	> 30		

The field SPT N values obtained were further corrected as per the guidelines given in IS: 2131 as follows:

(a) For overburden: - The N value for cohesionless soil is corrected with the help of fig. 1 given in IS-2131.

(b) Due to dilatancy :- Wherever N values observed below water table in fine sand, silty sand or silt was greater than 15, then corrected N values were corrected as under:

$$N' = 15 + \tfrac{1}{2}(N-15)$$

(ii) Undisturbed Sampling (Soil) in boreholes:

Undisturbed samples were collected using MS tubes of suitable diameter and length with Area ratio as per clause 4.1.1 (c) of IS: 1892 (latest) fitted to an adopter with ball and socket arrangement. Before taking any sample, sampling tube was properly greased. Immediately after taking on undisturbed sample in a tube, the adopter head was removed along with the disturbed material. The visible ends of the sample were trimmed off any wet disturbed soil. The ends were coated alternately with four layers of just molten wax. More molten wax was added to give a total thickness of min. 25 mm. The samples were carefully labeled and transported to the laboratory for testing. Undisturbed samples wherever slipped during lifting were duly marked in the field logs as well as in the soil profile.

(iii) Collection of Ground Water Samples from bore holes:

Water table was not encountered in the boreholes during the site investigation.

5.0 LABORATORY TESTS ON SOIL SAMPLES:

The following laboratory tests were conducted on selected soil samples:

Table 1.3: Description of Tests

Description of Test	Reference	Undisturbed (UDS) Soil Samples	Disturbed (DS/SPT) Soil Samples
Grain Size Analysis / Hydrometer	IS: 2720 (Part - 4)	√	-
Natural Moisture Content / Bulk / Dry density	IS : 2720 (Part – 2)	√	-
Atterberg Limits • Liquid Limit • Plastic Limit	 IS: 2720 (Part - 5) IS: 2720 (Part - 5)	 √ √	-
Specific Gravity	IS : 2720 (Part – 3)	√	-
Direct Shear Test	IS : 2720 (Part – 13)	√	-
Triaxial compressive shear test	IS : 2720 (Part – 11 & 12)	√	-
Chemical Analysis of Soil Samples	IS : 2720 (Part – 26, 27)	√	-

Note:- The detailed procedure adopted for conducting various laboratory tests is described in the following paragraphs:

5.1.1 Dry density and Bulk density

For determination of bulk density and dry density, a sample of known volume 'V' was extracted from the undisturbed sampling tube and it's bulk weight 'W' was noted down.Moisture content 'Wn' was determined by oven drying method.

The bulk density and dry density were determined by following equation-

Bulk density (γ_b) = W/V

Dry density (γ_d) = γ_b/ (1+Wn)

5.1.2 Natural water content

For this test, the soil sample of known quantity (Wm) was taken in a container.The container with soil sample was placed into an oven for drying at 105-110°c temperature for 16-24 hours. After drying, the dry sample was again weighted to determine the dry weight of sample (Wd).

The natural water content was computed by the following equation-

Wn = (Wm-Wd)*100/Wd

5.1.3 Grain Size Analysis (IS: 2720- Part-4)

Wet sieve analysis:

For determination of particle sizes finer than 75 micron, wet sieve analysis test was conducted. For this test, oven dried sample of known quantity was taken in a container and soaked with dispersing agent. The soaked soil sample was washed thoroughly over 75 micron IS sieve until the water passing sieve was substantially clean.

Fraction retained on 75 micron IS sieve was carefully collected in a container without any loss in material and placed into oven for drying.

Dry sieve analysis:

For this test, the oven dried soil sample after wet sieving was sieved through the set of IS sieves 20 mm, 10 mm, 4.75 mm, 2.0 mm, 1.0 m , 425 micron , 300 micron, 150 micron and 75micron. The amounts of soil retained on each sieve were noted down. The % retained, cumulative % retained and % passing were computed accordingly. Wherever the soil sample % passing 75 micron sieve was significant, Hydrometer method was used to find the percentage of silt and clay fraction.

Grain size analysis for the fraction passing 75 micron IS Sieve (Hydrometer method)

Calibration of Hydrometer

Hydrometer was calibrated to determine a relationship (an equation) between the effective depth H_R and corresponding hydrometer reading R_h (obtained during test).

50 to 100 gm of soil sample passing through 75 micron IS Sieve was taken. It was mixed with 100 ml of sodium hexametaphesphate solution and the mixture was warmed for about 10 minutes. It was then transferred to the cup of the mechanical mixer and the soil suspension was stirred for 15 minutes. The soil suspension was transferred into 1000 ml measuring cylinder and distilled water was added to make 1000ml solution. This solution was mixed vigorously. The measuring cylinder was then allowed to stand and the stopwatch was started. Hydrometer was immersed in the solution and reading were taken after half, one, two and four minutes. The hydrometer was then removed slowly and kept in distilled water at the same temperature as the soil suspension. Readings were taken after the periods of 8, 15 and 30 minutes, and one, two and four hours. Hydrometer was removed, rinsed and placed in the distilled water after each reading. After 4 hours reading was taken once or twice within 24 hours. Finally a reading was taken at the end of 24 hours. The temperature of the suspension was observed and recorded.

Calculations

Diameter of the particles (D):

$$D = \sqrt{\frac{30\mu}{980(G-1)}} \times \sqrt{\frac{H_R}{t}} = M\sqrt{\frac{H_R}{t}}$$

Where,

D = diameter of particle in suspension, in mm;

μ = co-efficient of viscosity of water at the temperature of the suspension at the time of taking the hydrometer reading, in poise;

G = specific gravity of the soil fraction used in the sedimentations analysis;

H_R = effective depth corresponding to R_n, in cm.

t = time elapsed between the beginning of sedimentation and taking of hydrometer reading in minutes

$M = \sqrt{\frac{30\mu}{980(G-1)}}$ = a constant factor for given values of μ and G at the temperature of the suspension.

Percentage finer than diameter D:

The percentage by mass (w) of particles smaller than corresponding equivalent particle diameters (D) was calculated from the formula:

$$w = \frac{100G_s}{W_b(G_s - 1)} \times R_h$$

Where

w = percentage finer

G_s = specific gravity of soil particle

W_b = weight of soil

R_h = Hydrometer reading

5.1.4 Specific Gravity (IS: 2720-Part-3 Sec-1)

The specific gravity of soil sample was determined by density bottle method. For this test 5-10g oven dried and cooled soil sample was taken in 50ml capacity density bottle and its weight was noted down as W_2 .The soil was covered with distilled water and left for sufficient period for suitable soaking. The entrapped air was removed by vacuum. The bottle with soil was filled fully with water and its weight was noted down (W_3). The mass of empty bottle and bottle filled with distilled water were noted down as W_1 and W_4 respectively.

The Specific Gravity was determined by using following equation :

$G=W_2-W_1/[(W_2-W_1)-(W_3-W_4)]$

5.1.5 Liquid Limit (IS: 2720- Part-5)

By Cone Penetrometer Method

The 'Cone Penetrometer Apparatus' is a variant of the fall-cone and consists of a cone with a smooth polished surface and angle of 30° ± 1/2°. The weight of the cone, together with its associated shaft is 80g ± 0.5g. A support assembly with an automatic cone release mechanism and cone height adjustment mechanism used to hold the cone vertically. The angle and weight of the cone were calibrated at regular intervals, and the sharpness of the cone tip was checked daily.

Distilled water was added and thoroughly mixed with the soil sample to produce a homogeneous paste. The paste was then placed in a cup with a diameter of at least 55mm and a depth of at least 40mm. The surface of the soil was smoothed off level and parallel to the base. The support assembly was used to position the tip of the cone so that it was just touching the top surface of the soil, and the automatic tripping mechanism was released. The cone was allowed to penetrate into the soil for a period of 5 (± 1) s, then the cone was locked off to stop further movement and the penetration was recorded. The cup was refilled and the test was repeated. The two recorded penetrations need to be within 0.5mm of each other, otherwise a third test is performed. when the three test vary by more than 1mm the test was repeated.

Further tests were conducted, at varying water contents, in order to produce a series of cone penetrations (usually 4) in the range 15mm to 25mm. The resulting cone penetrations were plotted verses the water content of the test specimens. The Liquid Limit (W_L) was read off the graph, being the water content at which the line of best fit through the test points crosses 20mm penetration.

5.1.6 Plastic Limit (IS: 2720-Part-5)

For this test, soil sample was prepared in the same way as for liquid limit test. A ball of soil sample weighed about 5 gm was formed. The ball was rolled between the fingers of one hand and the glass plate with pressure sufficient to reduce the mass into a thread of about 3 mm in 5 to 10 complete forward and back movements. When a diameter of 3 mm was reached, soil was again remolded into a ball. The process of rolling and remolding was repeated until the thread started just crumbing at a diameter of 3 mm. The crumbled thread was immediately transferred to an airtight container for determination of its moisture content by oven drying method.

This water content has been termed as plastic limit. (W_P)

5.1.7 Plasticity Index (IS: 2720-Part-5)

The plasticity index Ip was given by

$I_p = W_L - W_P$ (in percent)

5.1.8 Direct Shear Test (IS:2720-Part-13):

For this test shear box test apparatus was used. The prepared specimen from remolded/undisturbed sample was placed carefully in the box. The plain grid was kept on top of the specimen with its directions at right angles to the direction of shear. The upper porous stone was placed on the grid and loading pad on the stone. The box with specimen was gently placed in the container (water jacket). The specimen was submerged with water. The container was mounted with the shear box and the specimen inside, on the shearing machine. The upper part of the box was so adjusted that it touchéd the proving ring. The jack was brought forward to bear up against the box container. The proving ring dial gauge was set to read zero.

The steel ball was placed in the recess of the loading pad. The loading yoke was set in contact with the steel ball on the loading pad. Vertical displacement dial gauge to read zero in contact with the top of the yoke. The normal load was applied and any change in thickness of specimen was recorded. Shear displacement dial gauge was also set to read zero. The locking screw was now removed and two parts of the shear box were separated by advancing the spacing screws.

The specimen was sheared at constant rate of strain. The readings of the proving ring dial gauge were noted down every 15 seconds for the first one-minute and then every 30 seconds thereafter. The reading of change in the thickness dial gauge and shear displacement dial gauge were also recorded at the same time interval. The test was continued until the specimen fails. The specimen was assumed to fail when the proving ring dial gauge started receding or at shear displacement of approximately 15% of the length took place.

The soil was removed from the box and test was repeated on the identical specimen under increased normal load.

5.1.9 Triaxial Shear Test_UUT (IS: 2720-Part-11)

For this test, Triaxial Shear Test apparatus was used. The plain disc was placed on the pedestal of the triaxial cell. The specimen was placed centrally on the disc. A correct size rubber membrane was fitted inside the stretcher with ends of membrane folded over those of the stretcher. Vacuum was applied to stretch the membrane to the inside surface of the stretcher which was carefully slipped around the specimen kept on the pedestal. The vacuum on the membrane was released. Its bottom part was rolled down into the pedestal. plain disc was placed on the top of the specimen and then loading pad was placed. The top part of membrane was rolled on to the loading pad. Then the stretcher was removed and ends were sealed with ‘O’ rings. With the properly sealed specimen placed centrally on the pedestal, the cell was assembled, keeping the loading piston initially clear of the loading pad of the specimen, the assembly was placed in the loading frame.

For unconsolidated undrained test, the bottom drainage value (BDV) and top drainage value (TDV) of cell, was closed and air release valve (ARV) was opened. The cell was filled with water

through the cell water value CWV. ARV was closed when water begins to escape through it. The cell pressure was raised to the desired value and kept constant till the end of the test.

When the cell pressure was applied, the load piston rises upward, the loading machine was operated at the anticipated rate to bring the load piston slightly above the loading pad of the specimen and the load measuring dial gauge on proving ring was set to zero.

The piston was brought just in contact with loading pad by hand operation of the machine. The axial compression dial gauge was mounted and set to read zero.

The axial loading was started at 1.25 mm/min rate of strain. Simultaneous readings on the load and compression dial gauges were noted down. The test was continued until a recession of the axial load is observed or 20% of strain.

After failure, the specimen was unloaded by reversing the loading machine, cell pressure was reduced and cell water was drained out through BRV. The cell was dismantled and the specimen was taken out, rubber membrane was removed and weight of the failed sample and its water content was determined. The test was repeated on two more identical specimens with increasing cell pressure.

CHAPTER 2 ANALYSIS OF TEST RESULTS AND INTERPRETATION

6.0 STRATIFICATION

From the study of the borehole logs, it is revealed that the sub strata mainly consist of silty sand (SM),sandy silt of low plasticity (ML-CL) and silty clay of low plasticity(CL).

However,

At the location of (OLD) CH.1698.053(BH-1):-

a) From EGL to 7.50m depth consists of coarse grained strata i.e silty sand (SM).

b) From 7.50m to 10.00m depth consists of fine grained strata i.e. silty clay of low plasticity (CL) and silty clay of intermediate plasticity(CI).

At the location of (OLD) CH.1912.7(BH-2):-

a) From EGL to 8.25m depth consists of coarse grained strata i.e silty sand (SM) and silty sand with clay of low plasticity (SM-SC).

b) From 8.25m to 10.00m depth consists of fine grained strata i.e. silty clay of low plasticity (CL) and silty clay of intermediate plasticity(CI).

At the location of (OLD) CH.2807.817(BH-3):-

a) From EGL to 5.25m depth consists of coarse grained strata i.e silty sand (SM).

b) From 5.25m to 10.00m depth consists of fine grained strata i.e. silty clay of low plasticity (CL).

At the location of (OLD) CH.2972.708(BH-4):-

a) From EGL to 6.00m depth consists of coarse grained strata i.e silty sand (SM) and poorly graded sand(SM-SP).

b) From 6.00m to 10.00m depth consists of fine grained strata i.e. silty clay of low plasticity (CL).

6.1 GROUND WATER TABLE DEPTH

The Ground Water Table at all the bore hole locations was not encountered during the site investigation.

6.2 RESULTS OF CHEMICAL ANALYSIS

Results of chemical analysis of soil samples (as per **Appendix – B2**) indicates that the soil sample falls under Class I for sulphates and chlorides concentration (As per IS 456-2000 and CIRIA Sp. Publication No. 31). The results are summarized here in below :-

Summary of chemical analysis of soil samples

Chemical Property	Findings (Min. to Max.)	Remarks (Required limits as per IS 456-2000)
pH	7.60 to 8.74	> 6.0
Sulphite as SO_3^{2-} (%)	0.0021 to 0.0024 (%)	< 0.2% (Class I)
Chlorides as Cl^- (%)	0.0055 to 0.0063 (%)	No limit specified in IS 456. However, a limit of 0.10% specified for class I in CIRIA Sp. Publication No. 31)

Note :- All the chemical contents are within permissible limit hence no special precautions are required.

CHAPTER 3 TYPE AND DEPTH OF FOUNDATION WITH ANALYSIS

7.0 TYPE & DEPTH OF FOUNDATION:

Based on the nature & strength characteristics of the substrata and requirement of the project, the following type of foundation have been analyzed as given below:

Chainage (Old) (m)	BH No.	Type of foundation	Depth of foundation below E.G.L. (m)	Length x Width (m)	Remarks
1698.053	BH-01	Shallow Foundation	1.00	2.0 x 2.0	-
			1.50		
			2.00		
1912.700	BH-02		1.00	4.0 x 4.0	
			1.50		
			2.00		
2807.817	BH-03		1.00	2.0 x 2.0	
			1.50		
			2.00		
2972.708	BH-04		1.00	5.0 x 5.0	
			1.50		
			2.00		

The details of foundation analysis are given in the subsequent paragraph.

7.1 ANALYSIS OF SHALLOW FOUNDATION

7.1.1 From Shear Failure Criteria

Net Safe Bearing capacity from Shear Failure consideration has been computed in accordance with IS: 6403-1981, which is based on, modified Terzaghi's classical approach. The weighted average of shear strength parameters for various strata upto depth equal to 0.5*B*Tan (45+Ø/2) (where B = Width of the Foundation, Ø = Angle of internal friction) is used in the analysis. A factor of safety of 2.5 to estimate the net safe bearing capacity from ultimate net bearing capacity.

For soils, containing both coarse grained (gravels & sands) and fine grained (clays), c and Φ are used to determine the soil strength. In case of predominantly fine grained soils, c and Φ are determined by the Triaxial Compression test as per IS: 2720 pt XI. For predominantly coarse grained soils, c and Φ are determined by Direct Shear test as per IS: 2720 pt XIII. These c and Φ values were used for determining the SBC of soil as per shear failure criteria.

The ultimate net bearing capacity in case of general shear failure is given by following expression,

$$q_d = c\, N_c\, s_c\, d_c\, i_c + q\, (N_q\text{-}1)\, s_q\, d_q\, i_q + (1/2)\, B\, \gamma\, N_\gamma\, s_\gamma\, d_\gamma\, i_\gamma\, W'$$

The ultimate net bearing capacity in case of local shear failure is given by following expression,

$q'_d = (2/3)\, c\, N'_c\, s_c\, d_c\, i_c + q\,(N'_q - 1)\, s_q\, d_q\, i_q + (1/2)\, B\, \gamma\, N'_\gamma\, s_\gamma\, d_\gamma\, i_\gamma\, W'$

Where,

$d_c = 1 + 0.2\,(D_f/B)*SQRT(N_\phi)$

$d_q = d_\gamma = 1$ for $\phi < 10^o$

$d_q = d_\gamma = 1 + 0.1\,(D_f/B)*SQRT(N_\phi)$ for $\phi > 10^o$

$N_\phi = \tan^2(\pi/4 + \phi/2)$

ϕ' for local shear failure $= \tan^{-1}(0.67 \tan\phi)$

7.1.2 From Settlement Failure Criteria

Allowable Bearing Pressure from Settlement Failure consideration has been computed in accordance with IS: 8009 (Part-I). The magnitude of settlement, when foundation loads are applied, depends upon the compressibility of the underlying strata and rigidity of the substructure.

The total permissible settlement in cohesion-less soil is estimated using SPT value as per IS: 8009 (Part-I). While using this approach, the N value was corrected, wherever applicable, below the footing base to at least 1.5B below the base to account for the effects of energy ratio, adopted bearing pressure, dilation for submerged silty fine sands / fine sands as well as that due to the overburden pressure.

Further for settlement Calculation in cohesive soil the following equation has been used.

$S_t = \Delta P\, M_v\, H$

Where,

M_v = Coefficient of volume compressibility, cm^2/kg

ΔP = Pressure increment, kg/cm^2

H = Thickness of layers

CHAPTER 4 FOUNDATION RECOMMENDATIONS

8.0 FOUNDATION RECOMMENDATIONS

- Based on the nature & strength characteristics of the substrata and requirement of the project, shallow foundation have been analyzed.
- The recommended net allowable bearing capacity values are given in Table 4.1 to 4.2.

Table 4.1: Recommended Net Allowable Bearing Capacity for shallow foundation for allowable settlement 25mm

Chainage Old (m)	Chainage New (m)	BH. No.	Foundation Size (m x m)	Depth of foundation below EGL (m)	Net Safe Bearing Capacity from Shear Failure (t/m^2)	Net Allowable Bearing Pressure from settlement failure (t/m^2)	Recommended Net Allowable Bearing Capacity (t/m^2)
1698.053	1548.996	BH-01	2.0 x 2.0	1.0	25.00	34.38	25.00
				1.5	33.09	37.49	33.09
				2.0	41.73	39.60	39.60
1912.700	1767.989	BH-02	4.0 x 4.0	1.0	16.72	17.20	16.72
				1.5	20.52	18.02	18.02
				2.0	24.45	18.98	18.98
2807.817	2189.831	BH-03	2.0 x 2.0	1.0	15.66	29.41	15.66
				1.5	20.85	32.07	20.85
				2.0	26.41	33.87	26.41
2972.708	2823.679	BH-04	5.0 x 5.0	1.0	33.43	10.77	10.77
				1.5	39.60	11.68	11.68
				2.0	45.96	12.67	12.67

Table 4.2: Recommended Net Allowable Bearing Capacity for shallow foundation for allowable settlement 50mm

Chainage Old (m)	Chainage New (m)	BH. No.	Foundation Size (m x m)	Depth of foundation below EGL (m)	Net Safe Bearing Capacity from Shear Failure (t/m^2)	Net Allowable Bearing Pressure from settlement failure (t/m^2)	Recommended Net Allowable Bearing Capacity (t/m^2)
1698.053	1548.996	BH-01	2.0 x 2.0	1.0	25.00	68.77	25.00
				1.5	33.09	74.98	33.09
				2.0	41.73	79.20	41.73
1912.700	1767.989	BH-02	4.0 x 4.0	1.0	16.72	34.41	16.72
				1.5	20.52	36.05	20.52
				2.0	24.45	37.95	24.45
2807.817	2189.831	BH-03	2.0 x 2.0	1.0	15.66	58.82	15.66
				1.5	20.85	64.14	20.85
				2.0	26.41	67.75	26.41

Chainage Old (m)	Chainage New (m)	BH. No.	Foundation Size (m x m)	Depth of foundation below EGL (m)	Net Safe Bearing Capacity from Shear Failure (t/m^2)	Net Allowable Bearing Pressure from settlement failure (t/m^2)	Recommended Net Allowable Bearing Capacity (t/m^2)
2972.708	2823.679	BH-04	5.0 x 5.0	1.0	33.43	21.53	21.53
				1.5	39.60	23.37	23.37
				2.0	45.96	25.35	25.35

Notes: **-**

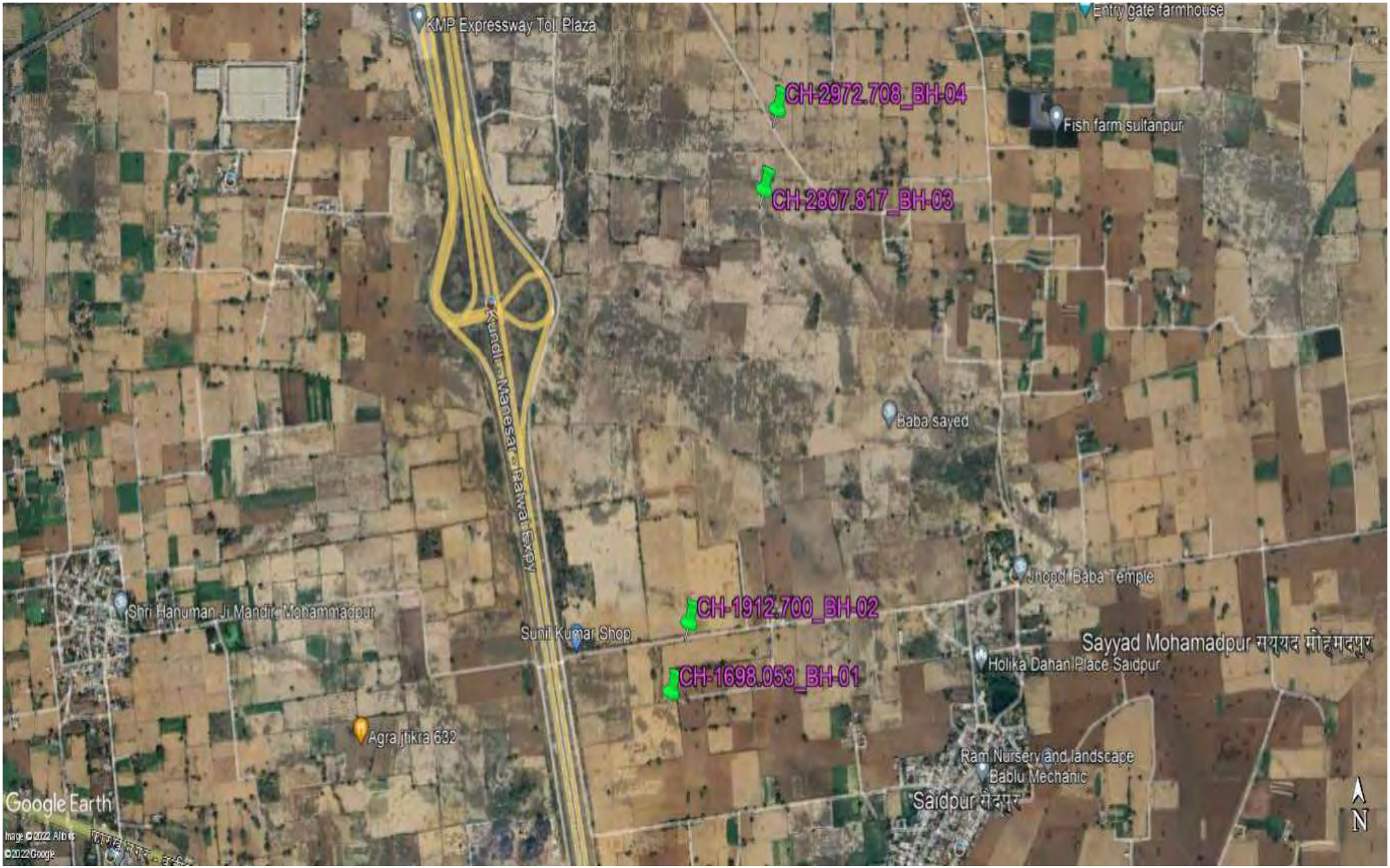
All The above recommendations are based on the field and laboratory tests conducted on selected soil/ rock core samples and our experience in this regard. If the actual substrata conditions during excavation for the foundation differ from the observations reported here, the design experts/consultants should be referred for suggestion, further investigations.

Abbreviations

BH	Borehole
ERT	Electrical Resistivity Test
EGL	Existing Ground Level
GWT	Ground Water Table
IS	Indian Standards
SPT	Standard Penetration Test
DS	Disturbed Soil
R.L.	Reduced Level
m	Metre
sp. gr.	Specific Gravity
%	Percentage
mg /l	Milligram per litre
mg /kg	Milligram per kilogram

APPENDIX – A (FIELD DATA RESULTS)

Appendix No.	ITEMS
A-1	LOCATION PLAN
A-2	FIELD BORE HOLE LOGS
A-3	SUB SOIL PROFILE DIAGRAM


KMP Expressway Toll Plaza
Entry gate farmhouse
CH-2972.708_BH-04
Fish farm sultanpur
CH-2807.817_BH-03
Kundli - Manesar - Palwal Expy
Baba sayed
Jhopdi Baba Temple
CH-1912.700_BH-02
Shri Hanuman Ji Mandir, Mohammadpur
Sunil Kumar Shop
Sayyad Mohamadpur सय्यद मोहमदपुर
CH-1698.053_BH-01
Holika Dahan Place Saidpur
Agra jtikra 632
Ram Nursery and landscape
Bablu Mechanic
Saidpur सैदपुर
Google Earth
N

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*1698.053m	*Northing :*3147693.121 m	*Easting :*682480.212 m
Reduced Level (m):(+)213.913	*BH. No. :*BH-01	*BH Termination Depth (m):*10
*Proposed / Existing Structure :*Minor Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*14-06-2022	*Date of Completion :*14-06-2022	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5	0.5	SPT-1	3	5	5	10					
1.0											
1.5	1.5	SPT-2	6	9	10	19					
2.0											
	2.25	UDS-1									
2.5											
3.0	3	SPT-3	8	11	13	24					
3.5											
4.0							Medium dense, Brownish, Silty Sand	SM			
4.5	4.5	SPT-4	10	12	14	26					
5.0											
	5.25	UDS-2									
5.5											
6.0	6	SPT-5	9	10	11	21					
6.5											
7.0											
7.5	7.5	SPT-6	10	13	16	29					
8.0											
	8.25	UDS-3									
8.5											
9.0	9	SPT-7	12	15	17	32	Very Stiff to Hard, Brownish, Silty Clay of low Plasticity	CL			
9.5											
10.0	10	SPT-8	18	19	24	43					

(Depth v/s SPT N Value) axis: 0 10 20 30 40 50 60 70 80 90 100

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*1912.700m	*Northing :*3147832.27 m	*Easting :*682529.013 m
Reduced Level (m):(+)214.395	*BH. No. :*BH-02	*BH Termination Depth (m):*10
*Proposed / Existing Structure :*Minor Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*13-06-2022	*Date of Completion :*13-06-2022	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5	0.5	SPT-1	3	5	5	10					
1.0											
1.5	1.5	SPT-2	4	7	7	14					
2.0											
	2.25	UDS-1									
2.5											
3.0	3	SPT-3	5	7	8	15					
3.5											
4.0							Medium dense, Brownish, Silty Sand	SM			
4.5	4.5	SPT-4	5	8	10	18					
5.0											
	5.25	UDS-2									
5.5											
6.0	6	SPT-5	8	10	11	21					
6.5											
7.0											
7.5	7.5	SPT-6	8	12	13	25					
8.0											
	8.25	UDS-3									
8.5											
9.0	9	SPT-7	14	19	22	41	Dense, Brownish, Sandy Silt with Clay	ML-CL			
9.5											
10.0	10	SPT-8	16	20	24	44					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*2807.817m	*Northing :*3148703.655 m	*Easting :*682734.079 m
Reduced Level (m):(+)212.675	*BH. No. :*BH-03	*BH Termination Depth (m):*10
*Proposed / Existing Structure :*Minor Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*14-06-2022	*Date of Completion :*14-06-2022	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5	0.5	SPT-1	5	7	7	14					
1.0											
1.5	1.5	SPT-2	8	10	12	22					
2.0											
2.5	2.25	UDS-1					Medium,Brownish,Silty Sand	SM			
3.0	3	SPT-3	6	7	9	16					
3.5											
4.0											
4.5	4.5	SPT-4	7	9	11	20					
5.0											
5.5	5.25	UDS-2									
6.0	6	SPT-5	9	14	14	28					
6.5											
7.0											
7.5	7.5	SPT-6	8	13	14	27	Very Stiff,Brownish, Silty Clay of Low Plasticity	CL			
8.0											
8.5	8.25	UDS-3									
9.0	9	SPT-7	6	9	11	20					
9.5											
10.0	10	SPT-8	8	10	12	22					

UDS*-UDS not recovered

FIELD BOREHOLE LOG

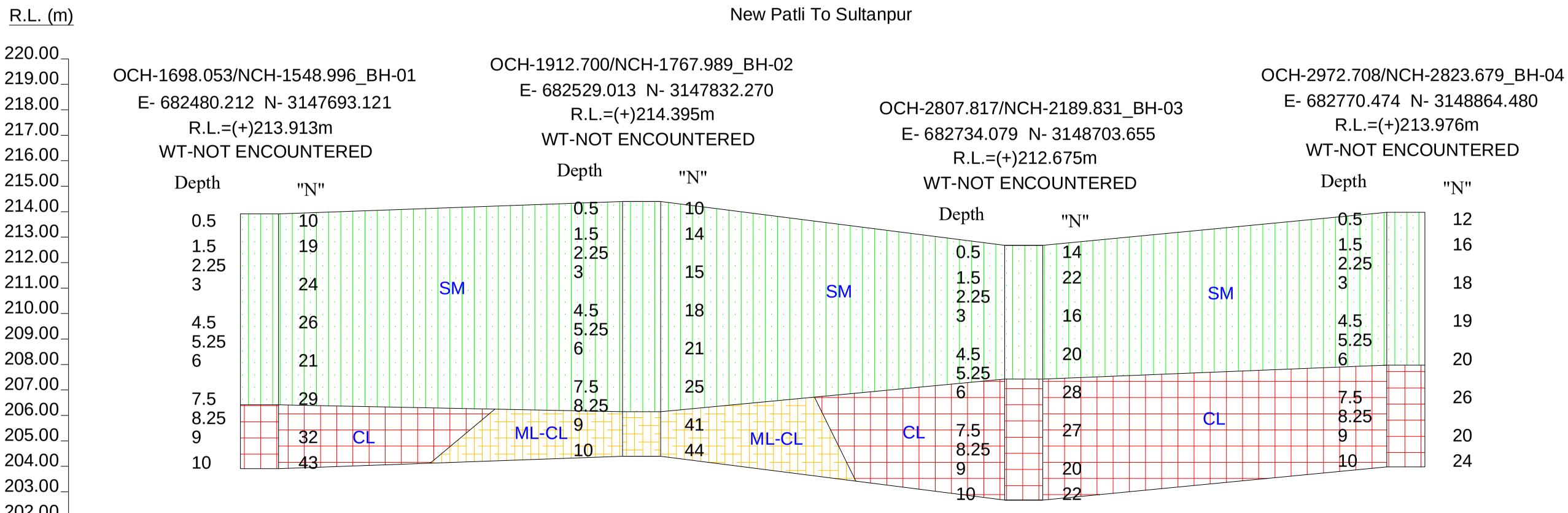
*Project Name :*GTI for (HORC) project from Palwal to Harsana Kalan in the state of Haryana.		*Client :*HRIDCL
*BH Location/Chainage :*2972.708m	*Northing :*3148864.48 m	*Easting :*682770.474 m
Reduced Level (m):(+)213.976	*BH. No. :*BH-04	*BH Termination Depth (m):*10
*Proposed / Existing Structure :*Minor Bridge	*Water Table (m):*Not Encountered	*Inclination :* Vertical
*Boring type :*Rotary	*Dia. of Boring :*150 mm	*Depth of Casing (m) :*Not Used
*Date of Start :*15-06-2022	*Date of Completion :*15-06-2022	

Depth (m)	In-Situ Sample Depth (m)	Sample Type	Blow counts per 15cm N1	N2	N3	SPT N Value	Strata Description	IS Classification	Graphic Log	(Depth v/s SPT N Value)	Special Observations
0.0		DS									
0.5	0.5	SPT-1	4	6	6	12					
1.0											
1.5	1.5	SPT-2	5	7	9	16					
2.0											
	2.25	UDS-1									
2.5											
3.0	3	SPT-3	7	9	9	18	Medium dense, Brownish, Silty Sand	SM			
3.5											
4.0											
4.5	4.5	SPT-4	6	9	10	19					
5.0											
	5.25	UDS-2									
5.5											
6.0	6	SPT-5	8	10	10	20					
6.5											
7.0											
7.5	7.5	SPT-6	7	12	14	26					
8.0							Very Stiff, Brownish, Silty Clay of Low Plasticity	CL			
	8.25	UDS-3									
8.5											
9.0	9	SPT-7	6	9	11	20					
9.5											
10.0	10	SPT-8	8	11	13	24					

UDS*-UDS not recovered

CONDUCTING GEOTECHNICAL INVESTIGATION, PREPARATION OF GEOTECHNICAL REPORT FOR DESIGNING OF BRIDGES AND FOR EMBANKMENT IN CONNECTION WITH CONSTRUCTION OF HARYANA ORBITAL RAIL CORRIDOR (HORC) PROJECT FROM PALWAL TO HARSANA KALAN INCLUDING CONNECTIVITY TO EXISTING IR NETWORK IN THE STATE OF HARYANA.

New Patli To Sultanpur



Chainage (Mtr.)	BH No.	Size (mxm)	Depth from EGL (m)	SBC in Shear (t/m^2)	SBC from Permissible Settlement (t/m^2)	Recommended Net safe Bearing Capacity (t/m^2)	Allowable Settlement (mm)
OCH-1698.053/ NCH-1548.996	BH-01	2 X 2	1.00	25.00	34.38	25.00	25
			1.50	33.09	37.49	30.00	
			2.00	41.73	39.60	30.00	
OCH-1698.053/ NCH-1548.996	BH-01	2 X 2	1.00	25.00	68.77	25.00	50
			1.50	33.09	74.98	30.00	
			2.00	41.73	79.20	30.00	
OCH-1912.700/ NCH-1767.989	BH-02	4 X 4	1.00	16.72	17.20	16.72	25
			1.50	20.52	18.02	18.02	
			2.00	24.45	18.98	18.98	
OCH-1912.700/ NCH-1767.989	BH-02	4 X 4	1.00	16.72	34.41	16.72	50
			1.50	20.52	36.05	20.52	
			2.00	24.45	37.95	24.45	

Chainage (Mtr.)	BH No.	Size (mxm)	Depth from EGL (m)	SBC in Shear (t/m^2)	SBC from Permissible Settlement (t/m^2)	Recommended Net safe Bearing Capacity (t/m^2)	Allowable Settlement (mm)
OCH-2807.817/ NCH-2189.831	BH-03	2 X 2	1.00	15.66	29.41	15.66	25
			1.50	20.85	32.07	20.85	
			2.00	26.41	33.87	26.41	
OCH-2807.817/ NCH-2189.831	BH-03	2 X 2	1.00	15.66	58.82	15.66	50
			1.50	20.85	64.14	20.85	
			2.00	26.41	67.75	26.41	
OCH-2972.708/ NCH-2823.679	BH-04	5 X 5	1.00	33.43	10.77	10.77	25
			1.50	39.60	11.68	11.68	
			2.00	45.96	12.67	12.67	
OCH-2972.708/ NCH-2823.679	BH-04	5 X 5	1.00	33.43	21.53	21.53	50
			1.50	39.60	23.37	23.37	
			2.00	45.96	25.35	25.35	

SYMBOL	DESCRIPTION
	FILLED UP STRATA
	SM- Silty Sand (Having fines Less Than 50% and no plasticity or below A-line)
	SM-SC -Clayey Sand (Having fines Less Than 50% and in the hatched zone (4<PI<7)
	ML-CL -Sandy with clay (Having fines greater than 50% and in the hatched zone (LL<35 & 4<PI<7)
	CL-Silty Clay of low plasticity (Above A-line, LL<35)
	WATER TABLE

Note:- Fines= Percentage of Silty + Clay A-line=.73(wl-20)

APPENDIX – B (LAB TEST RESULTS)

Appendix No.	ITEMS
B-1	SOIL CHARACTERISTICS SHEETS
B-2	RESULT OF CHEMICAL ANALYSIS OF SOIL SAMPLES
B-3	GSD CURVES

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.					Date of Boring			Chainage (m)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
						14-06-2022	to	14-06-2022	1698.053	BH-01	Not Encountered	10.00 m	682480.212 m	3147693.121 m	(+)213.913 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																			
DS	0.00		-	Medium dense, Brownish, Silty Sand	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	0.50	10	18		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-2	1.50	19	27		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.25	-	-		SM		0	14	78	7	1	0	0	-	NIL	NP	-	1.76	10.10	1.60	2.63	DST	0.00	29	-	-	-	-	-	-	-	-
SPT-3	3.00	24	29		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-4	4.50	26	28		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	5.25	-	-		SM		0	23	65	11	1	0	0	-	NIL	NP	-	1.77	11.20	1.59	2.63	DST	0.00	29	-	-	-	-	-	-	-	-
SPT-5	6.00	21	21		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-6	7.50	29	26	Very Stiff to Hard, Brownish, Silty Clay of low Plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	8.25	-	-		CL		10	51	32	6	0	1	0	33	22	11	-	1.87	16.40	1.61	2.67	UUT	1.21	5	-	-	-	-	-	-	-	-
SPT-7	9.00	32	32		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	10.00	43	43		CI		13	56	22	7	1	1	0	38	24	14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEGTH
CEG TEST HOUSE
AND RESEARCH CENTRE PVT LTD

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (m)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		13-06-2022	to	13-06-2022	1912.700	BH-02	Not Encountered	10.00 m	682529.013 m	3147832.270 m	(+)214.395 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00		-	Medium dense, Brownish, Silty Sand	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	0.50	10	18		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-2	1.50	14	20		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.25	-	-		SM		0	18	72	10	0	0	0	-	NIL	NP	-	1.67	10.10	1.52	2.63	DST	0.00	29	-	-	-	-	-	-	-	-	-	-
SPT-3	3.00	15	18		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-4	4.50	18	20		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	5.25	-	-		SM		0	28	62	10	0	0	0	-	NIL	NP	-	1.68	10.09	1.53	2.64	DST	0.00	30	-	-	-	-	-	-	-	-	-	-
SPT-5	6.00	21	21		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-6	7.50	25	23		SM-SC		8	38	44	8	2	0	0	26	20	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	8.25	-	-	Dense, Brownish, Sandy Silt with Clay	ML-CL		7	44	40	8	1	0	0	28	21	7	-	1.85	14.20	1.62	2.66	DST	0.21	26	-	-	-	-	-	-	-	-	-	-
SPT-7	9.00	41	35		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	10.00	44	36		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEGTH
CEG TEST HOUSE
AND RESEARCH CENTRE PVT LTD

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.					Date of Boring			Chainage (m)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
						14-06-2022	to	14-06-2022	2807.817	BH-03	Not Encountered	10.00 m	682734.079 m	3148703.655 m	(+)212.675 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	$C_v \times 10^{-4}$ (cm^2/Sec)	$M_v \times 10^{-2}$ (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																			
DS	0.00		-	Medium,Brownish,Silty Sand	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	0.50	14	25		SM		0	22	68	9	1	0	0	-	NIL	NP	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-2	1.50	22	32		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.25	-	-		SM		0	13	77	8	1	1	0	-	NIL	NP	-	1.70	10.10	1.54	2.62	DST+	0.00	29	-	-	-	-	-	-	-	-	-
SPT-3	3.00	16	19		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-4	4.50	20	22		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	5.25	-	-	Very Stiff,Brownish, Silty Clay of Low Plasticity	CL		12	43	37	6	1	1	0	29	21	8	-	1.79	14.20	1.57	2.64	UUT	0.72	5	-	-	-	-	-	-	-	-	-	-
SPT-5	6.00	28	28		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-6	7.50	27	27		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	8.25	-	-		CL		13	42	37	6	1	1	0	29	21	8	-	1.80	15.10	1.56	-	UUT	0.68	4	-	-	-	-	-	-	-	-	-	-
SPT-7	9.00	20	20		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	10.00	22	22		CL		12	59	23	3	0	3	0	31	22	9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

CEGTH
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AND RESEARCH CENTRE PVT LTD

SOIL CHARACTERISTICS

Project	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.	Date of Boring			Chainage (m)/Location	B.H. No.	Depth of Water Table	Termination Depth	Cordinates (E,N)		R.L.	Ref. Code
		15-06-2022	to	15-06-2022	2972.708	BH-04	Not Encountered	10.00 m	682770.474 m	3148864.480 m	(+)213.976 m	SR-544_21-22

Sample Type	Depth from G.L. (m)	Observed SPT Value (N)	Corrected SPT Value (N_c)	Soil Description	IS Classification	IS Symbol	Grain Size Distribution % wt retained							Atterberg Limits %				Bulk Density (g/cm^3)	Natural Moisture Content (%)	Dry Density (g/cm^3)	Specific Gravity	Shear Strength			Free Swell Index (%)	Swelling Pressure (kg/cm^2)	Permeability (cm/sec)	Consolidation Parameters				
							Clay	Silt	Sand			Gravel		Liquid Limit	Plastic Limit	Plasticity Index	Shrinkage Limit					Type of Test	Cohesion C (kg/cm^2)	Angle of Friction (φ°)				Void Ratio (e_0)	Pressure (kg/cm^2)	C_v x 10^{-4} (cm^2/Sec)	M_v x 10^{-2} (cm^2/Kg)	Compression Index (C_c)
									Fine	Medium	Coarse	Fine	Coarse																				
DS	0.00		-	Medium dense, Brownish, Silty Sand	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-1	0.50	12	22		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-2	1.50	16	23		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-1	2.25	-	-		SM		0	19	73	7	1	0	0	-	NIL	NP	-	1.73	10.20	1.57	2.63	DST	0.00	29	-	-	-	-	-	-	-	-	-
SPT-3	3.00	18	22		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-4	4.50	19	20		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-2	5.25	-	-		SP-SM		0	10	78	10	1	1	0	-	NIL	NP	-	1.73	10.88	1.56	2.64	DST	0.00	29	-	-	-	-	-	-	-	-	-
SPT-5	6.00	20	20	Very Stiff, Brownish, Silty Clay of Low Plasticity	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-6	7.50	26	23		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
UDS-3	8.25	-	-		CL		6	55	25	8	5	1	0	31	22	9	-	1.82	16.60	1.56	2.67	UUT	0.71	5	-	-	-	-	-	-	-	-	-
SPT-7	9.00	20	20		-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPT-8	10.00	24	24		CL		9	53	30	7	1	0	0	31	21	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Abbreviations:-
DS-Disturbed Sample, SPT-Standard Penetration Test, UDS-Undisturbed Sample, UDS*-UDS not recovered, DST-Direct Shear Test, UUT-Unconsolidated Undrained Triaxial Shear Test, DST+ - Direct Shear Test on Remoulded Sample, UUT+ - Unconsolidated Undrained Tri-axial Test on Remoulded Sample.

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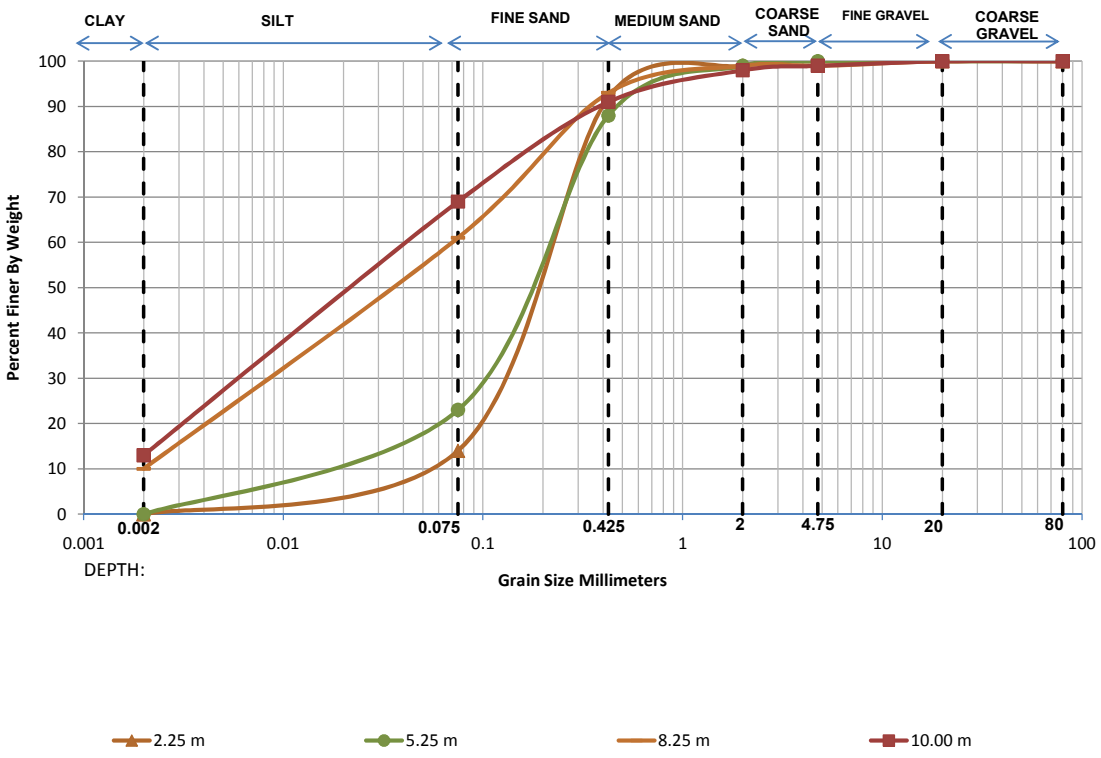
RESULT OF CHEMICAL ANALYSIS OF SOIL SAMPLES

Sr. No	Chainage/ Structure (m)	BH No.	Depth (m)	pH	Chlorides (Cl^-)		Sulphate (SO_3^{2-})	
					(mg/kg)	(%)	(mg/kg)	(%)
1.	1698.053 (Minor Bridge)	BH-01	2.25	7.60	63.68	0.0063	24.37	0.0024
2.	2807.817 (Minor Bridge)	BH-03	5.25	8.74	55.59	0.0055	21.23	0.0021

GRAIN SIZE DISTRIBUTION CURVES

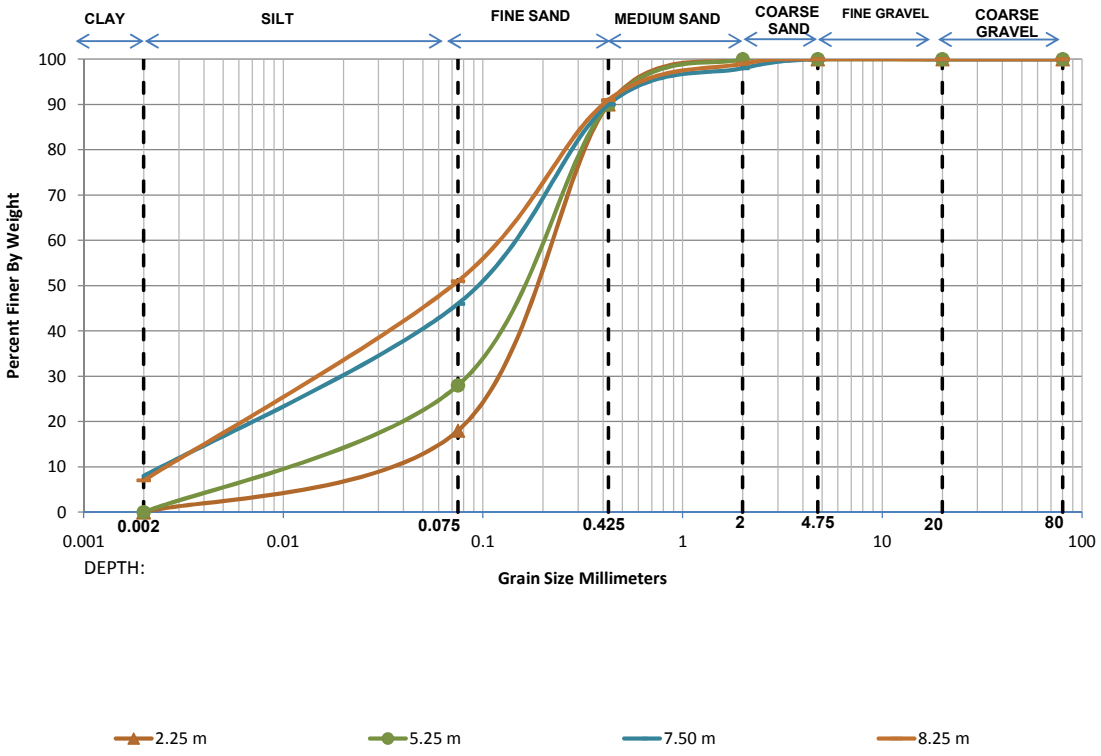
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	1698.053m
B.H. No.	BH-01



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
2.25 m	0.00	14.00	78.00	7.00	1.00	0.00	0.00	0.0507	0.1389	0.2360	4.66	1.61
5.25 m	0.00	23.00	65.00	11.00	1.00	0.00	0.00	0.0216	0.1016	0.2194	10.16	2.18
8.25 m	10.00	51.00	32.00	6.00	0.00	1.00	0.00	0.0020	0.0174	0.0725	36.25	2.09
10.00 m	13.00	56.00	22.00	7.00	1.00	1.00	0.00	-	0.0117	0.0550	-	-

GRAIN SIZE DISTRIBUTION CURVES

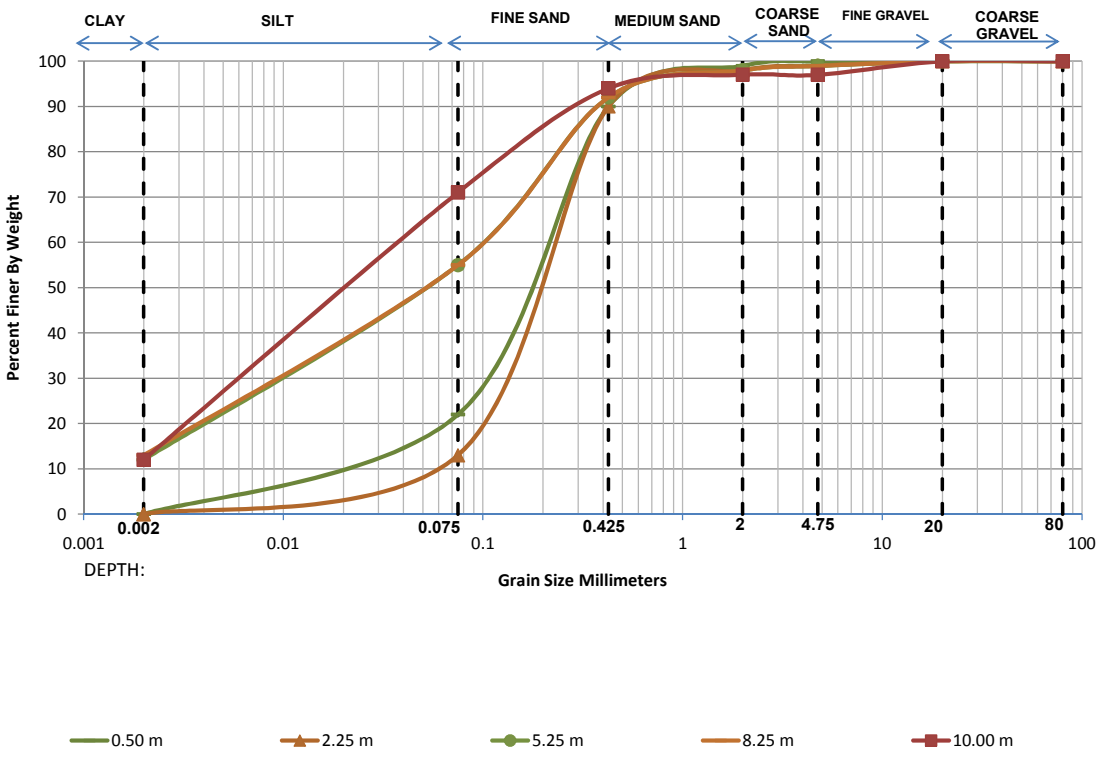
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	1912.700m
B.H. No.	BH-02



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
2.25 m	0.00	18.00	72.00	10.00	0.00	0.00	0.00	0.0336	0.1221	0.2293	6.82	1.93
5.25 m	0.00	28.00	62.00	10.00	0.00	0.00	0.00	0.0151	0.0821	0.1981	13.12	2.25
7.50 m	8.00	38.00	44.00	8.00	2.00	0.00	0.00	0.0031	0.0322	0.1325	43.13	2.55
8.25 m	7.00	44.00	40.00	8.00	1.00	0.00	0.00	0.0037	0.0275	0.1090	29.37	1.88

GRAIN SIZE DISTRIBUTION CURVES

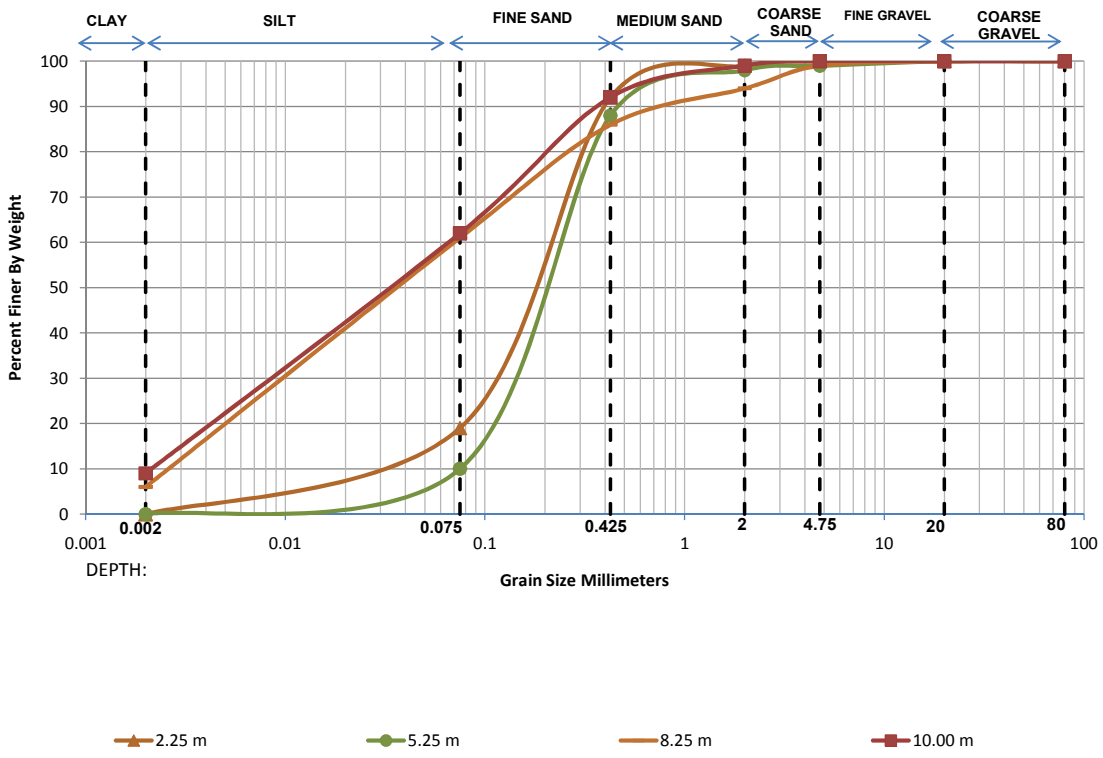
Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	2807.817m
B.H. No.	BH-03



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
0.50 m	0.00	22.00	68.00	9.00	1.00	0.00	0.00	0.0235	0.1052	0.2169	9.22	2.17
2.25 m	0.00	13.00	77.00	8.00	1.00	1.00	0.00	0.0562	0.1445	0.2435	4.33	1.53
5.25 m	12.00	43.00	37.00	6.00	1.00	1.00	0.00	-	0.0189	0.0925	-	-
8.25 m	13.00	42.00	37.00	6.00	1.00	1.00	0.00	-	0.0179	0.0928	-	-
10.00 m	12.00	59.00	23.00	3.00	0.00	3.00	0.00	-	0.0121	0.0522	-	-

GRAIN SIZE DISTRIBUTION CURVES

Project Name	Conducting geotechnical investigation, preparation of geotechnical report for designing of bridges and for embankment in connection with construction of Haryana Orbital Rail Corridor (HORC) project from Palwal to Harsana Kalan including connectivity to existing IR network in the state of Haryana.
Location/Chainage	2972.708m
B.H. No.	BH-04



Depth	Grain Size Distribution % wt retained							D10	D30	D60	Cu	Cc
	Clay	Silt	Sand			Gravel						
			Fine	Medium	Coarse	Fine	Coarse					
2.25 m	0.00	19.00	73.00	7.00	1.00	0.00	0.00	0.0307	0.1171	0.2210	7.19	2.02
5.25 m	0.00	10.00	78.00	10.00	1.00	1.00	0.00	0.0750	0.1604	0.2575	3.43	1.33
8.25 m	6.00	55.00	25.00	8.00	5.00	1.00	0.00	0.0043	0.0213	0.0726	16.96	1.46
10.00 m	9.00	53.00	30.00	7.00	1.00	0.00	0.00	0.0024	0.0179	0.0702	29.24	1.89

APPENDIX – C
(ANALYSIS & RECOMENDATION)

Appendix No.	ITEMS
C-1	SAMPLE CALCULATIONS FOR COMPUTATION OF ALLOWABLE BEARING CAPACITY OF SUB-STRATA FOR SHALLOW FOUNDATION

Calculation of SBC for shallow foundations as per IS : 6403 - 1981

INPUT DATA

CH. (m) :- 1698.053

BH NO. :- BH-01

Type of footing

1	Continuous Strip		
2	Rectangular	***Square***	**3**
3	Square		
4	Circular		

Angle of internal friction (ϕ^{o})	31.00
Cohesion (c in t/m^2)	0.00
Void ratio (e), $e = (G.\gamma_w/\gamma_d)-1$	0.64
Direction of load with vertical (^{o})	0.00
Density of foundation soil (t/m^3) γ_{bulk}	1.91
Depth of water table(m)	NE
Factor of safety	2.50

S.no.	Depth (m) of footing (D_f) below EGL	Width (m)
1	1.00	2.00
2	1.50	2.00
3	2.00	2.00

SHEAR FAILURE CRITERIA

Assumptions and formula used in calculation as per IS:6403-1981 are given below -

NOTE: The type of failure used for bearing capacity analysis depends upon the value of void ratio (see IS 6403 : 1981, Page No. 9, Table No. 3).

The ultimate net bearing capacity in case of general shear failure is given by (from IS 6403 : 1981, page No. 8)

$$q_d = c\,N_c\,s_c\,d_c\,i_c + q\,(N_q-1)\,s_q\,d_q\,i_q + (1/2)\,B\,\gamma\,N_\gamma\,s_\gamma\,d_\gamma\,i_\gamma\,W'$$

The ultimate net bearing capacity in case of local shear failure is given by (from IS 6403 : 1981, page No. 8)

$$q'_d = (2/3)\,c\,N'_c\,s_c\,d_c\,i_c + q\,(N'_q-1)\,s_q\,d_q\,i_q + (1/2)\,B\,\gamma\,N'_\gamma\,s_\gamma\,d_\gamma\,i_\gamma\,W'$$

Where,

$d_c = 1+ 0.2\,(D_f/B)*SQRT(N_\phi)$

$d_q = d_\gamma = 1$ for $\phi < 10^{o}$ (from IS 6403 : 1981, page No. 9)

$d_q = d_\gamma = 1 + 0.1\,(D_f/B)*SQRT(N_\phi)$ for $\phi > 10^{o}$

$N_\phi = \tan^2(\pi/4 + \phi/2)$

ϕ' is friction angle for local shear failure = $\tan^{-1}(0.67\tan\phi)$

OUTPUT

The computer aided results for shear failure criteria are tabulated below. The results are interpolated values of bearing capacity obtained from general and local shear failure criteria.

Bearing capacity factors : (from IS 6403 : 1981, page No. 8, Table No. 1)

ϕ	31.00	ϕ'	21.93
N_c	32.67	N'_c	16.80
N_q	20.63	N'_q	7.76
N_γ	25.99	N'_γ	7.06

Shape factors : (from IS 6403 : 1981, page No. 8, Table No. 2)

S.no.	Width(m)	S_c	S_q	S_γ
1	2.00	1.30	1.20	0.80
2	2.00	1.30	1.20	0.80
3	2.00	1.30	1.20	0.80
		1.30	1.20	0.80
		1.30	1.20	0.80
		1.30	1.20	0.80

Depth factors : (from IS 6403 : 1981, page No. 9)

S.no.	Depth(m)	Width(m)	dc	d_q	d_γ
1	1.00	2.00	1.18	1.09	1.09
2	1.50	2.00	1.27	1.13	1.13
3	2.00	2.00	1.35	1.18	1.18

Inclination factors : (from IS 6403 : 1981, page No. 9)

$i_c = (1-\alpha / 90)^2$	$i_q = (1-\alpha / 90)^2$	$i_\gamma = (1-\alpha / \phi)^2$
1.00	1.00	1.00

Water table factor : (from IS 6403 : 1981, page No. 9)

S.no.	Depth(m)	Width(m)	Z_w/B	W'
1	1.00	2.00	14.50	1.00
2	1.50	2.00	14.25	1.00
3	2.00	2.00	14.00	1.00

Safe Bearing Capacity

S.no.	Depth(m)	Width(m)	SBC in (t/m^2)		
			General shear	Local shear	Recommended
1	1.00	2.00	36.95	11.47	25.00
2	1.50	2.00	48.66	15.45	33.09
3	2.00	2.00	61.17	19.71	41.73

SETTLEMENT CALCULATION AS PER 8009 Part-1 1976														CH. (m):				1698.053			BH NO. :- BH-01			
Layer	Depth below FGL (m)	From (m)	To (m)	Layer Thickness	Stress at Foundation level (Kg/Cm2)	Length (m)	Breadth (m)	Layer Thickness(m)	Dispersed Length (m)	Dispersed Breadth (m)	Stress Increment at top for cohesionless layer & at mid Depth for cohesive layer (kg/Cm2)	Average N-Value	Mvc (Cm^2/Kg)	Consolidation Settlement (mm)	Modulus of Soil (Kg/Cm^2)	Influence Factor (I)	Poission's Ratio	Settlement (mm) for 10 t/m2 (from IS:8009 (Part I), Fig. 9, Page NO. 17)	Settlement in Non-Cohesive Soil Si (mm)	Elastic Settlement Si (mm)	Total Settlement (mm)	Depth Factor	Rigidity Factor	Corrected Total Settlement (mm)
Layer 1		1.00	4.00	3.00				3.00	2.00	2.000	3.438	25			200	0.9400	0.30	10.00	34.38	29.41	29.41			
	1.00				3.44	2.00	2.00															0.85	1.00	25.00
Layer 1		1.50	4.50	3.00				3.00	2.00	2.000	3.749	25			200	0.9400	0.30	10.00	37.49	32.07	32.07			
	1.50				3.75	2.00	2.00															0.78	1.00	25.00
Layer 1		2.00	5.00	3.00				3.00	2.00	2.000	3.960	25			200	0.9400	0.30	10.00	39.60	33.87	33.87			
	2.00				3.96	2.00	2.00															0.74	1.00	25.00

SETTLEMENT CALCULATION AS PER 8009 Part-1 1976														CH. (m):				1698.053			BH NO. :- BH-01			
Layer	Depth below FGL (m)	From (m)	To (m)	Layer Thickness	Stress at Foundation level (kg/Cm2)	Length (m)	Breadth (m)	Layer Thickness(m)	Dispersed Length (m)	Dispersed Breadth (m)	Stress Increment at top for cohesionless layer & at mid Depth for cohesive layer (kg/Cm2)	Average N-Value	Mvc (Cm^2/Kg)	Consolidation Settlement (mm)	Modulus of Soil (Kg/Cm^2)	Influence Factor (I)	Poission's Ratio	Settlement (mm) for 10 t/m2 (from IS:8009 (Part I), Fig. 9, Page NO. 17)	Settlement in Non-Cohesive Soil Si (mm)	Elastic Settlement Si (mm)	Total Settlement (mm)	Depth Factor	Rigidity Factor	Corrected Total Settlement (mm)
Layer 1		1.00	4.00	3.00				3.00	2.00	2.000	6.877	25			200	0.9400	0.30	10.00	68.77	58.82	58.82			
	1.00				6.88	2.00	2.00															0.85	1.00	50.00
Layer 1		1.50	4.50	3.00				3.00	2.00	2.000	7.498	25			200	0.9400	0.30	10.00	74.98	64.14	64.14			
	1.50				7.50	2.00	2.00															0.78	1.00	50.00
Layer 1		2.00	5.00	3.00				3.00	2.00	2.000	7.920	25			200	0.9400	0.30	10.00	79.20	67.75	67.75			
	2.00				7.92	2.00	2.00															0.74	1.00	50.00

5. APPROVED MANUFACTURES/SUPPLIERS LIST

APPROVED MANUFACTURES/SUPPLIERS LIST

All materials and products shall conform to the Outline Construction Specification (OCS), BIS codes and other relevant codes etc. and shall be of make as approved by the Engineer.

The list of approved makes for products and materials is given below. Other equivalent manufacturers may also be considered with prior approval of the Engineer, if found conforming to all standards. Such requests should be made with all documents to the Engineer at least 45 days before the material is required and any order shall be placed only after receiving the written approval of the Engineer.

S. No.	Details of Materials/ Products	Manufacturer's Name
1.	Cement	ACC, Ultratech, Ambuja Cements, JK Lakshmi, JSW, JK Cement, Lafarge, *Shree Cement, Birla Cement, Grasim*
2.	Reinforcement Bars	*SAIL, JSW STEEL, TATASTEEL, RINL, JSPL*
3.	Epoxy	FOSROC, SIKA QUALCRETE, BASF, CICO, MC–BAUCHEMIE, MAPEI, CHRYSO, Huntsmen Advanced Materials
4.	Expansion Joints for Viaduct	Prequalified Manufacturers as per RDSO's latest approved list
5.	Admixtures	FOSROC, SIKA, MBT, MC-BAUCHEMIE, PIDILITE, CHRYSO, BASF, MAPEI, CICO
6.	Pile Integrity Testing	CIMEC, Geodynamics, AIMIL, CBRI, Pile Dynamic, CEGTH, FUGRO
7.	*Anchor Fastener	HILTI, FISHER, *BOSCH*, (Please note that ETA Certification is mandatory for using/supplying fasteners for load bearing structural members)
8.	Structural Steel	TATA, SAIL, ESSAR, *JSPL, JSW*
9.	Pre- stressing Strand (LRPC)	TATA SSL Ltd, USHA MARTIN
10.	*Pot/Elastomeric /Spherical Bearings	Prequalified Manufactures as per RDSO's latest approved list.
11.	HDPE Sheathing	Rex *Polyextrusion*, Gwalior Poly Pipes Ltd, Dynamic Prestress, JK Prestressing
12.	Formwork Release Agent	FOSROC, MC BAUCHEMIE, CICO, BASF, MAPEI, MBT, CHRYSO
13.	*Prestressing System	Freyssinet, BBR, VSL, Dynamic, Killick Nixon, Tensacciai (India Ltd.), JK Prestressing, Usha Martin, VSIL
14.	*Reinforcement Couplers	DEXTRA, , SANFIELD, SPLICETECH COUPLERS

S. No.	Details of Materials/ Products	Manufacturer's Name
15.	Hollow Sections, Pipes	Surya Pipes, Hi-Tech Pipes, JSW, JSPL, TATA.
16.	Drainage Pipes	Tirupati Plastomatics, Duraline, REX, STIPL
17.	Acrylic Textured Coatings	Spectrum, Surfa Nova, Jotun, Asian Paints, Berger, Hempel, DULUX
18.	Non Shrink Grout	FOSROC, Fairmate, BASF, SIKA, CICO, MBT, MC-Bauchemie, CHRYSO
19.	Bonding Coat	CICO, FOSROC, BASF, SIKA, MAPEI, MC-BAUCHEMIE, CHRYSO
20.	Polysuphide Sealant	CICO, PIDILITE, BASF, FOSROC, SIKA, CHRYSO
21.	*Steel Structural Fasteners	Sundram Fasteners, Nelson, *Dextra India,* Panchsheel, Pooja Forge (Please note that ETA Certification is mandatory for using/supplying fasteners for load bearing structural members)
22.	*Corrosion Protection Paints	Berger, Johnson Nicholson, Nerolac, Asian Paints, Akzo Nobel, Jotun
23.	Fire Resistant Paint	Akzo Nobel, PPG, Jotun
24.	Water stopper/ Bar	Greenstreak, Duron, Maruti, Kanta Rubber
25.	*Liquid Polymer membrane waterproofing	BASF, MAPEI , NINA, CICO, MYK Schomburg, Geo-Constech
26.	Curing Compound	FOSROC, CHRYSO, CICO, MC- BAUCHEMIE, MAPEI, MBT
27.	*Polycarbonate Sheets	Gallina Acroplus, Coxwell, Poly U, Fabic, Lexan, (SABIC Innovative Plastics), DANPALON, GE Plastics, VMI Plastics, Power Chem Plast
28.	Fly Ash	Thermal Plants, Ashcrete, Ultra Pozz, Star Pozz, Ashtech
29.	*Pre-Coated Profiled Metal Sheetings	TATA Blue Scope, Multicolor, Essar Steel, Bhushan Steel, Ispat Profile India
30.	Fly Ash Block/ AAC Block	Siporex, Ascolite, J.K. Laxmi, Ashtech
31.	Rock Bolts/Swellex Bolts	Geo Constech, DSI, Atlas Copco, FIREP International, Minova
32.	Soft eye GFRP	Dextra, FIREP International, Minova, Hughes Brothers, Geo Constech
33.	Polymer	WALLGRIP, TRISHUL, Shubham Minerals, Goldy Minerals, GeoPolymer
34.	Welding electrodes	Ador welding Ltd.(Advani-Oerlikon),ESAB, D&H Welding Electrodes, Modi Arc

S. No.	Details of Materials/ Products	Manufacturer's Name
35.	Aluminium Sheets	Hindustan Aluminium, Jindal, Balco
36.	Vitrified Tiles	Asian Tiles, Somany, Johnson, Bell Ceramics, Kajaria, Simpolo
37.	Ceramic Tiles	NITCO, Orient, Regency Ceramics
38.	Wall Putty	JK White, Birla
39.	Flush Doors	Samrat, Kanchan, Prima Swastik, Kutty, Diamond
40.	Adhesives	Pidilite, Araldite, Toyo Ferrous Crete
41.	Plywood	Duroply, Century Plywood, Green Plywood, Kitply
42.	Veneers	Green Plywood, Century Plywood, Kitply
43.	FloatGlass/Toughened Glass/Insulated Glass/Laminated Glass	Saint Gobbain, Modiguard, Tata Float, Float Glass, Asahi Float
44.	Heavy Duty Chequered Tiles	NITCO. Hindustan Tiles, Super Tiles & Marbles Pvt.Ltd.
45.	Heavy Duty Vitrified Tiles	Kajaria World
46.	Emulsion Paint	Asian Paints, Berger, Nerolac, Johnson & Nicholson, Dulux, ICI
47.	Synthetic Enamel	Asian Paints, Berger, Nerolac, Johnson & Nicholson, Dulux, ICI
48.	Paver Blocks	As approved by the Engineer
49.	Sanitary & Bath Fittings	Hindware, Parryware, Jaquar, HR & Johnson, Cera, , Somany, Asian Granito
50.	Aluminium doors & windows	Sehgal & Sehgal Industries
51.	Yellow Tactile Tiles	Palican
52.	SS Railing	The Cavalier, D Line India, DOORMAT, Panchal Enterprises, SS Enterprises
53.	Glass Mosaic Tiles	Mridul Enterprises, Krishna,Italia,Bissazza,Kenzai,Opio
54.	Granite Slabs & Tiles	As approved by the Engineer.

NOTE: For the categories marked as *, the enclosed undertaking performa should be duly filled and signed by authorized representatives of concerned agencies.

UNDERTAKING

Name of Contract: **Date of start of work:**

Category of work: **Date of completion of work:**

This is to certify that work of …… (Category to be mentioned) at …… (Location) of the contract.....(Name of contract) has been executed/completed in accordance with the manufacturer's/supplier's specifications and as per the approved method statement.

The work has been jointly inspected by authorised representative of ……(Manufacturer/supplier), …… (Executing agency) &…….. (Contractor) during its execution and all non-conformities observed during inspection have been complied to achieve the best industry standards.

The undersigned take full responsibility of the overall adequacy, accuracy, effectiveness & warranty (upto design life) of the completed work as per the provision of the contract……. (Contract number) and Outline Construction Specifications of the Part 2- Employer's Requirements.

(Stamp and Signature)	(Stamp and Signature)	(Stamp and Signature)
Manufacturer Representative	Executing agency Representative	Contractor Representative

6. List of Existing Structures to be Dismantled

List of Existing Structures to be Dismantled

(Ref. Sub-Clause 10.14, Appendix 10, Section VII-9: Appendices, Part 2 – Employer's Requirements)

C23 Section: Existing Structures							
S. No	Type of Structure	Chainage (in m)	District	Sub Division	Length of obstruction to be considered (in m)	Chainage	
						From	To
Structures in Main Line							
1	Two Houses	30040	NUH	Tauru	20	30030	30050
2	Boundary Wall	30330	NUH	Tauru	80	30290	30370
3	Borewell with one room	30580	NUH	Tauru	10		
4	Four Houses	31130	NUH	Tauru	20	30120	30140
5	Borewell	31400	NUH	Tauru	10		
6	Borewell	31740	NUH	Tauru	10		
7	Borewell with one room	33360	NUH	Tauru	20	33350	33370
8	One House	33460	NUH	Tauru	30	33445	33475
9	Poultry Farm	33550	NUH	Tauru	40	33530	33570
10	Two Room	33880	NUH	Tauru	20	33870	33890
11	Borewell with one room	34020	NUH	Tauru	10		
12	Paulty farms and well	34100	NUH	Tauru	20		
13	Boundary wall	34660	NUH	Tauru	85	34660	34745
14	House	34800	NUH	Tauru	40	34780	34820
15	House + Boundary wall	35200	NUH	Tauru	20	35190	35210
16	Borewell with one room	36210	NUH	Tauru	10		
17	Bore well, Poultry shed	36440	NUH	Tauru	60	36420	36480
18	Bore well, Two Room	36480	NUH	Tauru			
19	Borewell with one room	36630	NUH	Tauru	10		
20	Borewell with one room	36960	NUH	Tauru	10		
21	One Room	37080	NUH	Tauru	10		

C23 Section: Existing Structures							
S. No	Type of Structure	Chainage (in m)	District	Sub Division	Length of obstruction to be considered (in m)	Chainage	
						From	To
22	Borewell with Two room	37630	NUH	Tauru	10		
23	Borewell with one room	38310	NUH	Tauru	10		
24	Borewell with one room	38920	NUH	Tauru	10		
25	Borewell with one room	39000	NUH	Tauru	10		
26	Borewell	39260	NUH	Tauru	10		
27	House , Poultry Shed	39340	NUH	Tauru	60	39300	39360
28	Borewell	39455	NUH	Tauru	10		
29	Borewell with one room	40310	Gurugram	Gurugram	10		
30	Borewell with one room	40450	Gurugram	Gurugram	10		
31	Borewell with one room	40980	Gurugram	Gurugram	10		
32	House in Ag. Field	41580 to 41660	Gurugram	Gurugram	80	41580	41660
33	House + Bore well	42460	Gurugram	Gurugram	30	42445	42475
34	water tank	42580	Gurugram	Gurugram			
35	Dhaba + Under Constructed Swimming Pool	42830	Gurugram	Gurugram	45	42810	42855
36	Bore well + one room	42960	Gurugram	Gurugram	10		
37	Gaushala Shed + Three Houses	43300 to 43360	Gurugram	Gurugram	60	43300	43360
38	Boundary Wall	43450	Gurugram	Gurugram	50	43450	43500
39	2 Houses and 1 bore well	43640	Gurugram	Gurugram			
40	Boundary wall	43720 to 43780	Gurugram	Gurugram	60	43720	43780
41	Cardboard Factory	43800	Gurugram	Gurugram	120	43720	43840
42	House	43900	Gurugram	Gurugram			
43	Four Houses	43890 to 43940	Gurugram	Gurugram	50	43890	43940
44	One Room	44530			20	44510	44530

C23 Section: Existing Structures							
S. No	Type of Structure	Chainage (in m)	District	Sub Division	Length of obstruction to be considered (in m)	Chainage	
						From	To
45	House + Factory + Boundary wall	44500			190	44990	45180
46	Boundary wall	45680	Gurugram	Gurugram	60	45650	45710
47	House	46000			50	45990	46040
48	Bore well and one room	46150	Gurugram	Gurugram	10		
49	Bore well and one room	46410	Gurugram	Gurugram	10		
50	Gaushala Shed	46640	Gurugram	Gurugram	10		
51	Bore well and one room	47100	Gurugram	Gurugram	10		
52	Borewell	47180	Gurugram	Gurugram	10		
53	House	48080	Gurugram	Gurugram	30	48080	48110
54	Bore Well and three Houses	48284	Gurugram	Gurugram	140	48200	48340
55	Teen Shed Room	48396	Gurugram	Gurugram	30	48380	48410
56	Bore well and one room	48930	Gurugram	Gurugram	10		
57	Bore Well	48980	Gurugram	Gurugram	10		
58	House	56064	Gurugram	Pataudi	30	55970	56000
59	Bore well and one room	56150	Gurugram	Pataudi	10		
60	Room	56200	Gurugram	Pataudi	10		
61	Bore well and one room	56514	Gurugram	Pataudi			
62	one room	57434	Gurugram	Pataudi	10		
63	Bore well and one room	57814	Gurugram	Pataudi	10		
64	Bore well	58614	Gurugram	Pataudi	10		
65	Bore Well and Room	58884	Gurugram	Pataudi	10		
66	Ice Factory	59164	Gurugram	Pataudi	60	59134	59194
67	Teen Shed Milk Dairy	59334	Gurugram	Pataudi	30	59320	59350
Structures in Connectivities							

C23 Section: Existing Structures							
S. No	Type of Structure	Chainage (in m)	District	Sub Division	Length of obstruction to be considered (in m)	Chainage	
						From	To
New Patli - Patli Connectivity							
68	Borewell with one room	1930	Gurugram	Pataudi	10		
New Patli - Sultanpur Connectivity							
69	Two Houses	1170 to 1200	Gurugram	Pataudi	30	1170	1200
70	House	1650	Gurugram	Pataudi	30	1630	1660
71	One Room	3220	Gurugram	Pataudi	10	3220	3230
72	Two Rooms	3700	Gurugram	Pataudi	20	3690	3710
Sultanpur Yard Modification							
73	6 houses & 1 flour Factory	0.00 to 130m	Gurugram	Pataudi	130	0	130

LIST OF CONTENTS

APPENDIX 1
DRAWING LIST

1. GENERAL

The Tender Documents contains a set of reference/Tender drawings that are applicable to the Contract Works. The Tenderer shall incorporate into the Tender only those drawings from that set which amplify aspects of the Contractor's Technical Proposals. General information drawings will not be included in the Contract. The dimensions mentioned in the tender drawings are indicative and may vary as per the design of the Contractor.

The List of Drawings issued with the Tender documents is stated in Part-2 Employer's Requirements - Tender Drawings and Documents.

APPENDIX – 2

CONTRACT KEY DATES AND COMPLETION DATE

Key Dates	Weeks from		Description of Stage	Delay Damage for each week of delay or part thereof for non-achieving the key dates
	LOA	Commencement Date		
Key Date 1	4		Submission of Initial Works Programme with all activities for entire work *Package C-23.*	
Key Date 2		*6*	*Submission and approval of* Preliminary Design & GAD of bridges, Retaining Walls and other civil structures from Ch. 55600 to 61500 including New Patli- Patli and New Patli-Sultanpur connectivties. (Submission may be in stages but to start NOT later than *2* weeks.))	
Key Date 3		*8*	Submission and approval of Detailed Works Programme *(resources & cost loaded)* incorporating all comments of Engineer including 2 weeks for review by the Engineer.	0.01% of the fixed lump sum price quoted in Schedule 'A'.
Key Date 4		*12*	Submission and approval of Definitive Design & GFC drawings for Bridges, Retaining Walls and other civil structures from Ch 55600 to 61500 including New Patli- Patli and New Patli-Sultanpur connectivties. (Submission may be in stages but to start NOT later than 6 weeks from Commencement Date and completed within *12* weeks)	0.01% of the fixed lump sum price quoted in Schedule 'A'.
Key Date 5		22	Completion of 1st 6 lakh cum of earthwork in formation.	0.01% of the fixed lump sum price quoted in Schedule 'A'.
Key Date 6		24	Installation of 1st 700m of retaining wall.	
Key Date 7		44	Completion of one major bridge having OWG superstructure.	

Key Dates	Weeks from		Description of Stage	Delay Damage for each week of delay or part thereof for non-achieving the key dates
	LOA	Commencement Date		
Key Date 8		52	Completion of all the works (excluding slope protection and drainage works) *of HORC main line* from Ch. 55600 m to Ch 59000 m including New Patli station and yard.	
Key Date 9		60	Completion of all the works (excluding slope protection and drainage works) of New Patli to Patli and New Patli to Sultanpur connecting lines including Sultanpur station and yard.	0.01% of the fixed lump sum price quoted in Schedule 'A'.
Key Date 10		*90*	*Completion of formation works (excluding slope protection and drainage works) from Ch. 49700m to Chandla Dungerwas*	*0.01% of the fixed lump sum price quoted in Schedule 'A'.*
Key Date *11*		*120*	Completion of all works (excluding slope protection and drainage works) in full length including stations and yards	

APPENDIX 3

WORKS AREAS AND TEMPORARY POWER SUPPLY

3. WORK AREA (WITHIN ROW) ACCESS DATES

3.1 General

"Works Areas" means the areas of the Site within the Right of Way of HORC including vacant land in KMP ROW and any additional areas which may be obtained by the Contractor and agreed by the Engineer as additional working area.

a) The dates on which Work Areas (within ROW) are available to the Contractor for the commencement of the Works are defined as Work Area Access Dates (AD).

b) The Work Area Access Dates that apply to this Contract are stated in terms of days after the Commencement Date of the Works.

c) Where Work Areas are to be made available to the Contractor, they shall be available within the specified day. Where Work Areas are to be vacated, they shall be released not later than midnight on the specified day.

3.2 Work Area Access Schedule

The access to and possession of Works Area (within ROW) shall be made available as per Part A Contract Data of Particular Conditions of the Contract (PCC).

3.3 ELECTRICAL GENERAL

Temporary electrical Site installations and distribution systems shall be in accordance with:-

(a) Indian Electricity Rules

(b) The Power Companies' Supply Rules;

(c) Electricity and its subsidiary Regulations;

(d) IEE Wiring Regulations (16^{th} Edition);

(e) BS 7375 Distribution of Electricity on Construction and Building Sites;

(f) BS 4363 Distribution Assemblies for Electricity Supplies for Construction and Building Sites; and

(g) BS 6164 Safety in Tunnelling in the Construction Industry.

(h) Any other applicable national standards

3.4 MATERIALS, APPLIANCES AND COMPONENTS

All materials, appliances and components used within the distribution system shall comply with BS 4363 and BS 7375 Appendix A.

3.5 DESIGN CONSIDERATIONS

(i) Distribution equipment utilised within the temporary electrical distribution system shall incorporate the following features:-

(a) flexibility in application for repeated use;

(b) suitability for transport and storage;

(c) robust construction to resist moisture and damage; and

(d) safety in use.

(ii) All cabling shall be run at high level whenever possible and firmly secured to ensure they do not present a hazard or obstruction to people and equipment.

(iii) The installation on Site shall allow convenient access to authorised and competent operators to work on the apparatus contained within.

3.6 MAINS VOLTAGE

(i) The Site mains voltage shall be as per the Electricity Authority, 415V/ 3 phase 4 wire system.

(a) Single phase voltage shall be as per the Electricity Authority, 230V supply.

(b) Reduced voltages shall conform to BS 7375.

(ii) Types of Distribution Supply

The following voltages shall be adhered to for typical applications throughout the distribution systems:

(a) fixed plant - 415V/ 3 phase;

(b) movable plant fed by trailing cable - 415V /3 phase;

(c) installations in Site buildings - 230V /1 phase;

(d) fixed flood lighting - 230V/ 1 phase;

(e) portable and hand held tools - 115V /1 phase;

(f) Site lighting (other than flood lighting) - 115V /1 phase; and

(g) portable hand-lamps (general use) - 115V /1 phase.

(iii) When the low voltage supply is energised via the Employer's transformer, any power utilised from that source shall be either 415V 3 phase or / 230V. 1 phase as appropriate. The Contractor shall carry out any conversion that may be necessary to enable him to use power from that source.

3.7 PROTECTION OF CIRCUITS

(i) Protection shall be provided for all main and sub-circuits against excess current, under and over voltage, residual current and earth faults. The protective devices shall be capable of interrupting (without damage to any equipment or the mains or sub-circuits) any short circuit current that may occur.

(ii) Discrimination between circuit breakers, circuit breakers and fuses shall be in accordance with:-

(a) BS 88;

(b) BS EN 60898;

(c) BS 7375; and

(d) Any other appropriate Indian Standards.

3.8 EARTHING

(i) Earthing and bonding shall be provided for all electrical installations and equipment to prevent the possibility of dangerous voltage rises and to ensure that faults are rapidly cleared by installed circuit protection.

(ii) Earthing systems shall conform to the following standards:-

(e) IEE Wiring Regulations (16th Edition);

(b) BS 7430;

(c) BS 7375; and

(d) IEEE Standard 80 Guide for Safety in AC Substation Grounding.

3.9 PLUGS, SOCKET OUTLETS AND COUPLERS

Low voltage plugs, sockets and couplers shall be colour coded in accordance with BS 7375, and constructed to conform to BS EN 60309. High voltage couplers and 'T' connections shall be in accordance with BS 3905.

3.10 CABLES

(i) Cables shall be selected after full consideration of the conditions to which they will be exposed and the duties for which they are required. Supply cables up to 3.3KV shall be in accordance with BS 6346.

(ii) For supplies to mobile or transportable equipment where operation of the equipment subjects the cable to flexing, the cable shall conform to one of the following specifications appropriate to the duties imposed on it:

(a) BS 6708 flexible cables for use at mines and quarries;

(b) BS 6007 rubber insulated cables for electric power and lighting; and

(c) BS 6500 insulated flexible cords and cables.

(iii) Where low voltage cables are to be used, reference shall be made to BS 7375. The following specifications shall also be referred to particularly for underground cables:-

(a) BS 6346 for armoured PVC insulated cables; and

(b) BS 6708 Flexible cables for use at mines and quarries.

(iv) All cables which have a voltage to earth exceeding 65 V (except for supplies from welding transformers to welding electrodes) shall be of a type having a metal sheath and/or armour which shall be continuous and effectively earthed. In the case of flexible or trailing cables, such earthed metal sheath and/or armour shall be in addition to the earth core in the cable and shall not be used as the sole earth conductor.

(v) Armoured cables having an over sheath of polyvinyl chloride (PVC) or an oil resisting and flame retardant compound shall be used whenever there is a risk of mechanical damage occurring.

(vi) For resistance to the effects of sunlight, overall non-metallic covering of cables shall be black in colour.

(vii) Cables which have applied to them a voltage to earth exceeding 12 V but not normally exceeding 65 V shall be of a type insulated and sheathed with a general purpose or heat resisting elastomer.

(viii) All cables which are likely to be frequently moved in normal use shall be flexible cables.

Flexible cables shall be in accordance with BS 6500 and BS 7375.

3.11 LIGHTING INSTALLATION

(i) Where Site inspection of the Works is required during the nights, the Lighting circuits shall be run separate from other sub-circuits and shall be in accordance with BS 7375 and BS 4363.

(ii) Voltage shall not exceed 55 V to earth except when the supply is to a fixed point and where the lighting fixture is fixed in position.

(iii) Luminaries shall have a degree of protection not less than IP 54. In particularly

bad environments where the luminaries are exposed to excesses of dust and water, a degree of protection to IP 65 shall be employed.

(iv) The Contractor shall upgrade the lighting level to a minimum of 200 lux by localised lighting in all areas where required by the Engineer,.

(v) Mechanical protection of luminaries against damage by impact shall be provided by use of wire guards or other such devices whenever risk of damage occurs.

3.12 ELECTRICAL MOTORS

(i) Totally enclosed fan cooled motors to BS 4999:Part 105 shall be used.

(ii) Motor control and protection circuits shall be as stipulated in BS 6164. Emergency stops for machinery shall be provided.

3.13 INSPECTION AND TESTING

Electrical installations on Site shall be inspected and tested in accordance with the requirements of the IEE Wiring Regulations (16^{th} Edition)

3.14 IDENTIFICATION

Identification labels of a type reviewed without objection by the Engineer shall be affixed to all electrical switches, circuit breakers and motors to specify their purpose.

3.15 MAINTENANCE

(i) Strict maintenance and regular checks of control apparatus and wiring distribution systems shall be carried out by an electrician (duly qualified to carry out the said checks) to ensure safe and efficient operation of the systems. The Contractor shall submit for review by the Engineer details of his maintenance schedule and maintenance works record.

(ii) All portable electrical appliances shall be permanently numbered (scarf tag labels or similar) and a record kept of the date of issue, date of the last inspection carried out and the recommended inspection period.

APPENDIX 4

PROJECT CALENDAR

4. GENERAL

4.1. For the Project, the Contractor shall adopt 7 days a week calendar, identical calendar for the purpose of programming and Execution of Works. Official documents shall be transacted during 5 days week - Monday through Friday, except for National (Govt. of India) Holidays.

4.2. The Project Weeks shall be commenced on a Monday. A day shall be deemed to commence at 0001 hour on the morning of the day in question. Where reference is made to the completion of an activity by a particular week, this shall mean by midnight on the Sunday of that week. Requirements for the computation of Key Date are given in Appendix 2 to the Employer's Requirements.

4.3. A 7-day week calendar shall be adopted for various (Work) programme schedules for scheduling purposes. For Project purposes, the presentation shall be in 'Week"' units.

APPENDIX – 5

INTERFACE, COORDINATION AND COOPERATION WITH OTHER PARTIES

5.1 LIST OF CONTRACT PACKAGES IN HORC

S. No.	Package	Name of Work
1.	C-1	Priority Section - Construction of Earthwork, Bridges, Station Buildings, Retaining Walls and other miscellaneous works in connection with laying of New BG Double Railway line of HORC Project from Km 49.7 to Km 55.6 and its connectivity (new BG single line) from proposed Manesar Station of HORC to existing Patli Railway Station of IR Network.
2.	T-1	T-1: Laying of Track and track related works including supply of ballast, special sleepers, switches and crossings track fittings but excluding supply of Rails and line Sleepers in connection with laying of New BG Double Railway Line of HORC project from Km 32.00 to Km 61.5 and its connectivities to IR Network from Manesar to Patli Stations and New Patli to Patli & New Patli to Sultanpur Stations.
3.	Br-1	Fabrication, assembly & launching of 1X76.2 m span Open Web Girder (OWG) each over three lines on NH-352W (Pataudi Road) between Manesar and Patli stations including supplying & fixing of H-beam sleepers in connection with laying of New BG Double Railway Line of HORC project at Km 54.498.
4.	C-23	Design and Construction of Civil Works (Earthwork, Bridges, Station Buildings, Retaining Walls and other miscellaneous Works) from km 29.68 to km 49.70 & from km 55.60 to km 61.50 and its connectivities to IR network from New Patli to Patli station & New Patli to Sultanpur station including modifications/civil works at Sultanpur Station in connection with laying of New BG Double Railway line of HORC project.
5.	C-4	C-4: Composite Contract package in connection with New BG Railway Line of HORC project for: (i) Design & Construction of Twin Tunnel using NATM and Cut & Cover method from km 24.880 to km 29.580; (ii) Design & Installation of Ballastless Track (excluding supply of rails) from km 24.856 to km 29.680; (iii) Detailed Design, Supply, Installation, Testing & Commissioning of General Electrical Services including Supply, Erection, Testing and Commissioning of 11kV HT/LT Power and Control Cable Network, GIS Substation (11/0.433) kVA, Tunnel lighting system etc. from km 24.880 to km 29.680. (iv) Design & Construction of Embankment, Bridges and other miscellaneous works from km 12.00 to km 18.00.

6.	C-5	Design and Construction of Viaduct (from Km 21.34 to Km 24.856), Earthwork, Viaduct, Bridges, Retaining Walls & other miscellaneous Works in Connection with laying of New BG Double Railway Line of HORC project from km -2.10 to km 12.00 and km 18.00 to km 24.856
7.	C-6	Design and Construction of Earthwork, Bridges, Station Buildings, Retaining Walls and other miscellaneous Works, in Connection with laying of New BG Double Railway Line of HORC project from Km 61.5 to Km 125.98 and its connectivities from proposed Badsa station of HORC to Existing Sultanpur station on IR Network and proposed Mandothi station to existing Asaudha Station on IR network.
8.	E-1	Design, Supply, Installation, Testing & Commissioning of OHE and General Electrical services in connection with laying of New BG Double Railway line of HORC Project from Km -2.14 to Km 125.98 (*including* Tunnel portion i.e from Km 24.856 to km 29.680) and its connectivities to IR/DFC networks from Prithla to New Prithla, New Patli to Patli, New Patli to Sultanpur, Badsa to Sultanpur and Mandothi to Asaudha including modifications in Sultanpur and Asaudha station yards.
9.	ST-1	Design, Supply, Installation, Testing & Commissioning of Signalling & Telecommunication in connection with laying of New BG Double Railway line of HORC Project from Km -2.14 to Km 125.98 and its connectivities to IR/DFC networks from Prithla to New Prithla, Manesar to Patli, New Patli to Patli, New Patli to Sultanpur, Badsa to Sultanpur and Mandothi to Asaudha including modifications in Patli , Sultanpur and Asaudha station yards.
10.	T-2	Design, Supply and laying of Track and Track related works in connection with laying of New BG Double Railway Line of HORC project from Km -2.14 to Km 24.856, Km 29.680 to Km 32.00 and from Km 61.50 to Km 125.98 including its connectivities from proposed Badsa station of HORC to existing Sultanpur station on IR Network and proposed Mandothi station to existing Asaudha Station on IR Network

Note:

The above list is only tentative and has been provided for giving overview of the Project to the Tenderers. However, it may undergo change in future at the sole discretion of HRIDC.

5.2 GENERAL

5.2.1 This Appendix describes the Contractor's responsibilities with regard to interface management and coordination and includes interfacing with other contractors employed by the Employer (referred to as "Interfacing Contractors" hereinafter), and Interfacing Parties including entities such as local authorities, statutory bodies, public utility companies, private service providers, consultants or contractors whether or not specifically mentioned in the Contract. This responsibility is not limited to a particular number of Interfacing Contractors and Interfacing Parties, and all interfaces as required in the Contract are the sole responsibility of the Contractor.

5.2.2 Interfaces internal to the Contract are the sole responsibility of the Contractor and are not covered by this Appendix.

5.3 RESPONSIBILITIES OF THE CONTRACTOR

5.3.1 So as to ensure that the whole Project including Interfacing Contractors' works as well as the Contractor's Works shall be executed in the most efficient manner in the best interest of the Employer, the Contractor shall:

a) Take the lead in the management of the coordination process with Interfacing Contractors and Interfacing Parties.

b) Accord access to the Site and/or services to any related party in the Contract including members of the Interfacing Contractors, Interfacing Parties and the Engineer/Employer.

c) Not impede the work of the Interfacing Contractors and Interfacing Parties and shall accord them all reasonable opportunities and facilities.

5.3.2 The Contractor shall, in accordance with the Works Requirements, coordinate and integrate the:

a) Contractor's own Works under the Contract with the works of the Interfacing Contractors and Interfacing Parties.

b) Works of the Interfacing Contractors and Interfacing Parties.

5.3.3 The Contractor shall comply with any instruction which the Engineer may give. The Contractor's responsibilities shall neither be mitigated nor in any way affected by virtue of similar responsibilities being placed on the Interfacing Contractors. The Contractor shall be responsible for the detailed coordination of his manufacturing, installation, construction, testing and commissioning activities.

5.3.4 The Contractor shall carefully review any pertinent information made available by the Engineer relating to the nature and programming of all related parties' contracts and use such information in his planning of the Works.

5.3.5 The Contractor shall communicate and exchange information directly with the Interfacing Contractors and Interfacing Parties with a copy to the Engineer for information. Information as necessary to fulfil the Contractor's interface obligations shall be directly requested and obtained from the Interfacing Contractors and Interfacing Parties with a copy to the Engineer for information and receipt acknowledged.

5.3.6 The Contractor shall ensure that the Contractor's requirements, including any design inputs to other packages, are provided to all related parties of the Interfacing Contractors and Interfacing Parties before the cut-off dates as identified in the Interface Management Plan to be developed by the Contractor and consented to by the Engineer.

5.3.7 Where other contracts requiring interface are yet to be awarded, the Contractor shall proceed with coordination activities with the Engineer, until such time as the Interfacing Contractors are employed by the Employer.

5.3.8 The Contractor shall take all reasonable steps to ensure that the Works are integrated with the manufacture, installation, execution and testing of such other works and shall in particular but without limitation to:

a) Comply with any instruction which the Engineer may give for the integration of the Works with the design of any other part of the Project;

b) Consult, liaise and cooperate with those responsible for carrying out such other works, including where necessary, in the preparation of the respective designs and drawings, the preparation of coordinated programmes, method statements, coordination drawings and specifications together with arrangements of service priorities and zoning to coordinate the priorities of tasks and division of the area together with the items mentionedpreviously; and

5.3.9 Participate in the Integrated Testing and Commissioning of the Works with the Interfacing Contractors and Interfacing Parties and demonstrate to the satisfaction of the Engineer that the Works have been constructed in a manner compatible with the works of the Interfacing Contractors and Interfacing Parties.

5.3.10 There shall be a continuous requirement for coordination by the Contractor between Interfacing Contractors/Interfacing Parties.

5.3.11 During the Works the Contractor shall provide within the Site the facilities including, but not limited to, staging, storage and unloading, and temporary storage areas for the temporary use of Interfacing Contractors and/or Interfacing Parties, as may reasonably be required during the construction/installation and commissioning process. Where separate locations need to be provided for each of the Interfacing Contractors and/or Interfacing Parties, prior to construction commencing, specific details shall be coordinated and agreed between the Contractor and the Interfacing Contractors and/or Interfacing Parties.

5.3.12 The Contractor shall attend meetings with Interfacing Contractor and Interfacing Parties (if necessary) and raise/provide correspondence in this regard in accordance with the Works Requirements and/or as instructed by the Engineer. The identity of the Interfacing Contractor(s) and/or Interfacing Parties may not be known before the execution of the Contract but this shall not be a grounds for the Contractor to object to the subsequent appointment of any Interfacing Contractor and/or Interfacing Party.

5.3.13 The Contractor shall in accordance with the requirements of the Contract and instructions of the Engineer coordinate his own Works with the works of Interfacing Contractors and/or Interfacing Parties strictly adhering to the Coordination and Interfacing Programme and shall accord the Interfacing Contractors and/or Interfacing Party's all reasonable opportunities for carrying out their works.

5.3.14 If the Contractor suffers delay by reason of failure caused by any Interfacing Contractor/Interfacing Party to meet the specified installation interfacing and/or coordination completion dates resulting in delay beyond the extent which could be reasonably foreseen by an experienced contractor at the time when the Coordination and Interfacing Programme is formulated and consented by the Engineer, then the Engineer shall take such delay into consideration in determining any extension of time to which the Contractor is entitled under the Contract.

5.3.15 If any act or omission of the Contractor, whether directly or indirectly, results in the delay in execution of the works of an Interfacing Contractor and/or Interfacing Party associated with the execution of the project, the matter shall be settled by the Engineer

5.3.16 All requests for information or clarification, acknowledgement of receipt of information and any official communication between the Contractor and Interfacing Contractors/Interfacing Parties shall be made in writing with a copy to the Engineer for information.

5.3.17 The Contractor shall notify the Engineer in writing of any problems encountered in obtaining necessary information and/or lack of cooperation from an Interfacing Contractor/Interfacing Party. In the event that the Engineer considers that the resolution of an interface is not proceeding satisfactorily, the Engineer shall review the matter and establish a coordinated plan directing the Contractor and the Interfacing Contractors/ Interfacing Parties regarding the required action.

5.3.18 The Contractor shall prepare minutes recording all the matters discussed and agreed at all the meetings.

5.3.19 The Contractor shall ensure that copies of all correspondence, drawings, meeting minutes, programmes, etc. relating to the Contractor's coordination and interfacing meetings with the Interfacing Contractors and Interfacing Parties or the sharing of correspondence, drawings, programmes, etc. are issued to all concerned parties and the Engineer no later than seven days from the date of such meetings and the date of issue of such correspondence, drawings, programmes, etc.

5.3.20 Should it appear to the Engineer that the Three Month Rolling Programme does not conform with the Coordination and Interfacing Programme, the Contractor shall be required to revise all such programmes so as to conform to the approved Contractual Works Programme.

5.4 INTERFACE ADMINISTRATION SYSTEM

5.4.1 The Contractor shall establish an Interface Administration System (the "IAS") and participate in the activities with the Interfacing Contractors and Interfacing Parties. The IAS shall include, but not be limited to, the following provision of:

a) An Interface Manager who shall be responsible for and the authority to resolve interfacematters to the satisfaction of the Engineer;

b) The necessary support team for the IAS;

c) Procedures and details for response to, confirmation of and making written agreements with regard to interfaces;

d) Details of the arrangement for attendance at coordination and interface meetings (including those that may be arranged by Interfacing Contractors, Interfacing Parties or the Engineer). The representatives of Contractor, Interfacing Contractors and InterfacingParties shall be empowered to make agreements on coordination and interfaces. The Contractor shall arrange regular meetings for the Engineer to monitor the status of coordination and interfaces and may arrange special coordination and interface meetingsas may be necessary to resolve specific issues. The Engineer can require the Contractor to arrange a special coordination and interface meetings if necessary. The Contractor mayrequest assistance from the Engineer to arrange coordination and interface meetings on particular subjects;

e) Details to the Engineer of regular status information and/or details of coordination and interfaces including copies of relevant correspondence and material; and

f) Details to the Engineer of access to information for the purpose of conducting audits on interface compliance and for confirming that interface coordination and interface management is proceeding consistently with the requirements of the Contract.

5.4.2 CONSTRUCTION INTERFACE

a) Construction coordination and interface shall be required throughout the duration of the Contract and shall commence from the time of the LOA until the Taking Over of the Works.

b) The Contractor shall coordinate and interface with the Interfacing Contractors and Interfacing Parties to execute the respective construction activities efficiently.

c) The Contractor shall cooperate with Interfacing Contractors and Interfacing Parties on all Site- related matters including but not limited to Site access and occupation, safety, verification of work compatibility and survey control, etc. The Contractor shall advise the Interfacing Contractors and Interfacing Parties in advance when a construction item is ready for site inspection to verify compatibility with the Interfacing Contractors' and Interfacing Parties' needs and shall facilitate access to the Site for the Interfacing Contractors and Interfacing Parties.

d) At or near the completion of the construction of any interface-related element of the Contractor's Work, the Contractor shall:

   i) Advise the Interfacing Contractors and Interfacing Parties that the as-constructed interface- related Works can be inspected and provide the necessary access to the Site and its occupation.

ii) Agree in writing to the Interfacing Contractors and Interfacing Parties, and as consented bythe Engineer, on the adoption of any Interfacing Contractors' and/ or Interfacing Parties' applicable comments on the constructed Works.

e) On advice from the Interfacing Contractor or Interfacing Party that an as-constructed interface- related element is ready for inspection, the Contractor shall:

f) Conduct on-site inspections of the Works elements and give comments in writing to the Interfacing Contractor and/or Interfacing Party.

g) Agree in writing to the Interfacing Contractor or Interfacing Party that the as-constructed Works meet the coordination and/or interface requirements.

h) Prior to applying for a Taking-Over Certificate, the Contractor shall obtain written confirmation from each Interfacing Contractor and each Interfacing Party, that the interface elements meet the requirements of the Interfacing Contractors and Interfacing Parties. If any Interfacing Contractor or Interfacing Party withholds such confirmation, the Engineer shall decide on further action, as requested by the Contractor prior to the issue of a Taking-Over Certificate.

i) Where Contractor's Works are identified as failing to meet the requirements of the Contract and such shall impact the Interfacing Contractors' works or Interfacing Parties' works, the Contractor shall submit the proposed remedial measures to the Engineer for review and shall copy the same to the Interfacing Contractors and/or Interfacing Parties.

j) The Contractor shall coordinate and interface with the Engineer with respect to all construction/installation activities and shall follow the Engineer's instructions for requesting access for such activities.

k) The Contractor shall undertake construction/ installation in accordance with the approved (Contractual) Works Programme. The Contractor shall coordinate and interface with Interfacing Contractors and/or Interfacing Parties for the planning and execution of the testing and commissioning activities.

5.5 INTERFACE DOCUMENTS

5.5.1 Preparation of Interface Documents

The Contractor shall prepare as required the following coordination and interface documents which shall be used to completely define the Contractor's coordination and interface details:

a. Interface Table;

b. Coordination and Interfacing Programme; and

c. Interface Management Plan (IMP).

5.5.2 These coordination and interface documents shall be submitted for review by the Engineer in order to obtain the Engineer's Approval. For all subsequent updates, these documents shall be submitted to the Engineer for information, review and comment. A summary of principal issues with suitable solutions shall be included in each Monthly Progress Report.

5.6 INTERFACE TABLE FOR SUPPLY AND INSTALLATION ITEMS

5.6.1 The Interface Table shall include at least (but without limitation) the items related with the Contractor's Contract described in Appendix 5. The Interface Table, which describes the relationships between the Contractor and Interfacing Contractors and/or the Interfacing Parties and their roles and responsibilities, shall be submitted to the Engineer for consideration after further development of Interface Table.

5.6.2 The Interface Table shall indicate the demarcation of scope of responsibilities between the Contractor and the Interfacing Contractors and the Interfacing Parties.

5.6.3 Within sixty (60) days of notification from the Engineer of the identity of each Interfacing Contractor, the Contractor shall develop and submit to the Engineer an Interface Table that is mutually acceptable to both the Contractor and the Interfacing Contractors and Interfacing Parties.

5.7 COORDINATION AND INTERFACING PROGRAMME

5.7.1 The Contractor shall prepare and submit a Coordination and Interfacing Programme to the Engineer in accordance with the Works Requirements and/or as instructed by the Engineer as detailed below.

5.7.2 The Coordination and Interfacing Programme shall be submitted to the Engineer for consent within sixty (60) days from the Letter of Acceptance (LOA) to allow for checking and monitoring by the Engineer.

5.7.3 The Coordination and Interfacing Programme shall include detailed activities describing all aspects of the works of Interfacing Contractors and Interfacing Parties to meet all Sections or Milestones given in the Contract and be clearly linked to other programmes such as the (Contractual) Works Programme (or Work Segment Programmes) to streamline the Works and the works of the Interfacing Contractors and Interfacing Parties.

5.7.4 The Coordination and Interfacing Programme shall indicate the physical areas to which the Interfacing Contractors and Interfacing Parties require access, with access dates, durations required and the required degree of completion of the Works prior to the access dates by Interfacing Contractors and Interfacing Parties.

5.7.5 It is the Contractor's responsibility to ensure timely coordination with the Interfacing Contractors and Interfacing Parties to review, revise and finalise his Coordination and Interfacing Programmes so as not to affect the progress of the Works and/or the works of the Interfacing Contractors and Interfacing Parties.

5.7.6 The Contractor shall note that the following conditions apply to the works of the Interfacing Contractors and/or Interfacing Parties:

a) The Interfacing Contractors and/or Interfacing Parties shall not have exclusive access to any part of the Site except with the consent of the Engineer;

b) The Contractor shall take note that concurrent time allocations for certain areas may be given to more than one Interfacing Contractors and or Interfacing Parties. The Contractorshall coordinate the Works in such areas with the works of the Interfacing Contractors and/or Interfacing Parties and report to the Engineer for his review and consent;

c) The absence of a Coordination and Interfacing Programme date or construction/ installation period for the Interfacing Contractors and/or Interfacing Parties in a specific area shall not prejudice the right of the Engineer to establish a reasonable Coordination and Interfacing Programme date or construction/installation period for thatarea;

d) The Contractor and the Interfacing Contractors shall comply with the Sections or Milestones and other successive activities specified in the Coordination and Interfacing Programme.

5.8 INTERFACE MANAGEMENT PLAN (IMP)

5.8.1 The Contractor shall develop and submit to the Engineer, within sixty (60) days from the LOA, an IMP for all interface issues that may arise during the construction, testing and commissioning of the Works, in consultation with the Interfacing Contractors / Interfacing Parties and the Engineer. The IMP shall allow adequate time periods for each of the Interfacing Contractors/ Interfacing Parties and the Contractor to install their Plant, equipment and Materials in the designated areas.

5.8.2 The IMP shall:

a) Identify all the systems and sub-systems and facilities with interfacing requirements;

b) Define as far as possible the authority and responsibility of the contractor's, the Interfacing Contractor's and interfacing party's involved in interface management and development;

c) Identify the information to be exchanged, together with the management and technical skills required for the associated development of the works, at each phase of the contractor's and Interfacing Contractor's and Interfacing Parties' project life-cycles;

d) Address the Contractual Works Programme (or Work Segment Programmes) of the Contract to meet the Contractor's sections or Milestones and the Interfacing Contractors' sections or milestones and highlight any programme risks requiring the Engineer's attention;

e) Include relevant consideration of the requirements of "Environment Social Health and Safety Manual" as described in Appendix 13;

f) Address the supply, installation, testing and commissioning programmes of the Contract to meet Interfacing Contractors' Sections or Milestones, and highlight any programme risks requiring management attention; and

g) Indicate dates for commencement and completion of each principal activity by the Contractor and those of the Interfacing Contractors and Interfacing Parties, including delivery and installation of Plant, equipment and Materials.

5.8.3 After the Engineer reviews and issues approval to the IMP, the Contractor shall execute the Works accordingly.

5.8.4 The Contractor shall raise and apprise the Engineer immediately of any difficulty in developing a mutually acceptable IMP.

5.8.5 Employer's / Engineer's Input

a) The Employer or Engineer or both will coordinate the activities of the Contractor with reference to interfacing with third parties during all the phases of the Contract.

b) The Employer or Engineer, within the scope of the relevant Contract provisions, may assist the Contractor in the following fields:

(1) Coordination and interface with state and local authorities for the timely receipt of required permits, certificates and approvals related to the construction process;

(2) Coordination and interface with state and local authorities for the implementation of acquisition procedures for any additional land areas that may be required by the Contractor; and

(3) Any other fields or activities related to the Contract as may be required for the purposes of facilitating the Contractor's performance.

c) The Engineer shall conduct a coordination and interface meeting with the interfacing parties every fortnight with the Contractor which may be attended by the Employer. The primary objective of the meeting will be to review progress of the coordination and interface activities.

d) The support and assistance of the Employer and/or the Engineer shall not release the Contractor of any of his obligations under this Contract.

5.9 DETAILED INTERFACE DESCRIPTION (DID)

5.9.1 The DID is the document that provides a clear technical description of each of interface in the Interface Table.

5.9.2 Any revision to the DID shall be mutually acceptable to both the Interfacing Contractors and Interfacing Parties. Only then shall this be submitted to the Engineer for his review.

5.9.3 DID shall contain the following items:

S. No.	Detailed Interface Description
1	Item number and name of interface in Interface Table
2	Name of the Contractor and Interfacing Contractor/Interfacing Party
3	Confirmation Table of both the Contractor and Interfacing Contractor/Interfacing Party
4	Creation date and modification date
5	Correction history
6	The following items shall be described: physical interface, functional interface, protocols, software and data interface, naming conversion, design constrains, environmental conditions, and drawings
7	Reference Documents

5.10 CONTENTS OF INTERFACE MANAGEMENT PLAN

Interface Management Plan (IMP) should be prepared including necessary contents referring Table 1. The intention of each section is described by the text inside angle brackets.

Table1: Sample Contents of Interface Management Plan

1	Introduction	
	1.1	Purpose of Document

		<Describe the methodology to be adopted by the Contractor in managing all interface issues >
	1.2	Overview <Project overview of the Contractor and the Interfacing Contractor>
2	Resource Management	
	2.1	Organization and Roles & Responsibilities
	2.2	Resource Requirement <Detailed description of the manpower, tools, logistics shall be included in this section>
3	Interface Requirements	
	3.1	Allocation of Interfacing Requirements <This is an introduction to Section3.2>
	3.2	Interface Description between Contractors <Task Allocation Table (TAT) shall be included in this section>
	3.3	Areas of Concern <Process for managing the interface concern>
4	Process Management	
	4.1	Change of Interfacing Requirement <The process for the management of interface requirement change shall be addressed in this section.>
	4.2	Verification and Validation of Interfacing Requirements <The approach to be adopted by the Contractor to manage verification and validation of interfacing requirements shall be addressed in this section.>
	4.3	Testing and Commissioning on Interfaces <The approach to be adopted by the Contractor for the management of Interface in the Testing and Commissioning stage shall be addressed in this section.>
	4.4	Quality Procedures <All Contractor's internal quality procedures applicable for the interface management shall be listed here.>
	4.5	Systems Assurance Plans <Considered requirement of the Systems Assurance.>
5	Document Management	
	5.1	Reference Documents <All applicable reference documents shall be listed in this section.>

	5.2	Structure of Reference Documents <The Structure of reference documents shall be addressed in this section.>
	5.3	Version Control of Interface Documents <Configuration management of interface documents shall be addressed in this section.>
6	Communication	
	6.1	Terms of Reference of Interface Meetings <The terms of reference of interface meetings shall be addressed here.>
	6.2	Exchange of Information between Contractors <The process for the exchange of information between the pair-wise contractors shall be stated here.>
	6.3	Submission to Employer <The approach to be adopted by the pair-wise contractors on the Submission of the Interface Management Plan to Employer shall be described here.>
	6.4	Request for Employer Attention <The criteria and methodology on requesting for Employer attention shall be mentioned here.>
7	Interface Hazard Management	
	7.1	Strategy and Approach
8	Programme	
	8.1	Key Activities <Include schedule of meetings, schedule of exchange of information, etc.>
	8.2	Section and Milestone <Include Design Freeze Dates, Integrated Test Dates, Critical Items dates, etc. Should include reference to appropriate programmes so that any future changes in programme date need not result in resubmission of this plan for approval.>
	8.3	Critical Items/ Critical Paths <This section shall highlight all the critical items and critical paths to the Employer.>

5.11 INTERFACE TABLE

5.11.1 Interface Table between C-1 and C-23

S. No	Interface Items	Requirements
1.	Cross Section of bank	C-1 Contractor shall provide stepped profile of bank at junction with C-23 Contractor.

5.11.2 Interface Table between C-23 and C-4

S. No	Description	Remarks
1.	Cross Section of cutting	C-23 Contractor shall provide stable cut slope at junction with C-4 Contractor.
2.	Drainage arrangement	C-23 Contractor shall design & construct side drains of adequate capacity in cutting portion in approach of C-4 and share design data of discharge of these side drains with C-4 Contractor to enable C-4 Contractor to design and construct side drains in cutting in the approach of the tunnel.

5.11.3 Interface Table between C-23 and T-1

S. No	Description	Remarks
1.	Handing/Taking over of site for laying of track	C-23 Contractor shall complete the work of formation and bridges as per drawings and handover site to T-1 Contractor for laying of track.

5.11.4 Interface Table between C-23 and C-6

S. No	Description	Remarks
1.	Cross Section of bank	C-23 Contractor shall provide stepped profile of bank at junction with C-6 Contractor.

5.11.5 Interface Table between C-23, *E-1* and ST-1.

S. No	Description	Remarks
1.	Provide access to site for *E-1 and* ST-1 contractor for OHE and S&T works	i) C-23 Contractor shall complete the work of formation and bridges as per drawings and hand over site *to E-1 and* ST-1 Contractor for OHE and S&T works *ii) C-23 Contractor shall complete the work of Signalling & Telecom structures at Dhulawat, New Patli and Sultanpur Stations and Hand Over to ST-1 Contractor for S&T works.*

5.12 Interface requirements specified above are by no means exhaustive and it remains the Contractors' responsibilities to develop, update and execute jointly Interface Requirements during design & throughout the execution of Works, to ensure that:

i. all interface issues between the Contracts/Systems are satisfactorily resolved;
ii. design, supply, installation and testing of equipment are fully co-ordinated; and
iii. all equipment and facilities supplied under the Contracts are fully compatible with each other, whilst meeting the requirements of the respective Specifications.

APPENDIX 6

PROGRAMME REQUIREMENTS

6. GENERAL

6.1 PURPOSE OF PROGRAMME

6.1.1 There are two primary purposes for the requirement of Programme (Scheduling) information described in this document:

a) Evaluation of tender.

b) Status Reports during Construction

To provide the Engineer with status reports for managing, monitoring and coordinating the awarded contracts during their execution within the overall multi-contract project schedule.

The requirements are organized in two stages. The first stage is a requirement for all Bidders and shall be submitted as part of Bid. The second stage is a requirement of the Employer and describes a series of reports to be submitted by the Contractor to the Engineer during the execution of contract, following the award of contract.

6.1.2 The Tenderer/Contractor shall programme his work at all times to meet the Key Date stated in Appendix 2 to the Employer's Requirements and the specified interface periods for the design and installation of the Works with those of the Interfacing Contractors and shall during the progress of the Works constantly monitor his progress against the programmes described below.

6.1.3 The Tenderer/Contractor shall include in all programmes his work obligations towards shared access, shared Site areas and other coincident or adjacent Works Areas.

6.1.4 The Works Programme, and all more detailed or revised versions, shall be submitted to the Engineer in hard copy as well as soft copy for his consent in accordance with the provisions of the GC.

6.2 METHODOLOGY

6.2.1 The computerized Critical Path Method (CPM) network using the Precedence Diagramming Method (PDM), has been selected by the Employer as the technique for contract management system and in co-coordinating the multi-contract project. This technique shall also be employed by the Tenderer in preparing their Tender submissions and by the Contractor in their Construction Stage submissions.

6.2.2 Unless otherwise agreed by the Engineer, all programmes submitted by the Contractor shall be produced using computerized Critical Path Method (CPM) Networks developed implementing the Precedence Diagramming Method (PDM) with Cost Loaded Charts and Tables.

6.2.3 The Contractor shall implement and use throughout the duration of the Contract, a computerized system to plan, execute, maintain and manage the planning, design, pre-construction, construction, and sub-contracts in executing the CPM scheduling by PDM. The reports, documents and data provided shall be an accurate representation of the current status of the Works and of the work remaining to be accomplished; shall provide a sound basis for identifying problems, deviations from the planned works, and for making decisions; and shall enable timely preparation of the same for presentation to the Engineer.

6.3 PROGRAMME MANAGEMENT SOFTWARE

6.3.1 CPM programming software used shall be Primavera Project Planning (P6) Program - Ver 21.12 or later. Any other compatible system capable of direct file interchange capability with software program used by the Employer - Primavera (P6), Ver 21.12 or later can be used with Engineer's consent. Scheduling software and relevant instruction manuals, licensed for use in connection with the contract, shall be provided by the Contractor according to the Employer's specifications

6.3.2 The Tenderer may use a system other than Primavera but will be required to demonstrate that full electronic data transfer to Primavera is available and that the various levels of reporting and coding capabilities are at least equivalent to Primavera. Compatibility and comparable performance between Primavera and the Tenderer's proposed system shall be demonstrated in his Tender submission. Should compatibility not be demonstrated to the Employer's satisfaction the Contractor shall utilise Primavera for development, stat using, updating and revision of all the Programmes during the duration of the Contract. Upon the Engineer's consent of a system other than Primavera, the Contractor shall supply the Engineer with an original licensed copy, including manuals and approved training of the software and any subsequent versions thereof at no extra cost.

6.4 POST CONTRACT AWARD

6.4.1 The Contractor shall develop his Tender Programme into the Initial Works Programme including an outline Narrative Statement and submit its more detailed version as per the key dates mentioned in Appendix 2 to the Engineer for approval.

6.4.2 The first Three Month Rolling Programme shall be submitted within thirty (30) days of the date of commencement and all subsequent editions shall accompany the Monthly Progress Report. The Monthly Progress Reports shall also include a Programme Update as described below. These programmes shall subsequently be updated as described below.

6.4.3 The Contractor shall take into account the programmes of Interfacing Contractors while finalizing the Works Programme It is the Contractor's responsibility to ensure timely co-ordination with the Interfacing Contractors to review, revise and finalise his Work Programme so as not to affect the progress of Works/ and or the works of the Interfacing Contractors. The Detailed Works Programme when approved by the Engineer after incorporating requirement of Interfacing Contractors shall form the Baseline Programme against which actual progress of the Contract shall be reckoned. As the work progresses, it may be necessary to update/ revise the Baseline programme but such updating shall only be carried out with the prior consent of the Engineer or when directed by them.

6.4.4 For Initial & Detailed Work Programme submission, one (1) original and three (3) copies each of the following Programmes and Reports shall be submitted to the Engineer:

a) Programme: Baseline CPM Network

b) Programme: Baseline Milestone based Cost Activity Schedule

c) Baseline Schedule Report

d) Narrative Statement

e) Baseline Physical Progress 'S' curve

f) Baseline Resource Charts

6.4.5 The Engineer shall review and comment on the Contractor's programmes and information submitted under this Clause. The Engineer will confirm his consent or otherwise of the submissions within thirty (30) calendar days.

6.4.6 The Engineer shall require the Contractor to re-submit within thirty (30) calendar days if he is of the opinion that the programmes and information submitted by the Contractor is unlikely to meet the Contract Key Date.

6.4.7 If in the opinion of the Engineer, any of the Contractor's revised programmes or Baseline Schedule Report is not acceptable, it shall be construed as a failure of the Contractor to meet the Contract Key Date.

6.4.8 Notwithstanding the above, the Engineer may at any time during the course of the Contract require the Contractor to reproduce the computer-generated Baseline Schedule Report described above to reflect actual activity dates and generate schedules based upon "what if" statements. The initial computer-generated report after receiving the Engineer's consent will serve as the base against which the contract progress will be measured. Any changes to the Report reflected in subsequent Baseline Schedule Reports shall also require the Engineer's consent.

6.4.9 Failure to include any element of work required for performance of the Contract shall not relieve the Contractor from completing all works required under the Contract to achieve the original or any extended key completion date.

6.5 WORKS PROGRAMME

6.5.1 The Works Programme shall show the Contractor's plan for organising and carrying out whole of the Works.

6.5.2 The Works Programme shall be a computerised Critical Path Method (CPM) network developed using the Precedence Diagramming Method (PDM) and shall be present in bar chart and time-scaled network diagram format to a weekly or monthly time scale.

6.5.3 Tasks in the Works Programme shall be sufficiently detailed to describe activities and events that include, but are not limited to, the following:

a) Key Date,

b) all physical work to be undertaken in the performance of the Contract obligations, including Temporary Works,

c) the requested date for issue of any drawings or information by the Engineer,

d) incorporation of principal aspects of the Design Submission Programme,

e) procurement of major materials and the delivery and/or partial delivery date on-Site of principal items of Contractor's Equipment,

f) any off-site work such as production or pre-fabrication of components,

g) installation of temporary construction facilities,

h) interface periods with Interfacing Contractors or utility undertakings,

i) design, supply and/or construction activities of sub-contractors,

j) any outside influence which will or may affect the Works.

6.5.4 The Works Programme shall show achievement of all Key Date.

6.5.5 Activity descriptions shall be unique, describing discrete elements of work. Any activity creating an imposed time or other constraint shall be fully defined by the Contractor.

6.5.6 The Works Programme shall be organised in a logical work-breakdown-structure including work stages and phases, and shall clearly indicate the critical path(s).

Each activity in the Works Programme shall be coded to indicate:

a) Activity ID and Activity Code.

b) The Engineer may request additional activity coding to the extent available without restraint to the Contractor's utilisation of the programme software. When requested the Contractor shall add the required additional coding to the Programme. The Contractor shall use additional code fields as requested to comply with the requirements and for the use of the Contractor.

6.5.7 Activity duration shall not exceed two (2) weeks, unless otherwise consented to by the Engineer, except non-construction activities such as submittals, submittal reviews, procurement and delivery of materials or equipment and concrete curing. The Contractor shall submit a Programme/Project Calendar cross reference clearly indicating the allowance for holidays.

6.5.8 The Works Programme, in each submission, shall be accompanied by an Activity Report and a Narrative Statement as described below in both electronic and hard copy format (time scale logic diagrams in A1 size, reports in A4 size).

6.5.9 Activity Report shall list all activities, and events in the Works Programme, sorted by activity identification number.

The Activity Report shall include the following for each activity and event:

a) activity identification number and description,

b) duration expressed in Days,

c) early and late start, & early and late finish dates. Planned start and finish dates,

d) calculated total float and free float,

e) predecessor(s) and successor(s), accompanying relationships and lead/lag duration,

f) imposed time or date constraints,

g) calendar.

6.5.10 Narrative Statement

The Narrative shall be a comprehensive statement of the Contractor's plan and approach for the execution of the Works and the achievement of Key Date, handover dates, submission dates and any intermediate dates. It shall incorporate outline method statements in respect of major items of work including construction sequences and primary item of plant, Construction Equipment, Temporary Works and the like. It shall fully explain the reasons for the main logic links in the Programme and include particulars of how activity durations are established. This shall include estimated quantities, production rates, hours per shift, work days per week and a listing of the major items of Construction Equipment planned for use on the project. Activities, which may be expedited by use of overtime or additional shifts, shall be identified and explained. A listing of holidays, and other special non-work days being used for the computer reports shall be included.

6.5.11 Baseline Physical Progress 'S' Curve

The Contractor shall also submit a forecast Cumulative Physical Progress 'S' curve based on the time-phased distribution of cost in the CPM Network Logic Diagram, expressed in percentage terms. This 'S' curve shall be generated from the computerized CPM Network Logic Diagram.

6.5.12 Baseline Resource Charts

The Contractor shall also submit a Resource Charts, generated from the Contractor's CPM Network Diagram, showing the anticipated manpower and main Construction Equipment usage during the execution of the Project.

As an additional monitoring facility, indicator resources shall be assigned to relevant activities for the major items of work. Indicator resources shall be directly allocated for excavation (cum.), piling (no.), diaphragm walling (m.), concrete (cum.), tunnel lining (m), etc. Resource indicators may be input as a daily rate, expected required rate, or as an activity total in the relevant units. These are purely indicative quantities and do not form part of contract.

6.5.13 All submissions of proposed Works Programmes subsequently, after approval of the Initial Works Programme, shall include the actual physical progress of work and forecast of the remaining work. Actual progress shall be stated in percent complete, remaining duration, and actual start and finish dates for each activity in the Works Programme.

6.6 INITIAL WORKS PROGRAMME

6.6.1 The Initial Works Programme submitted as under Clause 6.4 above need not include the full details. It should be a condensed version with combined activities of longer. The outline Narrative Statement shall be in sufficient detail to clearly show the Contractor's intention.

6.6.2 After the Engineer's consent to the Initial Works Programme, the Contractor shall submit to the Engineer an expanded and more detailed version of the Initial Works Programme containing all of the information and detail required as per Key Date mentioned in Appendix 2.

6.6.3 Such submission shall make use of the Tender Programme submitted earlier but refined to include the best estimates of dates for the work of Interfacing Contracts which has impact on the Contractor's programme. Such programmes shall be amended subsequently to incorporate the actual dates/ schedule of the affecting contracts. It is the Contractor's responsibility to ensure timely co-ordination with the Interfacing Contractors to finalise the Initial Programme, without affecting progress of the work.

6.7 WORKS PROGRAMME REVISIONS

6.7.1 The Contractor shall immediately notify the Engineer in writing of the need for any changes in the Works Programme, whether due to a change of intention or of circumstances or for any other reason. Where such proposed change affects timely completion of the Works or any other Key Date the Contractor shall within fourteen (14) days of the date of notifying the Engineer submit for the Engineer's consent its proposed revised Works Programme and accompanying Narrative Statement. The proposed revised Works Programme shall show the sequence of operations of any and all works related to the change and the impact of changed work or changed conditions.

6.7.2 If at any time the Engineer considers the actual or anticipated progress of the work reflects a significant deviation from the Works Programme, he may request the Contractor to submit a proposed revised Programme which together with an accompanying Activity Report and Narrative Statement, shall be submitted by the Contractor within fourteen (14) days after the Engineer's instruction. The proposed revised Works Programme shall show the sequence of operations of any and all work related to the change and the impact of changed work or changed conditions.

6.7.3 All activities that have negative float must be analysed by the Contractor to identify the impact on the timely completion of the Works or on the achievement of Key Date.

6.8 THREE MONTH ROLLING PROGRAMME

6.8.1 The Three-Month Rolling Programme shall be an expansion of the current Works Programme, covering sequential periods of three months. The Three-Month Rolling Programme shall provide more detail of the Contractor's plan, organisation and execution of the work within these periods. In particular, the Contractor shall expand each activity planned to occur during the next three (3) month period, if necessary, to a daily level of detail.

6.8.2 The Three-Month Rolling Programme shall be developed as a Critical Path Method (CPM) network, and shall be presented in bar chart and time-scaled network diagram format. Bar charts shall be presented on an A4 and time-scaled networks diagrams on an A1 size reproducible media. Tasks in the programme shall be derivatives of and directly related to tasks in the approved Works Programme.

6.8.3 The Contractor shall describe the discrete work elements and work element inter-relationships necessary to complete all works and any separable parts thereof including work assigned to sub-contractors.

6.8.4 Activity duration shall not exceed two (2) weeks unless otherwise consented to by the Engineer.

6.8.5 Each activity in the Three-Month Rolling Programme shall be coded, or described so as clearly to indicate the corresponding activity in the Works Programme.

6.9 THREE MONTH ROLLING PROGRAMME REVISIONS AND UPDATE

6.9.1 The Three-Month Rolling Programme shall be extended forward each month as described under Clause 6. 4 above. Each submission of the Three-Month Rolling Programme shall be accompanied by a Programme Analysis Report, describing actual progress to date, and the forecast for activities occurring over the next three-month period.

6.9.2 If the Three Month Rolling Programme is at variance with the Works Programme, the Programme Analysis Report shall be accompanied by a supporting Narrative Statement describing the Contractor's plan for the execution of the activities to be undertaken over the three-month period, including programme assumptions and methods to be employed in achieving timely completion.

6.9.3 The Contractor shall revise the Three-Month Rolling Programme or propose revisions of the Works Programme, or both, from time to time as may be appropriate to ensure consistency between them.

6.10 THREE WEEK ROLLING BAR CHART SCHEDULE

Once a week, on a day mutually agreed to by the Engineer and the Contractor, a meeting will be held to assess progress by the Contractor during the previous work week. The Contractor shall submit a construction schedule listing activity completed and in-progress from the previous week and the activities scheduled for the succeeding two weeks based on the detailed Works Programme. Copies of the schedule shall be submitted on A3 sized paper.

6.11 PROJECT CALENDAR

For the Project, the Contractor shall adopt 7 days a week calendar, identical calendar for the purpose of programming and Execution of Works. Official documents shall be transacted during 5 days week - Monday through Friday, except for National (Govt. of India) Holidays. For Project purposes, a week begins at 0001 hours on a Monday and ends at 2359 hours on a Sunday. The completion of an activity or the achievement of an event when given a week number shall be taken to mean midnight on the Sunday at the end of the numbered week. An access date or activity start date when given as a week number shall be taken to mean 0001 hours on a Monday of the Numbered week.

6.12 PROGRAMMING PERSONNEL

The Contractor shall submit, as part of its Staff Organization Plan, the names and required information for the staff to be employed on Works Programming. The Works Programmer shall hold reputable professional qualifications and relevant experience as per Attachment C-1 to Employer's Requirements – Construction .The programmer shall be employed by the Contractor full time on the Contract until the completion or such earlier time.

6.13 PROGRAMME AND REPORT SUBMISSION FORMAT

The Contractor shall submit one (1) original and three (3) copies and a soft copy of all submissions to the Engineer. All submissions shall be in A0, A1, A3 or A4 size, as appropriate except as may otherwise be agreed by the Engineer.

The format for all Programme and Report submissions shall be strictly in accordance with the format or as requested by the Engineer.

APPENDIX 7

MEETINGS

7. MEETINGS

7.1 Kick-Off Meeting

The Engineer shall hold Kick-Off Meeting within 7 calendar days from the Commencement Date. Purpose of the Meeting is formally to notify all parties concerned under the Contract thatthe project has begun, and every party has a common understanding and his role from the Commencement Date until issuance of the Taking-Over Certificate.

At the Kick-Off Meeting, followings will be, but not limited, discussed.

a) Outline of the Works

b) Communication rules (process, emails, approvals, etc.)

c) Other matters regarding proceeding and management of the Contract.

d) Profile of the Site

e) Time Schedule List of Contractual Events/Submissions, including Milestones, Time(s) for Completion and Defects Notification Period(s).

f) Introduction of key persons of the Contractor and Employer, with role, Function and authority of each person.

g) Role and responsibility of Emergency notification process.

7.2 Regular Meetings

7.2.1 The Engineer shall hold regular meetings with the Contractor as necessary for the proper management and co-ordination of the Works. The Contractor's representative and other personnel as considered necessary by the Engineer, shall attend such meetings.

7.2.2 Within twenty eight (28) days after the Commencement Date, the Engineer and the Contractor's Representative shall agree upon a programme for weekly and monthly meetings covering the first three (3) months after such twenty eight (28) days. The Contractor's Representative shall make sure that the Contractor's Personnel designated to attend meetings make themselves available for the meetings. The Engineer shall prepare the agenda for the meetings and the relevant documents to be submitted to the meeting, including as a minimum the minutes of the previous meeting. Thereafter, the programme for weekly and monthly meetings shall be updated monthly in the monthly progress meetings.

7.2.3 The Engineer may initiate ad-hoc meetings as and when the need arises, through prior consultation with the Contractor's Representative where possible, and the Contractor's Representative and other Contractor's Personnel designated by the Engineer and/or the Contractor's Representative shall attend such meetings. The Engineer shall prepare a proposed agenda of the meeting, for prior consultation with the Contractor's Representative where possible.

7.3 Monthly Progress Meeting

A Monthly Progress Meeting shall be called by the Engineer and shall be held every month within three (3) days following issuance of the Contractor's Monthly Progress Report. If the day specified, is not a working day, then the meeting shall be heldon the next working day after the specified date. The Engineer shall notify the Contractor of any change in the date or time, or both, of the meeting. The main purpose of the meeting is to discuss progress of the Works and if there is any delay in progress, being encountered by the Contractor, the Contractor shall indicate the cause of delay and present the method of recovery.The results of the discussions of the meeting shall be included in the Contractor's next MonthlyProgress Report to be provided.

7.4 Co-ordination Meeting

The Contractor shall organize co-ordination meetings as required with related parties. Before conducting such co-ordination meetings with the related parties, the Contractor shall give priornotice and agenda of the meeting to the Engineer and the Employer.

7.5 Meetings called by the Contractor

The Contractor's Representative may request the Engineer to meet him and other Contractor's Personnel whenever necessary to discuss the issues pertaining to the Works and the Contract. The Engineer shall comply with the request where physically possible. The Contractor shall prepare a proposed agenda for the meeting and submit it to the Engineer when making request for the meeting.

7.6 Other Meetings

The Contractor's Representative shall attend, and shall arrange for representatives of the Subcontractors, public departments, transportation companies, utility undertakings and other contractors employed by the Employer to attend, meetings when required by the Engineer. The Contractor shall inform the Engineer in 48 hours (or such a shorter period as agreed by the Engineer) before conducting meetings with the public departments, transportation companies, utility undertakings and/or the other contractors and shall give the Engineer an opportunity to attend such meetings.

7.7 Minutes of Meetings

The Engineer in principle shall be responsible for the preparation of the minutes of meetings, circulating it to the parties who attended the meeting before the next relevant meeting. The Engineer shall also be responsible for the minutes of ad-hoc meetings in a similar manner, unless otherwise agreed with the Employer.

7.8 MONTHLY PROGRESS REPORTS

7.8.1 GENERAL

The Contractor shall submit to the Engineer, a Monthly Progress Report. The first report shall cover the period up to the end of the first calendar month following the Commencement Date. Reports shall be submitted monthly thereafter, each within 7 days after the last day of the period to which it relates. It shall be submitted in a format to which the Engineer shall have given his consent and shall contain sections/sub-sections.

7.8.2 FINANCIAL STATUS

a) A narrative review of all significant financial matters, and actions proposed or taken in respect to any outstanding matters.

b) A spread sheet summarising each activity, the budget, costs incurred during the period, costs to date, costs to go, cost forecast (total of costs to date and costs to go) and cost variance (difference between cost forecast and budget).

c) A spread sheet indicating the status of all payments due and made.

d) A report on of the status of any outstanding claims. The report shall in particular provide interim updated accounts of continuing claims.

7.8.3 PHYSICAL PROGRESS

a) It shall describe the status of work performed, significant accomplishments, including critical items and problem areas, corrective actions taken or planned and other pertinent activities, and shall, in particular, address interface issues, problems and resolutions.

b) It shall include a simplified representation of progress measured in percentage terms compared with percentage planned as derived from the Works Programme.

7.8.4 PROGRAMME UPDATE (For Entire Project)

a) The monthly Programme Update which shall be prepared by recording actual activity completion dates and percentage of activities completed up to the end of the month together with estimates of remaining duration and expected activity completion based on current progress. The Programme Update shall be accompanied by an Activity Report and a Narrative Statement. The Narrative Statement shall explain the basis of the Contractor's submittal:

(1) Early Work and Baseline Submittals – explains determination of activity duration and describes the Contractor's approach for meeting required Key Date as specified in the Contract.

(2) Updated Detail Programme Submittals – state in narrative the Works actually completed and reflected along Critical Path in terms of days ahead or behind allowable dates. Specific requirements of narrative are:

i. If the Updated Detailed Work Programme indicates an actual or potential delay to Contract Completion date or Key Date, identify causes of delays and provide explanation of Work affected and proposed corrective action to meet Key Date or mitigate potential delays. Identify deviation from previous month's critical path.

ii. Identify by activity number and description, activities in progress and activities scheduled to be completed.

iii. Discuss Variation Order Work Items, if any.

b) The Programme Status which shall:

(1) show Works Programme status up to and including the current report period, display Cumulative progress to date and a forecast of remaining work.

(2) be presented as a bar-chart size A3 or A4 and as a time-related logic network diagram on an A1 media, including activity listings;

c) The Activity Variance Analysis which shall analyse activities planned to start prior to or during the report period but not started at the end of the report period as well as activities started and/or completed in advance of the Works Programme.

7.8.5 KEY DETAILS STATUS

A report on the status of all Key details due to have been achieved during the month and forecasts of achievement of any missed Key details, and those due in the next month.

7.8.6 THREE MONTH ROLLING PROGRAMME

The monthly issue of the Three-Month Rolling Programme.

7.8.7 PLANNING AND CO-ORDINATION

a) A summary of all planning/co-ordination activities during the month and details of outstanding actions.

b) A schedule of all submissions and consents/approvals obtained/outstanding.

7.8.8 PROCUREMENT REPORT

a) A summary of all significant procurement activities during the month, including action taken to overcome problems.

b) A report listing major items of plant and materials which will be incorporated into the Works. The items shall be segregated by type as listed in the Specifications and the report should show as a minimum the following activities:

(1) purchase Order Date - Scheduled/Actual,

(2) manufacturer/Supplier and Origin,

(3) letter of Credit Issued date,

(4) manufacturer/Supplier Ship Date - Scheduled/Actual,

(5) method of Shipment,

(6) arrival Date in India- Scheduled/Actual.

7.8.9 SAFETY

A review of all safety aspects during the month including reports on all accidents and actions proposed to prevent further occurrence.

7.8.10 ENVIRONMENTAL AND SOCIAL

A review of all the environmental and social issues during the past month to include all monitoring reports, mitigation measures undertaken, and activities to control environmental impacts.

APPENDIX 8
MANAGEMENT PLANS AND SUBMISSIONS

8 MANAGEMENT PLANS

8.1 General

8.1.1 In order to ensure the Contractor understands and complies with the requirements of the Contract, a series of Management Plan shall be developed. These Management Plans will serve to structure the submittals in a manner that the Contractor can develop and prepare the submittals and the Engineer can review and comment on a prescribed programme.

8.1.2 The Management Plans shall be configured as a family of "stand-alone" plans and associated documents, each covering one of the subjects listed below.

8.1.3 The plans and documents shall be co-ordinated with each other and shall collectively define describe and encompass the Contractor's proposed methods, procedures, processes, organisation, sequencing of activities etc. and shall show how these combine together to assure that the work truly meets the requirements of the specifications in respect of the subject listed.

8.1.4 All plans and documents shall be submitted as per Key Dates mentioned in Appendix 2. Further submissions shall be made:

a) when required in accordance with the Works Programme;
b) whenever the development of the Contractor's designs or planning allows the plan to be developed further;
c) in response to comments made by the Engineer:
d) whenever any change occurs that invalidates the information contained in the previously submitted and reviewed document, within 14 days of the occurrence of such change; and
e) when requested by the Engineer from time to time.

8.2 General Organisation

The plans listed below shall be developed and submitted by the Contractor for the Engineer's review:

a) Project Management Plan
   1) Contractor's Project Plan
   2) Interface Management Plan

b) Works Quality Management Plan
   1) Works Quality Management Plan
   2) RAMS Plan
   3) Electromagnetic Compatibility Management Plan
   4) Software Quality Assurance Plan

c) Design, Procurement and Manufacturing Management Plan
   1) Design Plan
   2) Factory Testing Plan
   3) Procurement, Manufacturing and Delivery Plan

d) Construction and Installation Management Plan

1) Construction and Installation Plan
2) Environment, Social Health and Safety, Management Plan

e) Completion Management Plan
1) Commissioning Plan
2) Operational and Maintenance Manuals Plan
3) Training Plan
4) Spares Management Plan
5) Defects Management Plan

8.3 Project Management Plan

The overall management of the Works shall be the Contractor's responsibility. The organisation of the resources for the design, procurement, manufacture, delivery, installation, testing and commissioning, and setting to work is to be developed into a Project Management Plan. Each section of this plan shall fully describe the Contractor's understanding of the Works and management skills and structure required to achieve the same.

8.3.1 Contractor's Project Plan

a) The Contractor's Project Plan shall provide a clear overview of the Contractor's organisation, management systems and methods to be used for execution and completion of the Works.

b) The Contractor's Project Plan shall include a summary description of each and every stage of implementation of the Works, clearly showing the principal organisational interfaces both within the Contractor's own organisation (including sub-contractors of every tier) and with Other Contractors and Relevant Authorities, defining how each of these interfaces is to be managed and controlled. An organisation chart shall be produced to illustrate the subdivision of the work into elements for effective technical and managerial control, the reporting structure and the interface relationship among all parties involved. Names, addresses, telephone and fax numbers of all principle contacts shall be listed.

c) The Contractor's Project Plan shall contain structured organisation charts showing the hierarchical relationship of the Contractor's organisation (including sub contractors of every tier). The organisation charts shall be produced as a "family" such that the basic chart shows the overall organisation structure supported by subsidiary charts detailing the internal structure of various departments or sections of the overall organisation.

d) The Contractor's Project Plan shall include full details of the qualifications, experience, authority and responsibility of the personnel assigned to all key positions of the Contractor's organisation (including sub-contractors of every tier). As a minimum, this shall include all levels down to senior managers and shall include the personnel responsible for each individual department and functional group. A clear reference shall be given as to the location of staff (e.g. site resident or factory based, etc). Names, addresses, telephone and fax numbers of all principle contacts shall be listed.

e) The Contractor's Project Plan shall define the Contractor's management structure for the execution of the Works and for the control of the quality of the Works and shall, without limitation, identify and set out:

(1) the procedure for audit;

(2) the procedures for the control of receipt and issue of all Works related correspondence so as to ensure traceability;

(3) the procedures for filing system to be implemented to maintain the Contractor's records during the course of the work. The filing systems used by the Contractor and sub contractors of any tier shall be compatible as for as is necessary;

(4) the procedures for the identification, production, verification, internal approval, review (when required) by the Engineer, distribution, implementation and recording of changes to all drawings, reports and specifications;

(5) the procedures for the evaluation, selection, engagement and monitoring of sub-contractor/suppliers together with the means of application of quality assurance to their work including audit and acceptance;

(6) the procedure for the regular review and revision of each type of quality plan and its supplemental individual specific quality plans to ensure their continuing suitability and effectiveness, in addition to the methods to be used for revision and issue of revised documentation;

(7) the procedures for the control, calibration and maintenance of inspection, testing and measuring equipment;

(8) the procedures for the selection, indexing, disposition and maintenance of project record for storage in the archives. A list of items to be archived, including their periods of retention shall be submitted for review by the Engineer;

(9) the procedures for identifying training needs and for the provision of training of all personnel performing activities affecting quality; and

(10) the procedures for the control of non-conformity.

f) The Contractor's Project Plan shall include details of Contractor's Office.

8.3.2 Interface Management Plan

The Contractor shall prepare Interface Management Plan in accordance with Appendix 5.

8.4 **Works Quality Management Plans**

8.4.1 The Contractor shall submit for review by the Engineer Works Quality Management plan in accordance with the requirements of Appendix 11

8.4.2 RAMS Plans

a) The Contractor shall implement a formal Reliability Plan and a formal Maintainability Plan in accordance with the PS.

b) The Contractor shall submit for review by the Engineer the Contractor's Reliability Plan and Maintainability Plan in accordance with the requirements of General Specification (S&T). The Contractors Reliability Plan and a Maintainability Plan shall include Failure Modes, Effects and Criticality Analysis and the production of a Reliability Critical Items List.

c) The contractor shall submit for review by the Engineer the Contractor's Systems Safety Plan. The Systems Safety Plan shall address all the factors referenced in this Specification and as required by the Particular Specification(S&T).

8.4.3 Software Quality Assurance Plan

Where software is a design deliverable, the Contractor shall submit a Software Quality Assurance Plan in accordance with the requirements of Appendix 11 The Software Quality Assurance Plan shall address all elements of the design and development of software

required as part of the Works.

8.5 **Design, Procurement and Manufacturing Plan**

The Design, Procurement and Manufacturing Plan shall be configured as a family of "stand- alone" plans and associated documents each covering one of the subjects listed below. The plans shall be coordinated with each other and shall collectively define, describe and encompass the Contractor's proposed methods, procedures, processes, organization, sequencing of activities, etc. and shall show how these combine together to assure that the Works fully meet the requirements of the Specification in respect of the subjects listed.

8.5.1 Design Plan

a) Design shall be undertaken in various phases to ensure a smooth flow of information for review by the Engineer. Submissions shall be strictly in accordance with the Design Submissions Programme.

b) The Contractor shall perform his designs for the Works and prepare a Design Plan for his design work in accordance with the following design stages. The Contractor shall submit to the Engineer for his review, relevant design information.

8.5.2 Factory Testing Plan

a) The Contractor shall prepare and submit for review by the Engineer the Contractor's Factory Testing Plan detailing and explaining how the Contractor will plan, perform, and document all inspections and tests that will be conducted to verify and validate the Works prior to delivery to the Site. The plan shall consist of a narrative description supported by graphics, diagrams and tabulations as required.

The plan shall contain but not be limited to the following topics:

(1) the Contractor's strategy for inspection and Factory Acceptance Tests of all constituent parts of the Works and how this relates to the sequence of delivery;

(2) the sequencing and interrelationships of the inspections and tests including:

i. First Article Inspection

ii. all Quality Hold Points; and

iii. all Quality Control Points;

(3) the type and extent of inspection and Factory Acceptance Tests to be undertaken and the parts of the Works to be proven by that testing;

(4) the objective of each inspection or test, what particular design and operating criteria the test or inspection will prove and how the success of the test or inspection will be demonstrated or measured;

(5) organisation chart and CV of key personnel in inspection and test team;

(6) the plan for the production and submission of the inspection and test procedures tothe Engineer for review including the submission of the inspection and test reports and records; and

(7) Type Tests, Routine Tests, First Article Inspections and any other tests constituting

the Factory Acceptance Tests.

~~b)~~ The Contractor shall arrange for all equipment and systems manufactured for incorporation into the Permanent Works to undergo a Factory Acceptance Test (FAT) before shipment from the place of manufacture. Any particular requirements for inspection and testing at the place of manufacture are prescribed in the PS.

c) The Contactor shall be responsible for re-inspecting and re-testing any failed inspection and Factory Acceptance Test including regression testing on previously passed items.

d) Inspections and tests that are to be witnessed by the Employer or the Engineer shall be sensibly grouped and scheduled so that as many inspections and tests as possible may be witnessed during a single visit.

e) If required, Type Tests as detailed in relevant Particular Specifications shall be performed on all items of equipment to be installed as part of the Permanent Works under the Contract. The Type testing shall be based on the environmental class of the sites into which the equipment will be installed.

f) For all production items a First Article Inspection shall be undertaken. Latest drawings, inspection & test procedures, specifications and quality documentation for inspection of equipment shall be submitted for First Article Inspection to the Engineer. Routine production testing methods shall be detailed for review by the Engineer. Routine testing shall ensure that all samples of a production item are within the tolerances required for complete interchangeability.

g) The Contractor shall prepare two copies of an inspection or test report immediately after the completion of each inspection or test whether or not witnessed by the Employer or the Engineer. If the Employer or the Engineer has witnessed the inspection or test, he will countersign the inspection or test report to indicate his review of the information and conclusions (i.e. whether or not the equipment being inspected or tested has passed satisfactorily) contained therein. If the Employer or the Engineer has not witnessed the inspection or test (i.e. if a waiver has been granted, or the Employer or the Engineer has not witnessed the inspection or test for some other reason in accordance with the Contract), the Contractor shall forward two copies of the inspection or test report without delay to the Engineer. The Engineer will countersign the report to indicate his review of the information and conclusions (i.e. whether or not the equipment being inspected or tested has passed satisfactorily) and return one copy to the Contractor. Where the results of the inspection or test do not meet the requirements of the Specification, the Employer or the Engineer may call for a re-inspection or re-test.

h) For standard equipment which is serial or bulk manufactured, manufacturer's type test certificates (or equivalent) may, subject to review by the Engineer be accepted.

i) Test equipment and instrumentation shall be subject to approved calibration tests within a properly controlled calibration scheme, and signed calibration certificates shall be supplied to the Engineer in duplicate. Such calibration checks shall be undertaken prior to testing and if required by the Engineer shall be repeated afterwards.

j) Materials and equipment shall not be released for shipment until all applicable inspections and tests including Factory Acceptance Tests have been satisfactorily completed.

8.5.3 Procurement, Manufacturing and Delivery Plan

a) The Contractor shall prepare a procurement, manufacturing and delivery plans in respect of all items and goods. Separate parts of the plan shall be prepared for Contractor or sub-contractor off-site activities. Each plan shall identify the scope of work to be applied. In relation to such scope of work, it shall, without limitation, define:

(1) the organization of the Contractor's staff directly responsible for the day-to-day management of the manufacturing activity on or off the Site;

(2) the specific allocations of responsibility and authority given to identified personnel for the day-to-day management of the work with particular reference to the supervision, inspection and testing of the work;

(3) the interfacing or co-ordination required with the Contractor's other related plans;

(4) the specific methods of manufacture to identify any relevant method statements and develop those method statements to a degree of sufficient detail reviewed by the Engineer; and

(5) the list of procedures and work instructions to manage and control the quality of work during purchasing, manufacturing and delivery, including without limitation:

i. the purchasing of items and goods and ensuring they comply with the requirements of the Specification, including (without limit) purchasing documentation and specific Verification arrangements for Contractor/Engineer inspection of material or manufactured product prior to release for use;
ii. the manufacturing process so as to ensure compliance with the design;
iii. the manufacturing process so as to ensure clear identification and traceability of material and manufactured parts;
iv. the inspection and testing of incoming materials, in process and final product so as to ensure specified requirements for the material and/or manufactured product are met;
v. the identification of the inspection and test status of all material and manufactured products during all stages of the manufacturing process to ensure that only products that have passed the required inspections and tests are dispatched for use and/or installation;
vi. review and disposal of non-conforming material or product so as to avoid unintended use;
vii. the assessment and disposal of non-conforming material and manufactured product and approval for reworking or rejection as scrap;
viii. the identification of preventive action so as to prevent recurrence of similar non-conformance; and
ix. the handling, storage, packaging, preservation and delivery of manufactured product.

b) The Contractor shall prepare and submit the inspection and testing plans to manage and control any test and inspection activities ;

c) The Contractor shall propose a structured set of inspection hold points. The hold points shall be structured such that a formal hold point is allowed for each significant element of the manufacturing process. At each hold point, the Engineer shall hold a formal inspection or advise that the inspection had been waived.

d) Once the inspection and any required remedial actions are completed to the satisfaction of the Engineer, the Engineer shall not withhold his notice of no objection for shipping unreasonably, provided all pre-delivery assembly and testing has been successfully completed.

e) Any unit delivered without the Engineer notice of no objection shall be rejected at the Site and all expenses thereby shall be borne by the Contractor.

8.6 Construction and Installation Management Plan

The Construction and Installation Management Plan shall be configured as a family of "stand-alone" plans and associated documents each covering one of the subjects listed below.

The plans shall be co-ordinated with each other and shall collectively define, describe andencompass the Contractor's proposed methods, procedures, processes, organization, sequencing of activities, etc and shall show how these combine together to ensure that theworks truly meet the requirements of the Specification in respect of the subjects listed

8.6.1 Construction and Installation Plan

a) The Contractor shall prepare plans for the construction and installation activities on and off the site and shall ensure that these are properly related to the subsequent testing and commissioning activity.

b) Separate parts of the plan shall be prepared for other contractor(s) or sub-contractor(s) off-site activities.

c) Each construction plan shall identify the scope of activity to be controlled. In relation to scope of such activity, it shall, without limitation, define:

(1) the organisation of Contractor's staff directly responsible for the day to day management of the activity on or off the site;

(2) the specific allocations of responsibility and authority given to identified personnel for the day to day management of the works with particular reference to the supervision, inspection and testing of works;

(3) the interfacing or co-ordination required with the Contractor's other related plans;

(4) the specific methods of construction and installation to identify any relevant method statements to a sufficient degree of detail reviewed by the Engineer;

(5) a detailed method statement which shall include but not be limited to;

i. description of main operations and sub-operations;
ii. sequence of sub-operations;
iii. quantities of the work and production rates to be achieved;

iv. resources to be employed; and

v. quality checks to be carried out, supervision being exercised and safety precautions to be employed;

(6) the list of procedures and work instructions to manage and control the quality of construction and installation works, including without limitation:

i. the inspection and testing activities of incoming materials, in process and final product so as to ensure specified requirements for the material and/or product are met;

ii. the purchasing of materials and ensuring they comply with the requirement of the specification, including purchasing documentation and specific Verification arrangements for Contractor/Engineer inspection of material or manufactured product prior to release for use/installation;

iii. the construction processes including Temporary Works so as to ensure compliance with drawings and specification. In addition, any software to be used in construction, installation and commissioning process shall be identified and details of the Verification and validation processes for the software application shall be given;

iv. the construction and installation process so as to ensure clear identification and traceability of material and manufactured product;

v. the identification of the inspection and test status of all material and manufactured product during all stages of the construction and installation process to ensure that only products that have passed the inspections and tests are dispatched for use and/or installation;

vi. review and disposition of non-conforming material or product so as to avoid unintended use/installation;

vii. the assessment and disposition of non-conforming material and product and approval of reworking or rejection as scrap;

viii. the identification of preventive action so as to prevent recurrence of similar non- conformance; and

ix. The handling, storage, packaging, preservation and delivery of product; and

d) The Contractor shall prepare and submit inspection and test plans to manage and control any test and inspection activities.

e) The following particulars shall be submitted to the Engineer for review within 28 days of the Commencement Date of the Works;

(1) drawings showing the layout within the Site of the Contractor's accommodation, project signboards, access roads and major facilities required early in the Contract;

(2) drawings showing the details to be included on Project signboards.

f) Drawings showing the location of stores, storage areas, work areas and other major facilities shall be submitted to the Engineer for review as early as possible, but in any case, not later 28 days before construction of the facilities.

8.6.2 Environment, Social, Health and Safety (ESHS) Plan

ESHS plan shall be submitted by the Contractor in accordance with ESHS manual

given in Appendix 13 for the Engineer's review within 28 days of issue of Letter of Acceptance.

8.6.3 Completion Management Plan

General

a) The Contractor shall organise the services required under the Contract to bring the Works into service under one plan. This co-ordinated approach shall allow the Engineer to review all aspects of completion in an integrated manner.

b) The Completion Management Plan shall be configured as an integrated plan with associated documents, covering the subjects described herein.

c) The plans shall be co-ordinated with each other and shall collectively define, describe and encompass the Contractor's proposed methods, procedures, processes, organisation, sequencing of activities and the like, and shall show how these combine together to assure that the Works truly meet the requirements of the Contract with respect to the matters listed herein after.

8.6.4 Commissioning Plan

a) The Contractor shall submit the first draft of the Commissioning Plan to the Engineer within 180 days of the Commencement Date of the Works.

b) The Commissioning Plan shall consist of the following for all Signalling & Telecommunication work:

(1) Installation Tests Schedule

The Contractor shall submit to the Engineer a comprehensive schedule of the installation tests as required by relevant Particular Specifications and in accordance with the Installation Programme. The schedule shall be submitted within the period of time laid down in the Particular Specifications , or, if none is given, not later than 56 days in advance of the date for the commencement of the Installation Tests. Pre-Installation Inspection shall include the verification of FAT/Quality test report, Invoice, OEM manuals etc. Post installation test shall include the installation of equipment as per approved drawing, Particular specification etc. Power supply test shall be the part of Post-installation test.

(2) System Acceptance Tests Plan

The Contractor shall submit to the Engineer, a comprehensive System Acceptance Tests Plan including all requirements detailed in the relevant Particular Specification(S&T). The plan shall be submitted within the period of time laid down in the Particular Specification(S&T) or, if none is given, not later than 112 days in advance of the date for the commencement of the System Acceptance Tests. System Acceptance test shall include the functional test of all equipment from the SM panel.

(3) Integrated Testing & Commissioning Plan

The Contractor shall submit to the Engineer a comprehensive Integrated Testing and Commissioning Plan including all requirements detailed in Particular Specifications . The plan shall be submitted within the period of time laid down in

Particular Specifications , or, if none is given not later than 112 days in advance of the date for the commencement of Integrated Testing and Commissioning. This test shall include the test of equipment from the IMD/ control centre of the project.

8.6.5 Operation and Maintenance Manuals Plan

a) The Contractor shall develop an Operation and Maintenance Manuals Plan to suit staged commissioning of the system and to ensure timely preparation of the Operation and Maintenance Manuals and the "As-Built" Documents in a format and to a level of detail reviewed without objection by the Engineer.

b) The Contractor shall submit the Operation and Maintenance Manuals Plan not later than 45 days prior to the issue of the Taking Over certificate for the works and according to the staged commissioning, if applicable, of the proposed systems.

8.6.6 Training Plan

a) The Contractor shall ensure the timely preparation of the Contractor's Training Plan in a format and to a level of detail reviewed without objection by the Engineer and fulfilling the requirements.

b) The Contractor shall submit the Training Plan by the date stated in the Particular Specifications , or, if none is given, not less than 84 days prior to the start of installation activities for the works.

8.6.7 Spares Management Plan

a) The Contractor shall submit for review by the Engineer a Spares Management Plan to furnish a priced manufacturer-recommended list of spare parts, necessary to support continuous operation of all such equipment for a minimum period of 24 months after the commencement of revenue operations.

b) The Contractor shall submit the Spares Management Plan not less than 182 days prior to the issue of the Taking Over Certificate for the Works.

8.6.8 Defects Management Plan

The Contractor shall submit for review by the Engineer a Defects Management Plan to repair, replace and perform any remedial item upon the Works identified by the Engineer during Defects Notification Period (DNP). The first submission of this plan is required not less than 365 days prior to the issue of the Taking Over Certificate for the Works. The Contractor shall;

a) endeavour to complete all necessary work in a timely responsible manner;
b) not proceed with any remedial work without the consent of the Engineer;
c) submit a plan that details the method and timing of any proposed work; and
d) update the plan monthly, showing progress of the work and time to completion.

APPENDIX 9

DOCUMENTS, DRAWING AND CAD STANDARDS

9. General

A document may consist of document cover, revision history, table of contents, text and attachment(s) in this sequence where applicable.

1) Cover format (Times New Roman)
2) Heading and name of client shall be on top, in capital, size 10.
3) Name of the project in bold letters, size 22.
4) Content of document in bold capitals, size 16.
5) Document reference number in bold capitals, size 12.
6) Company name: capitals, size 14.
7) Company logo in size 35 x 40 (W x H) mm.
8) Address of the company in regular letters, size 10.
9) Document Format (Time New Roman)
10) General Regulations
11) Letter size: 12.
12) Paper size A4 (A3 is used for table and figures).
13) Periods and semicolons shall be placed right after the preceding letter or number.
14) The space between paragraphs and headings shall be 1.15 lines.
15) Main headings shall be placed in number order, with a period placed right after the number, followed by a space, with a heading text in bold capital letters. For example.:

9.1 IN BOLD CAPITAL

Other headings are placed in number order, with a period placed right after the number, followed by a space, with a heading in regular letters. For ex.:

a) In normal letter.
b) Notes

Notes relating to tables shall be included in the table; in case they are not able to be included, it shall be clearly specified that they are notes relating to a particular table reference.

The text of notes is usually given in italics.

9.2 Language of Communication and Units

The language for communications shall be the English language. The Contractor shall utilize the SI system of measurement units.

9.3 Photographs

The Contractor shall take digital photographs of the Works at least on monthly basis and include them in the Contractor's Monthly Progress Reports. These photographs shall be taken at locations agreed with the Engineer as appropriate to record progress, quality and

other relevant aspects of the Works. The number of the photographs shall be sufficient to cover all aspects of the Works in progress.

The digital photograph shall be colour jpeg image format with standard aspect ratio 4:3 and resolution of 300 DPI for all graphics in the printing. Read Only Memory (ROM) based electronic media of digital photographs shall be included as an integral part of the submittal. The locations and directions of the photographs taken shall be marked on a key plan of the Site, to be included in the submittal.

Each photograph shall be properly numbered and dated and include a brief explanatory note of the subject matter of the photograph, for ease of understanding.

Immediately before the issue of any Taking-Over Certificates for Works or Sections, the Contractor shall commission a professional photographer (or any person with equivalent skills) and take photographs of (where applicable, the interior to be taken by wide angle lenses) of exterior and all salient sections and features of the Works, for record purposes. The Contractor shall submit to the Engineer for approval as an integral part of the As-Built Documents, four (4) separately bound sets of colour prints of such record photographs, including one (1) set of Read Only Memory (ROM)-based electronic media containing an original jpeg image file of each photograph in accordance with the directory and naming convention agreed with the Engineer. The number of colour print images in a set shall not exceed 100, and each hard copy set of photographs shall be of A4 size with a cover page indicating information such as date, titles of the project and the Contract, and name of the Employer and the Contractor. Each of the photographs shall be properly numbered, dated and include a brief explanatory note of the subject matter.

9.4 Videos

On a monthly basis, or earlier if directed by the Engineer, the Contractor shall take digital video records to record the progress of the Works on Site (minimum duration of each to be ten minutes, covering all the areas of the Site where works are ongoing) as agreed with the Engineer, and submit the videos every month along with the Monthly Progress Report. The first video shall be made before the Commencement of the Works on the Site.

Within twenty-eight (28) days of receipt of the Letter of Acceptance, but in no case later than the Commencement Date, the Contractor shall submit to the Engineer a proposal for the provision of digital video recordings along with commentary of the progress of the Works.

The videos shall be taken by a competent person from an approved professional service provider (or any person with equivalent skills). The video shooting locations are to be identified in the afore mentioned proposal. This video should be submitted in a video format acceptable to the Engineer, with or without editing.

Immediately before the issue of the Taking-Over Certificate for the whole of the Works, the Contractor shall complete video recording and start editing the videos taken, to produce a 60- minute digital video-audio presentation with a suitable title. Each section of the video shall indicate the date on which it was taken. The presentation material shall have narration in English. The Contractor shall use a professional service provider to video, edit and produce the presentation material.

9.5 DRAWING AND CAD STANDARDS

a) The purpose of this document is to define the minimum Drafting and CAD standard to be achieved by the Contractor for all drawings produced by the Contractor for the purpose of the works.

b) By defining a common format for the presentation of drawings and CAD files, the exchange of drawn information is improved and will maximize the use of CAD in the coordination process.

c) All submissions shall be made in accordance with the Employer's Requirements in a format reviewed without objection and in accordance with the requirements in :

i. The Contract;

ii. The Document submittal instructions to Consultants and Contractors.

d) Paper and drawing sizes shall be "A" series sheets as specified in BS3429.

e) The following software (latest and updated version) compatible with Intel-Windows based computers shall be used, unless otherwise stated, for the various required electronic submissions.

Document Type	**Electronic Document Format**
Text Documents	**MS Word**
Spread Sheets	**MS Excel**
Data Base Files	**MS Access**
Presentation Files	**MS PowerPoint**
Programmes	**Primavera for Windows, Suretrack**
AutoCAD Graphics	**AutoCAD**
Photographic	**Adobe Photoshop**
Desktop Publishing	**Page Make 6.5,5**
CADD Drawings	**AutoCAD**

f) Media for Electronic File Submission - Email

One copy shall be submitted unless otherwise stated in CD-ROM

g) Internet File Formats/Standards

The following guidelines shall be followed when the Contractor uses the Internet browser as the communication media to share information with the Employer.

a) All the data formats or standards must be supported by Microsoft Internet Explorer (latest version) running on windows professional (latest version).

b) The following list shows the file types and the corresponding data formats to be used on Internet. The Contractor shall comply with them unless prior consent is obtained for a different Data format from the Employer's Requirements:

File Type	Data Format
Photo Image	Joint Photographic Experts Group (JPEG)
Image other than Photo	GIF to JPEG
Computer Aid Design files (CAD)	Computer Graphics Metafile (CGM)
Video	Window video (.avi)
Sound	Wave file (.wav)

h) The following states the standards to be used on Internet when connecting to database(s). The Contractor shall comply with them unless prior consent is obtained for a different standard from the Employer's Requirements

Function to be Implemented	Standard to be Complied With
Database connectivity	Open Database Connectivity (ODBC)
Publishing hypertext language on the World Wide Web	Hypertext Markup Language (HTML)

The hard copy of all documents shall be the contractual copy.

1) GENERAL REQUIREMENTS

General:

i) The Contractor shall adopt a title block similar to that used in the Drawings for all drawings prepared under the Contract.

ii) Each drawing shall be uniquely referenced by a drawing number and shall define both the current status and revision of the drawing.

iii) The current status of each drawing shall be clearly defined by the use of a single letter code as follows:

P - Preliminary Design Drawing

D - Definitive Design Drawing

C - Construction Reference Drawing

W - Working Drawing

B - As-Built Drawing

M - As Manufactured Drawing

E - Employer's Drawing

Types of drawings:

i) 'Design drawings' mean all drawings except shop drawings and as-built drawings.

ii) 'Working drawings' are design drawings of sufficient detail to fully describe the Works and adequate to use for construction or installation.

iii) 'Site drawings and sketches' are drawings, often in sketch form, prepared on site to describe modifications of the Working drawings, where site conditions warrant changes that do not invalidate the design.

iv) 'Shop drawings' are special drawings prepared by the manufacturer or fabricator of various items within the Works to facilitate manufacture or fabrication.

v) 'As-built drawings' show the Works exactly as constructed or installed. They are usually prepared by amending the working drawings to take into account changes necessitated by site conditions and described in Site drawings. These drawings shall be completed on a regular basis as the works progress, and shall not be left until completion of the entire works.

2) COMPUTER AIDED DESIGN STANDARDS

a) Introduction
Scope of Use

Data input procedures between the Engineer and contractors must be co- ordinated, and the key parameters used to form CAD data files must be standardized. The production of all CAD data files shall comply with the following requirements.

b) Objectives

The main objectives of the CAD standards are as follows:

i. To ensure that the CAD data files produced for Project are co-ordinated and referenced in a consistent manner.

ii. To provide the information and procedures necessary for a CAD user from one discipline or external organization to access (and use as background reference), information from a CAD data file prepared by another discipline or external organization.

iii. To standardize the information contained within CAD data files which may be common to more than one discipline such as drawing borders, title boxes, grid lines etc.

iv. To establish procedures necessary for the management of CAD data files.

v. To ensure all contractors use 'Model space' and "Paper space' in the production of their CAD files.

c) General

i. To facilitate co-ordination between contractors, it is a requirement that all drawings issued by contractors for co-ordination or record purposes shall be produced using CAD methods. Drawings shall be issued in digital format in addition to the paper copies.

ii. The intent of the issue of digital information is to aid the related design by others. The definitive version of all drawings shall always be the paper orpolyester film copies which have been issued by the contractor or organization originating the drawing.

iii. (Drawings and drawing packages issued for co-ordination, record purposes or for acceptance shall be accompanied by a complete set of the corresponding CAD data files.

iv. Any contractor or organization making use of the CAD data from others shall be responsible for satisfying himself that such data is producing an accurate representation of the information on the corresponding paper drawing which is satisfactory for the purpose for which he is using it. Provided the general principles of this section have been achieved by the originator of the CAD data, contractors making use of the CAD data from others shall not be entitled to require alterations in the manner in which such CAD data is being presented to them.

v. In particular, automatic determination of physical dimensions from the data file shall always be verified against the figured dimensions on the paper or polyester drawings. Figured dimensions shall be taken as correct where discrepancies occur.

vi. The purpose is to ensure that total co-ordination is achieved between the CAD 'Model Space" file and the "Paper Drawing" output during the revision cycle of the design and production process. Duplicated data in "Model and Paper Space" file will not be acceptable unless an automatic update link exists between the two data sets. "Paper Space" files are not typically required as part of the CAD Media Receipt from contractors, unless specifically requested.

d) CAD Quality Control Check

(i) Random CAD Quality Control Audits will be carried out by Engineer on all CAD media received and transmitted.

(ii) These checks DO NOT verify the technical content of the CAD data received or transmitted (as this is the responsibility of the originating organization), however compliance with Project CAD and Draughting Standards shall be checked.

(iii) In addition, all contractors who transmit and receive CAD data from the Project shall have CAD quality control procedures in place. A typical control procedure shall contain CAD data quality checking routines coupled with standards for CAD data transmittal and archiving.

e) CAD Data Transfer Media and Format

i. Data exchange format between the Engineer and the Contractor, shall be as follows:

Documents including design sheets, tables and figures: Word (*.docx), Excel (*.xlsx) and PDF (*.pdf).

Drawings: Autodesk's AutoCad 2016 or higher release. Electronic

Data Transfer Media: Pen Drive/Hard disk.

ii. All documents/drawings shall be labelled on the data shield with: Name of Company/ Consultant

Project Tile Document/Drawing

Filenames

iii. The Contractor shall ensure the supplied media is free from virus.

f) CAD Media Receipt & Transmittal

i. CAD Media Transmittal (from the Contractor to Engineer) – this will consist of the following:

a) CAD Digital Media (disk(s), CD's or tape(s)) shall typically contain CAD "Model Space" and "Paper Space" files.

b) CAD data sheet

c) CAD issue/revision sheet

d) CAD quality Checklist confirming compliance

e) Plot of each "Model Space" file issued on an A1 drawing sheet (to best fit).

ii. The above CAD media will be collectively known as "CAD Media Transmittal Set". The CAD data file transmittal format required by Employer' Representative from all contractors shall be in AutoCAD (version 14)

iii. All CAD media received from contractors will be retained by Engineer except for SCSI disk (if used) as an audit trial/archive of a specific contractor's design evolution.

iv. CAD Media Receipt (from Engineer to the Contractor)

a. CAD Media should normally be obtained from the respective interfacing contractor(s), but should Engineer issue CAD media it will consist of the following:

a) CAD Digital Media (disk(s) or tape(s) typically contain only CAD "Model Space" files.

b) CAD data sheet

c) CAD issue/revision sheet

b) The above CAD media will be collectively known as the "CAD Media Receipt Set". The CAD data file transmittal format used by Engineer to all contractors will be in AutoCAD (version 14).

c) Each CAD transmittal disk/tape will be labelled with proper disk label as approved by the Engineer. Any CAD data transmitted without this label is assumed to be provisional information not to have been quality checked and therefore not formally issued.

a) Revisions

i. All "Revisions", 'In Abeyance' and 'Deletions' shall be located on a common layer. This layer can be turned on or off for plotting purposes.

ii. The following example text indicates the current CAD file revision, i.e., "Revision [A]". This shall be allocated to a defined layer on all CAD "Model Space" files, in text of a size that will be readable when the CAD "Model Space" file is fitted to the screen, with all levels on.

iii. Libraries, Blocks, & Block Names

a. All Construction Industry symbols produced as CAD Cells shall typically conform to British Standard BS1192 – part 3.

b. All Blocks created shall be Primitive (i.e., Not Complex) and shall be placed Absolute (i.e. NOT Relative).

c. The Contractor's specific block libraries shall be transmitted to Engineer together with an associated block library list containing the filename (max. 6 characters) and block description. The contractor shall ensure that the library is regularly updated and circulated to all other users, together with the associated library listing.

d. All Blocks of a common type, symbols or details should initially be created within a CAD "Model Space File" specifically utilized for that purpose. These files will be made available on request by Engineer.

e. All Blocks created will typically be 2D unless 3D is specifically requested. In both instances they shall have an origin at a logical point located within the extents of each Block's masked area or volume.

b) CAD Dimensioning

Automatic CAD Dimensioning will be used at all times. Any dimensional change must involve the necessary revision to the model space file. If the CAD Quality Control Checks find that the revisions have not been correctly carried out, the rejection of the entire CAD submission will result.

c) CAD Layering

All CAD elements shall be placed on the layers allocated for each different discipline. The layer naming convention to be adopted by the Contractor shall be submitted for acceptance and inclusion within these standards.

d) Global origin, Location & Orientation on the Alignment Drawing.

Location or Plan information in "Model Space" files shall coincide with the correct location and orientation on the Project grid for each specific contract.

Location plans shall have at least three setting out points shown on each CAD "Model Space" file. Each setting out point shall be indicated by a simple cross-hair together with related Eastings and Northings co-ordinates. The Civil Contractor(s) will establish the three setting out co-ordinates for their respective works, which will then be used by all other contractors including the Contractor.

e) Line Thickness and Colour

To assist plotting by other users, the following colour codes will be assigned to the following line thickness/pen sizes.

Colour	**Code No**	**Line Thickness**
Red	10	0.18
White	7	0.25
Yellow	2	0.35
Brown	34	0.5

Blue	130	0.7
Orange	30	1.0
Green	3	1.4
Grey	253	2.0

f) CAD Utilization of 2D & 3D Files

Although the project standard is 2D CAD files, certain disciplines and contractors may use 3D CAD files for specific applications or where the isolated use of 3D aids the design and visualization process (i.e. Architecture, Survey and Utilities). In these specific instances 3D CAD data will only be transmitted if all other users can use this data. If this is not the case, a 3D to 2D translation shall be processed by the creator prior to issue.

g) CAD File Numbering

Contractors CAD File Numbering shall be described in 5.2.1 above. Employer CAD File Numbering Unlike most of the contractors, Employer will not be required to produced numerous CAD files. This will follow the numbering system Except that the status of the drawing in 5.2.1 (E) shall be "E".

h) CAD File Naming Convention – General
CAD "Model Space" files shall be named in accordance with general drawing conventions

APPENDIX- 10

CONSTRUCTION & SITE MANAGEMENT

10. THE SITE

10.1 Location and Boundaries

10.1.1 Works Areas are those areas identified in *Appendix 3* to these Employer's Requirements and on the Drawings.

10.1.2 Within 28 days from Commencement Date, the contractor shall submit detailed and comprehensive Site Environmental, Social, Health and Safety plan (Appendix-13 of Employer's Requirements) based on Environmental, Social, Health and Safety (ESHS) manual.

10.1.3 Within 28 days of the date commencement, the contractor shall submit detailed Quality Plan (Appendix-11 of Employer's Requirements) demonstrating the proposed method of achieving the required quality standards of the Employer as defined in the Employer's Requirements.

10.1.4 Normal working hours at site will be as stated in the Contract Data. However, the Contractor, if required, shall carry out work during night hours or in shifts with the approval of the Engineer. No increase in rates or extra payments shall be admissible for night work.

10.2 ACCESS TO THE SITE

10.2.1 The Contractor shall be deemed to have inspected, examined and made himself fully familiar with the access routes necessary for the proper execution of the Works and accounted for in the Accepted Contract Amount any costs arising in connection with the accessibility to the ROW. The Employer will not be responsible for any claims which may arise from the use of or otherwise in connection with any access route. The Employer does not guarantee the suitability or availability of any particular access route and will not entertain any claim for any non- suitability or non-availability of any such route for use (whether continuous or otherwise) during the Contract Period.

10.2.2 *The Contractor shall make its own arrangements for access required to the Site*. The Contractor shall negotiate with the landowners or other appropriate government agencies to seek temporary occupation of land and seeking necessary permission for construction of temporary access roads.

10.3 CONTRACTOR OPERATIONS OUTSIDE THE SITE

10.3.1 The Contractor shall be solely responsible for acquiring any additional land (land in addition tothe Site) required by him for his Temporary Works areas outside the ROW, at his own expense,including maintaining and reinstating the same on completion of the Works to the entire satisfaction of the land owner and the Engineer.

10.3.2 The Contractor shall make the necessary arrangements with landowners and relevant government authorities for any work to be undertaken outside the Site. Two copies of all the relevant documents/ permissions/ agreements, etc., as required by the Engineer in respect of the land arranged by the Contractor outside the Site, shall be submitted to the Engineer. Before commencing operations, the Contractor shall also submit to the Engineer a detailed plan and a programme of the Works to be carried out in the works area, including areas outside the Site.

10.3.3 When using and/or occupying works areas on existing public roads, the Contractor shall undertake all necessary procedures and mitigation measures as per the requirements set by the relevant authorities.

10.3.4 The Contractor shall submit to the Engineer proposals for the use and occupation of such works areas. Any such proposal shall be submitted to the Engineer at least twenty-eight (28) days prior to the start of the programmed use of the specific works area.

10.3.5 On completion of the Works, the land arranged by the Contractor outside the Site shall be restored back to its original condition to the entire satisfaction of the land owner and the Engineer.

10.4 SITE SECURITY

10.4.1 The Contractor shall be wholly responsible for security on the Site and any other areas being used by him or any Subcontractors for the purposes of the Contract. The Contractor shall implement and cause Subcontractors to implement proper security management procedures in accordance with the approved security management plan described in Appendix 13 (Environmental, Social, Health and Safety Management Manual)

10.4.2 The Contractor shall assign on the Site an appropriate safety and security organisation headed by experienced and professionally qualified safety and security personnel, who shall be primarily responsible for the Contractor's security services and shall fully cooperate with the Employer's security organization throughout the Time for Completion.

10.4.3 The Contractor shall prepare and submit to the Engineer for approval a security management plan (it may be included in the Environment, Social, Health and Safety Management Plan) fully complying with not only the relevant applicable Laws but also the regulations of the Employer which may be imposed from time to time on the Project within twenty-eight (28) days after the Commencement Date or at least one week before commencing the Works on the Site or any other area being used by the Contractor (whichever is the earlier). The plan shall include detailed procedures for daily security management operations as described in Appendix 13 (ESHS Manual) of General Specifications.

10.5 Possession of Third Parties Facilities

10.5.1 The definition of "Possession" to be applied in this Clause is 'possession of a segment or stretch of the Works and/or Indian Railways (IR) track(s) and/or other related authorities required by the Contractor from the Employer and/or IR and/or other related authorities for execution of the Works during the Time for Completion and/or after issue of the Taking- Over Certificate and during the Defects Notification Period for maintenance / rectification of any defects in the Works.

10.5.2 While undertaking construction activities within an existing railway line or road under the Contractor's Possession, the Contractor shall abide by the rules/guidelines included within the relevant manuals of Indian Railways and/or the National Highways Authority of India (NHAI)/Public Works Department (PWD)/ Panchayats/ Municipal Corporations and/or any other authority.

10.5.3 The Contractor shall undertake any construction activities on existing 'live' or operating lines only after the grant of Possession by the relevant authorities.

10.5.4 An area under the Contractor's Possession is the sole responsibility of the Contractor and all issues relating to safe working within that area, including the movement of traffic, are his responsibility.

10.5.5 If the Contractor has more than one work front within the same Possession, one person shall be nominated by the Contractor as the person responsible for the coordination for all work fronts within the Possession.

10.5.6 The Contractor shall ensure that construction activities shall be undertaken strictly within the area which is under the Contractor's Possession.

10.5.7 The Contractor shall appoint a responsible person who shall coordinate with the Employer, IR/ relevant authorities, Interfacing Contractors and Interfacing Parties as applicable and who shall act as the Possession Coordinator for the Contractor. The person appointed shall have experience of IR/ relevant authorities operations and shall be fully aware of IR Rules and Regulations related to possession of track for construction of railway works and in accordance with IR/ relevant authorities regulations to issue Possession requests. For the purposes of the Works, such person shall be duly certified in accordance with the said Rules and Regulations, if required.

10.5.8 The Contractor shall use Possessions on the line as follows:

10.5.9 For each particular Possession and depending on the duration and the location of the Possession, alternative route(s) may be required, such alternative diversion route(s) if required to be constructed, shall be at the Contractor's cost.

10.5.10 The normal alternative mode of transport will be proposed by the Contractor, and the route and timings of this alternative transport are to be agreed with the Engineer / IR / Road Authorities / Panchayat prior to obtaining Possessions.

10.5.11 The Employer shall provide assistance necessary to the Contractor to enable him to obtain the Possessions required by him, subject to being approved by IR, NHAI or relevant authorities. No claim shall be entertained by the Employer on this account.

10.5.12 The Contractor's request for Possession shall include a technical and organizational schedule and submit the same to the Engineer for his consent.

10.5.13 The Contractor shall submit his requests for Possessions well in advance as per requirements of relevant authorities.

10.6 Damage and Interference

10.6.1 General

Work shall be carried out in such a manner that there is no damage to or interference with:

a) watercourses and drainage system,

b) Utilities,

c) Structures (including foundations), roads including street fixtures or other properties;

d) Public or private vehicular or pedestrian access, and

e) Monuments, graves or burial grounds other than to the extent that it is necessary for themto be removed and reinstated to permit the execution of the Works.

10.6.2 Heritage structures shall not be damaged or disfigured on any account. The Contractor shall inform the Engineer as soon as practicable of any items which are not stated in the Contract to be removed or diverted but which the Contractor considers necessary to be removed or diverted to enable the Works to be carried out. Such items shall not be removed or diverted until the approval of the Engineer has been obtained.

10.6.3 Assets/ items of the Employer, Indian Railway (IR), Other Contractors and any other entities and relevant authorities which include, but are not limited to, water, sewage, gas authority, electrical, OFC communication cables etc. carried out shall be replaced /

reinstated by the Contractor to the same condition as existed before the Works started and to the satisfaction of the Engineer and the concerned entity.

10.6.4 In case of damage to the existing cables, the Contractor shall have suitable procedure for cable joining under the technical supervision of IR or the relevant authority.

10.6.5 The Contractor shall indemnify the Engineer, Employer, Indian Railway, Other Contractors and relevant authorities against any damages or any penal action, any claim or legal action as a result of the damages.

10.7 Utilities

The Contractor shall follow the requirements on care for utilities as specified in this Appendix below.

10.8 Structures, Roads and Other Properties

10.8.1 The Contractor shall carry out a precondition survey of all roads and structures and drainage channels adjacent to the Site. Contractor originated deterioration of the roads and damage to adjacent structures and drainage facilities shall be reported to the Engineer with appropriate records.

10.8.2 The Contractor shall maintain / replace / reinstate to the same condition as existed before the Works started and to the satisfaction of the Engineer and the concerned entity.

10.9 Access

10.9.1 Where existing access to premises either public or private is damaged or unusable, alternative access shall be provided by the Contractor to enable the Works to proceed. The arrangements for the alternative access shall be as agreed by the Engineer, the relevant authorities and the owners of the premises affected.

10.9.2 Unless agreed otherwise, the permanent access shall be reinstated as soon as practicable after the Works are complete and the alternative access shall be removed immediately when it is no longer required, and the ground surfaces reinstated. Proper signage and guidance shall be provided for traffic/ users diversions.

10.10 Trees

10.10.1 Materials, including excavated materials, shall not be banked around trees. Trees shall always be protected from damages.

10.10.2 Unless otherwise consented to by the Engineer, trees shall not be trimmed or cut as stated in Appendix 13 [ESHS Manual]

10.11 Removal of monuments, graves, burial grounds and other obstruction

If any graves and other obstructions are required to be removed in order to execute the Works and such removal has not already been arranged, the Contractor shall draw the Engineer's attention to them in good time to make the necessary arrangement for authorization for removal.

10.12 Protection of the Other Adjacent Structures and Works

The Contractor shall take all necessary precautions during the construction to protect structuresor works being carried out by others, adjacent to or within the Site from the effects of vibrations,undermining or any other earth movements or the diversion of water flow, arising from its work

10.13 Defined Area and Train Operation

10.13.1 When the Project under construction has been made available for track and system related installation works, the area will be classified as a Defined Area for train movement. The definedarea shall be controlled by the Lead Contractor (as nominated by Engineer) with regard to access.

10.13.2 All persons whose duties require them to work within a Defined Area must have been required to be examined for safety knowledge and to have been safety inducted. Evidence of safety induction must be exhibited whenever present or working in a defined area. All persons present in defined areas are required to observe safety rules and procedures to be defined by the Contractor and reviewed without objection by the Engineer.

10.13.3 The Contractor shall ensure that the necessary rules and procedures for all persons are published from time to time and communicated to the workers and/or agents and the Interfacing Contractors on the Site. The Contractor shall also ensure that all such rules and procedures are being followed during the course of all works and construction activities at the Site.

10.13.4 When overhead lines are energized, Train Sets/Cars may be moving in the Defined Area. No work shall be undertaken on the tracks when Train Sets/Cars are moving. Procedures for obtaining access to the energized tracks will be detailed in the rules. The Contractor shall make requests for obtaining access to the energized track or in the vicinity of the tracks as per the approved and notified rules and procedures.

10.13.5 After overhead lines are installed, the lines are energized, the Contractor shall comply with the rules / measures against electric shock.

10.14 Site Clearance

The contractor shall clear the Site as required by demolishing all buildings, structures (above and below ground such as brick, concrete, steel, etc.) and removing all rubbish as agreed by the Engineer. *If any payment/compensation is payable to the structures owner, the same shall be paid by the Employer to the structures owner.* The Site shall also be cleared of vegetation, trees, stumps roots, etc. Cutting of trees within ROW wherever required for execution of the Works shall be done by the Contractor. Permission for cutting of trees will be obtained by the Employer. Compensatory plantation is not included in the Scope of the Works. All material so cleared from the site shall be disposed off by the Contractor outside the ROW as directed by the Engineer. *The list of structures to be demolished is given in Section VII:8-Tender Drawings and Documents, Part-2 Employer's Requirements*

10.15 MOBILIZATION AND DEMOBILIZATION

10.15.1 General

a) The Contractor shall mobilize to the Site the Contractor's Equipment and the Contractor's Personnel as appropriate for the execution and completion of the Works in strict accordance with the requirements of the Contract.

b) The Contractor shall demobilize Contractor's Equipment and Contractor's Personnel from the Site as appropriate when they are no longer required to be on the Site.

10.15.2 Engineer's Consents

a) The Contractor shall inform the Engineer regarding mobilization of Contractor's Equipment, including that required for use by any Subcontractor, at least seven (7) days before the date planned for the mobilization of same to the Site. The Contractor should note that:

i. the Contractor shall be solely responsible for the consequence of any such mobilization;

ii. the relevant insurances shall be in place as evidenced by insurance documents included in the application;

b) The Contractor's Equipment shall be mobilized to the Site complete with all necessary spare parts, consumables and the like indispensable for proper operation and maintenance thereof. The Contractor shall provide maintenance facility complete with qualified maintenance personnel on or in the vicinity of the Site.

c) The Contractor shall obtain a written consent from the Engineer before removing any of the Contractor's Equipment from the Site or any managerial person among the Contractor's Personnel mobilized exclusively for the Contract. Provided that the proposed demobilization is in accordance with the Contractual Works Programme to which the Engineer has given consent and that the Contractor shall be solely responsible for any consequences of such demobilization, the Engineer shall not unreasonably withhold consent.

d) Although they are deemed intended for exclusive use on the Works as set forth in Sub-Clause4.17 of the General Conditions of the Contract, the Contractor may divert any of the Contractor's Equipment to other uses within the Site, provided that the Contractor's written undertaking to return the same to the Works whenever needed is submitted to the Engineer and the Engineer's written consent to such diversion is granted.

10.16 Records

In addition to the Monthly Progress Reports described in Appendix 7 of the Employer's Requirements, the Contractor shall submit to the Engineer, on a daily basis, details of the mobilization and demobilization of any of the Contractor's Equipment or any managerial person among the Contractor's Personnel.

Without undue delay after demobilization from the Site, the Contractor shall submit to the Engineer copies of certified evidence of lawful re-export from the Country of any Contractor's Equipment imported into the Country on a temporary basis exclusively for use on the Contract.

10.17 Mobilization

10.17.1 The Contractor shall mobilize to the Site the Contractor's Equipment and the Contractor's Personnel as appropriate for the execution of the design, construction and completion of the Works. An Initial Mobilization Plan for the 3 months following the Commencement

Date shall be submitted to the Engineer within 7 days after the Letter of Acceptance has been received by the Contractor. An overall Mobilization Plan for the Works shall be submitted to the Engineer for his approval within 90 days after the Commencement Date.

10.17.2 In the event that manufacturing activities are to be carried out outside the Republic of India, the Contractor shall submit detailed organizational structure(s) for such manufacturing teams. This submission shall include the organization of such teams and details of the key personnel, including contact address, i.e., the addresses of the locations where such manufacturing activities are carried out and the e-mail address of each key personnel.

10.17.3 The Mobilization Plan shall include, but not be limited to the following:

a) Details of each major item of Contractor's Equipment, i.e., the name, size and capacity etc. of each item.

b) The number of each equipment and the time of mobilization and duration of the use of each equipment.

c) The name and details of key personnel for each section of the Works and their responsibilities.

d) Details and time for installation of temporary facilities for the Works including temporary facilities for the Employer and the Engineer.

e) The numbers of Contractor's Personnel, including site engineers, administrative staff and labour in each trade category.

10.18 Demobilization

Demobilization shall be carried out in accordance with the provision of Sub-Clause 4.22 [Contractor's Operation on Site], and Sub-Clause 11.11 [Clearance of Site] of General Conditions. Upon receiving the Performance Certificate under Sub-Clause 11.9 [Performance Certificate], the Contractor shall carry out the Clearance of the Site and the Contractor shall inform in writing to the Employer the completion of Demobilization or Clearance of Site and obtain the consent of the Employer. In case the Clearance of Site has not been completed in a specified period by the Contractor, the Employer may carry out the Clearance of Site. The Employer shall be entitled subject to Sub-Clause 20.2 [Claims for Payment and/or EOT] to payment by the Contractor of the costs reasonably incurred in connection with, or attributable to, such sale or disposal and reinstating and/or cleaning the Site, less an amount equal to the moneys from the sale (if any). In case the Taking-Over is conducted section by section, the Contractor shall inform in writing to the Employer the completion of Demobilization of the section and obtain the consent of the Employer or the Engineer as a representative or on behalf of the Employer.

10.19 SITE ACCOMMODATION FOR THE EMPLOYER/ ENGINEER

10.19.1 One Site Accommodation (total area 250 sqm) for the Engineer's & Employer's Staff including Meeting Room shall be provided.

10.19.2 Offices shall be accessible only from a corridor within the building. The corridor and reception area shall be provided with an external double door. The office will be provided with electronic surveillance system as approved by Engineer.

10.19.3 Materials for the construction shall be new, robust and durable. The building shall be weather proof, vermin proof, well insulated thermally and acoustically. Internal walls shall be soundproof. Electrical power/lighting, shall be provided to each room, including

air-conditioning and heating to maintain the internal temperature within the range of 20 to 24 degrees Celsius at all times.

10.19.4 Internal doors shall be flush, fitted with door closers, mortice locks with keys and lever handles.

10.19.5 External doors shall be a pair of solid core doors, external quality, hung on heavy duty hinges, one leaf fitted with barrel bolts top and bottom and the other leaf fitted with a Yale or similar lock.

10.19.6 Windows, of area not less than 10% of the floor area, shall be provided to all rooms, securely barred, fitted with blinds and having opening sections fitted with locks and mosquito screens.

10.19.7 The building shall be provided with a continuous water supply and drainage to Kitchen, Washroom and Toilets. The Toilets shall be equipped with low level suites and be adequately ventilated through the ceiling.

10.19.8 The Kitchen shall be fitted out with a 2-drainer stainless steel double sink unit, worktop with cupboards under, tiling above the sank and worktop and wall mounted cupboards.

10.19.9 Fire and Safety regulations shall be complied with and fire fighting equipment shall be provided in accordance with the statutory requirements.

10.19.10 The Contractor shall provide, erect, and maintain appropriate name boards as specified, for each of the offices. The working shall be agreed with the Engineer.

10.19.11 The Contractors shall provide the following new furniture and equipment for the exclusive use of the Engineer's Staff:

No.	Item	Nos
	Furniture	
1	Sofa set	2
2	Desk with side drawers.	10
3	Swivel Office Chair with arm rests	8
4	Swivel Office chair without arm rests.	10
5	Typist Chair	12
6	Visitor's Chair	1
7	3-Shelf Bookcase	2
8	4-Drawer Lockable Filing Cabinet	5
9	Lockable Cupboard 2m high, with shelves.	10
10	Table	3
11	Book shelf 2000x850x350mm (5 shelves)	5
12	White Board 2000x1000mm	4
13	TV set LED Screen	1
14	Projector Screen for Meeting Room (72"x72")	1
15	Wall Clock	2

16	Coffee Machine	1
17	Cupboard Table height	1
18	Printer cum scanner cum Photocopier A4/A3 capable of reduction	2
19	Wifi internet connectivity with 100mbps	1 set
20	Paper shredder	1
21	Desk Tray sets	2
22	Desk mounted pencil sharpeners	4
23	4-hole paper punches	4
24	Wastepaper baskets	2
25	Refrigerator 400 litres	1
26	Potable Water-cooler cum dispenser	1
27	Microwave oven (700W)	1
28	Cups, glasses, plates, cutlery for 12 persons,	2 sets
29	Electric kettle, coffee and tea pots	As required
30	Office consumables for the duration of site activities	As required
31	Front Door Mat	As required
32	Flashlight	1
33	Locker with Key (900x300x500)	For 10 Persons

10.19.12 The Contractor shall provide 04 SUV type vehicles having make not later than 2022 for use of the *Employer's* Staff from the Commencement Date till completion of the Contract. The Contractor shall also bear the expenditure of deploying experienced drivers along with fuel and other incidental expenses associated with the operation of the vehicle. Only experienced drivers shall be deployed.

10.19.13 The Contractor shall provide brand new protective clothing and safety equipment for 20 persons for exclusive use of the Engineer's Staff, comprising, as a minimum – Safety Helmets Safety Harness, Steel-toed construction boots (size to be notified), Day-Glo waistcoat, industrial safety goggles, Ear protectors.

10.19.14 The Contractor shall provide an adjacent shaded parking area for 5 cars.

The Contractor shall arrange for upkeep, service and security of the offices and compound. The office area shall be thoroughly cleaned and rubbish and waste to be removed, at least once a day as per current rules and regulations.

10.20 SURVEY AND SETTING OUT

10.20.1 General

a) A survey shall be carried out of the Site to establish its precise boundaries and the existing ground levels within it. This survey shall include a drone cum photographic survey sufficient to provide a full record of the state of the Site before commencing the work with particular attention paid to those areas where reinstatement will be carried out later on. The survey shall be carried out before the site clearance wherever possible and in any

case prior to the commencement of work in any Works Area. The survey shall be carried out by the Contractor and agreed with the Engineer. Videography by drone shall also be done at all work places every one month as per Outline Construction Specifications for Civil Works.

b) The Contractor shall plan and programme for the validation of any Site data provided by the Employer and develop a Survey Plan and Programme. The Contractor shall submit a Survey Plan and Programme to the Engineer for consent within 28 days after the Commencement Date. Generally, the contents of the Survey Plan and Programme shall comprise the following:

(1) The Contractor shall *revalidate/derive the elevations of Secondary Control Points (SCPs) and Tertiary Control Points (TCPs) using the Reduced Level (RL) of the Standard Benchmark (Type M) at SDC Quarters, Palwal with MSL value of 195.41 metres. Survey and levelling should be done using Total Station and Digital level. Thereafter,* the Contractor shall establish a horizontal and vertical control system (x, y, z) at the Site which shall be approved by the Engineer. *Final drawings and profiles shall be prepared based on the above Reduced Levels.*.

(2) The Contractor shall carry out validation of the Site data provided by the Employer, and any additional topographic surveys considered necessary by the Contractor, in order to:

i. validate the Horizontal and Vertical Alignment with no change in alignment;

ii. prepare Alignment "Plan and Profile" Drawings; and

iii. review the data with which the Contractor shall eventually draw up the cross-section drawings at required locations.

The Contractor shall summarize the results of their validation of the Site data and any additional surveys carried out in a Survey Report and develop a Site Location Map, and aStructure Setting-Out Map and submit them to the Engineer for consent. Finally, the Contractor shall set out the Works to commence the construction with consistent accuracy and entirely throughout the construction stages.

10.20.2 Horizontal and Vertical Control System

a) A set of the benchmarks comprising a horizontal control system (x, y) and vertical control system (z) shall be established at the Site based on the Temporary Bench Marks which are established and maintained by the Employer *only after revalidation is done as per Sub-Clause 10.20.1 (b) of Appendix 10, Section VII-9: Appendices* and the Global Navigation Satellite System (GNSS) Survey, applying the Universal Transverse Mercator (UTM) coordinate system and World Geodetic System 84 (WGS 84). A description of the various benchmarks along the route alignment has been provided by the Employer along with their height above Mean Sea Level. The Contractor shall ensure that the horizontal and vertical position (x, y. z) of each HORC benchmark shall not be subject to any interference and that they shall not be affected by any of the Permanent and Temporary Works.

b) All pillars shall be of CC in dimensions of 450 mm x 450 mm x 900 mm with a projection of 300 mm above ground . The exposed surfaces of the pillars shall be appropriately painted with enamel paint of a colour as specified by the Engineer so as to be easily identifiable. The foundation shall be as indicated in the Reference Information/Reports. Details shall be developed by the Contractor and be submitted to the Engineer for review.

Each pillar shall be protected by retractable fencing or other similar measures so as to prevent the occurrence of any movement, disturbance, interference and/or damage.

c) The Contractor shall establish additional benchmarks (x, y, z) which shall be staked and identified, and clearly painted in a different colour from the HORC benchmarks as approved by the Engineer. These temporary benchmarks shall be used for running a closed traverse for checking the HORC benchmarks. The pillars for additional benchmarks shall be staked at an interval of 500 m on both sides of the alignment at ROW and at abutment locations of major RUB.

d) The Contractor shall plan and programme to establish a horizontal and vertical control system at the Site by GNSS and correlate and adjust the system based on the benchmarks provided by the Employer or with reference to the existing control points as specified by the Engineer. The Contractor shall develop such plan and programme as part of the Survey Plan and Programme and submit to the Engineer. The Survey Plan shall include, but not be limited to, details of survey methods, error adjustment/correction, accuracy achieved, means to maintain accuracy, and coordination with others with respect to consistent accuracy in entirety.

e) The Contractor shall summarize the Traverse Survey results with verification studies in a HORC Benchmark Establishing Report.

f) Upon establishing the HORC Benchmarks and completing all necessary adjustments, the final and detailed survey data of the HORC Benchmarks shall be submitted to the Engineer for consent. Upon receipt of the Engineer's consent to the HORC Benchmark Establishing Report, the system shall be the sole horizontal and vertical control system (x, y, z), with reference pillars provided with coordinates (x, y, z), as described herein and shall be referred to as the HORC Benchmarks which shall be consistently applied to the Works under this Contract. A HORC Benchmark Establishing Report containing Traverse Survey results shall also be included as part of the Survey Report.

g) The HORC Benchmarks shall be periodically checked (at such intervals as consented to by the Engineer) by running closed traverses and closed level works. The Contractor shall submit the results to the Engineer for review. The periodical checks shall include the nearest equivalent benchmarks established by Interfacing Contractor(s), with whom the Contractor shall communicate and coordinate. If any discrepancy deemed to be crucial is found, the Contractor shall carry out appropriate corrective measures under the instruction of the Engineer.

h) The equipment to be used in the survey to establish the horizontal control system shall be Static GNSS System (horizontal/vertical) and Total Stations of 1" accuracy and to establish the vertical control system shall be Digital Level (and/or auto levels) which have sufficient accuracy to meet the requirements given hereinafter. The Contractor shall submit a certificate from the manufacturer or his authorized service agent for the equipment and peripherals. The date of the calibration certificate shall not be more than one (1) month from the date of commencing the survey. The calibration shall be checked and re-validated at pre-determined intervals, and in any event before the expiry of the calibration certificate.

i) Universal Transverse Mercator & Global Coordinates of TBM are described in Reference Information/Reports for the Contractor's reference.

10.20.3 Requirements for Horizontal Control

a) The Contractor shall establish a horizontal control system at the Site by GNSS, providing each HORC Benchmark with a horizontal coordinate (x, y). The horizontal coordinate (x,

y) shall be checked with reference to the existing control points, if available. The Contractor shall coordinate with adjacent Interfacing Contractor(s) to ensure that the HORC Benchmarks established by the Contractor and the equivalent benchmarks established by the Interfacing Contractor(s) are consistent. The Contractor shall include the survey results and the description in the Survey Report as described in the following paragraphs. Upon consent of the Engineer, the system shall be the sole horizontal control system for the Works under this Contract.

b) The horizontal control system shall be developed by GNSS and by running a closed traverse on the HORC Benchmarks and the temporary benchmarks along the alignment.

c) The maximum length of a traverse to be closed shall be around 5km and the number of azimuth courses within an azimuth check shall not exceed twenty-five (25). The Contractor shall compute angular closing error of the traverse followed by linear error. Limits of traverse for horizontal control shall have the following accuracy:

Angular error of closure:	15" (N)0.5 (N: number of angles measured) Where N shall not exceed twenty-five (25)
Total linear error of closure:	1 in 25,000 (after angular adjustment)

d) The error within the permissible limits of the traverse line shall be balanced by the Transit Method. In case the errors are beyond the above permissible limits, a traverse survey shall be carried out until the resulted error is within the permissible limits.

e) The Contractor shall summarize the established coordinates (x, y) with necessary adjustments of all HORC Benchmarks, along with raw observation data downloaded from the Total Station, together with the calculation process and descriptions of all HORC Benchmarks and submit them to the Engineer for his review.

10.20.4 Requirements for Vertical Control

a) The Contractor shall establish a vertical control system at the Site by Direct Levelling, providing each HORC Benchmark with a vertical coordinate (z). The vertical coordinate (z) shall be *established using the Reduced Level (RL) of the Standard Benchmark (Type M) at SDC Quarters, Palwal with MSL value of 195.41 metres,* to ensure the entire vertical control system is consistent, including the equivalent system of adjacent Interfacing Contractor(s). The Contractor shall include the survey results and the description in the Survey Report as described in the following paragraphs. Upon consent of the Engineer the system shall be the sole vertical control system for the Works under this Contract.

b) The vertical control system shall be developed by running a closed level work on the HORC Benchmarks and the temporary benchmarks along the alignment. The Contractor shall close the level work at an appropriate interval and find out the closing error as described in the following paragraph.

c) Each level work shall be connected with the HORC Benchmarks which have consistent accuracy and entirety in the system and the system of adjacent Interfacing Contractor(s) and shall be properly maintained at the Site. The closing error of loop closure shall not exceed 12 (K)0.5 [mm], where K is the circuit length in kilometres, where K shall not exceed 5 kilometres. In case the accuracy of loop closure exceeds the limit defined herein, the entire loop shall be repeated until the desired accuracy is achieved.

d) The Contractor shall summarize the established coordinates (z) of all HORC Benchmarks with necessary adjustments along with raw observation data, calculation sheets and

descriptions of all control marks in spreadsheet (MS Office Excel) format and submit to the Engineer for review.

10.21 Topographic Survey

a) The Contractor shall be responsible for carrying out validation of any Site data provided by the Employer and any additional surveys considered necessary by the Contractor for the execution of the Works, and shall ensure that the topography of the Site has been accurately recorded so that he can be fully satisfied to commence and proceed with the Works. The HORC Benchmarks as established by the Contractor shall be consistently used for surveys.

b) The Contractor shall confirm and locate all the Right of Way (ROW) marks given by the Employer at the Site and provide them with coordinates (x, y, z) so that both the Alignment and ROW are located based on the same horizontal control system.

c) The Contractor shall develop the documents including all reports, drawings, and maps. The Contractor shall summarise the results of Validation of Data, Additional Survey and Setting Out in the Survey Report. The submittals to be developed by the Contractor shall include but not be limited to the following:

a) the HORC Benchmark Establishing Plan;

b) the Survey Plan;

c) the HORC Benchmark Establishing Report;

d) the Survey Report;

e) the Site Location Map;

f) the Structure Setting-out Map;

g) the As-Built Alignment Plan and Profile Drawings; and

h) the Cross-Section Alignment Drawings (as required).

d) During the traversing of peripheral areas, the Contractor shall survey and record the broad alignment of important geographical and other features such as roads, watercourses and the locations of important buildings and facilities, etc., whenever considered necessary for development of the design.

10.22 Horizontal Alignment Staking

a) The Horizontal Alignment defined by the coordinates (x, y) of the centerline of the track shall be staked at an interval of twenty (20) meters in addition to TPTC, TP, TPCC points along the proposed alignment. While staking the Horizontal alignment at Site, the Contractor shall confirm the Right of Way (ROW) staking already done by the Employer at Site and provide and install any missing stakes. The Contractor shall ensure that staking of the ROW is carried out as per the relevant provisions of Indian Railways Engineering Code.

b) The Contractor shall use the TBMs provided by the Employer *only after revalidation is done as per Sub-Clause 10.20.1 (b) of Appendix 10, Section VII-9: Appendices,* in addition to the benchmarks established by the Contractor for staking the alignment.

c) Upon completing the Horizontal Alignment staking and providing all the ROW marks with coordinates (x, y, z), the Contractor shall submit to the Engineer the final coordinates (x, y, z) data of the Vertical Alignment at an interval of twenty (20) meters, the ROW coordinates (x, y, z) at an interval approximately twenty (20) meters, horizontal alignment

calculation report including curve details at every twenty (20) meters (transition curves, circular curves, IP coordinates (x, y, z) and direction).

d) The Contractor shall summarize the survey results of the Right of Way marks given to the Contractor by the Employer and the Centre Line Survey and the Right of Way staking and submit to the Engineer for his consent.

e) Upon the consent of the Engineer to the report, the confirmed Alignment and Right of Way marks, including maps and drawings which confirm the ROW as well as any control points established by the Centre Line and Right of Way staking, shall become the responsibility of the Contractor. The Contractor shall ensure that these marks and control points are protected and maintained and remain consistent throughout the Time for Completion.

10.23 Setting Out

a) The Contractor shall set out the Works at the Site. The Contractor shall ensure that all the

b) Permanent Works are accurately set out.

c) The setting-out of the Works shall be carried out based upon the Drawings which have been issued with a approval and have been issued to the site ''For Construction''

d) The Contractor shall consistently apply the HORC Benchmarks to the setting-out.

10.24 Auxiliary Works

In addition to the requirements specified elsewhere in the Works Requirements and the Conditions of Contract, the Contractor shall follow good industry practice when carrying out surveying, setting out and associated activities, which includes but is not limited to the following:

a) performing all necessary calculations accurately and presenting all computations and results clearly in order to facilitate verification by the Contractor and Engineer;

b) removing machinery and obstructions from required sight-lines;

c) prior to carrying out surveys, setting out or similar works, stopping or relocating any operating machinery, drilling, blasting, pile driving or the like which may cause ground or structure vibration; and stopping any activity which could generate smoke, dust, gas, etc., thereby obscuring clear views or causing refraction, which would thereby interfere with such survey works;

d) restricting or stopping pedestrian and/or vehicular traffic near instruments or in sight-lines during instrument observations, as required;

e) providing adequate equipment, labour and materials as deemed necessary and suitable to carry out control and any other surveys required.

10.25 Geotechnical/Geological Survey

a) Contractor's Surveys

b) The Contractor shall be responsible for carrying out validation of any Site data provided by the Employer and any additional geotechnical/geological or other surveys which, in the Contractor's opinion, are considered necessary for the execution of the Works.

c) Geotechnical Interpretative Report

d) The Contractor shall prepare and submit to the Engineer for review a Geotechnical Interpretative Report which includes site investigation results and the geotechnical interpretation of site investigation work including that undertaken by the Contractor in sufficient detail to confirm and justify parameters used in the design of temporary works. The report shall include full borehole logs, geological profile and descriptions of confirmatory boreholes drilled by the Contractor. The requirements for this Report are described in the Works Requirements.

10.26 Other Related Surveys

The Contractor shall be responsible for carrying out validation of any Site data provided by the Employer and any other surveys considered necessary by the Contractor for the execution of the Works. Such surveys may include, but are not limited to, the following:

a) Topographic Survey

b) Utilities Survey including Adjacent Structures and Works with Works Areas

c) Environmental Survey

d) Hydrological/ Hydro-Meteorological Survey

10.27 Temporary Facilities

10.27.1 General

a) The Contractor shall be entirely responsible for the provision, erection, maintenance and removal on completion of all required temporary facilities, as part of the Temporary Works, which are required for the proper execution and completion of the Permanent Works. Such temporary facilities shall include the Contractor's offices, laboratories, workshops, stores, utilities, services, accommodation, canteens, recreational and welfare facilities, health, safety, security and environmental protection facilities and the like, whether on or off the Site.

b) The Contractor's Personnel shall not be allowed to live on the Site. A limited number of security personnel designated to secure the Contractor's facilities will be permitted to stay after working hours subject to the approval of the Engineer. The Contractor shall make all necessary arrangements for suitable off-Site accommodation and transportation for the Contractor's Personnel.

c) All of the Contractor's temporary facilities on the Site or elsewhere within the Project site shall be designed, provided, erected, maintained and removed to the satisfaction of the Engineer and in strict accordance with applicable Laws. The Contractor shall obtain all necessary approvals and permits from the relevant authorities having jurisdiction for the provision, erection, operation, maintenance and removal of the Contractor's temporary facilities.

d) All of the Contractor's temporary facilities, other than those designated to remain, are to be removed on the completion of the Works and the ground surfaces reinstated to the satisfaction of the Engineer.

e) When deemed essential for the preservation or maintenance of health, safety, security and/or environmental protection, the Engineer may instruct the Contractor to modify the Contractor's temporary facilities, regardless of any approvals or consents previously given, and the Contractor shall promptly comply with such instructions. These instructions shall not constitute Variations.

10.28 Location of Area for Temporary Facilities

10.28.1 The Contractor shall be aware that the area for temporary facilities is not for the Contractor's exclusive use, and the Contractor shall cooperate fully with the Interfacing Contractors if it becomes necessary for the efficient use of a limited area among the said Interfacing Contractors.

10.28.2 The precise locations of the Contractor's Temporary Works including the temporary facilities within and outside the Site area shall be proposed by the Contractor and approved by the Engineer.

10.28.3 The Contractor shall submit drawings showing the proposed locations and outlines of the proposed temporary facilities. Drawings and details of the Temporary Works for a particular part of the Permanent Works may be submitted as part of the shop or working drawings and/or the work method statements forming part of the Contractor's Documents. These locations and outline drawings for the temporary facilities shall be submitted twenty-eight (28) days before commencing the construction of any temporary facility or twenty-eight (28) days after the Commencement Date. These drawings and outlines shall be updated whenever addition or removal of any facility is planned. Detailed drawings for any particular temporary facility, showing all necessary utilities and services, shall be

submitted at least fourteen (14) days before the planned commencement date of construction thereof.

10.28.4 The areas for the Contractor's temporary facilities may also be used for temporary storage of excavated material suitable for reuse in embankment or fill for the Works, or for use by the Employer in future projects or on other works packages.

10.28.5 The Contractor shall dispose of all surplus topsoil and all subsoil materials arising from the Works in the designated area wherever available within the ROW of the Project as agreed by the Engineer. In case area for disposal of surplus soil is not available, the Contractor shall make his own arrangements outside the ROW and the Contractor shall bear all costs including royalty for using/disposing of excavated material unless otherwise specified in the Contract.

10.28.6 The Contractor is free to make his own arrangements for any additional areas required for the proper execution of the Works, and the costs of same shall be borne by the Contractor.

10.29 Site Offices

10.29.1 The Contractor shall be responsible for identifying and establishing suitable facilities for the Contractor's office facilities as approved by the Engineer.

10.29.2 The Contractor's Site offices and facilities shall be provided within or in the vicinity of the work site, with all necessary facilities including furniture, office equipment, office supplies, utility services, sanitary system and vehicle parking. The Engineer will have one (1) Sub-Site Office established for this Contract. The Contractor shall establish the same number of Sub-Site Office and Site Huts in close proximity to the Engineer's Offices.

10.30 Project Information Signboards

10.30.1 The Contractor shall provide project profile sign board at each of the Site Offices and at prominent public places along the alignment of the project as directed by the Engineer of a size, minimum 1.5 m x 2.5 m, and maintain them in good condition. All information on the signboards will be written in English and local language for separate signboard. The signboards will be positioned on a steel frame as directed by the Engineer. The Contractor shall submit proposals for the signboard materials, the text layout (in English and local language) and installation of the signboards at the Site Offices of the Engineer and the Contractor for Engineer' s approval. Each sign board shall show:

a) The name of the Project and the Works,
b) The Location Map,
c) The name of the Bank,
d) The name of the Employer,
e) The name of the Engineer,
f) The name of the Contractor,
g) Date of Commencement of the Works,
h) Time for Completion,
i) Cost of the Works and
j) All other details as required by the Engineer

10.30.2 The Contractor shall maintain the sign boards and remove them on completion of the Works or when instructed by the Engineer. The Contractor shall clean, update, maintain and replace the signboards if damaged, throughout the duration of the Contract. No

additional payment shall be applicable for damaged signs which are required to be replaced.

10.30.3 Within twenty eight (28) days from the Commencement Date, the Contractor shall provide and install a Project information sign, as per the requirements for signboards at the Employer's/Engineer's Site Offices, at each of the entrance points to each Site Office location (both the Contractor's and Employer's/Engineer's offices) and the Site entrances, or, as directed by the Engineer.

10.30.4 The Contractor shall maintain the signboards and remove them on completion of the Works or when instructed by the Engineer, so as to inform the public of the implementation of the Works and the Project and to advise road users of on-going construction.

10.30.5 The Contractor shall clean, update, maintain and replace the signboards if damaged, throughout the duration of the Time for Completion. No additional payment shall be applicable for damaged signs which are required to be replaced.

10.31 First Aid Station

10.31.1 The Contractor shall construct, equip, and maintain First Aid stations at a sufficient number of appropriate locations on the Site and at each labour camp.

10.31.2 The Contractor shall comply with all requirements specified in the Works Requirements (including Appendix 13 [Environmental, Social, Health and Safety Management]) and the Conditions of Contract.

10.32 Labour Accommodation Camps

10.32.1 The Contractor shall supply, equip and maintain facilities as necessary for the living accommodation, feeding and welfare of its employees by providing, servicing, and maintaining a camp at appropriate location(s), as necessary.

10.32.2 The Contractor shall comply with all requirements specified in the Works Requirements (including Appendix 13 [Environmental, Social, Health and Safety Management]) and the Conditions of Contract.

10.33 Site Storage and Yards

10.33.1 The Contractor's Site storage areas and yards shall be utilized for, among other things, material and equipment storage, casting of precast structural elements, workshops, warehouses and secure storage.

10.33.2 The Contractor shall erect a 2.0 metres high chained security fence around the Site storage areas and yards, complete with suitable lighting and lockable gates.

10.33.3 The location of each Site storage area and yard shall be determined prior to the commencement of the works and the Contractor shall propose the locations and details of same and submit to the Engineer for consent.

10.34 Borrow Areas and Quarries

10.34.1 It shall be the responsibility of the Contractor to arrange for borrow areas (for fill material) and quarry sites (for ballast, aggregate and rock material) using his own resources. The Contractor shall be responsible for carrying out his own investigations to verify the availability, sufficiency, quality and quantity of materials from such sources. The Contractor may also arrange any additional borrow areas and quarry sites as required by him, all at his own discretion. No claim whatsoever shall be entertained by the Employer in this regard.

10.34.2 All costs and charges, including but not limited to permits, royalties, duties, taxes, rental or other costs associated with land or the temporary use of same, etc. as applicable, for arranging borrow areas and quarry sites and access thereto, including for the extraction of material therefrom, shall be borne by the Contractor.

10.34.3 Before commencing operations in each of the borrow areas and quarry sites, the Contractor shall submit a detailed plan of his operations and demobilization/grading and finishing/reinstatement, etc. in respect of the same to the Engineer for his approval, together with relevant drawings.

10.34.4 The quality of fill material, aggregates, etc. extracted from borrow areas and quarry sites shall meet the Works Requirements and be subject to the consent of the Engineer.

10.34.5 Borrow areas, quarry sites and the installation of rock crushers shall not be permitted within the ROW.

10.34.6 On completion of the Works, the Contractor shall leave borrow areas in a safe and stable condition.

10.34.7 The Contractor shall indemnify the Employer against all claims in relation to borrow areas and quarry sites both during the Time for Completion and after the Works are completed and taken over.

10.35 Stockpile Areas

10.35.1 The land available, if any, within the ROW may be used by the Contractor for storage of materials required for the project, subject to the consent of the Engineer.

10.35.2 The Contractor may also arrange any additional stockpile areas as required by him at his own discretion and cost.

10.35.3 The location and size of stockpile areas proposed by the Contractor shall be subject to consent of the Engineer. The Engineer's consent may be withheld, if:

a) in the opinion of the Engineer, a stockpile area or access thereto may be such as:
   i. would have a detrimental effect on the natural and social environment;
   ii. would disturb drainage system(s) around the stockpile areas;
   iii. would constitute a danger to the public; or
b) at the Engineer's discretion, a stockpile would become too high.

10.35.4 Before commencing operations, the Contractor shall submit detail drawings of the proposed stockpile areas, together with the proposed method of operation, including stockpile heights, angles of repose, runoff / dust control measures, access road layouts, drainage, measures to be taken for restoration, all verified by appropriate calculations and analysis.

10.35.5 On completion of stockpiling operations, the Contractor shall reinstate stockpile area(s) to a safe and stable condition.

10.35.6 The Contractor shall indemnify the Employer against all claims in relation to stockpile area(s), both during the Time for Completion and after the Works are completed and taken over.

10.36 Contractor's Plants.

10.36.1 The Contractor shall plan, install, erect, maintain, dismantle and remove all plants required for the Works, including but not limited to major items such as concrete batching/mixing plants, rock crushers, casting yard, curing yard, stacking yard etc. of sufficient number and capacity to meet planned peak requirements during construction. The capacity of such plants shall be subject to consent by the Engineer. The location of

concrete batching plants is subject to environmental approval from the appropriate authorities and shall not able to operate until such approval is obtained. All control and measuring equipment shall be regularly checked and calibrated and the Contractor shall regularly submit calibration certificates for same to the Engineer.

10.36.2 The land available, if any, within the ROW may be used by the Contractor for storage of materials, concrete batching/mixing plants, casting yards, curing yard and stacking yards subject to the consent of the Engineer. The Contractor shall arrange any additional areas as required by him at his own discretion and cost.

10.37 Material Testing Laboratories

10.37.1 The Contractor shall design, construct, equip, maintain, dismantle and remove all required material testing laboratories and associated facilities on the Site and / or at work areas as are required for the sampling and testing of materials as required in the Works Requirements. The Engineer's consent shall be obtained to the location of material testing laboratories.

10.37.2 Laboratory buildings shall be supplied with adequate electricity, water, air-conditioning, etc., and shall have sufficient area(s) for storing samples.

10.37.3 The laboratory equipment to be supplied and the methods of testing shall be in accordance with relevant International, Indian and/or other standards and codes as detailed in the Works' Requirements. All apparatus and equipment shall be brand new and of the latest design and manufactured by a reputable manufacturer. The proposed type and number of items of laboratory equipment shall be submitted to the Engineer for review and consent prior to purchase.

10.37.4 The laboratory equipment and apparatus shall be checked and calibrated before testing starts and thereafter at regular intervals as specified by the manufacturer and as directed by the Engineer. The Contractor shall regularly submit calibration certificates for same to the Engineer.

10.37.5 The Contractor shall complete the design, construction and installation of the laboratory facilities for operation within one hundred and forty (140) days after the Commencement Date and operate and maintain the facilities until the issue of Taking-Over Certificate, unless otherwise authorized by the Engineer. The Contractor shall also make all facilities and services available to the Engineer as required. All sampling and testing to be undertaken shall be under the direct supervision of the Engineer. The material testing laboratory shall be staffed by Contractor's personnel fully experienced in the sampling and testing of materials, and quality control.

10.37.6 Any testing which may be required in accordance with the Works Requirements and which cannot be performed in the Contractor's laboratory due to lack of time or equipment shall be assigned to an independent organization having NABL accreditation and as duly consented to by the Engineer. The Contractor shall accept all results, instructions or restrictions stipulated by the Engineer based on such tests.

10.38 Wheel Washing Facilities

10.38.1 In and around residential and commercial area, the Contractor is required to install wheel washing area within ROW at the "Exit" points/gates of the construction area to ensure the removal of wheel/band dirt from construction vehicles and machines. Wheel washing area design shall be proposed in CEMP. As a part of the Contractor's method statement for the site preparation plans, wheel washing area shall be proposed and approved by the Engineer before the commencement of the work. The facilities are required to have access

for cleaning out the sludge which collects together with provision for 2 high pressure hose connections and adequate water supply.

10.39 Temporary Roads

10.39.1 The Contractor at his own discretion construct and dismantle/alter/dispose of the temporary roads after the completion of Contract as directed by the Engineer.

10.39.2 Before constructing any temporary roads outside the ROW, the Contractor shall make all necessary arrangements, including payment if required, with the public authorities or landowners concerned, for the use of the required land and shall obtain the consent of the Engineer. Such consent will be dependent on the Engineer being satisfied with the Contractor's proposals for items such as capacity, signage, lighting and surface quality of the temporary road, together with proposed maintenance arrangements. Such consent shall not relieve the Contractor from any of its responsibilities under the Contract.

10.39.3 The Contractor shall note that temporary road shall not be for the Contractor's exclusive use and shall be subject to relocation or restrictions at his cost during the execution of the Works as and when such relocation or restriction is inevitable. Except in an emergency, the Contractor will be given a prior notice of any such relocation or restriction. The road layout and design proposal shall be revised and re-submitted to the Engineer for consent whenever road arrangements are to be modified for whatsoever reasons.

10.39.4 Within forty-two (42) days after the Commencement Date and consequent to the surveys performed by the Contractor, the Contractor shall submit for the Engineer's review and approval of the proposed design, including layout, and details of the temporary road, fences, protection to underground pipes and culverts at road-crossing points and all additional temporary pipes and culverts that shall be provided by the Contractor, to sustain road traffic, irrigation and drainage flow in all existing streams, irrigation canals and ditches, drainage canals and ditches, and utilities or services, whether buried or exposed, all of which, in the opinion of the Engineer, are necessary for the proper execution of the Works.

10.39.5 During the transportation of Goods and Contractor's Personnel, the Contractor shall be responsible for keeping all railways, roads, bridges, watercourses, utilities services, etc. free from damage and from spillage of construction materials, detritus, oils, etc. and shall repair any damage howsoever caused to any such structure or property (whether on or off the Site) by Contractor's Equipment (including that of any Subcontractor). In that respect the Contractor will be required to carry out a condition survey of all roads and other facilities in and adjacent to the works area which will show in detail the state of those items prior to the commencement of construction. The full records shall be submitted to the Engineer and the status monitored throughout the course of construction with further records maintained.

10.39.6 At the junction of temporary roads with existing roads, the Contractor shall provide suitable traffic marshals to warn and regulate the traffic as per the requirements.

10.39.7 The Contractor shall be responsible for upholding and protecting all slopes at the boundaries of the Site against slippage into adjacent properties. As adjacent areas may be irrigated, this requirement will also therefore include the provision of temporary coffering as appropriate.

10.39.8 All temporary roads, culverts, ditches and the like required for the Contractor's or Subcontractors' or any other Contractor's operations shall be provided and maintained by the Contractor, kept in good condition by cleaning, watering, rolling, grading, repairing and maintaining, all to the approval of the Engineer.

10.39.9 If the Engineer has provided drawings or details of any temporary works, then such drawings or details shall be understood to be indicative of the minimum required standard only. The Contractor shall remain responsible for the design of Temporary Works.

10.39.10 Unless otherwise approved by the Engineer, the demolition of any existing roads, culverts, etc. shall not commence until the replacement facilities therefore have been completed by the Contractor.

10.39.11 When any of the temporary approach roads are no longer required, or earlier if so directed by the Engineer, the Contractor shall carefully dismantle the temporary bridge or road, and remove and dispose of all surplus materials in compliance with the applicable Laws, and reinstate the area to its original condition to the approval of the Engineer.

10.40 Vehicles

10.40.1 The Contractor shall provide all necessary vehicles required for the transportation and movement of Goods and Contractor's Personnel, including but not limited to trucks, cranes, trailers, cars, motorcycles, etc.

10.40.2 The Contractor shall provide competent and licensed drivers and operators for all such vehicles. Vehicles shall be licensed and insured in accordance with the applicable Laws and the Contractor shall be responsible for all servicing, repairs and maintenance required.

10.41 Contractor's Equipment

10.41.1 The Contractor shall ensure that all Contractor's Equipment whether on or in the vicinity of the Site, including apparatus, machinery, vehicles and other similar things to be operated by him or his Sub-Contractors for the execution and testing of the Works, are maintained and operated in a good and safe condition.

10.41.2 All lifting and hoisting equipment shall be regularly certified in accordance with the applicable Laws, and the safe working load limits shall not be exceeded.

10.41.3 The Contractor shall operate and maintain an equipment repair facility within or in the vicinity of the Site, so that downtime of Contractor's Equipment can be minimized. Temporary fuel and lubricant stores shall be properly designed, constructed, secured, fire- and spill-guarded, and be well ventilated so as to comply with the relevant applicable Laws.

10.42 Utilities for Temporary Facilities

10.42.1 Power Supply and Lighting:

i. Electric power supplies for the Contractor's temporary facilities, including but not limited to Contractor's camps, offices, Site, work areas and other facilities as described herein, shall be arranged by the Contractor.
ii. The Contractor shall install, operate and maintain its own electrical distribution systems for the electrical supply required for his temporary facilities as described in paragraph (1) above.
iii. The Contractor shall also furnish, install and keep operational the diesel power generating facilities of such capacity as the Contractor considers necessary to prevent any interruption to the progress of the Works.
iv. The Contractor shall ensure adequate lighting is provided for all his operations at the Site and the temporary facilities and camp according to the National Building Code of India (2016).

10.42.2 Water Supply

i. The Contractor shall design, install, operate and maintain water supply systems including pumps, piping systems, valves, storage tanks etc., at the Site with respect to:

a) Industrial water supply system
For construction use the water quality shall meet the quality requirements in the Works Requirements.

b) Potable water supply system
For supply to all the Contractor's temporary facilities including but not limited to Contractor's camps, offices, Site, work areas and other facilities for human consumption and use.

ii. In case the Contractor plans to install bore well(s) for water supply, he shall thoroughly investigate the relevant legislation and regulations imposed by the competent authorities and the installation shall be subject to approval by the said competent authorities and/or consent of the Engineer.

iii. Throughout the Time for Completion the Contractor shall take samples from all water supplies at regular intervals and test it for suitability for the intended use.

10.42.3 Sanitation and Sewerage

i. All operational parts of the Site, offices, workshops, fabrication yards, laboratory, camp and other facilities, etc. shall be provided with sanitation and sewage handling and disposal systems complying with the statutory requirements and applicable Laws, codes and standards.

ii. If required, portable sanitary facilities including chemical toilets shall be provided and maintained by the Contractor for the use of all personnel at all work locations.

iii. All the requirements of the Works Requirements (including Appendix 13 [Environmental, Social, Health and Safety Management] of the General Specifications) and the Conditions of Contract shall also be complied with.

10.42.4 Waste and Garbage Disposal

i. The Site and the work areas shall be kept clean and free of detritus at all times.

ii. The Contractor shall collect waste material and garbage from Site, camp, offices, yards, workshops, etc. on a daily basis and dispose of same in an approved disposal area(s) and as per guidelines prescribed by local and governmental authorities having jurisdiction. No waste of any kind shall be deposited in any watercourses.

iii. All the requirements of the Works Requirements (including Appendix 13 [Environmental, Social, Health and Safety Management Management] of the General Specifications) and the Conditions of Contract shall also be complied with.

10.42.5 Fencing, Site Security and Safety

i. The Contractor shall be responsible for the security and safety of the Site. Accordingly, the Contractor's temporary facilities including offices, workshops, fabrication yards and storage compounds, campsites, all construction areas, storage areas shall be adequately fenced, gated, lighted and guarded on a twenty-four hour, seven days a week basis. Firefighting equipment shall be provided in accordance with the applicable Codes and the requirements of local authorities.

ii. Any storage facilities for explosives shall comply with the relevant Laws and regulations of India and shall be situated at locations approved by the competent authorities. Detonators and fuses shall be stored in facilities separate from explosives. In no case shall detonators and fuses be transported in the same vehicle as explosives. Storage facilities for explosives, detonators, fuses, etc. shall be secure, kept locked and the keys shall be accounted for at all times.

iii. All the requirements of the Works Requirements (including Appendix 13 [Environmental, Social, Health and Safety Management Management] of the General Specifications) and the Conditions of Contract shall also be complied with.

iv. The Contractor shall be responsible for any losses occurring within the Site premises.

10.42.6 Inspection by the Employer or Engineer

The Employer and the Engineer have the right at any time to inspect any part of the Contractor's temporary facilities and to require immediate rectification to comply with the specified requirements.

10.42.7 Final Clean-Up

i. Upon the completion of Works, or when any of the Contractor's Equipment and/or temporary facilities have fulfilled or completed their function, the Contractor shall dismantle and demobilize such Contractor's Equipment and/or temporary facilities and remove all equipment, machinery, materials, refuse, debris, objectionable material, and reinstate, including filling, grading and dressing all areas to their original condition prior to completion of the Works.

ii. The Contractor shall not proceed with any demobilization and/or removal of temporary facilities and equipment without the prior consent of the Engineer.

10.43 Maintenance of Temporary Facilities

10.43.1 The Contractor shall provide all necessary maintenance requirements and shall keep the temporary facilities and other areas established for the Works, clean, tidy and litter-free.

10.43.2 The Contractor shall be responsible throughout the Time for Completion for keeping the Site and temporary facilities to the satisfaction of the Engineer.

10.43.3 The Contractor shall maintain all existing security fences required for the Works until completion of the Works. Existing fences which interfere with construction operations, shall not be relocated or dismantled, until written permission has been obtained from the fence owner.

10.44 Damage to Existing Property

10.44.1 The Contractor shall be responsible for any and all damage that may occur to any existing structures, works, materials, or equipment that is due to any operation(s) for which the Contractor is responsible, including any operation(s) of any Subcontractor.

10.44.2 The Contractor shall repair or replace any damaged structures, works, materials, or equipment to the satisfaction of the Engineer.

10.44.3 The Contractor shall be responsible for all damage to roads, railway infrastructure, curbs, sidewalks, highways, shoulders, embankment, ditches, drains, culverts, bridges, or other public or private property, which may be caused by their construction activities and shall indemnify for losses due to such damages.

10.45 UTILITIES

10.45.1 General

a) The Contractor shall at all times work with due diligence to ensure the safety of all personnel and property from injury and damage from known ("Charted Utilities") and unknown utilities ("Uncharted Utilities").

b) The Contractor shall always take care of concerning buried Charted and Uncharted Utilities and if any such Utilities infringe the work, the Contractor shall make the area affected safe and ensure that no unauthorised member of the workforce or members of the public shall enter such area.

c) Contractor shall be responsible for relocation/diversion/shifting/modification of all charted *(except specified otherwise) and* uncharted utilities infringing the Works.

d) Contractor shall indemnify the Employer against any losses/claim/damage cost to any damage to utility/services during execution of Works.

10.46 Utilities, Services and Facilities

10.46.1 The Utilities are categorised as (i) Charted Utilities, which have been identified by the Employer and may be affected during the execution of the Works. and, (ii) Uncharted Utilities, which are not known and would get identified during the execution of the Works.

10.46.2 Charted Utility

The Charted Utilities identified by the Employer are enclosed in Part 2, Section VII-8-Employer's Requirements, Tender Drawings and Documents. These are further categorised as discussed under:

i. Type A –Overhead Electrical Crossings

a. These are Overhead Electrical Crossings, traversing the proposed HORC alignment and likely to infringe during execution of the work primarily due to inadequate ground clearance. The Employer has already taken action to remove these infringements by either raising or laying underground cables. *75% of infringements due to LT and HT (up to 33 KV) utilities shall be removed by the Employer within 90 days of the Commencement Date. Balance 25% shall be removed in a phased manner within 180 days of the Commencement Date . It is pertinent to point that these infringements are of minor nature and are unlikely to significantly hamper the progress of the work. Hence, for any delay in removal of any of these utilities, no claims on these grounds by the Contractor shall be accepted. The Contractor shall plan his works taking this aspect into consideration.* The Crossings shifted underground shall normally be laid within ten (10) metres of the chainages given in the list of Overhead Electrical Crossings except at locations where stations and buildings of HORC are proposed. At the stations and HORC buildings, the utility will be shifted beyond the structure area. For cables crossing the HORC alignment, extra length of 3m to 5m is being provided on both sides, so that cable can be slewed if required during construction. The Contractor shall consider the effect of these shifted utilities in his work planning and price. The coordinates of the new locations where utilities have been shifted will be shared with the Contractor once the shifting is completed. Electrical utilities which have been laid underground, will be considered as charted utilities. The Contractor shall design the span in such a way that further utility shifting is avoided unless inescapable. *However, in case such utilities are not dismantled by the Employer and which may affect execution of work, the Contractor will be asked for*

relocation/diversion/shifting/modification of utilities. The cost of relocation/diversion/shifting/modification of utilities shall be payable by the Employer as per Conditions of the Contract. If any payment/compensation is payable to the utility owner, the same shall be paid by the Employer to the Utility owner.

b. The infringements due to EHT (above 33 KV) Utilities will be progressively removed *by the Employer* and is likely to be completed within 12 months *from the Commencement Date. It is pertinent to point that these infringements are of minor nature and are unlikely to significantly hamper the progress of the work. Hence, for any delay in removal of any of these utilities, no claims on these grounds by the Contractor shall be applicable.* The Contractor shall plan his works taking this aspect into consideration.

ii. Type B – Overground Utility

Deleted.

iii. Type C- Underground Utilities

Deleted.

10.46.3 Uncharted Utility

The Uncharted Utilities will be those unknown utilities which get identified during execution of the Works. These may be identified during Ground Penetration Survey or anytime during execution of the Works.

10.46.4 The Contractor shall do a general survey and Ground Penetrating Radar (GPR) Survey of the Site after possession and notify the Engineer of Charted & Uncharted Utilities, which may obstruct the works and need to be relocated.

10.46.5 For all Charted & Uncharted Utilities requiring relocation identified by the Contractor in the Utilities survey, the Contractor shall inform the Engineer and provide relevant details, including but not limited to, the following:

i. location of the Utility;

ii. date on which Utility was encountered;

iii. nature and size of the Utility;

iv. condition of the Utility

v. type of the Utility & its owner:

a) Electrical cables;

b) OFC & Telecom cables;

c) Gas pipelines;

d) Water/sewerage/drainage/storm water/hume pipelines;

e) Irrigation pipelines/channels;

f) Telecom towers;

g) Overhead Water tanks and others overhead tanks;

h) Others, if any

vi. Reasonable estimate of time required for shifting of Unchartered Utilities.

vii. The information shall also cover the details of the agency/department carrying out the utility shifting.

10.46.6 The trial trenching, arrangements and working methods to be employed in respect of such Charted & Uncharted Utilities which warrants removal/relocation, including proposed protection measures, diversions, reinstatements in consultation with utility owner shall be done within 56 days after Handing Over of the Site by the Employer. The Contractor shall provide relevant justification for the identified utilities (Charted & Uncharted) which require removal/diversion for proceeding with the works.

10.46.7 The Engineer will accord approval within 21 days to the Contractor for initiating required action for the utilities warranting removal/relocation/modification.

10.46.8 The Contactor shall be responsible for taking prompt necessary action for such identified utilities (Charted & Uncharted) including the following but not limited to:

i. Identification of the extent of the utility to be relocated

ii. Coordinate and get permissions from utility owner & all relevant authorities.

iii. Preparation and submission of relevant documentation to the authorities.

iv. Mitigate the situation and re-arrange the work to minimise the effect on the timeline of the Works

v. Continue with other related works in as much as possible to maintain the timeline of the Works.

Any relocation/removal/diversion of Charted Utility shall be entirely the Contractor's responsibility and any cost on this account shall be borne by the Contractor.

10.46.9 The relocation/removal/diversion of identified Uncharted Utilities shall be assigned to the Contractor to be carried out through the utility agencies, or their specified contractor or by the Contractor himself. The cost of relocation/removal/diversion of Uncharted Utility shall be paid by the Employer as mentioned below:

i. If Uncharted Utility relocation/removal/diversion is carried out by Utility agency or theirspecified contractor, the Contractor shall make the payment to such agency or specified contractor. The Employer shall reimburse such amount as Specified Provisional Sum based on invoices.

ii. If Uncharted Utility relocation/removal/diversion is carried out by Contractor himself, then he shall be paid under Specified Provisional Sum.

10.46.10 The Contractor shall not divert, remove or relocate any such identified Charted & Uncharted Utilities without having first received the Engineer's consent to such diversion, removal or relocation.

10.46.11 The Contractor shall liaise and co-ordinate with the relevant Utilities Companies to ensure that all the above-mentioned works of relocation/diversion, support and protection are executed satisfactorily. Contractor shall obtain necessary clearances from the Utility company/owner prior to the start of any relocation/removal/diversion works of the utilities. The same shall be submitted to the Engineer prior to start of the works.

10.46.12 Throughout the execution of the Contract, the Contractor shall reasonably comply, in all respects, with the requirements of all the utility owners and authorities regarding the handling, protection and maintenance of the utility facilities. The responsibility in respect of diversion/ modification/ relocation/ protection etc. of the Utilities (Charted or Uncharted) to facilitate safe construction lies with the Contractor. If required, the

employer shall provide support to facilitate approvals/permits from utility owner/concerned department for the proposed diversion/relocation of utilities.

10.47 Prevention of Damage and Interference

10.47.1 Temporary supports and protection methods proposed by the Contractor and agreed by the utility owner shall be provided to the utilities. The permanent supports and protection shall be provided wherever required for the safety and security of the utility service.

10.47.2 The Contractor shall not interfere in any manner with the Utility lines and services without prior approval of the Utility owner and Engineer. Whenever the interfering necessity arises, the Contractor shall submit a proposal to the Engineer for his approval. Any unintentional interference caused shall be immediately corrected without causing danger and trouble to any on-going operations or the existing utility lines or services. The Contractor shall immediately inform the Engineer and the utility agencies of:

i. damage to utilities;

ii. leakage of utilities;

iii. discovery of utilities not previously identified; and

iv. Any hazardous material found during the excavation.

a) location of utility

b) date on which the utilities were encountered;

c) nature and sizes of the utilities;

d) condition of utility;

e) temporary or permanent supports provided; and

f) diversions made –temporary or permanent

The Contractor shall include the details (plan, location, ownership, size and material) of all suchutilities in the As-built Drawings.

10.48 Drainage Systems

10.48.1 All existing drainage systems that are affected by the Temporary and the Permanent Works shall be protected, relocated and/or diverted as required for the Works, by the Contractor.

10.48.2 Such protection, relocation or diversion works shall be carried out by the Contractor, and his designs shall be approved by the utility owners / relevant authorities and the Engineer.

10.48.3 Upon completion of the works, all the diverted or temporarily diverted drains/box culverts and canals shall be fully reconstructed to their original size or to a revised size as required by the utility owners /relevant authorities. However, if the utility owner or relevant authority requires to keep the Utility at the original location, the same shall be reconstructed at the original location.

10.49 Building Service Connections

10.49.1 Building service connections shall be maintained and protected or if required to be shifted, shall be informed to the Engineer during the execution of the works. The Contractor shall take necessary steps to ensure these services with the approval of utility owner and the Engineer.

10.49.2 Building service connections shall include the branch pipes from the main water pipe, water meter chambers/bulk meter, sewer and drainage discharge pipes, grease traps, etc.

10.49.3 Building service connections shall be identified by trial trenches or other methods approved by the relevant Utility Companies. Where these service connections interfere with the works, the Contractor shall follow the methodology as approved by the relevant Utility Companies and the Engineer.

10.50 Street Furniture and Minor Service

Where street furniture, including lamp posts, traffic lights, fire hydrants, signage, minor electrical cables, water services, etc. are required to be dismantled and stored or relocated temporarily or permanently, the Contractor shall propose such works to the Engineer and Utility Companies or relevant authorities for their approval.

10.51 TRAFFIC MANAGEMENT PLANS

10.51.1 General

a) The Contractor shall thoroughly acquaint itself with existing traffic conditions and understand the importance of maintaining traffic safety and the avoidance of excessive traffic delay. The Contractor shall co-operate with the relevant agencies regarding traffic control and all details shall be subject to the Engineer's approval.

b) The requirements concerning temporary road works shall include, but not be limited to, construction of detours, temporary bridge approach roads, traffic control devices and services for the control and protection of traffic through areas of construction.

c) The Contractor shall be responsible for investigating and establishing the requirements for traffic control and ensuring safety at each site and shall submit such details in the form of a Temporary Traffic Control Plan for the Engineer's review and consent.

d) All temporary roadworks and traffic management shall be as specified in this appendix, unless specified otherwise elsewhere in the Contract or local Indian regulations and standards, and the more onerous provision shall apply.

10.52 Temporary Traffic Control Plan (TCP)

10.52.1 Submission, Consent and Change

a) Within twenty-eight (28) days after the Commencement Date, the Contractor shall submit a Temporary Traffic Control Plan (TCP) to the Engineer for review and consent. The Engineer's consent shall be obtained prior to the start of Works on Site.

b) The Contractor shall comply with the TCP which has received the Engineer's approval and any Engineer's instructions issued concerning traffic control.

c) Should the Contractor propose any to change to the TCP which has received the Engineer's approval, the Engineer shall be notified in writing at least seven (7) calendar days prior to the date planned for the implementation of any such proposed change. Changes proposed are subject to receipt of the Engineer's consent. If the Engineer makes any subsequent recommendations or issues instructions concerning the TCP in writing, the Contractor shall revise the TCP accordingly.

10.52.2 Contents of Temporary Traffic Control Plan

a) The main contents of the Temporary Traffic Control Plan shall include, but not be limited to,the following:

i. Type and main specifications of traffic control devices and facilities;

ii. A scale plan of the location(s), clearly identifying existing road(s), proposed diversions ofpedestrian and road traffic, locations of warning signs and traffic control measures;

iii. Details of all lane widths, temporary surfaces, etc.;

iv. Construction details of any proposed diversion(s);

v. Safety measures including signage and staffing;

vi. Program for installation and erection of traffic control devices and facilities;

vii. Traffic control means during non-working time and during night time;

viii. Protection/diversion of any existing utilities;

i. Environmental measures to be implemented, e.g. dust suppression, noise abatement,

ix. watercourse diversion and the like; and

x. Person responsible for overseeing implementation of all aspects of the TCP.

b) In addition to the above and prior to the implementation of any Site-specific traffic control schemes, the Contractor shall obtain any necessary approval letters from relevant authorities who have jurisdiction over or ownership of the existing traffic way including the Traffic Police,NHAI, PWD and any other local government/authorities and other related parties having jurisdiction, as applicable and as required.

10.52.3 Number of Lanes for Traffic Control

a) The existing traffic on roads at the Site must be maintained at all times during the execution of the Works and if diversions are required these must be of the same traffic capacity as the original road. Notwithstanding the above, the Engineer may give consent to reductions in traffic capacity if the Contractor can demonstrate that such will not cause excessive delays to traffic flow. If such consent is given, the Engineer may specify the hours during the day when the reduction in capacity may be applied and it should be anticipated by the Contractor that these hours will not include any peak periods for the traffic movement.

b) The Contractor shall cooperate with relevant authorities having jurisdiction regarding traffic control and all details will be subject to receipt of the Engineer's consent.

10.52.4 Temporary Traffic Ramps and Speed Breakers

a) In locations where it is necessary (for example, pipeline crossing a road above ground), the Contractor shall construct and maintain temporary traffic ramps.

b) In cases where it is necessary (for example, requirement by an agency having jurisdiction) or required by the Engineer, the Contractor shall provide and maintain temporary speed breakers.

10.52.5 Traffic Control for Public Roads

a) The Contractor shall maintain close liaison with the Traffic Police, NHAI, PWD and any other local government/authorities and other related parties having jurisdiction, as applicable to traffic control requirements and shall comply with all approval and permit requirements from such authorities.

b) In order to facilitate traffic through or around the Works, or wherever ordered by the Engineer, the Contractor shall erect and maintain at prescribed points on Site roads and at approaches to the Works, a temporary fence made of corrugated metal sheet supported by hard posts with foundations and horizontal bars, traffic signs, lights, barricades, traffic cones with traffic warning lamps and other facilities for the direction and control of traffic. The fence is to be painted and maintained in good condition. Drawings and details of the fence are to be prepared and submitted to the Engineer for review and issue of a approval.

c) Where required, or as directed by the Engineer, the Contractor shall provide competent flagmen whose sole duties shall consist of directing the movement of traffic through or around the Works.

d) In addition to the requirements as described above, the Contractor shall furnish and erect, within or near Works areas, such warning and guide signs as may be ordered by the Engineer.

e) For all traffic safety precautions, the Contractor shall refer to Traffic Management and Site Barricading. The Contractor shall refer to Section VII-8, Tender Drawings and Documents for details of barricading.

f) The repair of any existing roads that have been damaged by the Contractor during the execution of the Works (including any damage caused by Contractor's Equipment) shall be at the risk and cost of the Contractor.

10.53 Extraordinary Traffic

The Contractor shall be responsible for carrying out any necessary investigations and the obtaining of approvals, licenses, escorts and any other necessary facilities in order to enable extraordinary traffic to be moved on the roads in the Works area.

10.54 Maintenance and Protection of Traffic

10.54.1 During the execution of the Works the Contractor shall keep open to traffic existing roads, provided that where required or as directed by the Engineer, the Contractor shall arrange detours subject to the consent of the Engineer. The Contractor shall at all times keep roads and footpaths affected by its operations, free from obstruction and nuisance and suitable for public use.

10.54.2 The Contractor shall take necessary care at all times during the execution of the Works to ensure the convenience and safety of residents along and adjacent to public roads and highways that may be affected by the Works. Street lighting shall be relocated as necessary to maintain the same standard of lighting during the course of the Works, until new lighting facilities are brought into operation.

10.54.3 Any failure of the Contractor to meet these requirements will entitle the Engineer to carry out such works as he deems to be necessary and to charge the Contractor with the full cost thereof plus ten percent of such cost, which sum will be deducted from any money due or which may become due to the Contractor under the Contract.

10.55 Vertical Clearance

In general, any Temporary Works placed over roads or diversions used by public traffic shall maintain a vertical clearance of at least 5.5 metres unless otherwise directed by the Engineer. Where required by the Engineer the Contractor shall erect and maintain suitable check-gates, fitted with warning signs indicating the vertical clearance.

10.56 Materials

Materials and other specifications related to traffic control devices shall conform to IRC Standards unless otherwise specified elsewhere in the Contract.

10.56.1 Retro-reflective Material

Unless otherwise specified in the Contract, sign panels, barricades, traffic cones, vertical panels, and flagmans' paddles shall have retro-reflective sheeting, as consented to by the Engineer.

10.56.2 Sign Panels

Sign panels shall be yellow with black legend unless otherwise specified in the Contract or local Indian regulations and standards.

10.56.3 Sign Posts

Sign posts shall be fabricated from materials as acceptable to the Engineer. Signs shall be provided with suitable foundations and be designed so as to be capable of remaining in position during normal traffic flow and wind conditions.

10.56.4 Barricades

The Contractor shall erect barricades demarketing public areas to ensure safety of pubic and vehicular traffic in accordance with the Tender drawings.

10.56.5 Traffic Cones

a) Traffic cones shall be capable of withstanding impact without damage to the cones or vehicles. All cones shall be orange with highly reflective white bands which is easily visible both in daylight and darkness. Traffic cones shall be capable of remaining visible and in position during normal traffic flow and wind conditions in the area where they are used. Lamps for cones shall be suitable for purpose.

b) Where traffic cones are used for the diversion of pedestrians the cones shall be fitted with yellow/black reflective cone bars to prevent pedestrians walking outside the protected walk area.

c) All cones shall be as above unless otherwise specified in the Contract or local Indian regulations and standards, whichever is more onerous.

10.56.6 Warning Lights (flashing or steady-burn)

High visibility traffic warning lights shall be provided and used at all locations where Works are being carried out and visible warnings are required, i.e. road works, excavations, pedestrian diversions, etc. The requirements for warning lights shall be:

i. Lens colour shall be amber;

ii. Lens diameter shall be not less than 185mm;

iii. Flashing shall be 110 per minute;

iv. Suitable for fitting to traffic cones;

v. Battery operated; and

vi. Continuous operation of more than 600 hours.

10.57 Construction Requirements

10.57.1 The Contractor shall keep the length of construction areas to manageable lengths such that traffic will be accommodated safely. Traffic control devices and services shall be provided and maintained both inside and outside the limits of work as required to facilitate traffic guidance, should this be necessary. The provision of traffic control devices and services shall comply with the provisions of the Works Requirements and the Conditions of Contract and local Indian regulations and standards.

10.57.2 Prior to the start of construction operations, the Contractor shall erect such signs, barricades, and other traffic control devices as may be required by the Works Requirements and the Conditions of Contract or as directed by the Engineer. Traffic control devices shall be operated only when required and only those devices that apply to conditions actually in existence shall be operable.

10.57.3 Wherever required or directed by the Engineer, temporary fences shall be placed to provide a visual barrier between the work area and adjacent traffic or buildings.

10.57.4 Any devices provided under this clause that are lost, stolen, destroyed, or deemed unacceptable while in use on the Works shall be replaced by the Contractor at the Contractor's risk and cost.

10.57.5 During non-working hours and following completion of a particular construction operation, all warning signs, except those necessary for the safety of the public, shall be removed or entirely covered with either metal or plywood sheeting so that the sign panel will not be visible.

10.57.6 Retro-reflective sheeting on signs, barricades, and other devices shall be kept clean. Stretches, rips, and tears in the sheeting shall be promptly corrected by the Contractor. Retro-reflective sheeting shall have a maintained retro-reflection.

10.57.7 Nighttime operations shall be illuminated by a lighting system which has received the Engineer' s consent. The lighting system shall be positioned and operated to avoid glare to road users.The heat produced by any lighting system shall be considered and allowed for. The use of lights with flames (such as gas-powered lighting) will not be permitted.

10.57.8 The Contractor shall ensure that no Contractor's Equipment leaves the work sites with mud, debris or rock that may drop or be deposited on a public highway or private right-of-way, and the roads in the vicinity of the Site shall be kept clean. Suitable vehicle washing facilities shall be provided by the Contractor.

10.58 PACKAGING STORAGE SHIPPING AND DELIVERY

10.58.1General

a) Unless otherwise required by the Particular Conditions, Plant and the Materials shall be delivered to the Site at the most suitable time(s) in accordance with the Works Programme and Procurement Work Segment Programme, so as to avoid undue damage and/or deterioration due to a storage period of excessive duration.

b) All Plant and the Materials, if manufactured or assembled off-Site, shall be properly and securely packed at the point of origin, in order to prevent damage during transport to the Site and due to storage in the weather conditions to be encountered at the Site.

c) The Contractor shall securely crate or box all consignments for ocean shipment in a manner suitable to protect them from damage in transit and shall be responsible for and rectify any and all damage due to any improper packing. Crates shall have external markings identifying the Contract reference number, origin, destination, contents and consignee.

d) The Contractor may be required to furnish the Employer, by courier or other approved means with advance copies of shipping documents, invoices and other pertinent papers showing the date and origin of shipment, a description of the Goods, the shipping weight of each item, destination, name of the vessel and other pertinent information.

e) The Contractor shall also be responsible for the trans-shipment up till the delivery to the installation sites.

f) The Contractor shall ensure, prior to delivery of Plant or Material, that adequate storage facilities and/or areas are available on Site to properly store and protect the Plant or the Material so as to prevent any damage or deterioration. Air-conditioned or other controlled-environment storage shall be provided for Plant items sensitive to high humidity and/or temperature.

g) Materials of an inflammable, explosive, toxic or similarly hazardous nature shall be securely stored separately at approved locations. The Contractor shall provide adequate security and safety control at such locations throughout the storage period. Before delivery of such Materials to Site, all necessary permits and licenses shall have been obtained from the authorities having jurisdiction, all in accordance with the applicable Laws.

h) When Plant or Materials arrive on Site it shall as soon as practicable be inspected by the Contractor in the presence of the Engineer, for damage or deterioration. The Contractor shall be responsible for unpacking and re-packing in an appropriate manner and for provision of all necessary equipment, tools, materials and labour at his own expense. If damage or deterioration has occurred as determined by the Engineer, payment for shall not be made for such damaged or deteriorated Plant or Materials, and such shall be removed from the Site and repaired or replaced according to the instructions of the Engineer, at the Contractor's risk and cost.

i) For the Plant or the material which is subject to deterioration after opening the packing, appropriate alternative inspection measures shall be determined on Site between the Engineer and the Contractor. No payment shall become due to the Contractor for those uninspected Plant or Material, unless otherwise determined by the Employer.

j) Packing materials shall remain the property of the Contractor and shall be removed from the Site immediately when no longer required on the Site, as determined by the Engineer.

k) The Contractor shall be responsible for the safe and secure storage and handling of Plant and Materials on Site until the issuance of the Taking-Over Certificate for the relevant part of the Works, regardless of any transfer of ownership thereof to the Employer.

l) Any action taken by the Engineer in inspecting Plant or Materials upon arrival on Site or any determination subsequently made by the Engineer shall not relieve the Contractor of any of his responsibilities under the Contract.

10.59 Storage of Plant and Materials

10.59.1 The Contractor shall provide and maintain storage facilities at acceptable locations in consultation with the Engineer, for the equipment and materials of all kinds intended for use in carrying out the Permanent Works or for incorporation into the Permanent Works.

10.59.2 The Contractor shall prepare, protect, provide security and store in an agreed manner for all Works, Contractor's Equipment, equipment and materials until the Project completion so as to safeguard them against any loss, damage and any other hazards arising during shipment, storage on/off the Site or climatic influences.

10.60 Crating

The Contractor shall provide all packing, crates and markings. In doing so, it shall comply with the following requirements:

a) Each case, crate or package shall be waterproof, rot, insect and rodent proof. It shall be of robust construction and fit for its intended purpose. The Contractor shall, in determining the packaging materials to be used, take into consideration the climatic conditions likely to occur during the period of transport, shipment and storage.

b) Each case, crate or package shall be legibly and indelibly marked in large letters with the Site address, Contract number, "right way up", opening points and other markings as necessary to permit materials to be readily identified and handled during transit and when received at the Site.

c) Each case, crate or package shall contain a comprehensive packing list showing the number, mark, size, weight and contents, together with any relevant drawings. A

second copy of the packing list shall be enclosed in a watertight enclosure on the outside of each case, crate or package. Distribution of additional copies of each packing list shall be in accordance with the Engineer's instructions.

d) All items heavier than 100 kg shall be marked on the outside of the case, crate or package, indicating the gross and net weights, the points for slinging, and where the weight is bearing.

e) Care shall be taken to prevent movement of items within cases, crates or packages by the provision of bracing, straps and securing bolts as necessary. Bags of loose items shall be packed in cases and shall be clearly identified by well-secured metal labels on which the quantity and name of the parts and their index or catalogue number have been stamped.

f) All packing shall be free from sharp edges to prevent injury to persons or other objects.

g) Each bulky/heavy case, crate or package shall include wedge(s) for easy loading and unloading by mechanical handling equipment such as forklift truck.

h) Electronic circuit boards, integrated circuits and the like shall be well protected by using appropriate packing, e.g. anti-static bubble wrap or similar.

i) Rubber products and the like shall be suitably packed to avoid damage including but not limited to hardening, deformation and peel-off.

10.61 General Precautions

10.61.1 Spare parts shall be tropicalized in their packing for prolonged storage in accordance with appropriate international/ Indian standards and shall be suitably and individually labelled to indicate:

a) Name of parts;

b) Shelf life and date of manufacture;

c) Type or condition(s) of storage and special handling information;

d) Description of item and relevant part number;

e) Serial number, if applicable;

f) Inspection/test certificate number and batch number; and g) Contract number, order number and item number.

10.61.2 Tubes, cable, conductor and other similar openings shall be properly sealed and blanked off to prevent ingress of dirt or moisture.

10.61.3 Spare ball and roller bearings and similarly protected items shall not be removed from the manufacturer's wrappings or packing.

10.61.4 Fragile materials shall be packed in such a way that they shall not be damaged during transit and when they are properly unpacked for quality inspection. Glass items shall be capable of being easily re-packed without removing the original wrappings or packing for long- term storage within the same packing case.

10.61.5 Appropriate precautions in accordance with the Contractor's safety regulations, the regulations of the Employer, Appendix 13 [Environmental, Social, Health and Safety Manual] and statutory regulations in respect of all hazardous, toxic, inflammable, etc. materials.

10.62 Packaging Procedures

10.62.1 All required inspection/test certificates shall be supplied and packed together with individual materials. All packaging materials and procedures shall be subject to review by the Engineer.

10.62.2 All empty cases, crates or packages, whether or not returnable, shall be removed from the Site by the Contractor or stored by the Contractor in such a way that they do not interfere with the progress of the Works.

10.63 Shipping

10.63.1 The Contractor shall notify the Engineer at least fifteen (15) days in advance of any expected shipment date and give further notification of the actual shipment date and routing when such information is subsequently established. This shall complement the inspection requirements prior to delivery as specified herein.

10.63.2 Two (2) copies of packing lists and quality certificates shall be attached with each case or package to be shipped. One copy shall be placed inside the package and the second copy shall be enclosed in a watertight enclosure on the outside of each case or package. A copy of packing lists and quality certificates shall be sent to the Engineer after each package of the Works, the equipment, spare parts and other items have been shipped.

10.63.3 Without prejudice to any other provisions of the Contract, the Contractor shall be responsible for all legal requirements, insurance, customs, duties, dues, taxes and other such requirements and expenditures required for the plant, equipment, spare parts and other items to be supplied under the Contract.

10.64 Delivery

10.64.1 The Contractor shall deliver Plant and Materials required for the Works and all items to be supplied under the Contract to the Site.

10.64.2 The Contractor shall unload all items to be supplied under the Contract at the designated delivery point and place them in position or store them.

10.64.3 Any part of the Works or any item to be supplied under the Contract that is damaged in transit shall not be considered as delivered until repairs or replacements have been made and all necessary spare parts or items have been delivered to the Site.

10.64.4 All documents, manuals, drawings and other deliverables shall be delivered to an address to be designated by the Engineer in writing.

10.64.5 The Contractor shall store and secure Plant and Materials until the same have been inspected by the Engineer and are considered delivered at the designated point.

10.64.6 The Contractor shall remove temporary fittings required for shipment and re-assembly of Plant and Materials and shall complete this prior to the inspection of same and before they are considered delivered.

10.64.7 An item shall be considered delivered when all damage has been repaired and all documentation and post-delivery preparation has been completed.

APPENDIX 11

WORKS QUALITY MANAGEMENT PLAN

11.1. General

The Contractor shall implement a Project Quality Management Plan in accordance with ISO-9001 "Quality System - Model for Quality Assurance in Design/Development, Production, Installation and Servicing" to ensure that all materials, workmanship, plant and equipment supplied and work done under the contract meets the requirements of the contract. This plan shall apply to all activities related to the quality of items, including designing, purchasing, inspecting, handling, assembling, testing, storing, and shipping of materials and equipment and different elements of construction work and installations of system components.

The Quality Plan to be prepared by the Contractor and submitted to the Engineer shall follow the requirements of ISO 9000 and address each element therein.

Registration of the Contractor's organisation, or subcontractors or subconsultants is not required for this Project but the Project Quality Management Plan as submitted shall meet the intent of the ISO 9000 requirement in that there is a comprehensive and documented approach to achieving the project quality requirements.

11.2. Works Quality Management Plan

The Works Quality Management Plan (WQMP) shall as a minimum address the quality system elements as required by ISO 9001, generally noting the applicability to the Contractor's Works Programme for the Project. Procedures or Quality Plans to be prepared by others (Suppliers, Subcontractors, Subconsultants) and their incorporation in the overall WQMP shall be identified.

The Contractor shall provide and maintain a Quality Assurance Plan (QA) to regulate methods, procedures, and processes to ensure compliance with the Contract requirements. The QA Plan, including QA written procedures, shall be submitted to the Engineer for his review.

Adequate records shall be maintained in a readily retrievable manner to provide documented evidence of quality monitoring and accountability. These records shall be available to Employer at all times during the term of the Contract and during the Defects Liability Period and for a five-year period thereafter.

The Plan shall identify:

- Design Process: that control, check and verify the accuracy, completeness and integration of the design shall be performed by certified personnel and in accordance with documented procedure that have the written consent of the Engineer.
- Special Processes: that control or verify quality shall be performed by certified personnel and in accordance with documented procedures that have the written consent of the Engineer;
- Inspection and Test: Inspection and testing instructions shall provide for reporting nonconformances or questionable conditions to the Engineer; Inspection shall occur at appropriate points in the installation sequence to ensure compliance with drawings, test specifications, process specifications, and quality standards. The Engineer shall designate, if necessary, inspection hold points into installation or inspection planning procedures;
- Receiving Inspection: These procedures shall be used to preclude the use of nonconforming materials and to ensure that only correct and accepted items are used and installed;
- Identification and Inspection Status: a system for identifying the progressive inspection status of equipment, materials, components, subassemblies, and assemblies as to their acceptance, rejection, or non-inspection shall be maintained;

- Identification and Control of Items: an item identification and traceability control shall be provided;
- Handling, Storage, and Delivery: provide for adequate work, surveillance and inspection instructions.

The Plan shall ensure that conditions adverse to quality such as failures, malfunctions, deficiencies, deviations, and defects in materials and equipment shall be promptly identified and corrected.

The Plan shall provide for establishing, and maintaining an effective and positive system for controlling non-conforming material including procedures for the identification, segregation, and disposal of all non-conforming material. Dispositions for the use or repair of non-conforming materials shall require the Engineers consent.

11.3. Plan Implementation and Verification

The Plan shall clearly define the QA Organisation. Management responsibility for the QA shall be set forth on the Contractor's policy and organisation chart. The Plan shall define the requirements for QA personnel, their skills and training. Records of personnel certifications shall be maintained and monitored by the QA personnel. These records shall be made available to the Engineer for review, upon request.

The QA operations shall be subject to the Engineers, Employer or Employer's authorised representative's verification at any time, including: surveillance of the operations to determine that practices, methods and procedures of the plan are being properly applied; inspection to measure quality of items to be offered for acceptance; and audits to ensure compliance with the Contract documents.

Monthly Quality Report (MQR): The contractor shall submit the Monthly Quality Report to the Engineer. MQR will contain, apart from the Material Testing Reports, the following major items:

a) Status of Approval of Method Statements: The Contractor shall submit Method Statements including check lists & ITP (Inspection & Test Plan) for execution of each and every item of work including temporary works at least four weeks before their execution, conforming to the outline construction specifications given in the contract document for review and approval by the Engineer. (copies of sample Method Statements are available with the Engineer).

b) Quality Walk: Quality Walk of the project site shall be held once in a week by the employer/Employer's authorized representative.

c) Weekly Quality Report (WQR): The contractor shall submit the Weekly Quality Report for review of the quality by the Engineer in weekly progress review meeting. The WQR will be based on the lines of MQR.

d) Internal Quality Audit (IQA): The contractor shall conduct an internal audit of the quality of the project by the quality team of their HQ every month and shall submit the report to the Engineer.

e) External Quality Audit (EQA): The contractor shall get conducted the External Quality Audit quarterly by the reputed agency approved by the Engineer and shall submit the report to the Engineer.

f) Calibration of Batching Plant: The contractor shall be done the calibration of batching plant, immediately after installation of the batching plant and at an interval of six months thereafter, by a reputed external agency approved by the Engineer. However, the contractor shall check the calibration in presence of Engineer's authorized representative on regular basis at least once in a month.

g) Laboratory at Site: The contractor shall get calibrated the Laboratory equipment and their dial gauges from the reputed agency/laboratory accredited by NABL and approved by the Engineer. The calibration certificate including their validity shall be displayed near each and every equipment of the Lab.

h) External Laboratory for Conducting Tests: The contractor shall get conducted the tests of materials and elements of the work for which testing facility is not available in the field Lab, from the external laboratories having valid accreditation of NABL approved by the Engineer. In addition to this, the contractor shall get conducted 5% of the tests, for which testing facility is available in field Lab also, in the external Lab, to facilitate independent review.

i) Water: The contractor shall get the water tested, from the reputed external laboratory approved by the Engineer, at the start of the work and at an interval of three months thereafter. The contractor shall also conduct the testing of the water at least once in a month in the field laboratory.

j) Status of deployment of Machinery and other T&P (Tools & Plants): The contractor shall deploy machinery and other T&P as per the provisions of the contract. Method statements approved by the Engineer and as per the requirement of the site. The contractor shall indicate the schedule of deployment of the machinery and other T&P in the Monthly Quality Report. The fitness of the machinery and other T&P shall be regularly got checked by the contractor by external inspection/Audit Team.

k) NCNs (Non-Conformity Notice) of quality issued by Engineer/Employer & NCR's (Non-Conformity Report) of quality raised by the Contractor: The status of NCNs and NCRs of quality shall be included by the contractor in the Monthly Quality Report.

The Contractor shall provide all necessary access, assistance and facilities to enable the Engineer to carry out on-site and off-site surveillance of Quality Assurance Audits to verify that the quality system which has the consent of the Engineer is being implemented fully and properly.

APPENDIX 12

CONTRACTOR'S SITE LABORATORY

12. SITE LABORATORY

12.1 The Site Laboratory shall be approximately 250m^2 in area. It shall consist of the following accommodation:

1 concrete laboratory	60 m^2 floor area
1 Soil laboratory	30 m^2 floor area
2 office	each 15 m^2 floor area
1 storeroom	10 m^2 floor area
1 kitchen	10 m^2 floor area
Male *& female* toilets, changing room & shower	sufficient for 6 persons

12.2 The remainder of the 250m^2 shall consist of storage area for concrete cube curing tanks. The laboratory, office etc. shall be in one building; the curing tank storage building may be in a separate building, but if so, it shall be adjacent to the laboratory building & connected to it by a level, weatherproof passageway. In addition, an area of covered hard standing of 50m^2 for motor vehicles shall be provided adjacent to the laboratory.

12.3 STANDARD OF CONSTRUCTION

12.3.1 *The laboratory shall be constructed to the best Engineering practice and as approved by* the Engineer. Two independent telephone lines with two extensions each shall be provided for the laboratory. Telephones shall be in areas as agreed with the Engineer.

12.3.2 A water tank with minimum capacity of 2000 litres shall be installed, as a source of constant water pressure (15 kPa minimum) for each laboratory.

12.3.3 In the case of sinks used for washing samples, adequate trapping and/or separating devices shall be provided to ensure the proper functioning of the facility.

12.4 FURNISHINGS AND FIXTURES

The contractor's site laboratory shall be provided with required furnishings and fixtures.

12.5 LABORATORY EQUIPMENT

12.5.1 The laboratory equipment, as listed below, shall be approved by the Engineer. The Contractor shall submit for the Engineer's approval within 2 weeks of the order to commence work the name of the supplier it intends to use for each piece of apparatus together with the relevant catalogue number. All the equipment shall be ISI marked. The list of equipment for earthwork shall be as per Annexure-VIII and Appendix -N of RDSO Specification No. RDSO/2020/GE:IRS-0004, September 2020. Equipment for concreting shall conform to specification given in relevant IS codes.

12.5.2 The layout of the equipment in the testing laboratory shall be instructed by the Engineer. The equipment shall be maintained to an accuracy appropriate to the required testing methods with routine calibration by an accredited organization as recommended by the appropriate Authority. Equipment shall also be calibrated after maintenance or relocation.

12.5.3 The Contractor's site laboratory shall be equipped with the following material testing equipment as a minimum. The nature and quantity of equipment required for testing may be varied by the Engineer depending on the detail of the Contractor's Design and

Construction methods or for any other reason which he deems to be valid and necessary for the proper control of quality:

S. No	***Description***	***Unit***
1.	*Determining Liquid Limit*	*1 complete set.*
2.	*Liquid limit device (Casagrande type)*	*2 Set.*
3.	*Cone penetrometer*	*2 Nos.*
4.	*Grooving tools*	*3 Nos.*
5.	*Evaporating dish*	*2 Nos.*
6.	*Spatula 100mm blade*	*2 Nos.*
7.	*Laboratory balance, capacity 500 gm, (Sensitivity 0.01 gms.)*	*1Nos.*
8.	*Wash bottle, capacity 500 ml.*	*3 Nos.*
9.	*Wash bottle, capacity 1 lit.*	*2 Nos.*
10.	*Moisture cans, capacity 50 ml.*	*36 Nos.*
11.	*Determining Plastic Limit*	*(1 complete set)*
12.	*Glass plate 50cm x50cm x10 mm*	*3 Nos.*
13.	*Stainless steel rods, 3 mm dia.*	*2 Nos.*
14.	*Determining Moisture Content*	*1 complete set.*
15.	*Micro Oven- thermostatically controlled to maintain a temperature 105 to 110 °c.*	*1 No.*
16.	*Electronic weighing machine capacity 200 gm., sensitivity 0.01 gm.*	*2 Set.*
17.	*Lab. Tongs*	*1 No.*
18.	*Moisture cans 75ml. with lid*	*36 Nos.*
19.	*Compaction Characteristics*	*1 complete set.*
20.	*Standard compaction mould 100mm dia.*	*6 Nos.*
21.	*Modified compaction mould 150mm dia.*	*6 Nos.*
22.	*Standard compaction Rammer, 2.6 kg.*	*2 Nos.*
23.	*Modified compaction Rammer, 4.89 kg.*	*2 Nos.*
24.	*Straight edge 300mm long*	*2 Nos.*
25.	*Sample ejector for 100mm and 150mm mould*	*2 Nos.*
26.	*Sample tray 60 x 60 x 8 cm*	*10 Nos.*
27.	*Wash bottle, 500 ml.*	*2 Nos.*
28.	*Moisture cans 250 ml.*	*80 Nos.*
29.	*Density of soil in-place by sand cone method*	*2 complete set.*
30.	*Sand density cone apparatus, 150mm*	*2 Nos.*
31.	*Plate, 300mmx300mm with center hold 150mm*	*2 Nos.*
32.	*Glass jug for sand cone*	*2 Nos.*
33.	*Chisel 25mmx 150mm*	*6 Nos.*
34.	*Hammer*	*6 Nos.*
35.	*One-gallon field cans*	*24 Nos.*
36.	*Sampling spoon*	*3 Nos.*
37.	*Soft hairbrush*	*3 Nos.*

S. No	*Description*	*Unit*
Sieve Analysis		
38.	*Electric Sieve shaker (portable)*	*1 unit*
39.	*Coarse sieves in Sizes from 100mm to 10mm (As per IS 383 table no. 2) Fine Sieves 10mm, 4.75mm, 2.63mm, 1.18mm, .600mm, .300mm, .150mm) Pans & Covers Specific Gravity and Absorption of Coarse Aggregate Wire basket, 200mm dia.*	*1 Set each*
40.	*Heavy duty suspension balance, 20 kg x 1 gm. with accessory for weight in water.*	*2 Set.*
41.	*Suitable water container*	*1 Nos.*
42.	*Unit Weight of Aggregate Balance, 100 kg. capacity with 10 gm precision*	*1 No.*
43.	*Tamping rod 16mm diameter x 600mm long*	*3 Nos.*
44.	*Measuring containers (3,10,15,30 liters)*	*1 each*
45.	*Flakiness and Elongation Flakiness gauge, elongation index*	*2 Set.*
46.	*Soundness Test*	
47.	*Sodium sulphate*	*25 Kg.*
48.	*Soaking tank*	*1 Nos.*
49.	*Balance, Capacity 3 kg., Sensitivity 0.1 gm.*	*1 Set.*
Concrete		
50.	*Buckets for concrete sampling*	*12 Nos.*
51.	*Slump cone*	*12 Nos.*
52.	*Tamping rod*	*12 Nos.*
53.	*Base plate*	*12 Nos.*
54.	*Mixing pan for concrete*	*2 Nos.*
55.	*Scoop for general purpose*	*6 Nos.*
56.	*Concrete thermometer*	*6 Nos.*
57.	*Concrete cylinder mould, 150 mm * 300 mm;*	*30 each*
58.	*150 mm * 200 mm*	*30 each*
59.	*Concrete cube mould, 100 mm cube & 150 mm cube*	*10+100 each*
60.	*Adjustable spanners for dismantling cube moulds*	*6 Nos.*
61.	*Capping set*	*2 Nos.*
62.	*Capping Compound*	*As per requirement*
63.	*Riffle*	*1 No.*
64.	*Concrete curing tank with capacity for 270 cubes, temperature controlled, with circulation system drain and lockable cover*	*2 Nos.*
65.	*Schmidt test hammer*	*1 No.*
66.	*Compression testing machine (Fully automated)*	*1 No.*
67.	*Mould oil*	*As per requirement*
68.	*Temperature chart recorder*	*1 No.*
Miscellaneous		
69.	*Vernier calipers to measure up to 200mm, with elongated jaws*	*5 Nos.*
70.	*Steel rule, 300 mm long graduated*	*2 Nos.*
71.	*Rubber gloves*	*10 pr.*
72.	*Cotton working gloves*	*20 pr.*

S. No	***Description***	***Unit***
73.	*First aid kit*	*1 Set.*
74.	*Wire brush*	*6 Nos.*
75.	*Steel tape, 3m, 5m, 30m*	*3 each.*
76.	*Ball peen hammer, 1 kg*	*2 Nos.*
77.	*Paint scraper. Approx. 100mm wide*	*8 Nos.*
78.	*Float, steel Approx.280 x 120 mm*	*8 Nos.*
79.	*Sack barrow*	*1 No.*
80.	*Shovel: Square Mouthed*	*2 Nos.*
81.	*Round Mouthed*	*2 Nos.*
82.	*24- wheel trolley, heavy duty, approx. 0.7m x 1.0m long pneumatic tyred type*	*2 Nos.*
83.	*Wheelbarrow, rubber tyred*	*1 Nos.*
84.	*Comprehensive tool kit. To include screwdrivers, pliers, claw hammer, multi-grips, spanners (adjustable)*	*1 No.*
85.	*Type NR Schmidt Hammer and tester with recording device*	*1 No.*
86.	*Testing Anvil for Schmidt Hammer test (SHT)*	*1 No.*
87.	*Chart recording paper for SHT*	*10 pkts.*
88.	*Cover meter for detecting metal objects to depth of 100mm below the surface of non-magnetic objects*	*3 Nos.*
89.	*Noise meter*	*1 No.*
90.	*RCPT Testing Machine with mould*	*1 No.*
91.	*Permeability Testing Machine*	*1 No.*
92.	*Rain Gauge*	*1 Set.*
93.	*Loss angeles abrasion machine*	*1 Set.*
94.	*Mortar cube casting machine*	*1 Set.*
95.	*Cement testing kit as per Is-4031*	*1 Set.*
96.	*Nuclear Moisture Density Gauge (NMDG) Apparatus*	*2 Set.*
97.	*Core cutter with dolly and hammer (as per appendix D od RDSO-004)*	*4 Set.*

S. No.	***Consumable Item***
1	*Sieve brush Wire brush*
2	*Sodium carbonate*
3	*Sodium hexa meta phosphate.*
4	*Kerosene Mercury*

S. No.	***Additional Equipment***
1	*Hand auger 150mm dia with extension rod*
2	*Sampling tube 100mm dia. And 450mm length*

Note: All machines and equipment should have Calibration Certificate.

Appendix 13

Environment, Social, Health and Safety Management Manual

Table of Contents

1. ESHS FRAMEWORK

1.1. General

1.1.1. The Contractor shall be responsible for Environment, Social, Health and Safety (ESHS) on the Site and any other areas being used by him for the purposes of the Contract. Each Contractor shall develop his own contract specific ESHS Management Plan, which will represent his approach to the management of ESHS activities on his work, sites under the Contract with the Employer. The ESHS Management Plan should contain all the measures in the project Environmental and Social Management Plan (ESMP) which is part of the EIA.

1.1.2. The Contractor shall ensure that all appropriate ESHS measures are implemented throughout the execution of the Works.

1.2. Scope

1.2.1. The Environment, Social, Health and Safety Management Manual defines the principal requirement of the Employer and forms an essential part of the overall Environment, Social, Health and Safety Management System proposed to be employed by the Employer for the construction of the Project.

1.3. Definition

a) HEALTH & SAFETY – Conditions and factors that affect the well-being of employees, temporary workers, Contractor personnel, visitors and any other person at the workplace;

b) ENVIRONMENT – Surroundings in which an organization operates, including air, water, land, natural resources, flora, fauna, humans, and their interaction;

c) ENVIRONMENT ASPECT – Element of an organization's activities or products or services that can interact with the environment;

d) ENVIRONMENT IMPACT – Any change to the environment, whether adverse or beneficial, wholly or partially resulting from an organization's environmental aspects;

e) HAZARD – Source, situation, or act with a potential for harm in terms of human injury or ill health or a combination of these;

f) Ill Health – Identifiable, adverse physical or mental condition arising from and/or made worse by a work activity and/or work-related situation;

g) Incident – Work related event (s) in which an injury or ill health (regardless of severity) or fatality occurred, or could have occurred:

- "Accident" is an incident which has given rise to injury, ill health or fatality;
- "Emergency" is an incident having potential to affect many persons orsevere property damage;
- "Near Miss" is an incident or a situation with clear potential for an undesirable outcome to occur, even though no actual negative consequenceshappened. In other words, it is an event with potential to cause injury, property damage, environmental release or an adverse community reaction; and
- "Dangerous Occurrence" is an unplanned and undesired occurrence(incident) which

has the potential to cause injury, and which may or maynot cause damage to property, equipment or the environment.

h) AUDIT – Systematic examination to determine whether activities planned areimplemented effectively and related results are suitable for achieving theorganization policy and objectives;

i) INTERESTED PARTIES – Individual or group concerned with or affected by the ESHS Management Performance of an Organization;

j) NON-CONFORMITY – Any deviation from work standards, practices, procedures, regulations, management system performance, etc. that could either directly or indirectly lead to injury or illness, property damage, damage to workplace environment, or a combination of these;

k) OBJECTIVES – Goals in terms of ESHS Management Performance that an organization sets itself to achieve;

l) ESHS MANAGEMENT SYSTEM – Parts of overall management system that facilitates the management of the ESHS risks associated with the business of the organization. This includes the organizational structure, planning activities, responsibilities, practices, procedures, processes and resources for developing, implementing, achieving, reviewing and maintaining the organization's ESHS Management Policy;

m) ORGANIZATION – Company, operation, firm enterprise, institution or association, or part thereof, whether incorporated or not, public or private, that has its own functions and administration;

n) PERFORMANCE – Measurable results of the ESHS Management System, related to the organization's control on environment, health and safety risks, based on its ESHS Management Policy and objectives;

o) RISK – Combination of the likelihood and consequences of a hazardous event occurring;

p) RISK ASSESSMENT – Overall process of establishing the magnitude of risk and deciding whether the risk is tolerable;

q) ACCEPTABLE RISK – Risk that has been reduced to a level that can be tolerated by the organization having regard to its legal obligations and its own ESHS Policy;

r) DEVIATION – Is defined as something not in compliance with quality standard, specification or measuring requirements, or as deviations from specified procedures or way of working within production, environment, working environment (safety) or security;

s) CORRECTIVE ACTION – Action taken to eliminate the causes of an existing non-conformity, defect or other undesirable situation;

t) PREVENTIVE ACTION – Action taken to eliminate the causes of a potential non-conformity, defect or other undesirable situation to prevent occurrence or recurrences;

u) ENGINEER – Employer's Representative

v) Abbreviation

- "Ministry of Environment, Forest and Climate Change, Government of India" is abbreviated as MoEFCC;

- "Central Pollution Control Board" is abbreviated as CPCB;
- "State Pollution Control Board" is abbreviated as SPCB;
- "Haryana Pollution Control Board" is abbreviated as HPCB;
- "National Green Tribunal" is abbreviated as NGT;
- The use of "shall" indicates a mandatory requirement. "ESHS" means Environment, Social, Health and Safety;
- "Haryana Rail Infrastructure Development Corporation Limited" is the Employer abbreviated as HRIDC;
- "ESHS Manager" is an officer approved by the Engineer who is overall responsible for monitoring all ESHS functions prescribed in this document on behalf of the Contractor;
- "BOCWA" Building and Other Construction Workers (Regulation of Employment and Conditions of Service) Act, 1996 and amendment done thereafter;
- "BOCWR" Haryana Building and Other Construction Workers (Regulation of Employment and Conditions of Service) Rules, 2005 and amendment done thereafter;
- "BOCWWCA" Building and Other Construction Workers' Welfare Cess Act, 1996;
- "BOCWWCR" Building and Other Construction Workers' Welfare Cess Rules, 1998;
- "CHIEF INSPECTOR" is the Chief Inspector of Inspection of Building and Other Constructions of Government of Haryana;
- "HIRA" is Hazard Identification and Risk Assessment; and

1.4. Application of This Document

1.4.1. This document applies to all aspects of the Contractor's Scope of Work including Subcontractors and all other agencies. There shall be no activity associated to the Contract, which is exempted from the purview of this document.

1.5. Purpose of This Document

1.5.1. The objective of these guidelines is to ensure that adequate precautions are taken for incident/occupational illness free safe work execution as well as to avoid harmful effects on the environment and social during construction.

1.5.2. This document:

a) Describes the Environment, Social, Health and Safety interfaces between theEngineer and the Contractor;

b) Details the processes by which the Contractor shall manage Environment, SocialHealth and Safety issues while carrying out the work under the contract.

1.5.3. These requirements shall be read together with, ISO 45001: 2018 Occupational Health and Safety Management System and ISO 14001: 2015 Environmental Management Systems.

2. ESHS MANAGEMENT

2.1. General

2.1.1. This document defines the principal requirements to be practiced at the Site at all times.

2.2. ESHS Targets and Goals

2.2.1. Following ESHS targets and goals shall be set and achieved by the Contractor/Subcontractor based on time bound work plan:

a) Zero total recordable injuries;

b) Zero non-conformances in respect of statutory laws related to Environment, Health, Social and Welfare measures, living conditions and Safety regulations.

c) Total compliance of recording and reporting of all types of incidents.

d) 100% compliance on Safety Induction of all personnel

e) Total compliance of conducting inspections and audits as per approved ESHSManagement Plan;

f) 100% incident recording and reporting;

g) 100% adherence to usage of appropriate PPEs at work;

h) Executing construction work with least disturbance to the environment, adjoiningroad users and traffic;

i) Minimize waste generated at sites and maximize reuse of materials;

j) Maintaining environment conditions of site as per statutory requirement of HPCB,NGT etc. to avoid penalty;

k) To achieve construction site as zero discharge site as far as possible.

2.3. Contractor's Obligation to Abide by Mandatory Legislations and Standards

2.3.1. The construction works shall be undertaken in accordance with the Employer's ESHS Management Policy and Management Systems as amended from time to time provided in ESHS Management Manual.

2.3.2. The construction works shall be undertaken in accordance with all updated applicable legislation listed below, but not limiting to:

a) Indian Electricity Act 2003 and Electricity Rules, 2005;

b) National Building Code, 2016;

c) Factories Act, 1948 and state respective factory Rules;

d) Motor Vehicles Act as amended in 1994 and The Central Motor Vehicles Rules,1989;

e) Indian Road Congress Code IRC: SP: 55-2014 'Guidelines on Safety in Road Construction Zones';

f) The Petroleum Act, 1934 and Rules, 1976;

g) Gas Cylinder Rules, 2003;

h) Indian Explosives Act, 1884, along with the Explosives Substance Act, 1908 andthe Explosives Rules, 1983;

i) Environmental and Social Legislations as listed in Clause 6.0 of this document.

2.4. Contractor's Environmental, Social, Health and Safety Management Policy and Plan

2.4.1. The Contractor as per Rule 39 of the BOCW Central Rules shall formulate an Environment, Social, Health & Safety policy and display it at conspicuous places at work sites in English and Hindi so that the policy shall be understood by majority of the construction workers. The policy shall contain the following as minimum coverage:

a) The intention and commitments of the Contractor regarding Environment, Social, Health & Safety protection of the workers;

b) Organizational arrangement made to carry out the policy specifying the responsibilities at different levels of hierarchy;

c) Responsibilities of the Contractors, Subcontractor, transporter or other agencies involved in the construction work ;

d) Techniques and methods for assessment of Aspects/Impact and risk to safety and health and remedial measures;

e) Arrangement for training of workers, supervisors or other persons engaged in the construction work;

f) Other arrangements for making the policy more effective.

2.4.2. The Contractor shall revise the policy whenever any modification having implication on the Environment, Social, Health and Safety of the workers is made or any new construction work, substances, or technique are introduced which have implication on environment, health and safety of workers.

2.4.3. The contractor shall submit ESHS Management plan for review by the engineer within 28 days after the commencement date.

2.4.4. The Contractor shall revise and submit the ESHS Management Plan if at any time the ESHS Management Plan is insufficient in the Engineer's opinion. The Contractor shall within 7 days submit the revised ESHS Management Plan to the Engineer for review.

2.4.5. Any omissions, inconsistencies, and errors in the ESHS Management Plan or the Engineer's acceptance or rejection of the ESHS Management Plan and/or supplements thereto shall be without prejudice to the Contractor's obligations with respect to site safety, industrial health and environment and shall not be excused for any failure by the Contractor to adopt proper and recognized safety practices throughout the execution of the Works. The Contractor shall adhere to the ESHS Management Plan and shall ensure, as far as practically possible, that all supervisors and subcontractors of all tiers each have a copy of the ESHS Management Plan on the Site and comply with its provisions.

2.4.6. The details of contents to be covered in the ESHS Management Plans are given in Attachment - 1[Contents of ESHS Management Plan] of this document.

2.4.7. Contractor will inform AIIB of any significant ES events such as accidents, near misses, fatalities. AIIB is to be informed within two days of the event.

2.5. Designer's Role

2.5.1. The Designer's primary role includes to minimize the risk to environment, safety and health of those who are going to construct, maintain, clean, repair, dismantle or demolish the structures and anyone else like adjoining road users/public, who might be affected by the work.

2.5.2. Every temporary structure like scaffold, temporary deck, earth retaining structures etc. shall be properly designed.

2.6. Site ESHS Organisation

2.6.1. The Contractor shall appoint the required ESHS Management Personnel as prescribed in the Contract.

In order to effectively implement labour welfare provisions and to interact on such provisions with the Employer and the statutory authorities enforcing the labour welfare legislations, every Contractor shall employ fulltime, qualified, and experienced Labour Welfare Officer.

2.6.2. **Conduct and Competency**

The Contractor shall ensure that all personnel are competent to perform the job assigned to them. In the event that the Contractor is unable to demonstrate the competency of any person whose activities can directly impact the Works' Environment, Social, Health & Safety performance, the Engineer shall remove that person from the Site without any procedural formalities.

Labor Code of Conduct: The Contractor shall have a Code of Conduct for the Contractor's Personnel. The Contractor shall ensure that each Contractor's Personnel is provided a copy of this Code of Conduct, written in a language comprehensible to that person, and shall seek to obtain that person's signature acknowledging receipt of the same.

2.6.3. **Approval from The Engineer**

The name, address, educational qualification, work experience and health condition of each ESHS personnel deployed shall be submitted to the Engineer for approval well before the start of the Works or before deployment whichever is earlier. These personnel are authorized to work only after approval of the Engineer. In case any ESHS personnel leaves the Contractor, the same shall be intimated to the Engineer within a week. Non-informing the employer will attract penalty. The Contractor shall recruit new personnel and fill up the vacancy before relieving a person. Proper handing over of all the documents shall be ensured before relieving a person.

2.6.4. The Contractor shall provide all ESHS Management Personnel with such facilities, equipment and information that are necessary to enable them to discharge their duties effectively. The minimum requirements of such facilities/equipment to be provided for ESHS Management Personnel are given in Attachment-4 [General Instruction:ESHS/GI/001].

2.7. Responsibility of ESHS Personnel

2.7.1. PICOW (Person In-Charge of Work)

a) "Person in Charge of Work" under whose supervision, the Workers operate as per approved method statement and ESHS Management Manual.

b) PICOW shall lead/supervise and direct the Workers to undertake the work in a safe manner.

c) Each Request for Inspection (RFI) must indicate the name of PICOW for that work.

2.7.2. Responsibility of a PICOW

PICOW should ensure that:

a) A safe system of work is adopted;

b) Everyone in the group is briefed and understand the system of work before work starts;

c) The current system of work is altered whenever there is any change in conditions or circumstances make it necessary and ensure that everyone understands the new arrangements; and

d) The work is stopped and everyone moved to a position of safety immediately, should there be any doubt whether the work may safely continue.

2.7.3. All ESHS Management Personnel are to report to the ESHS Manager who shall always report

directly to the Contractor's Project Manager. Their primary role is to oversee environment, social, health and safety aspects at work site. The Engineer shall always monitor adherence to this procedure. In case of non-adherence penalty shall be levied.

2.8. ESHS Committee

2.8.1. The Contractor shall form Site ESHS Committee within 60 days of award of the Contract and notification regarding the same shall be communicated to the members.

2.8.2. The Terms of Reference for the Site ESHS Committees shall be as follows:

a) To oversee implementation of the Contractor's Environment, Social, Health and Safety policies and practices;

b) To monitor the adequacy of the Contractor's ESHS Management Plan and ensure its implementation;

c) To review ESHS training;

d) To review the Contractor's ESHS monthly reports;

e) To identify probable causes of accident and unsafe practices in construction work and to suggest remedial measures;

f) To stimulate interest of the Workers in environment, health and safety by organizing environment/safety week, safety competition, talks and film-shows on environment/safety, preparing posters or taking similar other measures as and when required or as necessary;

g) To go around the Site with a view to check unsafe practices and detect unsafe conditions and to recommend remedial measures for their rectifications including first-aid medical and welfare facilities;

h) Committee team members should perform a site inspection before every committee meeting and to monitor ESHS inspection reports;

i) To bring to the Notice of the Engineer hazards associated with use, handling and maintenance of the equipment used during the course of construction work;

j) To suggest measures for improving environment, social, health and safety in construction work at the Site;

k) To investigate the health hazards associated with handling different types of explosives, chemicals, and other construction materials and to suggest remedial measures including personal protective equipment; and

l) To review the last ESHS committee meeting minutes and the remedial measures taken for Non-Compliance.

Chairman	Project Manager
Secretary	ESHS Manager (Will be nominated by Project Manager)
Members	i) Contractor's ESHS staff. ii) Labour Welfare Officer; iii) In -charge of Plant and Machinery & Site Electricals; iv) In-charge of Special Work Operations (e.g. bridge, viaduct, and tunnel, etc.); v) In-charge of Stores; vi) Subcontractor's representative; and vii) Workers' representatives;
Engineer's Representatives	To be nominated by the Engineer

2.8.3. **Minimum time between two monthly ESHS Committee meetings**

A minimum period of 21 days shall be maintained between any two ESHS monthly committee meetings.

2.8.4. **Agenda**

The Secretary shall circulate the agenda of the meeting at least seven working days in advance of the scheduled date of the meeting to all members as well as to the Employer.

2.8.5. The agenda should broadly cover the following:

a) Chairman's overview of ESHS Management Performance;
b) Confirmation of minutes of last meeting;
c) Previous month ESHS statistics;
d) Incident and accident investigation/Dangerous occurrence/Near miss report;
e) Site ESHS inspection and compliance report;
f) The Contractors' ESHS issues;
g) Report from the Employer and Engineer;
h) Non-compliances raised by Engineer/Statutory Authorities;
i) Report and compliance of GRC; and
j) Any other concern.

2.8.6. In case of station and other contiguous areas where more than one main Contractor is working together, the Engineer shall instruct the other Contractors/ Sub-contractors to join for the monthly ESHS committee meeting of the main civil Contractor, to discuss and decide about the common provision of safety, security, lighting, toilet, drinking water etc. and sharing the maintenance cost of the same etc.

2.8.7. The Minutes of the Meeting shall be prepared as per the format provided and sent to all members within 2 working days by mail. Minutes of ESHS Committee Meeting shall also be displayed on the notice board for wider publicity to all concerned.

2.8.8. The chairman shall inform the members of any outstanding issues in the meeting and in case of repeated offence/ non-compliance by some members or other Subcontractors shall impose suitable disciplinary action including provisions of monetary penalty as per Clause 7. [Financial Deduction/Withholding].

2.8.9. In addition, there shall be a Project ESHS Committee whose composition shall be as follows:

Chairman	Project Director
Secretary	ESHS Manager (Will be nominated by PD)
Members	i) Deputy Project Director/Civil ii) Project Manager along with ESHS manager from each Contract Package iii) ESHS experts of GC
Employer's Representatives	Chief Project Manager

2.8.10. Project ESHS Committee shall also meet once a month after the meeting of Site ESHS Committee. Project ESHS Committee shall oversee the implementation of ESHS Policy and ESHS Management Plan of the Contractor in execution of the Project. This Committee shall also redress the grievances/complaints/representations received from public, other stakeholders and employees of the Contractor and Subcontractors. The agenda of the meeting shall be circulated by the Secretary of the Committee after taking approval from the Project Director.

2.9. ID Card and ESHS Induction

2.9.1. The Contractor shall ensure that all personnel working at the Site receive an induction ESHS training immediately on the first day of joining explaining the nature of the work, the hazards that may be encountered during the site work. Personnel shall only be deployed at site once he/she has completed ESHS induction. The training shall cover the contents as given in Clause 8, Attachment-4[General Instruction: ESHS/GI/002].

2.9.2. All personnel shall be issued a photo identity card as per the format given in Clause 8, Attachment-4[General Instruction: ESHS/GI/003].

2.9.3. The Contractor shall also issue a Personnel pocket ESHS Booklet in a language known to the Workers, which provides information on ESHS and emergency procedures

2.10. Other ESHS Training

2.10.1. The Contractor shall organize the ESHS training to engage managers, supervisors and other personnel in behavioural change and improve safety performance. The contents of ESHS training to managers/supervisors as given in Attachment-4[General Instruction: GI/005].

2.10.2. The Contractor shall provide a training/workshop on ESHS to all its workers/staff/employees/subcontractors of at least 2 days. It shall be completed in various modules and each employee/worker shall have a record of completing all modules.

2.10.3. On-the spot practical skill development training on height safety including scaffold safety, crane safety, welding safety, electrical safety, and traffic safety for marshals shall also be conducted.

2.10.4. Every employee including workman shall take a safety oath followed by toolbox talk every day.

2.10.5. All vehicles and machine drivers including heavy work vehicle and machine operators shall be trained on defensive driving with necessary certificate or license.

2.11. ESHS Inspection

2.11.1. The Contractor shall evolve and administer a system of conducting ESHS inspection and other risk management analysis on a periodical basis.

2.11.2. The purpose of ESHS inspection is to identify any deviation in construction activities and operations, machinery, plant and equipment and processes against the ESHS Management Plan and its supplementary procedures and programs.

2.11.3. The Contractor shall initiate a monthly joint site ESHS Management inspection with the Engineer and report shall be generated on the same day with the corrective action and accepted target date (within a week) by the Engineer.

2.11.4. The Compliance of the joint inspection "Non-Conformance" shall be witnessed/accepted by the Engineer.

2.11.5. The Contractor shall submit follow up compliance report of the weekly ESHS inspection report within six days of the date of Inspection.

2.11.6. The Contractor shall evolve and administer a system of conducting ESHS inspection and other risk management analysis on a periodical basis.

2.11.7. Following ESHS inspections program shall be adopted:

a) Planned general inspection;

b) Routine inspection;

c) Specific inspection; and

d) Other inspection.

2.11.8. Planned general inspections are performed at predetermined intervals. Inspections that will be classified under this inspection program are:

a) Monthly Contractor and subcontractor's site safety committee inspection;

b) Weekly safety inspection by construction supervisors (the Contractor and the Subcontractor); and

c) Daily safety inspection by the Contractor site ESHS team.

2.11.9. Routine inspections are often referring to the inspection of the Site, equipment and temporary structures performed by the Site and equipment operators and temporary structure erectors.

Inspections that will be classified under this inspection program are:

a) Daily inspection of plant and equipment by operators;

b) Weekly inspection of scaffold by scaffolding supervisors;

c) Monthly Inspection of electrical hand tools by competent electrical supervisors;

d) Quarterly inspection of temporary electrical systems by competent electrical supervisors; and

e) Half-yearly inspection of lifting machinery, lifting appliances, equipment and gears by Govt. approved competent persons.

f) Quarterly inspection of lifting gears, tools tackles and appliances.

g) Quarterly colour coding of lifting gears, tools & tackles. The recommended colour coding for the 4 quarters of the years shall be as under

i) January – March: GREEN

ii) April – June: YELLOW

iii) July – September: BLUE

iv) October – December: WHITE

2.11.10. The list mentioned above is not exhaustive. The Contractor may add additional categories. The ESHS Manager will ensure that a system of routine inspections is carried out periodically to all plants, equipment, powered tools and any other temporary structures that will pose a hazard to operators and workmen.

2.11.11. **Specific Inspection**

Specific inspections are performed on activities without a predetermined date. Competent supervisors usually perform inspections for ensuring an activity whether it is executed in accordance to a general set of rules; Method Statement submitted or developed procedures.

The following are examples that will be commonly performed as required on the Site:

a) Inspection performed before a heavy lifting operation;

b) Inspection performed before and after the entry of person into a confined space;

c) Inspection performed before and after a welding and gas cutting operation;

d) Inspection of formwork before concreting by formwork erector.

The list mentioned above is not exhaustive. The Contractor shall ensure that a competent supervisor inspects all high-risk processes and activities.

2.11.12. Other inspections include the following:

a) Mandatory inspections by Labour Department of Government of Haryana; and

b) HRIDC site ESHS management team.

c) Inspections by Central Pollution Control Board, Haryana Pollution Control Board, Ministry of Environment and Forest and Climate Change, National Green Tribunal etc.

2.11.13. The Contractor shall prepare all required safety inspection checklist for all activity operations and equipment. Checklists will be prepared based on the Indian SafetyStandards, Rules and Regulations and the Works requirements.

2.11.14. All inspection records and reports will be properly kept and filed for audit purpose. Inspection reports of planned general inspection and routine inspection will be used for discussion during safety committee meetings.

2.11.15. The contractor project manager & ESHS expert with site team shall be participating in the ESHS inspection.

2.12. ESHS Audit

2.12.1. The purpose and scope of ESHS Audit is to assess potential risk, liabilities and the degree of

compliance of the ESHS Management Plan and its supplementary procedures and programs against applicable and current ESHS legislation regulations and the Works requirements.

2.12.2. The Contactor's project manager shall hold the ultimate responsibility in ensuring implementation of ESHS audit program during the construction work.

2.12.3. Monthly Audit Rating Score (MARS)

2.12.4. Monthly Audit Rating Score (MARS) will be performed once in a month. A team consisting of the Contractor's project manager and the Engineer's representative based on the pre-designed score-rating format will conduct it.

2.12.5. This Monthly ESHS Audit Rating Score (MARS) report will enable the Engineer to evaluate the general compliance by the Contractor with the Conditions of Contract, and the ESHS Management Plan. A Minimum Compliance level to achieve 75% overall Audit Rating is essentially required. Falling this, the Engineer will take punitive action which includes non-processing of running account bills.

2.12.6. The Contractor's project manager accompanied by the Engineer's representatives shall carry out the Audit. The Contractor's senior manager and the ESHS in-charge should also be invited to attend.

2.12.7. **Timing**

The Monthly Audit Rating Score (MARS) should be conducted at least 7 days prior to the scheduled date of monthly ESHS Committee Meeting.

2.12.8. **Evaluation**

The numerical scoring has been weighed on a 1-10 scale. The audit team will use their observations noted in evaluating the points to be awarded against each of the elements of the audited section. Wherever some topics and sub-topics are not applicable the score rating need not be given. The overall audit ratings shall be achieved by:

$$\text{Overall Audit rating} = \frac{\text{Actual Score Achieved}}{\text{Maximum Possible Score}} \times 100$$

The criticality of the required actions for the respective sections of the Audit will be classified as:

S.No.	Score	Description	Action
1	< 60%	Immediate	Require the Contractor to rectify within 24 hours
2	< 75%	Improvement Necessary	The Contractor rectification within 7 days and confirmed in writing to the Engineer
3	< 90%	Improvement Desirable	The Contractor rectification within 1 month and confirmed in writing to the Engineer

2.12.9. **Report**

A copy of each Audit Report will be sent to the Engineer and to all subcontractors, with whom it will then be discussed in detail at the monthly ESHS Committee Meeting to ensure that any corrective actions are agreed upon.

2.12.10. **External ESHS Audit**

External ESHS Audit is to be conducted by the external agencies that are competent with ISO

qualified auditors with the prior approval of the Engineer.

a) Areas of Competence of Audit Team

i) The Audit team shall have practical understanding of BOCWR/A statutory requirements on health/medical and welfare of workmen, construction hazardsand its prevention and control, traffic management, electrical safety, rigging, safety of construction equipment and environment and social management.

ii) Audit shall be conducted as per the guidelines of ISO, ILO and national standards. Audit report shall also be presented as per the formats given in thestandards; and

iii) External ESHS Audit shall be conducted on a quarterly basis throughout the currency of the Contract.

b) Targets of ESHS Audit:

The contents and coverage of the audit shall include the following items:

i) ESHS Management:

- ESHS Organization;
- ESHS Policy and Plan;
- ESHS committee;
- ESHS orientation;
- ESHS training;
- ESHS communication and motivation;
- ESHS submittals to the Employer;
- ESHS promotional and awareness program;
- Incident reporting &investigation;
- Onsite/offsite emergency preparedness plan;
- Hazard identification and risk assessment;
- Implementations of work permit system.

ii) Technical:

- Work Method Statement;
- Operational control procedures/ Safe operating procedures;
- Working at height;
- Hand tools and power tools;
- Electrical safety;
- Fire prevention and control;
- Housekeeping;
- Overhead protection;
- Slipping, tripping, cutting, drowning and falling hazards;
- Lifting appliances and gear, tools and tackles;
- Lifting and launching operation;
- Construction plant and machinery;

- Machine and area guarding;
- Material handling;
- Hot work;
- Demolition;
- Excavation and tunnelling;
- Work permit system;
- Traffic management;
- Chemical handling;
- Dangerous and harmful Environments;
- Maintenance matrix of mechanical and electrical machines / equipment;
- Working on or under water;
- Working near or under high tension line;
- Personal protective equipment;
- Visitors at Site;
- Occupational health and welfare measures;
- All statutory forms, returns under various statutes;
- First-aid and medical facilities;
- Welfare measures; and
- Environmental and Social management.

c) Audit Documents:

The Contractor shall make the below itemized documents available for review by the Audit team;

a) ESHS Policy;

a) ESHS Management Manual;

b) ESHS Rules and Regulation;

c) ESHS Organization chart;

d) Annual ESHS objectives/programs;

e) Accident/near miss statistics and analysis;

f) ESHS training program/records for all personnel;

g) Operating manuals and maintenance manual of all equipment;

h) Safe worthiness certificates of all lifting appliances and gears;

i) Medical fitness record for all personnel;

j) Risk identification, assessment and control details;

k) Environmental and Social management reports;

l) Emergency management records including mock drill;

m) Housekeeping inspection records;

n) Minutes of ESHS committee meetings;

o) Calibration and testing records;

p) Safety budgets;

q) Records of previous audits;

r) Safety inspection records;

s) First Aid, medical facilities and other welfares measures;

t) Maintenance procedure of plant &machinery;

u) Records of Industrial hygiene surveys (noise, ventilation, and illumination level, airborne and toxic substances, explosive gases).

d) Reporting

Audit report shall be prepared and directly sent to the Engineer within 7 days of conducting the audit.

e) Report Contents:

a) Executing Summary - Based on the finalized checklists as written the findings to the Engineer by the audit team members, the audit leader will compile a concise and accurate summary of observations and findings;

b) Introduction- This will contain basic information regarding the facilities or organization audited, the specific audit dates (inclusion of those for preparation and post-audit activities);

c) Principal Positive Findings - This will contain the summary of positive aspects as observed by the auditors. It will also contain highlights of those issue, which may warrant dissemination as best practice regarding methodology used or achievement;

d) Audit Findings - All audit findings as detailed in the audit checklists shall be grouped together as priority 1 and 2 as detailed below in a separate listing:

i. Priority 1: Actions to rectify gaps or weakness should generally beimplemented within two-weeks' time if risk potential is high or unacceptable; and

ii. Priority 2: Actions should be generally implemented or rectified with a maximum of 3- 4 weeks, if not rectified would create a likelihood of minor injury or business loss.

f) Conformity Report Action to the Engineer:

a) The auditor shall inspect the Site after 14 days of conducting initial audit for checking the adequacy of implementation of items maintained under priority 1 by the Contractor and shall submit a Conformity/Non-conformity Report to the Engineer;

b) The auditor shall again inspect after 28 days of conducting initial audit for checking the adequacy of implementation of items mentioned under priority 2 by the Contractor and shall submit a Conformity/Non-conformity Report to the Engineer; and

c) In case of non-conformity of items mentioned by auditor, the Engineer shall take necessary steps including stoppage of work and or imposing any penalty for getting the item implemented.

d) If the Contractor fails to conduct the External ESHS Audit in time, the Engineer shall get it done. All expenses related to the external ESHS audits shall be borne bythe Contractor.

2.13. ESHS Communication

2.13.1. The Contractor shall make every effort to communicate the ESHS Management measures through posters campaigns/billboards/banners/glow signs being displayed around the Site as part of the effort to raise ESHS awareness amongst the work force. Posters should be in Hindi, English and other suitable language deemed appropriate. Posters/billboards/ banners/glow signs should be changed at least once in a month to maintain the impact.

2.13.2. The Contractor shall also observe important days as listed in Attachment-4[General Instruction: ESHS/GI/006] and printing and displaying safety signage and posters as listed in Attachment-4[General Instruction: ESHS/GI/007].

2.14. ESHS Submittals

2.14.1. The Contractor's ESHS Management shall send the following reports to the Engineer periodically in soft copy:

a) Daily reporting of total number of workmen;

b) Monthly ESHS Reports;

c) Minutes of ESHS Committee meeting;

d) ESHS inspection and compliance reports; and

e) ESHS audits reports;

- Monthly Audit Rating Score (MARS) reports;
- External ESHS audits;

2.14.2. The Contractor shall prepare a Monthly ESHS Report consisting of the following within 7th of next month to the Engineer:

a) Monthly man-hour details as specified in the ESHS Management Plan;

b) Monthly accident/incident details as specified in the ESHS Management Plan;

c) ESHS committee details;

d) ESHS inspection and compliance report;

e) ESHS internal audit details.;

f) ESHS communication activities undertaken in the month indicating the number of posters displayed and balance availability in stock;

g) Monthly Environment (including air, noise, water and soil testing results) and Social Report;

h) Graphical representation of monitored results over past four reporting periods;

i) Details of interactions with regulators (e.g. Pollution Control Board, Forest Department etc.) including dates, subjects, outcomes (report the negative if none);

j) Details of Clearance/ Permission//Permit obtained;

k) Compliance status for conditions of all relevant clearances /permissions / consents/permits for the Work, including quarries, etc.;

l) Tree felling, transplanting and compensatory planation details;

m) Details of consumption of construction material, energy and water;

n) Details of different types of waste and scrap generated during the month and sold to authorised recyclers;

o) Summary of complaints, results of investigations and follow-up actions;

p) Gender: Number of female workers, percentage of female workforce, gender issue raised and dealt with;

q) HIV/AIDS: Provider of health services, information& training;

r) GBV/SEA: Details of training conducted;

s) Grievances: List of grievances received in the reporting period and unresolved past grievances by date received, complaint how received, to whom referred to for action, resolution and date (if completed), date of resolution of community grievances if any.

t) Toolbox talks details;

u) PPE details: Quantity purchased, issued to the workmen and stock available;

v) Details on IP 44 panel boards, lighting poles, welding and cutting equipment, Ladders, Hoists, Tools & Tackles;

w) Monthly lux meter study results;

x) Housekeeping;

y) Barricade maintenance details;

z) No of critical excavations;

aa) Health and welfare activities;

bb) ESHS activities planned for next month.

Formats in which information to be given for monthly Environment and Social aspects are given in Attachment 4 [General Instruction: ESHS/GI/008]

2.15. Accident Reporting and Investigation

2.15.1. All accidents and dangerous occurrences shall immediately be informed through message to the Engineer and the Employer. AIIB is to be informed within two days of the event. This will enable the Engineer to reach to the scene of accident/dangerous occurrences to monitor/assist any rescue work and/or start conducting the investigation process so that the evidences are not lost.

2.15.2. Reports of all accidents (fatal/injury) and dangerous occurrences shall also be sent within 24 hours by the Contractor.

2.15.3. No accident/dangerous occurrences are exempted from reporting to the Employer.

2.15.4. Any wilful delay in verbal and written reporting to the Employer and Engineer shall be penalized as per Clause 7. [Financial Deduction/Withholding].

2.15.5. In addition to the above verbal and written reporting to the Employer and Engineer, as per Rule 276 of HBOCWR, notice of any accident to a worker at the Site that:

a) Causes loss of life; or;

b) Disables a worker from working for a period of 48 hours or more immediately following the accident; shall forthwith be sent by telegram, telephone, fax, orsimilar other means including special messenger within 4 hours in case of fatal accidents and 72 hours in case of other accidents, to:

i) The Assistant Director, Industrial Safety and Health having jurisdiction in the area in which the establishment in which such accident or dangerous occurrence took place is located. The Assistant Director, Industrial Safety and Health shall be the authority appointed under section 39 of the Act;

ii) Board with which the building worker involved in accident was registered as a

beneficiary;

iii) Chief inspector; and

iv) The next of kin or other relative of the Worker involved in the accident.

2.15.6. Further, notice of any accident shall be sent in respect of an accident which:

a) Causes loss of life; or;

b) Disables the injured worker from work (for a period of more than 10 days) to;

i) The Officer-in-charge of the nearest police station;

ii) The District Magistrate or, if the District Magistrate by order so desires to;

iii) The Sub-Divisional Magistrate.

2.15.7. In case of an accident-causing minor injury, first-aid shall be administered, and the injured worker shall be immediately transferred to a hospital or other place for medical treatment.

2.15.8. Where any accident-causing disablement that subsequently results in death, notice in writing of such death, shall be sent to the authorities within 72 hours of such death.

2.15.9. The following classes of dangerous occurrences shall be reported to the inspector having jurisdiction, whether any disablement or death caused to the Worker, namely:

a) Collapse or failure of lifting appliances, or hoist, or conveyors, or similar equipment for handling of building or construction material or breakage orfailure of rope, chain or loose gears; or overturning of cranes used in construction work;

b) Falling of objects from height;

c) Collapse or subsidence of soil, tunnel, pipelines, any wall, floor, gallery, roof or any other part of any structure, launching girder, platform, staging, scaffolding or means of access including formwork;

d) Explosion of receiver or vessel used for storage of pressure greater than atmospheric pressure of any gas or any liquid or solid used as building material;

e) Fire and explosion causing damage to any place on the site where the Workers are employed;

f) Spillage or leakage of any hazardous substance and damage to their container;

g) Collapse, capsizing, toppling or collision of transport equipment; and

h) Leakage or release of harmful toxic gases at the Site.

2.15.10. In case of failure of launching girder, lifting appliance, loose gear, hoist machinery and transport equipment at the site, such appliances, gear, hoist, machinery or equipment and the site of such occurrence shall, as far as practicable, be kept undisturbed until inspected by the authorities.

2.15.11. Every notice given for fatal accidents or dangerous occurrences shall be followed by a written report to the concerned Authorities under Section 39 of BOCWA and the Chief Inspector of Government of Haryana in the specified Form **XLVI** of the **HBOCWR.**

2.15.12. Actions to be taken post incident/accident:

a) In case any incident/accident happens at site leading to injury to the worker, the worker/s is/are required to be taken to the nearest hospital immediately;

b) Project Manager/ESHS Manager/Labour Welfare Officer of the Contractor

c) needs to report the incident to the Engineer immediately without fail for all the death cases including natural deaths;

d) In case of fatal accident, doctor from the nominated hospital is the only authorized person to declare the death of the worker. It is not to be decided suo-moto by any other person. FIR should be registered for all the fatal cases which happen at the Site/labour camp;

e) Post Mortem of the dead body is mandatory in all the death cases i.e. whether it is natural or due to any incident / accident;

f) Family members of the injured / deceased worker are to be informed immediately;

g) In case of fatal accident, the dead body is to be handed over to the family members. Arrangement of sending the dead body to the native place shall be made by the contractor including cash payment for meeting out last rites expenses as per Rules;

h) Fatal accident report is to be sent to State Labour Authority in Form EE (as per workmen's compensations act) within seven days and to the Licensing Authority in Form XLVI within 24 hours of the incident/accident;

i) Workmen's Compensation dues are to be deposited with the Employee's Compensation Commissioner within 30 days of the death or the period of notice served by the Employee's Compensation Commissioner;

j) Copy of all the documents deposited with any labour authority, FIR, Post Mortem, Medical Reports etc. shall be submitted to the Engineer in duly approved Labour Welfare Fund (LWF) Form;

k) The Contractor shall be liable for getting disbursement of Provident Fund benefits, compensation under Employee compensation Act, benefits of ESI Act to the workman/dependents of the deceased workman. The Contractor shall also provide accommodation and transportation to dependents of the deceased workman or to the disabled workman who come for settlement ofterminal claims.

2.15.13. **Accident Investigation:**

a) Investigations shall be conducted in an open and positive atmosphere that encourages the witnesses to talk freely. The primary objective is to ascertain the facts with a view to prevent future and possibly more serious occurrences;

b) Accidents and dangerous occurrences which result in death, serious injury or serious damage must be investigated by the Contractor immediately to find out the cause of the accident/occurrence so that measures can be formulated to prevent any recurrence; and

c) Near misses and minor accidents should also be investigated by the Contractor as soon as possible as they are signals that there are inadequacies in the ESHS Management System.

2.15.14. Procedure of Incident Investigation

It is important after any accident or dangerous occurrence that information relating to the incident is gathered in an organized way. The following steps shall be followed:

a) Take photographs and make sketches;

b) Examine involved equipment, work piece or material and the environmentalconditions;

c) Interview the injured, eye-witnesses and other involved parties;

d) Consult expert opinion where necessary; and

e) Identify the specific Contractor or subcontractor involved.

2.15.15. Having gathered information, it is then necessary to make an analysis of incident:

a) Establish the chain of events leading to the accident or incident;

b) Find out at what stage the accident took place;

c) Considering all possible causes and the interaction of different factors that led up to the accident and identify the most probable cause, the cause of an accident should never be classified as carelessness; and

d) The specific act or omission that caused the accident must be identified.

2.15.16. The next stage is to proceed with the follow-up action:

a) Report on the findings and conclusions;

b) Formulate preventive measures to avoid recurrence; and

c) Publicize the findings and the remedial actions taken.

2.15.17. The Engineer's Independent Incident Investigation

In case of fatal/dangerous occurrence, the Engineer shall also conduct independent investigation. The Contractor and his staff shall extend necessary co-operation and testify about the accident.

2.15.18. The Contractor shall take every effort to preserve the scene of accident till the Engineer completes the investigation.

2.15.19. All persons summoned by the Engineer in connection to witness recording shall obey the instructions without delay. Any wilful suppression of information by any person shall be removed from the site immediately and/or punished as per Clause 7. [Financial Deduction/Withholding].

2.16. Emergency Preparedness Plan

2.16.1. The Contractor shall prepare as required under BOCWR, an Emergency Response Plan for the Site as a part of the Contractor ESHS Management Plan. The plan shall integrate the emergency response plans of the Contractor and all other Subcontractors. The Emergency Response Plan shall detail the Contractor's procedures, including detailed communication arrangements, for dealing with all emergencies that could affect the Site. The plan shall address items such as injury, sickness, evacuation, fire, chemical spillage, severe weather and rescue.

2.16.2. The Contractor shall ensure that the Emergency Response Plan is prepared to deal with emergencies arising out of, but not limited to:

a) Fire and explosion;

b) Collapse of lifting appliances and transport equipment.

c) Collapse of building, sheds or structure etc.

d) Gas leakage or spillage of dangerous goods or chemicals;

e) Bomb threatening, Criminal or Terrorist attack;

f) Drowning of workers; and

g) Landslides getting workers buried, floods, earthquake, storms and other natural calamities etc.

The above list is not exhaustive and other emergencies can also be included.

2.16.3. Arrangement shall be made for emergency medical treatment and evacuation of the victim in the event of an accident or dangerous incident occurring, the chain of command and the responsible persons of the Contractor with their telephone numbers and addresses for quick communication shall be adequately publicized and conspicuously displayed in the workplace.

2.16.4. The Contractor shall require to tie-up with the hospitals and fire stations located in the neighbourhood for attending to the casualties promptly and emergency vehicle kept on standby

duty during the working hours for the purpose.

2.16.5. The Contractor shall conduct an onsite emergency mock drill once in every month for all his workers and his sub-Contractor's workers.

2.16.6. It shall be the responsibility of the Contractor to keep the Local Law and Order Authorities informed and seek urgent help to mitigate the consequences of an emergency. Prompt communication to the Employer and Engineer, through telephonically initially and followed by a written report, shall be made by the Contractor.

2.17. Experts/Agencies for Environment, Social, Health & Safety Services

2.17.1. The Contractors may utilise the services of experts/agencies empanelled for the purpose of training, audit and any other ESHS services with prior approval of the Engineer. This approval can be withdrawn by the Engineer at any time if the quality of output of the agency is found not satisfactory.

3. LABOUR PROTECTION

3.1. General

3.1.1. The Contractor shall comply in full of the project Workplace Policy as described in Attachment-2 [Work Place Policy on HIV/AIDS, Prevention & Control] and Attachment -3 [Covid 19 policy].

3.2. Engagement of Staff and Labour

3.2.1. The Contractor shall ensure that the employees deployed by him in the premises of the Employer are physically and mentally fit and do not have any criminal record.

3.3. Payment of Minimum Wages

3.3.1. The Contractor shall ensure payment of at least the minimum wages as prescribed and applicable from time to time under the Minimum Wages Act, 1948 in the presence of an authorised representative of the Engineer and shall maintain proper records of their timely disbursement. These records shall be preserved for a period of at least 3 years and made available even after the Contract is over for any verification by the statutory authorities.

3.4. Conditions of Labour

3.4.1. The Contractor shall observe conditions of labour that are no less favourable than those established for the relevant trade or industry.

3.4.2. During the work, the Contractor shall afford all employees all basic rights enumerated in the conventions of the International Labour Organisation, including freedom of association, right to freedom from forced labour, and right to freedom from discrimination based on race, colour, sex, religion, political opinion and social origin.

3.4.3. The Contractor shall ensure coverage of his employees under the Employees Provident Fund and Miscellaneous Provisions Act, 1952 and the Employees State Insurance Act, 1948 via independent code numbers allotted to them by the Central Provident Fund Organisation and Employees State Insurance Corporation respectively.

3.4.4. The Contractor shall insure all his employees under Group Personal Accident Insurance scheme through a recognised and registered insurance company.

3.5. Labour Laws

3.5.1. The Contractor shall ensure that all his employees and the Subcontractors obey applicable following laws and regulations, including those concerning safety at work.

a) Minimum Wages Act, 1948;
b) Payment of Wages Act, 1936;
c) Equal Remuneration Act, 1976;
d) Employees Provident Fund and Miscellaneous Provisions Act, 1952;
e) Payment of Gratuity Act, 1972;
f) Employees State Insurance Act, 1948;
g) Payment of Bonus Act, 1965;
h) Maternity Benefit Act, 1951;

i) Industrial Disputes Act, 1947;

j) Trade Unions Act, 1926;

k) Child Labour (Prohibition and Regulation) Act, 1986;

l) Building and Other Construction Workers (Regulation of Employment of Service) Act, 1996;

m) Haryana Building and Other Construction Workers (Regulation of Employment and Conditions of Service) Rules, 2005;

n) Building and Other Construction Workers Welfare Cess Act, 1996;

o) Building and Other Construction Workers Welfare Cess Rules, 1998;

p) The Contract Labour (Regulation and Abolition) Act, 1970;

q) Inter State Migrant Workmen's (Regulation of Employment and Conditions of Service) Act, 1979;

r) Haryana Major Accident, Hazard Control Rules, 2009;

s) Workmen's Compensation Act. 1923;

t) Factories Act, 1948;

u) Mines Act, 1952; and

3.5.2. The Contractor shall comply with all other statutory requirements, rules, regulations and notifications in relation to employment of his staff and workers that may be issued from time to time by the concerned government authorities.

3.6. Working Hours

3.6.1. No work shall be carried out beyond the statutory limit given under BOCWA, 1996.

3.6.2. No work shall be carried out outside the normal working hours stated in the Contract unless otherwise:

a) The Engineer gives his consent in writing for additional work; and

b) The work is unavoidable or necessary for the protection of life or property or forthe safety of the Works, in which case the Contractor shall immediately inform the Engineer.

4. SAFETY GENERAL

4.1. General

4.1.1. The following standards whichever is more stringent shall be applicable:

a) The BOCW Acts 1996 and the Haryana BOCW Rules 2005 framed there under;

b) Other relevant National Legislations & IS Codes.

4.2. Housekeeping

4.2.1. General Housekeeping shall be carried out by the Contractor and ensured always at the Site, Construction Depot, Batching Plant, Labour Camp, Stores, Offices and Toilets/Urinals.

4.2.2. Full height fence, barriers, barricades etc. shall be erected around the Site to prevent the surrounding from excavated soil, rubbish etc., which may cause inconvenience to and endanger the public. The barricade especially those exposed to public shall be aesthetically maintained by regular cleaning and painting as directed by the Engineer. These shall be maintained in one line and level.

4.2.3. The Contractor shall ensure that all his sub-contractors maintain the site reasonably clean through provisions related to housekeeping. All surplus earth and debris are removed/disposed of from the working areas to officially designated dumpsites. Trucks carrying sand, earth and any pulverized materials etc. to avoid dust or odour impact shall be covered while moving. The tyres of the trucks leaving the site shall be cleaned with water, wherever the possibility of spillage on carriageways meant for regular road traffic exists

4.2.4. Water logging or bentonite/polymer spillage on roads shall not be allowed. If bentonite/polymer spillage is observed on road endangering the safety of road users, the Contractor shall be penalized as per Clause 7. [Financial Deduction/Withholding].

4.2.5. No parking of trucks/trolleys, cranes and trailers etc. shall be allowed on roads, which may obstruct the traffic movement.

4.2.6. Roads shall be kept clear and materials like pipes, steel, sand, boulders, concrete, chips and brick etc. shall not be allowed on the roads to obstruct free movement of road traffic.

4.2.7. Proper and safe stacking of material are of paramount importance at yards, stores and such locations where material would be unloaded for future use. The storage area shall be well laid out with easy access and material stored/stacked in an orderly and safe manner. Lumber with protruding nails shall be bent/removed and properly stacked.

4.3. Working at Height

4.3.1. Working at height means work in any place, including a place at or below ground level.

4.3.2. The Contractor shall ensure that work at height is properly planned, appropriately supervised, and carried out in a safe manner and without any appreciable risk. Appropriate care shall be taken during bad weather.

4.3.3. Adequate protection in the form of working platform with railing, toe board, safe access, safety net, roof ladder etc. shall be provided. Where fall hazards cannot be eliminated, use fall-arrest systems while erecting, modifying, and dismantling scaffolds.

4.3.4. A trained and certified person shall check working platform, railing, toe board, safe access, safety

net, roof ladder etc. after erection and once in a week. A certificate shall be tagged on this equipment.

4.3.5. Employees involved in the erection, dismantling, moving, repairing, etc., of scaffolding and also workers who perform work on a scaffold shall receive training from a competent person. The purpose of the training is to recognize any hazards associated with the work.

4.3.6. When the height of a scaffold exceeds three times of the smallest width of the base, secure it to the building or structure at every other lift and every 9.0 m horizontally. The scaffold and scaffold working platform with handrails approximately 1.0 m high, mid rails, and toe boards, all secured rigidly by both ties and braces to prevent movement. Working platforms should be completely decked with safety planks, manufactured scaffold decking, or metallic planks.

4.3.7. Only metal frame working scaffold is permitted. Steel stairs are used as a means of raising and lowering the metal frame working scaffold, except for special cases. It is prohibited to directly raise and lower the framework with limbs or to use only ladder.

4.3.8. The Contractor shall ensure that following areas are clearly indicated:

a) where a workplace contains an area in which, owing to the nature of the work, there is a risk of any person at work;

b) Falling a distance; or

c) Being struck by a falling object:

4.3.9. The Contractor shall ensure that work equipment exposed to conditions causing deterioration, which is liable to result in dangerous situations, is inspected at suitable intervals and after any exception occurrence jeopardizing the safety of work/equipment.

4.3.10. In relation to work at height involved in construction work;

a) The top guard-rail or other similar means of protection shall be at least 1100 mm above the edge from which any person is liable to fall;

b) Toe-boards shall be suitable and sufficient to prevent the fall of any person, or any material or object, from any place of work; and

c) Any intermediate guardrail or similar means of protection shall be positioned sothat any gap between it and other means of protection does not exceed 550 mm.

4.3.11. Requirements for all Working Platforms:

a) Every working platform requires a firm & stable supporting structure for holding it;

b) A working platform shall possess a suitable surface and be so constructed that the surface of the working platform has no gap through which a person/material/object could fall;

c) A working platform and any supporting structure shall not be loaded to give rise to a risk of collapse or to any deformation, which could affect its safe use;

d) When altered or modified, it should be so altered or modified as to ensure that it

e) remains stable;

f) A working platform shall be of sufficient dimension to permit the safe passage of persons and the safe use of any plant or materials required to be used and to provide a safe working area having regard to the work being carried out there;

g) Depending on the complexity of the scaffolding selected, a responsible person shall draw up an assembly, use and dismantling plan;

h) A copy of the plan, including any instructions it may contain, shall be kept available for the use of persons concerned in the assembly, use, dismantling or alteration of scaffolding until

it has been dismantled; and

i) While a scaffold is not available for use, including during its assembly, dismantling or alteration, it shall be marked with general warning signs in accordance with and be suitably delineated by physical means preventing access to the danger zone.

4.3.12. Requirements for collective safeguards for arresting falls:

a) Collective safeguard is a safety net, airbag or other collective safeguard for arresting falls;

b) A safeguard shall be used only if:

i) A risk assessment has demonstrated that the work activity can (so far as is reasonably practicable) be performed safely while using it and without affecting its effectiveness;

ii) The use of other safer work equipment is not reasonably practicable; and

iii) A sufficient number of available persons have received adequate training specific to the safeguard, including rescue procedures.

4.3.13. Requirements for personal fall protection systems:

a) A personal fall protection system shall be used only if a risk assessment hasdemonstrated that;

i) The work can (so far as be reasonably practicable) be performed safely while using that system; and

ii) The use of other safer work equipment is not reasonably practicable.

The user and a sufficient number of available persons have received adequate training specific to the operations envisaged, including rescue procedures; and

b) A personal fall protection system designed for use with an anchor shall be securely attached to at least one anchor, and each anchor and the means of attachment thereto shall be suitable and of sufficient strength and stability to supporting any foreseeable loading.

4.3.14. Requirements for Ladders:

a) Every Contractor shall ensure that a ladder is used for work at height only if a risk assessment has demonstrated that the use of more suitable work equipment is not justified because of the low risk;

b) The short duration of use;

c) Existing features on the Site, which he cannot alter;

d) Only metal ladders shall be allowed. Bamboo ladders are prohibited;

e) Any surface upon which a ladder rests shall be stable, firm, of sufficient strength and of suitable composition safely to support the ladder so that its rungs or steps remain horizontal, and any loading intended to be placed on it;

f) A ladder shall be so positioned as to ensure its stability during use;

g) No interlocking or extension ladder shall be used unless its sections are prevented from moving relative to each other while in use;

h) Where a ladder or run of ladders raises a vertical distance of 9.0 m or more above its base, there shall, where reasonably practicable, be provided at suitable intervals sufficient safe landing areas or rest platforms;

4.4. Overhead Protection

4.4.1. All contractors shall provide overhead protections as per BOCW Act & Haryana BOCW Rules.

4.5. Slipping, Tripping, Cutting, and Falling Hazards

As Per Rule 98 of HBOCWR:

a) All places should be free from dust, debris or similar materials;

b) Sharp projections or any protruding nails or similar objects shall be suitably guarded or shall even be avoided to make the place safe to work;

c) Contractor shall not allow workmen to work or use platforms, scaffolds/passageways or any walkways, which has water, or oil or similar substances spilt and has a slipping hazard, unless it is cleaned off or covered or sanded or saw dusted or make it safe with any suitable material;

d) Open side or opening where worker, equipment, vehicle or lifting appliance may fall at a building or outside shall be guarded suitably except in places of free access by reasons of nature of work;

e) Suitable safety net shall be provided at places of material / man falling is possible in accordance with national standards.

f) Reinforcement of pier/columns/walls/abutments shall be secured from the risk of tilting through provisioning of minimum four guy wires ropes/ steel bracing anchored to any concrete block/counterweight of sufficient capacity.

4.6. Lifting Appliances including Cranes

4.6.1. Lifting appliances means a crane, hoist hydra, derrick, winch, gin pole, sheer legs, jack, hoist drum, slewing machinery, slewing bearing fasteners, lifting machinery sheaves, pulley blocks, hooks or other equipment used for lifting materials, objects or the Workers and lifting gears means ropes, chain slings, shackles, hooks, lifting lugs, wire ropes, lifting eyebolts and eye nuts and other accessories of a lifting appliance.

4.6.2. Each of the lifting appliances and lifting gear including all parts thereof, whether fixed or moveable shall be thoroughly tested and examined by a competent person once at least in every 6 months or after it has undergone any alterations or repairs liable to affect its strength or stability. Within the validity, if the lifting appliances are shifted to a new site, re-examination by the competent person for ensuring its safety shall also be done.

4.6.3. The Contractors shall utilize the services of any competent person as defined in Factories Act, 1948 with the permission of the Engineer.

4.6.4. No machine shall be selected to do any lifting on a specific job until its size and characteristics are considered adequate:

a) The weights, dimensions and lift radii of the heaviest and largest loads;

b) The maximum lift height, the maximum lift radius and the weight of the loads that must be handled at each;

c) The number and frequency of lifts to be made;

d) How long the crane will be required on site;

e) The type of lifting to be done (for example, is precision placement of loads important;

f) The type of carrier required (this depends on ground conditions and machine capacity In its operating quadrants: capacity is normally greatest over the rear, less over the side, and non-existent over the front;

g) Whether loads will have to be walked or carried;

h) Whether loads will have to be suspended for lengthy periods;

i) The site conditions, including the ground where the machine will be set up, access roads and ramps it must travel, space for erection and any obstacles that might impede access or operation.

4.6.5. The Contractor shall ensure that a valid certificate of fitness issued is available for all lifting appliances including synchronized mobile jacks, pre-stressing hydraulic jacks, jacks fitted with launching girders etc. and the Engineer approval is obtained before inducting to the site. Only after obtaining the approval from the Engineer any lifting appliances and gear shall be used.

4.6.6. The laminated photocopies of fitness certificate issued by competent person, the Engineers approval letter, the operators photo, manufactures load chart and competency certificate shall always be either kept in the operator cabin or pasted on the visible surface of the lifting appliances.

4.6.7. All lifting appliances and loose gears shall be clearly marked for its safe working load and identification by stamping or other suitable means.

4.6.8. The Contractor shall also maintain a register containing a system of identification of all tools and tackles, its date of purchase, safe working load, competent person date of examination etc.

4.6.9. Sufficient lighting arrangement shall be ensured at all lifting operations.

4.6.10. **Qualification of operator of lifting appliances etc.:** The Contractor shall not employ any person to drive or operate a lifting machine-like crane, hydra etc. whether driven by mechanical power or otherwise or to give signals to work as an operator of a rigger or derricks unless he:

a) Is above 21 years of age and possesses a valid heavy transport vehicle driving license as per Motor Vehicle Act and Rules;

b) Is competent and reliable;

c) Possesses the knowledge of the inherent risks involved in the operation of lifting appliances by undergoing a formal training at any institution of national importance acceptable to the Engineer; and

d) Is medically examined periodically as specified in schedule VII of BOCW Rules.

4.6.11. All hydraulic piping and fittings shall be maintained leak proof.

4.6.12. Only four legged slings shall be allowed which includes master link (ring), intermediate master link (ring) if necessary, chain / wire rope sling, sling hook or other terminal fitting.

4.6.13. Hand spliced slings up to 32mm diameter shall not be used at site for any lifting purpose. The slings used shall confirm to IS 2762: 2009 Wire rope slings and sling leg specification.

4.6.14. No load shall be slewed over public areas without stopping the road traffic first.

4.6.15. Failure to do any of the above shall attract penalty from the Employer as per Clause 7. [Financial Deduction/Withholding].

4.6.16. Automatic safe load indicator (ASLI) to be provided in crane with audible and visible warning system and made functional and calibrated by the manufacturer or its authorized representative every 6 months or after repair of the lifting equipment.

4.6.17. **Automatic safe load indicators and data logger in lifting appliances**

As stipulated in Rule 123 of HBOCW Rules, every lifting appliances and gears like cranes, hydras etc., if so constructed that the safe working load may be varied by raising or lowering of the jib or otherwise, shall be attached with an automatic indicator of safe working loads approved by Bureau of Indian standards/International certifying bodies which gives a warning to the operator whenever the load being handled exceeds the safe working limit.

a) Provision of functional data logger with alert facility through SMS and web in all cranes shall

be mandatory;

b) Cut-out shall be provided which automatically arrests the movements of thelifting parts of every crane if the load exceeds the safe working limit.

4.6.18. The crane should have a substantial/durable safe working load chart which has clearly legible characters in English and Hindi and figures displayed inside the crane and is easily visible to the crane operator.

4.6.19. General Requirements

The sweep area (work area) of the construction machinery shall be always free from obstructions. All hydraulic piping and fittings shall be maintained leak proof. The operator cab shall posses good and safe:

a) Structure, windows and windshield wipers;

b) Drivers chair and footrest;

c) Control handles;

d) Cab instrumentation;

e) Telecommunication;

f) Cab outfitting;

g) Wind indicator with an adjustable set point shall be in a position representative for the wind on the crane. The indicator shall give continuous information regarding constant speeds and gusts.

4.6.20. Mandatory Rigging requirement

a) Rigging shall be done under experienced and qualified rigger only. All Load shall be adequately and safely rigged to prevent any danger;

b) The primary requirement in rigging shall be to assess the weight of load before attempting any lift;

c) All hooks shall be fitted with Master Rings having certificate of fitness from the competent person, so that the hooks are subjected to balanced vertical loading only;

d) Only four legged slings shall be allowed which includes master link (ring), intermediate master link (ring) if necessary, chain / wire rope sling, sling hook or other terminal fitting;

e) Requirements of outriggers

i) All outriggers shall be fully extended and at all tyres are clear of theground;

ii) Heavy duty blocking having large bearing area shall be necessary to prevent sinking of floats;

iii) Provision of heavy steel plates/ high density interconnected wooden logs of required dimension shall be used to uniformly distribute the load;

iv) The crane shall be setup on fully compacted ground;

4.6.21. Pick & carry operation

Prohibition on Use of "Tractor transmission type Pick and Carry Hydra Crane": Tractor transmission type Pick and Carry-1st Generation model is prohibited at HRIDC works. Contractor shall mobilize "Truck transmission type" Pick and Carry (Hydra)Crane– minimum 2nd Generation model only or higher model.

Pick and Carry operation is prohibited at all HRIDC construction sites except for the tailing purpose for lowering of pile cage, erection of radio tower, electrical poles, exhaust structures etc.

4.6.22. Operation of lifting appliances

Every Contractor shall ensure that:

a) The complete lifting operation shall be governed by signals as per established standards;

b) Adequate measures to be taken to ensure that no workers is allowed to stand, pass, rides or sit under the suspended load;

c) No lifting appliances shall be left by the operator while power is on or load is suspended;

d) After completion of the lifting operation, all doors of the appliances shall be closed by the operator and ignition/operation key should be handed over to competent reliever operator or site In-charge;

e) All loads are provided with minimum two tag lines to ensure that the load can be controlled at all times;

f) No close working to any live over head power line is permitted without system of a 'Permit to Work' and prior permission of the engineer shall be obtained before performing such operation;

g) Danger zone shall be identified and cordoned off for all lifting appliances during their operation;

h) All lifting gears & slings shall be stamped or appropriate tags for their identification no & SWL;

i) Knotting/wrapping of chains & slings shall not be allowed at site;

j) Lifting appliances shall not be used for any dragging or pulling purposes. Contract shall refer to 75% capacity load chart for ascertaining the suitability of crane for safe lifting of load;

k) During tandem lift, available capacity of crane in respect of SWL shall be considered after reduction of 15% for 75% (DIN) load chart respectively. In addition, additional de rating as advised by third party testing and certified agency shall also apply;

l) During hoisting of long material, use of suitable lifting beam is recommended;

m) Only original equipment manufacturer (OEM) supplied/provided load chart shall be used during lifting operation;

n) Before performing any lifting operation, all electronic devices, control levers, hydraulic oil, wind pressure etc. shall be checked and necessary spare parts to be kept in stock to handle any breakdown during time bound lifting operation;

o) Lifting point shall be considered on the I-Girders/U Girder/C Girder/Steel girder/parapet etc. during the casting of the same. Design load calculation for the same should be conducted;

p) All lifting activities shall be stopped in case of high speed wind and similar adverse whether condition or as prescribed by the crane manufacturer; and

q) All cranes shall be provided with fail safe devices to avoid any hoist free fall in case of brake failure.

4.7. Launching Operation

4.7.1. As launching operation is one of the riskiest jobs, the Contractor shall take utmost precaution at all stages like; planning, establishing casing yard, casting segments, transporting segments, fabrication and erection of launching girders, launching of segments, pre-stressing, auto launching of girders and dismantling of launching girders.

4.7.2. The Contractor shall prepare a comprehensive Method Statement for the launching operation, adhering to the ESHS conditions laid down in conditions of contract on the ESHS Management

Manual. Reference shall be made to the provisions on working at height. As the entire process of launching must be undertaken at an elevated level the safety of workers and the girder is paramount important. In addition to general precautions, such as trained personnel, PPE, etc. listed in earlier clauses, the following general guidelines shall be adhered to throughout the launching operation:

a) The segments shall rigidly secure to the truck with necessary wooden wedges and necessary red indicators/safety tapes provided so that the vehicle is clearly seen by other road users both in day/night time;

b) Every launching operation shall have a responsible engineer on duty all the time;

c) All the time from erection to dismantling the area between the two piers wherein launching is in progress shall always be barricaded;

d) Auto launching shall be done only after approval from the Engineer. After every auto launching the stability of launching girder shall be ensured;

e) The vertical deflection of launching girder shall be monitored at all critical stages like with/without loads and after every auto launching;

f) A register containing all important operational details from erection to dismantling of launching girders shall be maintained and made available to the Engineer whenever called for;

g) Driver shall also have undergone proper medical examination as per sub-Clause-5.2 (Medical Facilities) and checked for influence of alcohol before any kind of lifting operation;

h) Test certificate for all lifting gears including Macalloy Bars shall be maintained at a

i) location closer to the launching girder itself so that it can be referred during all inspections;

j) Proper & safe access stairways shall be maintained for safe ascending /descending of workmen /engineers to or from launchers;

k) Adequate collective and personnel fall protection measures like provision of safety nets while working over live roads/railways, lifeline for anchoring of safety harness, safe means of access on main box girder shall be ensured;

l) Before starting of the launching, valid third party test certificate of the launcher hoist shall be available;

m) Safe and fully deck working platform duly covered from all side shall be ensured for stressing work at front support;

n) Safety checklist for all activities of launching cycle shall be prepared, got approved & implemented;

o) Use of nonstandard locking pins shall attract penalty;

4.8. Construction Machinery

4.8.1. Construction machineries may include dumpers and dump trucks, lift trucks and telescopic handlers, piling rigs, vibration hammers, rail welding equipment, mobile elevating work platforms, cranes, tipper lorries, lorry loaders, skip wagons, 360° excavators, 180° backhoe loaders, crawler tractors, scrapers, graders, loading shovels, trenchers, side booms, pavers, planers, chippers, road rollers, locomotives, tankers and bowsers, trailers, hydraulic and mechanical breakers etc.

4.8.2. Every construction equipment shall be in sound mechanical working condition and certified by either competent person under Factories Act or manufacturers' warranty in case of brand new equipment or authorized persons/firms approved by the Engineer before induction to any site.

4.8.3. Fitness of the machine shall be carried out on regular basis or after every maintenance work excluding any minor service/oil or filter change and be documented properly. The certificate shall

be available in operator/driver cabin.

4.8.4. All vehicles shall be fitted with audible reverse alarms and maintained in good working condition. Reversing shall be done only when there is adequate rear-view visibility or under the directions of a banksman.

4.8.5. **General operating procedures:** Drivers entering site shall be instructed to follow the safe system of work adopted on site. These shall be verbal instructions or, preferably, written instructions showing the relevant site rules, the site layout, delivery areas, speed limits, etc.

a) No passengers shall be carried, unless specific seating has been provided in accordance with the manufacturer's recommendations;

b) Working on gradients beyond any equipment's capability shall not be allowed.

c) Prevention of dumper and dump truck accidents should be managed by providing for adequate lateral clearances, wheel stops at a sufficient distance from the edgesof excavations, spoil heaps, pits, markers, etc.;

d) No construction material, other than soil shall be carried in excavator buckets;

e) When two or more scrapers are working on the same job, a minimum distance of at least 25m shall be kept between them;

f) Every contractor shall ensure that Competency certificate for driver/operatorsshall be issued by their Plant and Machinery In-charge. The certificate shall be pasted on the machine body in such a way that drivers/operator vision is nothindered;

g) Checklist shall be prepared for all construction machinery and be filled on daily basis by the operator and be counter signed by plant & machinery person;

h) Provision of helper is mandatory for each construction appliances and vehicles during their movement inside and outside of site; and

i) All wood working machines shall be fitted with suitable guards and devices such astop guard, riving knife, push stick, guards for drive belts and chains, and emergency stop switch easily accessible by the operator.

4.8.6. Failure to do any of the above shall attract penalty as per Clause 7. [Financial Deduction/Withholding].

4.9. Machine Guarding

4.9.1. The Contractor shall ensure at the site all motors, cog wheels, chains and friction gearing, fly wheels, shafting, dangerous and moving parts of machinery are securely fenced or legged.

4.9.2. Fencing of dangerous parts of machinery shall not be removed while the machinery is in use or in motion and when removed, it shall be replaced as soon as practicable and in any case before the machinery is again brought into use.

4.10. Site Electricity

4.10.1. The Contractor shall refer to the applicable guideline "Indian Electricity Rules, 1956" and any amendment thereafter. ESHS requirements are:

a) Graduate Electrical Engineer having Electrical Supervisory CompetencyCertificate;

b) Diploma Electrical Engineer having Electrical Supervisory Competency Certificate;

c) ITI Certificate Holder Electrician with Wiremen Permit; and

d) Assessment of Electrical Load and properly designed power distribution system;

4.10.2. The Contractor shall assess the size and location of the electrical loads and the manner in which they vary with time during the currency of the Contract.

4.10.3. The Contractor shall elaborate as to how the total supply is to be obtained/generated. The details of the source of electricity, earthing requirement, substation/panel boards, distribution system shall be prepared and necessary approval from the Engineer obtained before proceeding of the execution of the job.

4.10.4. The main Contractor shall take consideration, the requirements of the Subcontractors' electric power supply and arrive at the capacity of main source of power supply from diesel generators.

4.10.5. No electrical equipment shall be put into use where its strength and capability may be exceeded in such a way as may give rise to danger.

4.10.6. Adverse or Hazardous Environments:

a) Power supply from public utility service provider is preferable;

b) The Contractor shall provide sufficient ELCBs (maintain sensitivity 30 mA)/ Residual Current Circuit Breakers (RCCBs) for all the equipment (including Potable equipment), electrical switchboards, distribution panels etc. to prevent electrical shocks to the Workers;

c) Lightening Protection for all structures, gantry, metal portable cabins, silos etc; Lighting ought not to introduce the risk of electric shock. Therefore, 230V supplies should be used for those fittings, which are robustly installed, and well out of reach e.g. flood lighting or high-pressure discharge lamps;

d) No single insulation cable shall be used;

e) Cables shall be selected after full consideration of the condition to which they shall be exposed and the duties for which they are required. Supply cable up to 3.3 kV shall be in accordance with BS 6346:1997;

f) Cables buried directly in the ground shall be of a type incorporating Armor or metal sheath or both;

g) Cabling passing under the walk way and across way for transport and mobile equipment shall be laid in ducts at a minimum depth of 0.6 m;

h) The Contractor shall ensure plugs, socket-outlets, and couplers available in the Site as "splash EM proof" type. The minimum degree of Ingress Protection should be of IP44 in accordance with BS EN 60529;

i) Only plugs and fittings of the weather proof type shall be used and they should be colour coded in accordance with the Internationally recognised standards for example as detailed as follows:

    i) 110 volts: Yellow;

    ii) 240 volts: Blue;

    iii) 415 volts: Red.

j) No loose connections or tapped joints shall be allowed anywhere in the Site, office area, stores and other areas. Penalty as per Clause 7. [Financial Deduction/Withholding] shall be put in case of observation of any tapped joints;

k) All equipment shall have the provision for major switch/cut-off switch in the equipment itself;

l) Isolate exposed high-voltage (over 415 Volts) equipment, such as transformer banks, open switches, and similar equipment with exposed energized parts and prevent unauthorised access;

m) All temporary metal structures like barricade boards, temporary metal containers/shed etc. shall be adequately earthed through suitable means;

n) All the earth pits shall be properly numbered along with display of resistance value and inspection records of the same shall be maintained

4.10.7. Work on or near live conductors

No person shall be engaged in any work activity on or so near any live conductor (other than one suitably covered with insulating material so as to prevent danger) that danger may arise unless-

a) It is unreasonable in all the circumstances for it to be dead;

b) It is reasonable in all the circumstances for him to be at work on or near it while it is live; and

c) Suitable precautions (including where necessary the provision of suitable protective equipment) are taken to prevent injury.

4.10.8. Whenever pilling work is undertaken manually through tripod in the influence zone of live OHE, method statement shall be prepared, submitted and got approved before start of work.

4.10.9. All electrical equipment should be permanently numbered, and a record kept of the date of issue, date of last inspection and recommended inspection period.

4.10.10. Appropriate electrical protection shall be provided for all circuits, against over load, short circuit and earth fault current.

4.10.11. For supplies to mobile or transportable equipment where operating of the equipment subjects the cable to flexing, the cable shall conform to any of these codes BS 6007/BS 6500/BS 7375.

4.10.12. Flexible cords with a conductor cross sectional area smaller than 1.5 mm2 shall not be used and insulated flexible cable shall conform to BS 6500 and BS 7375.

4.10.13. Power Tools:

The Contractor shall ensure that:

a) Electric tools are properly grounded or/and double insulated;

b) Ground Fault Circuit Interrupters (GFCIs)/Residual Current Circuit Breakers (RCCBs) shall be used with all portable electric tool operated especially outdoors or in wet condition;

c) Only trained employees shall use explosive actuated tools and the tool shall also be

d) unloaded when not in use;

e) Usage of such explosive actuated tools shall be avoided in case of places where explosive/flammable vapours or gases may be present;

f) Explosive actuated tools and their explosives shall be stored separately and be taken out and loaded only before the time of immediate use; and

g) Misfired cartridges of explosive actuated tools must be placed in a container of water and be removed safely from the project.

4.11. Illumination

4.11.1. The Contractor shall provide sufficient site lighting, of the right type and at the right place for it to be properly effective as per the relevant national standards & guidelines.

4.12. Welding and Cutting

4.12.1. Gas cylinders in use shall be kept upright on a custom-built stand or trolley fitted with a bracket to accommodate the hoses and equipment or otherwise secured. The metal cap shall be kept in place to protect the valve when the cylinder is not connected for use.

4.12.2. Test Certificate for cylinders and Vendor license shall be obtained. Gas Cylinder Act & Rules shall always be followed at workplace.

4.12.3. All gas cylinders shall be fixed with pressure regulator and dial gauges. clamp or clip shall be used to connect hoses firmly in both sides of cylinders and torches.

4.12.4. Non-return valve and flashback arrester shall be fixed at both end of cylinder and torch.

4.12.5. Domestic LPG cylinders shall not be used for gas welding and cutting purpose.

4.12.6. Dry Chemical Pressure (DCP) or CO2 type Fire Extinguisher not less than 5 kg shall be fixed at or near to welding process zone in an easily accessible location. Fire extinguisher should confirm to IS 2190:1992.

4.12.7. Oxygen cylinders and flammable gas cylinders shall be stored separately, at least 6.6 m (20 feet) apart or separated by a fireproof, 1.5 m (5 feet) high partition. Flammable substances shall not be stored within 15m of cylinder storage areas.

4.12.8. Welding grounds and returns should be securely attached to the work by cable lugs, by clamps in the case of stranded conductors, or by bolts for strip conductors. The ground cable will not be attached to equipment or existing installations or apparatus.

4.12.9. All electrical installations shall meet the IS: 5571: 1997 and NFPA 70 for gas cylinder storage area and other hazardous areas.

4.12.10. Use firewatchers if there is a possibility of ignition unobserved by the operator (e.g. on the other side of bulkheads).

4.12.11. Transformer used for electrical arc welding shall be fixed with ammeter and voltmeter and fixed with separate main power switch.

4.12.12. Use a low voltage open circuit relay device if welding with alternating current in constricted or damp places.

4.12.13. The current for Electric arc welding shall not exceed 300 A on a hand welding operation.

4.13. Excavation General

4.13.1. References:

a) The Haryana Building and other construction workers (Regulation of Employment of conditions of Service) Rules, 2005;

b) IS: 3764 -1992 (Re-affirmed 1996): Code of Safety for Excavation Work;

c) IS: 4756 -1978 (Reaffirmed 1996): Safety Code for Tunnelling Work;

d) BS 6164: 2011 (Code of practice for health and safety in tunnelling in the construction industry);

e) BS EN 16191: 2014 (Tunnelling Machinery-Safety requirements);

f) IS 4081:2013 Blasting and related drilling operations-code of safety.

4.13.2. The Contractor shall ensure:

a) Where any construction & building worker engaged in excavation is exposed to hazard of falling or sliding material or article from any bank or side of such excavation which is more than 1.5 m above his footing, such worker shall be protected by adequate piling and bracing against such bank or side;

b) Undercutting during excavation shall be avoided. Whenever it is inescapable and banks of an excavation are undercut, adequate shoring is provided to support the material or article overhanging such bank;

c) Excavated material is not stored at least 0.65 m from the edge of an open excavation or trench and banks of such excavation or trench are stripped of loose rocks and the banks of such excavation or trench are stripped of loose rocks and other materials which may slide, roll or

fall upon a construction building worker working below such bank;

d) Metal ladders and staircases or ramps are provided, as the case may be, for safe access to and egress from excavation where, the depth of such excavation exceeds 1.5 m and such ladders, staircases or ramps comply with the IS 3696 Part 1&2 and other relevant national standards;

e) Trench and excavation is protected "against falling on a person by suitable measures if the depth of such trench or excavation exceeds 1.5m and such protection is an improved protection in accordance with the design and drawing ofa professional engineer, where such depth exceeds 4.0m;

4.13.3. Warning Signs and Notices:

The Contractor shall ensure that suitable warning signs or notices, required for the safety of workers carrying out the work of an excavation, shall be displayed or erected at conspicuous places in Hindi and in a language understood by most of such workers at such excavation work.

4.14. Tunnelling Works

4.14.1. The Contractor shall inform in writing to the Chief Inspector of Government of Haryana within 30 days, prior to the commencement of any tunnelling work.

4.14.2. The Contractor shall appoint a responsible person for safe operation for tunnelling work as per BOCWR.

4.14.3. In addition to general precaution such as display of warning sign/notices, deployment of trained staff, housekeeping, etc., the Contractor shall ensure that:

a) All portable electrical hand tools and inspection lamp used in underground and confined space at an excavation or tunnelling work is operated at a voltage not exceeding 24V;

b) Every compressed air system in a tunnel is provided with emergency power supply for maintained continued supply of compressed air ad per Rule 155 of BOCWR.

c) Only flame proof equipment of appropriate type as per IS: 5571:2000 and or another relevant national standard is used inside the tunnel;

d) Petrol or LPG of any other flammable substances are not used, stored inside the tunnel except with prior approval from the Engineer, and no oxy-acetylene gas is used in a compressed air environment in excavation or tunnelling;

e) Adequate number of water outlets provided for fire fighting purpose, an audible fire alarm and adequate number and types of fire extinguishers are provided and maintained;

f) Temperature in any working chamber in an excavation or tunnelling work where workers employed does not exceed 29°C as per Rule 165 of BOCWR;

g) All working areas in a free air tunnel are provided with ventilation system as approved by the Chief Inspector of Government of Haryana and the fresh air supplied in such tunnel is not less than 6 m3/min for each worker employed in tunnel and the free air flow movement inside such tunnel is not less than 9.0 m/min as per Rule 153 of BOCWR;

h) The oxygen level shall not be less than 19.5% in the working environment;

i) The excavated areas are made safe by use of suitably designed and installed steel sets, rock bolts or similar other means;

j) The responsible person referred to in BOCWR examines and inspects the workplaces in a tunnel before the commencement of work in such tunnel, and at regular intervals thereafter, to ensure safety of the Workers in such tunnel;

k) The portal areas of a tunnel with loose soil, or rock, likely to cause injury to a person are adequately protected with supports;

l) The Contractor shall ensure safe means of access to enter into tunnel.

m) The Contractor shall establish controlled Access/Egress system for the tunnel entry. Tally board system shall be adopted where any person entering the tunnel shall register his/her details before entering.

n) All life saving and fire fighting facilities shall be arranged in accordance with BS 6164 latest version.

o) The Contractor shall ensure continuous gas monitoring inside the tunnel before and after the blasting. Monitoring of the gas shall also be conducted with the help of hand held gas monitors. Such instrument shall be calibrated on regular basis.

p) The Contractor shall install emergency illumination (with battery backup) at an interval of not less than 15 m.

4.14.4. Means of Communication

The Contractor shall ensure that: reliable and effective means of communication such as telephone or walkie-talkie is provided and are maintained in working order for arranging better and effective communication at an excavation as per Rule 136 of BOCWR.

4.14.5. Permissible Limit of Exposure of Chemicals

The Contractor shall ensure that the responsible person referred to in BOCWR conducts necessary test before the commencement of a tunnelling work for the day and at suitable intervals as fixed by Chief Inspector to ensure that the permissible limits of exposure are not exceeded, and a record of such test is maintained and is made available for inspection to Chief Inspector, on demand.

4.14.6. Rock Fall Prevention (NATM)

The Contractor shall:

a) Draw up a method statement that includes preventive measure to fall of rock, tunnel face watching, evacuation methods from the face, and the construction sequence etc. to ensure that workers are informed.

4.14.7. Evacuation and Training

The Contractor shall ensure that:

a) Implementation of the training for evacuation and fire fighting immediately before the distance reaches about 100m from the portal to the tunnel face; and

b) Implementation of evacuation training by a responsible person appointed in terms of dealing with technical matters.

4.15. Blasting and Drilling

4.15.1. The following standards whichever is more stringent shall be applicable:

a) Safety Code for Blasting and Drilling operation IS 4081:2013;

b) Safety Code for tunnelling Work IS 4756-1978;

c) Code of practice for construction of tunnels IS 5878;

d) The Haryana BOCWR ; 2005 and Other Relevant National Legislations & ISCodes; and

e) Code of Practice for the safe use of explosives in the construction industryBS 5607:1988.

4.15.2. The Contractor shall ensure that all blasting operations will only be permitted following consultations with the relevant authorities and subsequent issuing of the permission to blast permits.

The Engineer must also give his consent in writing before any blasting operations take place.

4.15.3. The Contractor shall:

a) appoint the manager, the deputy manager and officer in charge of handling explosives to prevent handling accidents;

b) when doing blasting work, the Contractor shall appoint a work supervisor from among those who can take on the blasting work;

c) All blasting shall be conducted under the direct supervision of a Licensed Shot firer.

4.15.4. Handling of explosives- as per Rule 278 HBOCWR;

The Contractor shall ensure at a construction site of a building or other construction work that-

a) All explosives are handled, used or stored in accordance with the instructions and the material data sheet supplied by the manufacturer of such explosives;

b) The use of explosives is carried out in safe manner to avoid injury to any person and under the direct supervision of a responsible person;

c) Before using any explosive, necessary warning and danger signals are erected, at conspicuous places of such use to warn the building workers and the general public of the danger involved in such use.

d) Safety Precautions- as per Rule 279 of HBOCWR;

The Contactor shall ensure at a construction site of a building or other construction work that-

i) Notwithstanding the provisions of rule 278, the following precautions are observed at the places of transporting, handling, storage and use of such explosives, namely-

ii) Prohibition of smoking, naked lights and other sources of ignition in the vicinity where explosives are handled, stored and used;

iii) To keep safe distance and to use non-sparking tools while opening packages containing explosives;

iv) To stop the use of explosives and handling thereof while the weather conditions are not suitable for such use or handling.

v) In addition to the provisions of this chapter, all measures, and precautions

vi) required to be observed for use, handling, storing or transportation of explosives under the rule framed under the Explosives Act, 1884(4 of 1884), are observed.

4.15.5. Risk Assessment and Method Statements

The Contractor shall produce a detailed hazard and risk assessment and an in depth method statement for amongst others the following elements:

a) Type of explosives to be used;

b) Anticipated effects of vibration on nearby structures;

c) Blasting patterns;

d) Delivery of the explosives;

e) Transportation and storage of explosives on site;

f) Drilling and charging of holes;

g) Warning sirens;

h) Measurement of Vibration;

i) Use of blast screens;

j) Ventilation following blasting;

k) Atmosphere monitoring;

l) Procedure for miss-fires;

4.16. Material Transportation

4.16.1. The Contractor shall develop the System Procedure/Methods Statement for heavy/big material/machinery transportation such as Rolling Stock, Transformer, and Bridge Main Girder, etc.

4.16.2. The Contractor shall ensure that the person in charge should inspects the safety implementation like properly fixing of wire with vehicle slab bed, condition of vehicle breaks etc. before starting the job and record the accidents and records.

4.16.3. The Contractor shall ensure that every vehicle/moving machinery should have a signal man who has a whistle, a flag or a signal light (in the night) with striking clothes and stands at a safe visible place from a machine operator by means of the proper signal and way determined.

4.16.4. The induction related to moving and parking safely should be given to driver/operator like parking construction vehicles at a specified place with a parking brake and making sure to put a drag.

4.17. Foundation Works

4.17.1. The Contractor is required to evaluate the risk in each activity and suggest a control measures of piling works:

a) Covering of bore holes with adequate warning signs;

b) Cage to be lowered by using crane;

c) The auxiliary hook of the rig shall not be used to pull or lower the cage in bore hole;

d) The tremie pipe lowering and lifting after concreting shall be done by using crane;

e) Control measure to arrest polymer spillage from the Site to avoid contaminating the surface drains;

f) An entry restraining fence shall be provided around the pier excavation completion;

g) No man suffering from any chronic disease, alcoholic excess, ear or heart troubles or having a sluggish blood circulation or who has excess of fat should be employed as a diver;

4.18. Batching Plant and Casting Yard

4.18.1. The Contractor is required to evaluate the risk in each activity and suggest Control Measures:

a) Adequate space between the casting bed, segment storage area and the adjoining road shall be maintained so that a steel railing could be installed to segregate the gantry crane movement area from the road;

b) All safety precautions stated in Sub-Clause4.8[Construction Machinery], Automatic Safe Load Indicator (ASLI) for crane and gantry shall be complied during erection of gantry crane and other equipment;

c) The aggregate/sand storage area shall be kept under the full coverage of effective water sprinkler to avoid dust generation;

d) The entire batching plant/aggregate storage Area shall be adequately walled of sufficient height, above which the Contractor is required to erect green dust protective net. This is a mandatory requirement to avoid dust in surrounding environment;

e) The batching plant and casting yard required to obtain ''Consent to Establish'' and

f) ''Consent to Operate'' certificate from State Pollution Control Board;

g) The batching plant/casting yard shall be barricaded and made as a compulsory Personal Protective Equipment (PPE) zone;

h) Time office, canteen, drinking water, toilet and rest place shall be suitably located for the easy access to workers. All the facilities shall be properly cleaned and maintained during the entire period of operation;

i) Drainage shall be effectively provided, and waste water shall be disposed after proper treatment; and

j) Manual handling of cement shall be avoided. Whenever it is necessary the workmen shall be given full body protection, hand protection and respiratory protection as a basic measure of ensuring better health.

4.19. Form Works

Ensure no attaching equipment to the formwork assembly unless specifically designed for this purpose; and not using a stripping process which may cause damage to the permanent structure.

4.20. Concrete Works

a) Concrete pumping equipment, trucks etc. are not to be washed down on site and any waste-water, concrete slurry or other contaminants are to be contained; and

b) These contaminants are not to be discharged into or onto roadways, footpaths, gutters, drainage systems, watercourses or any other surface area that will result in damage to the environment or contravenes environmental legislation.

4.21. Pier Casting Works

a) Using crane to hold the pier reinforcement during the time gap between de-staging and placement of shutter; and

b) Location and pier height specific securing arrangement and specific Method Statement for pier more than 9.0 m shall be submitted and approved by the Engineer.

4.22. Bridge Erection Works

4.22.1. References:

a) The BOCW Acts and Rules;

b) The Haryana BOCW Rules 2005;

c) Indian Railways Bridge Manual; and

d) Safety Assessment with regard to Steel Bridge Erection Works 1985, Ministry of Health, Labour and Welfare;

4.22.2. General

As bridge erection works are one of the riskiest jobs, the Contractor shall take utmost precaution at all stages like; planning, establishing temporary yard, casting segments, transporting segments, fabrication and operation of erection machinery, if any, launching of segments/lifting of segments, pre-stressing, cutting and welding, auto (or manual) launching and dismantling of erection machineries. For pre-stressed concrete bridges, the Contractor shall further ensure that:

a) a responsible person should be appointed for post-tensioning works testing and inspection of tendon tensioning devices and using material;

b) installation of protective board behind a tensioning jack and keep out behind a jack during

tensioning;

c) use of protective glasses, laver gloves, and masks during grouting for safety of the Workers; and

d) fall prevention installation of overall boarding at the bottom of a bridge and installation of funnel type boarding at the side of a bridge during construction in case of RFO (Railway Flyover) or ROB (Road over Bridge) for preventing the flying and fall of materials and tools by safety net, should be ensured.

4.22.3. The Contractors Obligation

The Contractor shall prepare a comprehensive method statement for the bridge erection works, adhering to the ESHS conditions laid down herein. Particular reference shall be made to the provisions on working at height. As the entire process of launching/lifting has to be undertaken at the Site especially during night time, the safety of workers is of paramount important. Daily inspection of scaffold structure and mechanical equipment for the traveller crane should be done.

4.22.4. Basic Consideration under Site Condition:

Erection works over or adjacent roads or highways:

a) The work area should be demarcated properly, and route map and traffic management plan should be developed and implemented with proper signages and

b) caution;

c) The Contractor shall ensure the implementation of proper stop traffic and detour plan;

d) The Contractor shall arrange the proper guide and signs to be followed while working on highway or adjacent roads, railways; and

e) The Contractor should plan and establish all the required measures for the protection of overhead wires and buried utilities.

i) The regular inspection is done for all the installed protection equipment;

ii) The movement restriction site plan to be developed with defined operation path for safe working at site;

iii) watchmen should be appointed who are given training related to all type of traffic management and all signals used for smooth traffic flow and site transportation and works;

iv) The railway schedule is taken in consideration while planning the site works and ensures the safe management system with the details given regarding the kind of works suspended while a train is passing and clarifying the way of opening or closing railway in case of track closure works. For steel truss bridges;

v) The Contractor must install the protective net just after erecting truss upper chord material;

vi) The Contractor must install safety operation path to an end of erected member and a cross point of lateral bracing;

The Contractor may use any of the erection methods. However, following general points will be kept in view and ensured as applicable-

A. The Contractor should develop and confirm the Engineer his Method Statement with details of position of bearing, jacking operation, roller passing etc.;

B. Detailed inspection report related to the movement and condition of superstructure from the place of launching equipment and rollers should be given to the Engineer;

C. The Contractor shall give confirmation of binding situation such as a bolting erection member;

D. The Contractor shall give confirmation of displacement per every erection phase;

E. The Contractor shall give confirmation of fixing situation for bearings;

F. The Contractor must take measures to avoid a fall and lateral buckling of member; and

G. The Contractor shall take measures of fall prevention for main superstructure.

4.23. Building and Roof Erection Works

4.23.1. The Contractor shall plan erection sequence and work procedures properly under competent and experienced personnel to ensure the safety of workers and prevent structure failure during erection:

a) Contractor shall develop and confirm with the Engineer his method statement with details;

b) The stability of structural members is to be ensured by means of ties, braces, anchor/fixing bolts, or other suitable means before releasing lifting gear, slings, chains etc;

c) Tag lines must be attached to the ends of components/loads to maintain control during crane lifting operations;

d) Structure stability is to be ensured always. Unattended and incomplete buildings/structures are NOT to be left in an unsafe and hazardous condition, to pose a risk to the safety and health of site personnel or the public;

e) The Workers placing and securing roof battens are to be protected and are to work from an enclosed environment (e.g. scaffolding, deck guardrail or equivalent) and work up from the bottom of the truss/rafter towards and finish at the ridge /peak of the roof framing; and

f) When the spacing of trusses and roof battens exceed 600mm the appropriate procedures are to be considered and applied after conducting a risk assessment to provide the optimum fall protection.

4.24. Overhead Contact Wire Works

4.24.1. During starting of works using rack vehicle/moving scaffold/ladder/insulation tower/step ladder, etc., the Contractor's operation in charge shall confirm as follows:

a) The work sequence shall be determined while using Ariel Track vehicle. Communication system between drivers and conductors shall be developed and adopted;

b) A deck which must be used by workers, shall have enough capacity of carry necessary loads for work at a high place with a pre-operation inspection;

c) The workers shall be given the safety protection equipment which has enough capacity to hold necessary loads to prevent any accidental fall with a pre-operation inspection;

d) State of electrical equipment installation and a route of going up and down from ground;

e) The Worker is given required training for electrical works at height and the Worker must use a safety rope, an auxiliary rope, a fall prevention equipment such as a rolip which is a fall arrest device for a fixed rope when they work at high place;

f) The Worker shall fix the grip of an auxiliary ropes at the upper position of their safety ropes and uses special wires or a lift when delivering materials and tools from ground to high place;

g) The Contractor shall ensure that no one lean out of the rail of the track vehicles, or take a foot on the rail; and Shall take all the precautions for self-propellant or roll prevention when bringing the track vehicle to a stop;

h) The installation of medium rail at the place where handrail is more than 85cm high;

i) The training is given to all, for putting on a foot brake when bringing the rolling tower to a stop or working on the deck of the rolling tower suspended;

j) Putting on a foot brake and fixing the insulation tower by an assistant when bringing the insulation tower to a stop or working on its suspension;

4.24.2. While going up and down along an Electric Pole, Power Pylon or a High Steel Structure or working above it, the Contractor shall ensure the safety precautions mentioned below:

a) Use of a safety rope, an auxiliary rope and a fall prevention equipment with using an exclusive scaffold when going up and down along the electric pole;

b) Use of an escort rail, or both a Full Body Harness and an auxiliary rope when going up and down along the power pylon or the high steel structure;

c) While working on a Beam, the Contractor shall ensure the safety precautions mentioned below:

i. Use of a horizontal rope on working consecutively on the beam or painting the beam surface without an auxiliary rope; and

ii. Use of a safety rope and an auxiliary rope when moving on the beam under unavoidable circumstances.

4.25. Locomotives and Wagons

4.25.1. Speed limit is determined, and traffic signs of speed limits, lights and related hazards signage and cautions shall be installed at work place.

4.25.2. Person in charge shall be nominated as maintenance officer to inspect and repair temporary rails or track surface situation regularly.

4.25.3. Ensure the installation of an alarm device such as a horn and a buzzer, a head light, and a flood light for the driver's seat.

4.25.4. Training and education shall be given to the driver and the signal man regarding how to send standard signal and operate vehicle diagram and turning off and putting on the brakes while the driver leaves his seat. And making sure to set wheel stoppers when stopping or parking at the slope track.

4.25.5. Each locomotive shall carry an extinguisher for fires

4.26. Confined Space Entry

4.26.1. The Contractor must ensure all confined spaces are identified and managed using documented site confined space management methods.

4.26.2. When internal combustion engines are to be used into confined space or excavation or any other workplace where natural or artificial ventilation system is inadequate to keep carbon monoxide below 50ppm, exposure of workers shall be avoided unless suitable measures are taken and provided by the Contractor.

4.26.3. No worker shall be allowed into any confined space or tank or trench or excavation wherein there is given off any dust, fumes/vapours or other impurities which is likely to be injurious or offensive, explosive or poisonous or noxious or gaseous material or other harmful articles unless steps are carried out by the Contractor and certified by the responsible person to be safe.

4.27. Fire Protection

4.27.1. The contractor shall ensure that the construction site is provided with—

a) Fire extinguishing equipment sufficient to extinguish any probable fire at such construction site;

b) An adequate water supply at ample pressure as per national standards;

c) Number of trained persons required to operate the fire extinguishing equipment provided; and

d) Is properly maintained and inspected at regular intervals of not less than once in a year by the responsible person and a record of such inspections is maintained.

4.27.2. The extinguishers shall be chosen as per type of fire load and surrounding location.

4.27.3. All construction machinery including crane shall carry a portable fire extinguisher in operator's cabin.

4.27.4. Emergency plan and Fire Evacuation plan in ESHS Management Plan shall be prepared and issued by the Contractor. Mock drills should be held on a monthly basis to ensure the effectiveness of the arrangements and as a part of the programme, the telephone number of the local fire brigade should be prominently displayed near each telephone on site.

4.27.5. Recharging of fire extinguishers and their proper maintenance should be ensured and as a minimum should meet Indian National Standards.

4.27.6. All drivers of vehicles, foreman, supervisors and managers shall be trained on operating the fire extinguishers and firefighting equipment.

4.28. Corrosive Substance

As per Rule 100 of HBOCWR, The contractor shall ensure that corrosive substances, including alkalis and acids, shall be stored and used by a person dealing with such substances at a building or other construction work in such a manner that it does not endanger the building worker and suitable protective equipment shall be provided by the contractor to a building worker during handling or use of such substances at a building or other construction work and in case of spillage of such substances on the building worker, immediate remedial measures shall be taken by the contractor.

4.29. Demolition

4.29.1. All demolition works be carried out in a controlled manner under the management of experienced and competent supervision.

4.29.2. The concerned department of the Government or local authority is informed, and permission obtained wherever required. Media shall also be informed regarding this concern.

4.29.3. All glass or similar materials or articles in exterior openings are removed before commencing any demolition work and all water, steam, electric; gas and other similar supply lines are disconnected.

4.29.4. No demolition work be performed if the adjacent structure seems to be unsafe unless and until remedial measures life sheet piling, shoring, bracing or similar means be ensured for safety and stability for adjacent structure from collapsing.

4.29.5. Debris/bricks and other materials or articles shall be removed by means of chute, bucket or other safe method.

4.29.6. No person other than the Workers or other persons essential to the operation of demolition work shall be permitted to enter a zone of demolition and the area be provided with substantial barricades.

4.30. Permit to Work

4.30.1. The Contractor shall develop work permit system, which is formal written system used to control certain types of work that are potentially hazardous. A work permit is a document, which specifies the work to be done, and the precautions to be taken.

4.30.2. Work Permits form an essential part of safe systems of work for many construction activities. They allow work to start only after safe procedures have been defined and they provide a clear record that all foreseeable hazards have been considered. Permits to Work are usually required in high-risk areas as identified by the Risk Assessments.

4.30.3. A permit is needed when construction work can only be carried out if normal safeguards are dropped or when new hazards are introduced by the work.

4.30.4. Examples of high-risk activities include but are not limited to:

a) Entry into confined spaces;

b) Hot work;

c) To dig where underground services may be located;

d) Work with heavy moving machinery;

e) Work with radioactive isotopes;

f) Heavy lifting operations and lifting operations closer to live electric power line;

g) Work with using track motor vehicles etc.; and

h) Work under electric facility and overhead electric (OHE) line energized.

4.30.5. The Contractor shall prepare operation manuals above mention and implement training course at any time based on such manuals to the Workers given completion of certificates before the commencement of works.

4.30.6. The permit-to-work system should be fully documented, laying down:

a) How the system works;

b) The jobs it is to be used for;

c) The responsibilities and training of those involved; and

d) How to check its operation.

4.30.7. A work permit authorization form shall be completed with the maximum duration period not exceeding 12 hours or end of shift, which is earlier.

4.30.8. A copy of each permit to work shall be displayed at work place. during its validity, in a conspicuous location in close proximity to the actual works location to which it applies.

4.31. Traffic Management and Site Barricading

4.31.1. The basic objective of the following guiding principles is to lay down procedures to be adopted by the Contractor to ensure the safe and efficient movement of traffic and also to ensure the safety of workmen in the all work areas.

4.31.2. The guiding principles to be adopted for safety in construction zone are to:

a) Warn the road user clearly and sufficiently in advance;

b) Provide safe and clearly marked lanes for guiding road users;

c) Provide adequate traffic marshals to regulate the movement of traffic;

d) Provide safe and clearly marked buffer and work zones; and

e) Provide adequate measures that control driver behaviour through construction zones.

4.31.3. In all cases, the Contractor shall employ proper precautions. Wherever operations undertaken are likely to interfere with public traffic, Specific Traffic Management Plans shall be drawn up and implemented by the Contractor in consultation with the approval of Local Police Authorities and/or the concerned politburo/Civil Authorities and followed to the IRC:SP;55- 2014 (Guidelines on Traffic Management in work zones) & IRC: 67 (Code of Practice for Road Signs).

4.32. Working near Railway

4.32.1. The details of Safe work procedure for work near Railway Track is given in **Attachment -5** of this document.

4.33. Other Works to be Scrutinized

4.33.1. Other works including, but not be limited to, the works in the Site (the ROW), the works in the Borrow Pit, the works in the Quarry and Works on road shall be included to be scrutinised with

respect to the accident prevention.

4.33.2. If blasting is anticipated in excavation in rock, preventive measures against accidents and protective measures against environmental/social impacts shall be of paramount importance.

4.33.3. The Contractor shall include all those items as well as work elements to formulate the preventive and protective measures considering envisaged conditions, situations, and activities of the works which may induce accidents or hazard to environment and/or society.

4.34. Personal Protective Equipment

4.34.1. The Contractor shall provide required PPEs to workmen to protect against safety and/or health hazards. Primarily PPEs are required for the following protection:

a) Head protection (Safety helmet with a chin strap);

b) Foot protection (Safety footwear, Gumboot, etc.);

c) Body protection (High visibility clothing (Waistcoat/Jacket), Apron, etc.);

d) Personal fall protection (Full body harness, Rope-grip fall arrester, etc.);

e) Eye protection (Goggles, Welders Glasses, etc.);

f) Hand protection (Gloves, Finger coat, etc.);

g) Respiratory protection. (Nose mask, Self-contained breathing apparatus, etc.); and

h) Hearing protection (Ear plugs, Ear muffs, etc.).

4.34.2. The PPEs and safety appliances provided by the Contractor shall be of the standard as prescribed by Bureau of Indian Standards (BIS). If materials conforming to BIS standards are not available, the Contractor as approved by the Engineer shall procure PPE and safety appliances.

4.34.3. The Contractor shall provide the PPEs which the Contractor deems necessary including; but not be limited to, safety helmets, safety shoes to all the Contractor's Employees including workmen (including those of its sub-contractors). When and Where the Contractor thinks that he needs to provide the Contractor's Employees including workmen' (including those of its sub-contractors) with high visibility clothing as per the following requirement.

a) Hi-visibility jacket covering upper body and meeting the following requirements as per BS EN 471:1994;

b) Background in fluorescent orange-red in colour;

c) Jackets with full-length sleeves with two bands of retro reflective material, which shall be placed at the same height on the garment as those of the torso. The upper band shall encircle the upper part of the sleeves between the elbow and the shoulder; the bottom of the lower band shall not be less than 5cm from the bottom of the sleeve;

d) Two vertical green strips of 5cm wide on front side, covering the torso at least 500 cm2;

e) Two diagonal strips of 5 cm wide on back in an 'X' pattern covering at least 570cm2;

f) Horizontal strips not less than 5cm wide running around the bottom of the vertical strip in front and 'X' pattern at back;

g) The bottom strip shall be at a distance of 5cm from the bottom of the vest; and

h) viii) Strips shall be retro reflective and fluorescent.

Safety Helmet Colour Code (Every Helmet should have the LOGO*affixed/painted)	Person to use
Hard hat with company Logo (Employees)	Hard hat with reflective tape (Marshals)
White	Employer/Engineer
Grey	All designers, Architect, Consultants, etc.
Violet	Main Contractors (Engineers/Supervisors)
Blue	All subcontractors (Engineers/Supervisors)
Red	Electricians (Both Contractor andSubcontractor)
Green	Safety professionals (Both Contractor and Subcontractor)
Orange	Security guards/Traffic marshals
Yellow	All workmen
White (with "VISITOR" sticker)	Visitors
Safety Shoes (Anyone at the Site incl. Marshals)	
All employees of the contractor including workmen	Traffic marshals

Note: LOGO·

a) Logo shall have its outer dimension 2"X2" and shall be conspicuous
ii) Logo shall be either painted or affixed
iii) No words shall come either on Top / Bottom of Logo

Logo of the corresponding main contracting company for their employees and sub-contracting company for their employees shall only be used.

4.34.4. In addition to the above any other PPEs required for any specific jobs like, welding and cutting, working at height, tunnelling etc. shall also be provided to all workmen and also ensure that all workmen use the PPEs properly while on the job.

4.34.5. The Contactor shall not pay any cash amount in lieu of PPEs to the workers/sub- contractors and expect them to buy and use during work.

4.34.6. The Contactor shall at all-time maintain a minimum of 10% spare PPEs and safety appliances and properly record and show to the Engineer during the inspections. Failing to do so shall invite penalty as per Clause 7. [Financial Deduction/Withholding].

4.34.7. It is always the duty of the Contactor to provide required PPEs for all visitors. Towards this required quantity of PPEs shall be kept always at the security post.

4.34.8. The Contractor shall ensure that safety equipment and protective clothing is available and used on the site at all material times and those measures for the effective enforcement of proper utilisation and necessary replacement of such equipment and clothing shall be incorporated into the Site ESHS Plan.

4.35. Visitor at Site

4.35.1. No visitor can enter the Site without the permission. All authorised visitors should report at the site office. The Contractor shall provide visitor's helmet (White helmet with visitor sticker) and other PPEs like Safety Shoe, reflective jacket, respiratory protection etc. as per requirement of the Site. Entry of visitors in underground shall be suitably controlled.

4.35.2. The Contractor shall be fully responsible for safety and health of all visitors within the Site.

4.36. Site Security

4.36.1. The Contractor shall be wholly responsible for security on the Site and any other areas being used by him or the Subcontractor's for the purposes of the Contract. The Contractor shall implement and cause the Subcontractor's to implement proper security management procedures in accordance with the approved ESHS Management Plan.

4.36.2. The Contractor shall assign on the Site a security officer (adequately trained person,) and his alternate(s), who shall be primarily responsible for the Contractor's security services and fully cooperate with the Engineer's security organization throughout the Time for Completion. Necessary approval of agency shall be obtained from the Engineer.

4.36.3. The security plan covered by the ESHS Management Plan shall contain the following:

a) Security policy statement and objectives;

b) The Contractor's security organization;

c) Role, responsibility and authority of each member of the security organization;

d) Procedure for enforcement of security regulations;

e) Daily, weekly and monthly security meeting procedures;

f) Sample forms for security reports;

g) Personnel security control procedures;

h) Goods security control procedures;

i) On-site security patrol procedures;

j) Liaison and coordination procedure with local fire/police and other authorities;

k) Liaison and coordination procedure with the Employer and relevant other authorities; and

l) Liaison, coordination and joint security inspection procedure with other Contractors.

4.36.4. Where necessary, the Contractor shall install, modify, maintain and remove the temporary security fences, gates, posts, security lightings and other facilities required for proper security control, in addition to those to be constructed as part of the Works. The Contractor shall operate these facilities to properly control ingress to and egress from the areas under his control throughout the Time for Completion. This control shall apply to every person including the Employer's Personnel.

5. OCCUPATIONAL HEALTH AND WELFARE

5.1. Physical Fitness of Workmen

5.1.1. The Contractor shall ensure that his employees/workers subject themselves to such medical examination as required under the law or under the contract provision and keep a record of the same.

5.1.2. The Contractor shall not permit any employee/workers to enter the work area under the influence of alcohol or any drugs.

5.1.3. The Contractor shall maintain the confidential records of medical examination or the physician authorized by the Engineer.

5.1.4. No worker is charged for the medical examination and the cost of such examination is borne by the Contactor employing such worker.

5.1.5. If the Contractor fails to get the medical examination conducted as mentioned above, the Engineer will have the right to get the same conducted through an agency with intimation to the Contractor and deduct the cost and overhead charges from his dues.

5.2. Medical Facilities

5.2.1. Occupational Health Centre (First Aid Station)

The Contractor shall ensure at a construction site an occupational health centre, mobile or static is provided and maintained in good order. Services and facilities as per the scale lay down in Schedule IV of HBOCWR. A construction medical officer appointed in an occupational health centre, possess the qualification as laid down in Schedule V Rule no 113 of HBOCWR:

5.2.2. The Contractor shall appoint appropriate full-time staff including one nurse, one dresser- cum-compounder, one sweeper-cum-ward boy with each construction medical officer.

5.2.3. The Contractor shall communicate the complete details including name, qualification and experience of the construction medical officer, to the inspector having jurisdiction under HBOCWR.

5.2.4. Ambulance Room, Ambulance Van and Stretchers:

The Contractor shall ensure at a construction site of a building or other construction work that an ambulance van and room are provided at such construction site or an arrangement is made with a nearby hospital for providing such ambulance van for

transportation of serious cases of accident or sickness of workers to hospital promptly and such ambulance van and room are maintained in good repair and is equipped with standard facilities specified in Schedule VI of Rule 114 & Schedule VII of Rule 115 of HBOCWR.

5.2.5. The Contractor shall provide enough stretchers at each site for use in an emergency.

5.2.6. First Aid Boxes and Emergency Care:

The Contractor shall ensure at construction site one First-aid box for 100 workers for providing first-aid to the workers. Every First-Aid box is distinctly marked "First-Aid" and is equipped with the articles specified in Schedule IX of Rule 119 of HBOCWR. Adequate no. of trained first aid persons shall be available at each work site in each shift.

5.2.7. HIV/AIDS Prevention and Control:

a) The Contractor shall adopt the Employer's "Workplace Policy on HIV/AIDS Prevention and Control for Workers Engaged by Contractors" and implement it. A copy of the policy is given in **Attachment-2 [Workplace Policy on HIV/AIDS Prevention & Control]**; and

b) The Contractor shall prepare and submit the Manual for HIV/AIDS Prevention and Control for his workers in terms of the aforesaid Employer's Policy within 28 days of the date of notification of the Contract.

c) The Contractor shall organize awareness program for labourers on the risks of AIDS and STDs in coordination with Haryana State AIDS Control society.

5.2.8. COVID -19 Prevention and Control

The Contractor shall ensure that the latest guidelines issued by Ministry of Health and Family Welfare (MoHFW), local government and the district administration are strictly followed at the construction works site. The Workplace Policy on COVID-19 Prevention and Control is given in **Attachment-3 [Workplace Policy on COVID-19 Response].** The Contractor shall undertake a COVID-19 risk assessment of project area and prepare and submit COVID-19 Response and Management Plan.

5.2.9. Prevention of Mosquito Breeding

Measures shall be taken to prevent mosquito breeding on the Site. The measures to be taken shall include:

a) Empty cans, oil drums, packing and other receptacles, which may retain water, shall be deposited at a central collection point and shall be removed from the site regularly;

b) Stagnant water shall be treated at least once every week with oil to prevent mosquito breeding;

c) The Contractor's equipment and other items on the site, which may retain water, shall be stored, covered, or treated in such a manner that water could not be retained; and

d) Water storage tanks shall be provided.

5.2.10. Posters in local language, Hindi and English, which draw attention to the dangers of permitting mosquito breeding, shall be displayed prominently on the Site.

5.2.11. The Contactor at periodic interval shall arrange to prevent mosquito breeding by fumigation/spraying of insecticides, and the ideal larvicide etc.

5.2.12. Alcohol, Smoking and Drugs

The Contactor shall always ensure that no employee is working under the influence of alcohol/drugs which are punishable under BOCWR;

Smoking at public places by any employee is also prohibited as per Government Regulations. The Contractor shall comply with the legal provisions in this regard, such as; Prohibition of Smoking in Public Places Rules, 2008. He shall be solely responsible for any penalty or punitive action by the government authorities because violations of the provisions contained in these rules by him or his representatives or his employees or his Subcontractors. Requisite notice boards, posters, etc., shall be put by him, as per the Rules.

5.3. Occupational Noise

5.3.1. The Contractor shall comply with the codes, regulations and standards regarding noise pollution and control as notified and amended by Central Government and State Government from time to time on the Site including but not necessarily limited to:

a) Chapter VII, Part -I, Schedule-I of Haryana BOCWR 2005;

b) Noise Pollution (Regulation and Control) Rules, 2000;

c) Environment (Protection) Act, 1986;

d) Environment (Protection) Amendment Rules, 2000; and

e) Central Motor Vehicles Rules, 1989;

f) Notification on Control of Noise from DG Sets, 2002.

5.4. Welfare Measures for Workers

5.4.1. Latrine and Urinal Accommodation:

a) Latrine and urinals shall be provided as per Chapter VI, Part – II of Rule 80 of Haryana BOCWR and shall also comply with the requirements of public health authorities; and

b) When women are employed, separate latrine and urinals accommodation shall be provided.

5.4.2. Moving Sites:

a) In case of works like track laying, the zone of work is constantly moving. In such cases, mobile toilets with proper facility to drain the sludge shall be provided at reasonably accessible distance; and

b) In case the Contactor fails to provide required number of urinals and latrines or fails to maintain it as per the requirements of Public Health Laws, the Engineer shall have the right to provide/maintain through renowned external agencies at the cost of the Contactor.

5.4.3. **Canteen**

In every workplace wherein not less than 250 workers are employed, the Contractor shall provide an adequate canteen conforming to Chapter VI, Part – II of Rule 81 of Haryana BOCWR

5.4.4. **Drinking Water.**

As per Section 32 of BOCWA, the Contractor shall make in every site, effective arrangements to provide sufficient supply of wholesome drinking water. Quality of the drinking water shall conform to the requirements of national standards on Public Health Laws. While locating these drinking water facilities due care shall be taken so that these are easily accessible from the place of work for all workers at all location of the Site. All such points shall be legible marked "Drinking Water" in a language understood by most of the workmen employed.

5.4.5. **Crèche**

In every workplace where in more than 50 female workers are ordinarily employed, there shall be provided and maintained a suitable room for use of children under age of 6 years, conforming to the provisions of Section 35 of BOCWA.

5.4.6. Labour Accommodation Camps

Labour camp management plan shall be prepared and approved by Engineer. Where workers are based some distance from their normal place of residence, the Contractor shall provide them with suitable and safe accommodation free of charge and shall take all necessary precautions to protect their health and welfare. The accommodation shall conform to the requirements of Section 34 of BOCWA and include but not be limited to the further measures specified hereunder.

5.4.7. All accommodation camps shall be provided always with a sufficient supply of clean drinking water (of potable quality according to national legal standards), in suitable and easily accessible locations:

5.4.8. The quality of drinking water shall be tested once a fortnight as prescribed in IS 10500:2012and immediate remedial action shall be taken if quality falls below the standard. Test results shall be provided to the Engineer at least monthly.

5.4.9. The Contractor shall provide all accommodation camps with clean and properly equipped and staffed kitchen and canteen facilities to supply meals for workers.

5.4.10. The Contractor shall provide sufficient toilet and bathroom facilities for the numbers of workers accommodated in each camp. Separate accommodation and toilet/bathroom facilities shall be provided for men and women and all facilities shall be kept in full working order always and cleaned and re-equipped daily.

5.4.11. The Contractor shall provide a laundry facility at the Labour Accommodation Camps.

6. ENVIRONMENT AND SOCIAL MANAGEMENT

6.1. General Conduct of the Works

6.1.1. The purpose and objective of these guidelines is to outline how the project will avoid, minimise or mitigate effects on the environment and surrounding area. These guidelines detail the implementation of measures in accordance with environmental and social commitments of HRIDC. These guidelines will be 'live' guidelines that will be reviewed and updated at regular intervals throughout the project life cycle. These guidelines will ensure that the development is compliant with current Environmental and Social legislations and will guide and assist the Contractor in exploring all reasonable and feasible means for reducing construction related Environmental and Social impacts.

6.1.2. The Contractor shall comply with the Environment and Social Management Plan (ESMP) given in the Environmental and Social Impact Assessment (ESIA) report available on HRIDC portal for information disclosure and will note and implement any requirements therein, in addition to those found in this specification.

6.1.3. The Contractor is required to build good public relations before the commencement of the Works particularly with the local level representatives such as the Gram Panchayat, by informing the expected impacts by the Works and their schedule and dispute resolution mechanism known as GRM set by the Employer.

6.2. Environmental Legislation

6.2.1. The Contractor shall always comply with all relevant National and State legislations regarding environmental protection, pollution prevention and control, waste management and other relevant environmental matters, including but not necessarily limited to, the following with their latest amendments:

a) The Environment (Protection) Act, 1986 and Rules 1986

b) The Indian Wildlife (Protection) Act, 1972;

c) The Forest (Conservation) Act, 1980 &Rules;

d) Punjab Land Preservation Act, 1900;

e) The Noise Pollution (Regulation and Control) Rules, 2000;

f) Notification on Control of Noise from Diesel Generator (DG) sets, 2002;

g) The Air (Prevention and Control of Pollution) Act, 1981and Rules 1981;

h) The Water (Prevention and Control of Pollution) Act, 1974 and Rules 1974;

i) Guidelines to control and regulate ground water extraction in India, 24th September2020, Central Ground Water Authority;

j) The Solid Management Rules, 2016;

k) The Construction and Demolition Waste Management Rules, 2016;

l) The Hazardous and Other Wastes (Management and Transboundary Movement)Rules, 2016;

m) The Bio-medical Waste Management Rules, 2016;

n) Plastic Waste Management Rules, 2016;

o) E-Waste (Management) Rules 2016;

p) The Batteries (Management and Handling) Rules, 2001;

q) Manufacture, Storage, and Import of Hazardous Chemical (Amendment) Rules,1989;

r) Ancient Monuments and Archaeological Sites and Remains (Amendment andValidation) Act 2010;

s) Fly ash utilization notification, Sept 1999;

t) Applicable NGT Guidelines issued time to time; and

u) Provisions of Graded Response Action Plan notified by the MoEFCC.

6.2.2. The Contractor shall comply the Environmental and Social Framework (ESF) of Asian Infrastructure Investment Bank (AIIB) February 2016.

6.2.3. If the requirements stated in this document are in conflict or inconsistent with the requirements of applicable laws, the more stringent requirements shall apply.

6.2.4. It is also the Contractor's responsibility to obtain all environment clearances, official approvals, consents, or other authorizations as may be necessary to comply with the relevant statutes, and to pay all related fees and other costs. The Contractor shall obtain all authorizations in a timely manner and submit to the Engineer as the evidence for the regulatory obligations before commencement of any related construction activity. The indicative clearances/permission/permit are presented in Table below and Contractor is required to take any other clearance as required for its construction activities.

Clearance/ Permission/Permit	**Relevant Acts/Rules**	**Concerned Agency**
Consent to Establish and Consent to Operate batching plants and casting yards	• The Water (Prevention and Control of Pollution) Act, 1974, and its amendments; • The Air (Prevention and Control of Pollution) Act 1981 and its amendments	Haryana Pollution Control Board
Authorization for generation, handling, storage, and transportation of hazardous waste	Hazardous and other Wastes (Management & Transboundary Movement) Rules, 2016	Haryana Pollution Control Board
Permission for extraction of ground water	Central Ground Water Authority guidelines to regulate and control ground water extraction in India, 24th September, 2020	Central Ground Water Authority
Pollution Under Control Certificate	Central Motor and Vehicle Act 1998 Vehicular Exhaust Norms, CPCB 2007	Department of Transport, Government of Haryana
Construction and Demolition Waste Management Plan	Construction & Demolition Waste Management Rules, 2016	Local Authority (Municipal Corporation)
Deleted	*Deleted*	*Deleted*

6.3. Environmentally Friendly Construction Practices

6.3.1. Containment of Air Pollution

a) All construction equipment's should be cleaned of visible dirt/mud before exiting the construction sites and streets shall be promptly cleaned by manual sweeping, or by deploying electro – mechanical devices if such material has been dropped;

b) The Contractor shall provide a wash pit or a wheel washing and/or vehicle cleaning facility at the exits from work sites such as construction depots and batching plants. This facility will be provided with efficient drainage, water re-circulation apparatus and silt traps to prevent any excessive buildup of water. Where wheel-washing facility is not possible, the Contractor shall ensure manual cleaning of wheels by wire brushes or similar suitable means;

c) The Contractor shall ensure that vehicles shall have properly fitted side and tailboards. No open load carrying vehicle shall be used for moving potentially dust-producing materials and dust potential material shall not be loaded to a level higher than the side and tail boards, and shall be fitted with cover lids or tarpaulin covers;

d) The Contractor shall place excavated materials in the dumping/disposal areas with suitable slopes designated in the drawings;

e) The Contractor shall place material in a manner that will minimise dust production. Material shall be stabilized each day by watering or other accepted dust suppression techniques;

f) Materials should not be dropped from more than 1.5 m to limit fugitive dust generation;

g) During dry weather especially on windy, water sprinkling must be used daily at every two hours intervals or at any time that it is required for dust control to prevent any dust from blowing and causing nuisance.

h) The Contractor shall provide storage facilities at each construction site in the form of closed containers/bins or wind protected shelters or mat covering or walled or any combination of the above to the satisfaction of the Engineer.;

i) Stockpiles of sand and aggregate greater than 20m3 for use in concrete manufacture shall be enclosed on three sides, with walls extending above the stockpile and two (2) metres beyond the front of the stockpile;

j) Areas within the Site such as construction depots and batching plants, where there is a regular movement of vehicles shall have an approved hard surface that is kept clear of loose surface material;

k) Unless the Engineer has given notice otherwise, the Contractor shall restrict all motorised vehicles on the Site to a maximum speed of 15 kilometers per hour and confine haulage and delivery vehicles to the designated roadways inside the site;

l) The Contractor shall erect hoardings as specified in Engineer requirements securely around all construction work sites during the main construction activity, to contain dust within the site area and also to reduce air turbulence caused by passing traffic. The hoarding shall be safely secured to the ground to prevent from toppling with minimum gap between the base of hoarding and ground surface.

m) Water spray should be used to control dust during breaking of rock/concrete;

n) During tunnel construction the Contractor shall monitor dusts concentration, wind velocity, air capacity of ventilation system every month and will keep monitoring record including date, method, location, condition, results, and evaluation of results.

o) The contractor shall take all necessary actions to control air pollution as per guidelines issued by the commission for Air Quality Management in National Capital Region time to time.

p) The contractor shall take necessary actions as per the provisions of Graded Response Action Plan (GRAP) issued time to time.

6.3.2. **Containment of Water Pollution**

a) List of sources (surface/ground) to be provided for approval from Engineer;

b) Prior to use of source, written permission to be obtained from authority to use the water in construction activity, and submit a copy to Engineer;

c) During construction only permitted quantity (permission taken) from approved sources to be used in construction activity;

d) A Drainage system should be constructed during the commencement of the works, drain off all surface water at the site into suitable drains;

e) At construction depots and batching plants temporary drainage works should be maintained, removed, and reinstated as necessary and all other necessary precautions should be taken for avoidance of damage by flooding and silt;

f) The Contractor shall provide a hard surface with suitable drainage system for Transit Mixture washing at Casting Yard and/or Batching plant. The slurry water from Transit Mixture washing area shall go to sedimentation tank of suitable capacity to treat the slurry water. The contractor shall ensure the facility remains functional till the end of the contract;

g) The Contractor shall take measures to prevent discharge of oil on land and in water bodies. Oil separator/interceptors shall be provided at Batching Plant and Construction Depot location for vehicle maintenance to prevent the release of oils and grease into the drainage system. These shall be cleaned on a regular basis;

h) Open stockpiles of construction materials (e.g. aggregates, sand and fill material) should be covered with tarpaulin or similar fabric during rainy season or at any time of the year when rainstorms are likely. Washout of construction or excavated materials should be diverted to drainage system through appropriate sediment traps;

i) Rainwater pumped out from trenches or foundation excavation should be discharged into storm water drains after obtaining notice of no objection from the Agency controlling the system;

j) The Contractor shall prevent soil particles and debris from entering the wells or water discharge points by use of filters and sedimentation basins as required;

k) The Contractor shall always ensure that all existing stream courses and drains within, and adjacent to the site are kept safe and free from any debris and any excavated materials arising from the Works;

l) The Contractor shall discharge wastewater arising from site offices, canteens or toilet facilities constructed by him into sewers after obtaining prior notice of no objection of agency controlling the system;

m) The volume of oil spill should be calculated as well as storage volume to contain spill within the materials storage containment areas. The procedure shall include measures to contain and mitigate transportation of oil, grease or hazardous materials to the drainage system or any water body;

n) The Contractor shall ensure that earth, bentonite, chemicals and concrete agitator washings etc. are not deposited/drained in the watercourses but are suitably treated and effluents and residue disposed off in a manner approved by local Regulatory Authorities;

o) Construction works should be programmed to minimize soil excavation works in rainy season. If carried out during rains, temporarily exposed slope surfaces should be covered by tarpaulin, and temporary access roads should be protected by crushed stone or gravel, as

excavation proceeds.

p) Wastewater from Concrete Batching & Precast Concrete Casting and that generated from the washing down of mixer trucks and drum mixers and similar equipment should wherever practicable be recycled. The discharge of wastewater should be kept to a minimum;

q) The road between the vehicle washing bay and the public road should be paved to reduce vehicle tracking of soil and to prevent site run-off from entering public road drains;

r) Surface run-off should be segregated from the concrete batching plant and casting yard area as much as possible and diverted to the storm water drainage system. Surface run-off contaminated by materials in a concrete batching plant or casting yard must be treated to, within the discharge norms before disposal into storm water drains;

6.3.3. **Containment of Noise and Vibration**

a) Contractor shall minimize the use of impact devices, such as jackhammers, and pavement breakers and instead use concrete crushers or pavement saws;

b) Equip noise producing equipment such as jackhammers and pavement breakers with acoustically attenuating shields or shrouds recommended by the manufacturers thereof, to meet relevant noise limitations;

c) Use hydraulic tools instead of pneumatic impact tools. If pneumatic impact tools and equipment are used, they shall have intake and exhaust mufflers recommended by the manufacturers thereof, to meet relevant noise limitations;

d) Provide mufflers or shield panelling for other equipment, including internal combustion engines, recommended by manufacturers thereof;

e) Employ prefabricated structures instead of assembling on-site;

f) Use electric instead of diesel-powered equipment;

g) Provide enclosures for stationary equipment and barriers around noisy areas;

h) Locate stationary equipment in such a way, so as to minimize noise and vibration impact on community.

i) Keep noisier equipment and activities as far as possible away from noise sensitive locations and nearby buildings.

j) Plant and equipment known to emit noise strongly in one direction should where possible, be oriented in a direction away from noise sensitive receptor.

k) Reduce the number of plant and equipment operating in critical areas close to noise sensitive receptors.

l) Schedule truck loading, unloading, and hauling operations in such a way so as to minimize noise impact near noise sensitive locations and surrounding communities;

m) Plan noisier operations during times of highest ambient noise level, keep noise levels relatively uniform and avoid excessive and impulse noises;

n) Use only well-maintained, regular serviced plant/equipment, and not to be kept idling when not in use;

o) Maintain equipment such that parts of vehicles and loads are secure against vibrations and rattling;

p) Grading of surface irregularities on construction sites to prevent the generation of impact noise and ground vibrations by passing vehicles;

q) If back-up alarms are used on construction equipment, their noise emission level near noise

sensitive receptors such as residences, schools, hospitals and similar areas where calmness is essential, should be regulated, especially at night time;

r) Select truck routes for muck disposal so that noise from heavy-duty trucks will have minimal impact on sensitive areas (e.g., residential);

s) Conduct truck loading, unloading and hauling operations in a manner such that noise and vibration are kept to a minimum;

t) Avoid operating truck on streets that pass by schools during school hours;

u) Efforts to be made to bring down the noise levels due to the DG set, outside the premises, within the ambient noise requirements by proper setting and control measures;

v) The Contractor shall ensure that all necessary permissions/ approvals/consent is obtained from relevant authorities before installation and operation of Generator set;

w) A proper routine and preventive maintenance procedure for the DG set should be set and followed in consultation with the DG set manufacture;

x) At all times noise levels of DG sets shall comply the standards set out by CPCB/SPCB;

y) During tunnel operation following measures to be taken:

i) Blasting activities to be so schedule that local people are not disturbed and notify them prior to undertaking such activity;

ii) Operations to be scheduled to coincide when people are busy with their daily tasks so that they would be least likely to be affected. Blasting operation shall not be carried out in night.

iii) Charge mass per delay should be decreased by minimizing the number of blastholes firing on each delay.

iv) Smaller blasthole patterns and longer delays shall be used between dependent charges.

v) A preconstruction survey of nearby structure likely to be adversely affected by the construction activities to be performed and threshold or limiting values to be established that take into account each structure or use's ability to withstand the loads and displacements due to construction vibrations;

vi) An extensive outreach to be conducted in advance in the surrounding villages that could be affected;

vii) Vibration levels shall be monitored in the foundations of nearby buildings during all blasting activities. Blasting activities resulting in peak particle velocity (vibration) levels in excess of appropriate damage criteria as measured in the foundations of nearby structures would be immediately stopped until further precautionary measures are taken to reduce blasting-related vibration impacts.

viii) Work shall not begin again until the steps proposed to stabilize and/or prevent further damage to the designated buildings are approved.

6.3.4. **Containment of Waste**

a) The Contractor is required to develop, institute and maintain a Waste Management Plan (WMP) during the construction of the project for his works, which may include:

ix) Identification of disposal sites;

x) Identification of quantities to be excavated and disposed off;

xi) Identification of split between waste and inert material;

xii) Identification of amounts intended to be stored temporarily on site and location of such storage;

xiii) Identification of intended transport means and route;

xiv) Obtaining permission, where required, for disposal;

b) Such mechanism is intended to ensure that the designated area for the segregation and temporary storage of reusable and recyclable materials are incorporated in the WMP. The WMP shall be prepared and submitted to Engineer for approval.

c) Construction activities are expected to generate a variety of waste such as:

i) General refuse;

ii) Construction and Demolition waste including waste from excavated material;

iii) Chemical waste;

iv) Hazardous waste; and

v) Biomedical waste.

All wastes shall be stored at a designated areas and not to be mixed with each other.

General Refuse

a) Each worksite would generate general refuse including paper and food waste which shall be stored in enclosed bins or units.

b) The Contractor shall not burn debris or vegetation or construction waste on the site;

c) The refuse shall be stored and transported in accordance with good practice and disposed at licensed landfills;

d) An authorised waste collector shall be employed by the Contractor to remove general refuse from the site, on a daily basis to minimise odour, pest and litter impacts.

Construction and Demolition (C&D) Waste

a) C&D Waste would mainly arise from the project construction activities and from the demolition of existing structures where necessitated. It will include: material and equipment wrapping packaging material, unusable/surplus concrete/grouting mixes, damaged/contaminated/surplus construction materials, wood from formwork and false work, concrete rubble, plastics, metal, glass, asphalt, wood and refuse obtained from demolition of houses.

b) The Contractor shall be responsible for collection, segregation, storage and disposal of C&D waste as directed or notified by the concerned local authority in consonance with the Construction & Demolition Waste Management Rules, 2016;

c) The Contractor shall ensure that there is no littering or deposition of C&D waste and disposal of C&D waste along the riverbed, natural drainage and wet land is strictly prohibited;

d) The requirement of concrete/RCC/PCC waste disposal, generated from the entire contract shall be either when 15 Tons of C&D waste which has been generated or such C&D waste has been stored for 15 days (irrespective of quantity), of the two whichever is earlier;

e) A proper arrangement for record keeping has to be maintained to ensure disposal of C&D waste to C&D waste recycling plant. Contractor shall submit the record of C&D waste disposal to recycling facility, in his Monthly Environment Report;

Hazardous Waste

f) Hazardous waste would mainly arise from the maintenance of equipment. These may include, but not be limited to: Used engine oils, hydraulic fluids, waste fuel, spent

mineral oils/cleaning fluids from mechanical machinery, scrap batteries or spent acid/alkali, spent solvents/solutions, some of which may be derived, from equipment cleaning activities which shall be disposed off in a manner in compliance with the procedure given in "Hazardous Waste (management, handling and trans-boundary movement) rules, 2016" only to authorized recyclers under intimation to the Employer's Representative ;

g) Chemicals classified as hazardous chemicals under "Manufacture, Storage and Import of Hazardous Chemical Rules, 1989 of Environment (Protection) Act, 1986 shall be disposed off in a manner in compliance with the procedure given in the rules under the aforesaid act;

h) The hazardous waste shall be stored on an impermeable surface with containment bunding to retain leaks, spills and ruptures;

i) All waste collection containers shall be of appropriate size with a closed lid. Each container will be clearly labelled with a colour code system in local language and English. Original labels of empty containers should be completely covered and the contents of the type of waste stored in the used containers clearly indicated.

j) Drip pans of suitable size and numbers shall be used to collect oil leakage and spills. The area shall be cleaned after completion of maintenances/repair and generated waste disposed off in approved manner.

Bio medical waste

k) Collection, segregation, storage and disposal of Bio Medical waste shall be in accordance with The Bio-medical Waste Management Rules, 2016;

l) Storage time of waste shall be as less as possible so that waste storage, transportation and disposal is done within 48 hours;

m) The contactor shall ensure Posters/ placards for bio-medical waste segregation shall be installed at the point of generation;

n) Disposal of biomedical waste shall be through a licensed waste collector, duly authorized by MoEFCC or Haryana Pollution Control Board as the case may be. License of the waste collector shall be shown to the Employer's Representative on demand. Staff handling the biomedical waste shall be provided with PPEs;

Storage and Segregation of Waste

a) Collection and storage points of appropriate size containers shall be established around all construction work sites, with a 'display board' showing quantity and nature of waste;

b) All waste shall be stored in different coloured bins as per table below:

Colour coding of Waste storage bins

Type of Waste	**Colour**
Wet/Organic/ Bio-Degradable Waste	Green Bins with lids
Dry/Recyclable waste (excluding Bio-medical waste/ hazardous waste)	Blue
Bio-Medical waste	Red with lids

E-Waste	Black
Hazardous Waste	Brown
COVID Waste	Yellow

6.3.5. **Housekeeping**

a) The Contractor along with his sub-Contractors shall maintain the site, labour camps, stores and offices reasonably clean, keep free from obstruction and properly store any construction equipment, tools, and materials.

b) Full height fence, barriers etc. will be installed at the site in order to preserve the surrounding area from excavated soil, rubbish etc. which may cause inconvenience to public.

c) The Contractor's through daily pre-work meeting (tool box talk), safety meeting etc. will impart the necessary education to labour on housekeeping. Other staff such as supervisors and engineers working at the site will also be educated on the necessity of good housekeeping;

d) The Contractor shall ensure the availability of dustbins in Labour Camps at required place and ensue regular cleaning of rooms, kitchens, toilet blocks and dustbins.

e) Proper access and stacking shall be ensured at the Stores. A list will display daily stock of materials.

f) Everyone shall be responsible to maintain housekeeping of their work station.

g) To keep the area free of litter and garbage, specific locations shall be designated for consuming food and snacks to prevent random disposal of waste.

h) Drip pans of suitable size shall be used to collect oil leakages and spills while plants/equipment/machinery maintenance.

i) The Contractor shall make available Material Supply Data sheet (MSDS) for material/chemicals/substances used, for which these are available to the Engineer when requested;

j) Such material/chemicals/substances used shall be treated, handled, stored, transported and disposed off, by the Contractor, in a manner specified in the MSDS.

6.3.6. **Landscape, Greenery and Aesthetics**

a) As far as is reasonably practicable, the Contractor shall maintain ecological balance by preventing deforestation and defacing of natural landscape. In respect of ecological balance, the Contractor shall observe the following instructions.

   i) Prevent any avoidable destruction, scarring or defacing of natural surroundings in the vicinity of work;

   ii) Any damage shall be repaired, replanted or otherwise corrected at Contractor's expense.

   iii) Directional shielding for light used for illumination shall be used to prevent from striking adjacent areas, where feasible;

b) Tree Felling

   i) All trees and shrubs, which are not specifically required to be cleared or removed for construction purposes, shall be preserved and protected from any damage by use of protective barriers or other methods approved by Engineer;.

   ii) The Contractor shall not fell, remove or dispose of any tree or forest produce in any land handed over to him for the construction of works and facilities related to project except

with the previous permission obtained from the Forest Department;

iii) Trees shall not be used for anchorage.

6.3.7. **Energy Management**

a) The Contractor shall use energy efficient pumps and motors. The efficiency shall be measured during installation and also periodically;

b) The Contractor should rigorously follow the maintenance regime of his DG sets;

c) The Contractor shall maximize the use of energy efficient luminaries such as LED's, metal halide lamps and ensure optimum illumination levels to save energy.

d) The Contractor shall make provision of Earth Leakage Circuit Breakers (ELCBS) to prevent loss of excessive earth currents which are unsafe;

e) The Contractor shall plan in advance and select locations to receive and store material such that these are at the least distance from place of use;

f) The Contractor shall design site offices for maximum daylight and minimum heat gain.

6.3.8. **Archaeological And Historic Resources**

a) If any archeological and historic structure is likely to be affected, a resource protection plan shall be prepared by the Contractor in consultation with the Archaeological Survey of India (ASI) to identify and assess construction effects and seeks ways to avoid, minimize or mitigate adverse effects on such monuments;

b) The Contractor shall stop work immediately and notify the Engineer if, during construction, an archaeological or burial site is discovered. The work will not recommence until approval of the Engineer is obtained for the same.

6.3.9. **Fly Ash**

MoEFCC fly ash notification dated September 1999 and its subsequent amendments makes it mandatory for use of fly ash-based products in construction activities located within 300Km from coal or lignite based thermal power plants. The Contractor shall use fly ash as a percentage substitution of cement, in concrete for certain structures and works as prescribed in the latest amendment. The Contractor shall provide details of usage of such products to Engineer and shall maintain a detailed record of usage of Fly Ash.

6.4. Environmental Monitoring

6.4.1. **Baseline Study:** Before commencement of actual construction work, all items and parameters as specified in ESHS manual shall be monitored once as the baseline of the environmental condition prior to the construction and compared with the monitored values during the construction period;

6.4.2. **Qualification of Monitoring Agency:** Monitoring shall be conducted by MoEFCC approved or NABL accredited laboratory and approved by the Engineer;

6.4.3. **Enforcement of the Monitoring**: Monitoring plan shall be proposed in the Contractor's ESHS Management Plan and must be approved by the Engineer before commencement of the monitoring. If the monitoring results are more than baseline and standards, cause analyses and necessary counter measures shall beproposed to the Engineer in the monitoring reports;

6.4.4. **Parameters, Location and Frequency of the Monitoring:** Environmental Monitoring parameters, locations and frequency is given in following table.

Parameters, Standards, Location and Frequency of Monitoring

Parameters	Sampling Standards	Location	Frequency
Air (PM_{10}, $PM_{2.5}$)	CPCB (2011) Guidelines for the Measurement of Ambient Air Pollutants, Manual Sampling & Analyses	One representative location within each construction yard and batching plant	Monthly
		Closest residential or commercial area (one location) within 100m from each active construction site or representative locations approved by theEngineer	Monthly
		$PM_{2.5}$ In Tunnel portion	Bi weekly
Noise **Day Time** (6 AM – 10PM) L_{max}, L_{min}, L_{eq}, L_{10}, L_{90}, L_{50} **Night Time** (10PM – 6AM) L_{max}, L_{min}, L_{eq}, L_{10}, L_{90},L_{50}	CPCB (2015) Protocol for Ambient Level Noise Monitoring	One representative location within each construction yard and batching plant	Weekly
		Closest residential or commercial area (one location) within 100m from each active construction site or representative locations approved by the Engineer	Weekly
Vibration (in mm/s orVdB)	IS 14884 (2000)	During complaints or as directed by employer.	
Drinking/GW (pH, Total Alkalinity, Electrical Conductivity, Total Dissolved Solids, Fluoride, Arsenic, Nitrate, Iron, Lead, Cadmium, E-coli)	IS 3025 (2008) & IS 10500 (2012)	**Drinking water**: construction yard, batching plant andlabour camps	Quarterly (April, July, October, January)
		Groundwater: one representative tube/bore well in the adjacent residential area or within 100m from each active construction site	Quarterly (April, July, October, January)

Parameters	Sampling Standards	Location	Frequency
Surface Water pH, Total Dissolved Solids, Fluoride, Arsenic, Iron, Lead, E-coli	IS 3025 (2008) & IS 2296 (1982) & CPCB (2012) Guide Manual Water and Wastewater Analysis	Upstream and downstream of the river/stream if any. Any natural water course (ex. Pond etc.) located or within 100 m of each a) construction yard, b) labour camp, and c) active construction site	Quarterly (April, July, October, January)
Waste	Not available but fully complying with monitoring the quantities of wastes specified by the Solid Management Rules 2016 & the Construction and Demolition Waste Management Rules2016	Each construction yard and construction site	Quarterly (April, July, October, January)
Hazardous waste	Not available but typed reporting (not handwriting) fully complying with monitoring the quantities of wastes specified by the Hazardous and Other Wastes (Managementand Transboundary Movement) Rules2016,	Each construction yard and active construction site	Quarterly (April, July, October, January)
Complaints if any		All Works' related locations	Weekly

6.5. Complaint Response Process

6.5.1. Enquiries, complaints and requests for information can be expected from a wide range of individuals and organisations both private and government. Most complaints are likely to be received by HRIDC, although the site offices are also likely to be contacted;

6.5.2. The objective of complaint process is to ensure that public and agency complaints are addressed

and resolved consistently and expeditiously;

6.5.3. The Contractor's Project Manager will be notified immediately on receipt of complaint that may relate to environmental impacts. The Project Manager will immediately inform the Engineer;

6.5.4. Field investigation shall determine whether the complaint has merit, and if so, action shall be taken to address the complaint;

6.5.5. The outcome of the investigation and the action taken shall be documented on a complaint Performa prepared by the Contractor and submitted for notice by the Engineer in advance of the works;

6.5.6. Where possible, a formal response to each complaint received shall be prepared by the Contractor within seven days to notify the concerned person(s) that action has been taken.

6.6. Social Legal Requirement

6.6.1. The Contractor shall always comply with all relevant national and state legislations regarding social safeguard including but not necessarily limited to, the following with their latest amendments

a) National Policy for the Empowerment of Women, 2001;

b) The Sexual Harassment of Women at Workplace (Prevention, Prohibition and Redressal) Act, 2013;

c) The Protection of Children from Sexual Offences Act, 2012;

d) The Human Immunodeficiency Virus and Acquired Immune Deficiency Syndrome (Prevention and Control) Act, 2017;

e) Child Labour (Prohibition & Regulation) Act 1986

Some of the key International instruments for the protection of women include the following:

a) United Nations General Assembly, Resolution 52/86 on Crime Prevention and Criminal Justice Measures to Eliminate Violence Against Women, 2 February1998;

b) United Nations Security Council Resolution 1325 on Women, Peace and Security, 31 October 2000;

c) Environmental and Social Framework (ESF) of Asian Infrastructure Investment Bank (AIIB) February 2016

6.7. Gender equality

6.7.1. The Contractor is responsible for providing equal opportunities to both genders and end gender related discrimination, if any. The ESHS Committee will proactively identify cases of gender discrimination with key focus on the following topics:

a) Gender based violence, including sexual harassment at the workplace;

b) Disparity in benefits provided;

c) Termination on account of pregnancy.

6.7.2. The Contractor shall enhance female workforce participation and maintain sex -disaggregated data for periodic reporting.

6.7.3. The Contractor shall ensure that women workers are paid at par with male workers

6.7.4. If women workers are deployed at site then day crèche facilities shall be provided to facilitate the women with infant working on site.

6.8. Labour Requirements

6.8.1. The contractor shall use unskilled labour drawn from local communities to avoid any additional stress on the existing facilities (medical services, power, water supply etc.)

6.8.2. The recruitment of women and members of vulnerable groups shall be prioritized

6.8.3. The Contractor shall provide training to build the skills of locally recruited labour.

6.8.4. All staff, skilled and unskilled labours employed on a site shall be required to sign Code of Conduct that shall ensure compliance with the ESHS provision of civil works and consultancy contracts.

6.9. Cultural and Religious Issues

6.9.1. Disturbance from construction works to the cultural and religious sites, and Contractors lack of knowledge on cultural issues cause social disturbances. The Contractor shall

a) Communicate to the public through community consultation, informing the peers and newspaper announcements regarding the scope and schedule of construction, as well as certain construction activities causing disruptions or access restriction;

b) Not block access to cultural and religious sites and sites of importance for livelihood activities, wherever possible;

c) Need to take mitigation measures while working near religious place/ educational institutions close to the construction sites;

d) Provide freedom to construction workers to observe their cultural and religious practices;

e) Monitor and be responsible for the behaviour of construction workers especially migrant workers towards the community. The workers must be debriefed well regarding local aspects and need to follow good behaviours, and informed regarding unexpected behaviours at the time of employing;

f) Provision of cultural sensitization training for migrant labours regarding engagement with local community;

g) Resolve cultural issues in consultation with local leaders and Project Manager;

h) Establish a mechanism that allows local people to raise grievances (directly and

i) indirectly) arising from the construction process;

j) Inform the local authorities responsible for health, religious and security duly informed before commencement of civil works so as to maintain effective surveillance over public health, social and security matters.

6.10. Guidelines for Addressing GBV in Projects

6.10.1. The Contractor's ESHS Plan shall include implementation of Gender Based Violence (GBV), Sexual Exploitation and Abuse (SEA) and Sexual Harassment (SH) Prevention and Response Action Plan. This action plan shall describe Code of Conduct (CoC), mechanism to address such incidents, assess the project scenario and potential risks of GBV/SEA/SH, training plan for workers on GBV/SEA/SH and awareness programme amongst workers regarding socially, culturally appropriate behaviour that would ensure that the project community and women in particular are safe, secured, and not vulnerable to abuse. A sample GVB/SEA/SH action plan is given in Table below.

Table - GBV/SEA/SH Prevention Action Plan

Objective	Activity	Responsibility
Assess Potential Risk of GBV	Rapid assessment of worksite, project footprint (e.g. community structure, local self-governance, national regulations, history of incidence), type of workers (local or migrant) for possible GBV risk.	As part of the social impact assessment (to be updatedat the time of construction).
Inclusive development	• Engage women in project planning and implementation • Incorporate women's feedback in project design and construction schedule • Organize systematic consultations with women to ensure continuous feedback on projects and identify any gender-sensitive adverse impacts	
Training – women	• Sensitization of women on GBV and women's rights to avoid/avert such incidents • Sensitization of women on actions to be taken in case of GBV	
Training – men	• Sensitization of male workers on GBV and women's rights to avoid/avert such incidents • Sensitization of male workers on actions to be taken in case of GBV • Sensitization of male workers on appropriate socially and culturally acceptable behaviour towards women • Training of managers on • methods of dealing with	

Objective	Activity	Responsibility
	cases of GBV	
Awareness generation	• Distribution of leaflets propagating gender-appropriate behaviour • Signing of self-declaration format on commitment towards gender-sensitive behaviour	

6.10.2. The Contractor shall constitute an appropriate Grievance Redress Mechanism (GRM) for addressing grievances at worksite. Grievances of workers will be first brought to the attention of supervisor at site. Grievances not redressed by the supervisor within 7 days will be brought to the Grievance Redress Committee (GRC). The composition of GRC will have representatives from workers, women representative, ESHS staff of the Contractor ESHS staff of GC. The main responsibilities of the GRC are to: (i) provide support to workers on problems arising at worksite, (ii) record workers grievances, categorise, prioritize grievances and resolve them, (iii) immediately inform the Engineer of serious cases and (iv) report to workers on development regarding their grievances and decisions of GRC. The panel of the GRC will function without any prejudice or fear of retaliation. The well-being of the panel members will be protected by HRIDC. A format for record of complaints is given in General Instruction: ESHS/GI/008. The GRC will redress the grievances within 14 days. The Contractor shall provide grievance box at Project Site Office.

6.10.3. This project has zero tolerance of any form of:

a) **Gender-based violence (GBV)**, that is perpetrated against a person's will and that is based on socially ascribed gender-related differences between people.

b) **Sexual exploitation and abuse (SEA**) which is attempted abuse of a position of vulnerability, differential power, or trust, for sexual purposes, including, but not limited to, profiting monetarily, socially or politically from the sexual exploitation of another.

c) **Sexual harassment (SH**) which is unwelcome sexual advances, requests for sexualfavors, and other unwanted verbal or physical conduct of a sexual nature.

6.10.4. Any incidence of GBV, SEA or SH should be reported to the Grievance Redress Committee (GRC). The panel of the GRC should take appropriate gender-sensitive actions to verify authenticity of the incident with due consideration to the safety, security, and dignity of the offended person. The investigation should be concluded within three days of receiving the report or as reasonably possible. Depending on the severity of the incident, the panel may report the case to appropriate authorities.

Following the investigation, the GRC shall recommend appropriate actions to the company which may include but not limited to:

a) Informal warning

b) Formal warning

c) Additional training

d) Loss of up to one week's salary

e) Suspension of employment (without payment of salary), for a minimum period of one month up to a maximum of six months

f) Termination of employment

6.10.5. The affected person will be provided with appropriate support (e.g. psychological counselling, medical support and any other support as needed).

6.10.6. A self-declaration format for adherence to gender-sensitive behaviour should be signed by all contractors, subcontractors, employees, and senior managers, engaged by the Project to avoid GBV/SEA/SH at worksite. A self-declaration format is given in below:

6.10.7. **Commitment Statement for all Project Workers**

(to be translated into local language or explained in a manner that is appropriate for general understanding of the signee)

I, (name of person), acknowledge that preventing Gender-Based Violence (GBV), Sexual exploitation and abuse (SEA) and Sexual harassment (SH) is essential, and that preventing it is my responsibility. At [Company], GBV activities constitute acts of gross misconduct and are therefore grounds for sanctions, penalties or potential termination of employment. All forms of GBV are unacceptable, be it on the worksite, the worksite surroundings, at workers' camps, or in the community. Prosecution of those who commit GBV may be pursued if appropriate.

I agree that while working on the [Project], I will:

- Cooperate with any relevant investigations.
- Treat women, children (definition of "child" shall be as specified in Child Labour (Prohibition and Regulation) Act, 1986) and men with respect regardless of race; color; language; religion; political or other opinion; national, ethnic or social origin; sexual orientation or gender identity; disability; birth or other status.
- Not use language or behaviour towards women, children or men that is inappropriate, harassing, abusive, sexually provocative, demeaning or culturally inappropriate.
- Not request or engage in sexual favors - for instance, making promises or favorable treatment dependent on sexual acts, in or outside the work site.
- Refrain from abusive and violent behaviour, in the workplace, labor camp or surrounding communities.
- Attend and actively partake in training courses related to HIV/AIDS, GBV, SEA and SH as requested by my employer.
- Report through the grievance redress mechanism or to my manager any suspected or actual GBV by a fellow worker, whether in my company or not, or any breaches of this Code of Conduct.

[Company] recognizes that false accusations of sexual harassment can have serious effects on innocent persons. If, after the investigation, it is found that the complainant has maliciously or recklessly made a false accusation, the complainant will be subject to appropriate sanctions. In such a case, the company will also take appropriate action to restore the reputation of the accused.

I understand that it is my responsibility to use common sense and avoid actions or behaviours

that could be construed as GBV or breach this Self-declaration format. I do hereby acknowledge that I have read the foregoing Self-declaration format, do agree to comply with the standards contained therein and understand my roles and responsibilities to prevent and respond to GBV. I understand that any action inconsistent with this Self-declaration format or failure to act, as mandated by this Self-declaration format may result in disciplinary action and may affect my ongoing employment.

I have familiarized myself with the contents of this Self-declaration format. By my signature below, I acknowledge, understand, accept and agree to comply with the information contained in

the Self-declaration format provided to me.

I hereby confirm I have read and understand the Self-declaration format.
Name (Employee)

Signature
Date

7. FINANCIAL DEDUCTION/WITHHOLDING

7.1. Financial deductions from Contractor on occurrences of an incident.

7.1.1. Table No. 1 below indicates ESHS incidents and the corresponding deductions to be made from the Contractor under Sub-Clauses 20.1 [Employer's Claims], Sub-Clauses 14.3 [Application for Interim Payment], Sub-Clauses 14.6 [Issue of Interim Payment Certificates] and Sub-Clauses 14.7 [Payment] of the General Conditions of Contract.

7.1.2. The affected part of the Works shall remain suspended until all necessary investigations are completed as prescribed in Clause 2. [ESHS Management], Sub-Clause 2.15 Accident Report and Investigation and as per the related local laws of the state.

7.1.3. Upon submission of the Contractor's Request for Inspection (RFI),a joint inspection of the affected part of the Works shall be carried out by the Engineer and the Contractor. On receipt of the Engineer's Consent (Notice of No Objection: NONO), the Contractor may resume the work.

7.1.4. The Contractor shall not be entitled to any extension of time or to the payment of any cost or profit due to any suspension in accordance with this Sub-Clause 8.5 [Extension of time for Completion]

7.1.5. The maximum amount of delay damages set out in Sub-Clause 8.8 [Delay Damages] of the General Conditions of Contract shall not be applicable where the cause of delay to completion is suspension of part of the Works due to the Contractor's non-compliance as described in this clause 7.1.

Table No. 1: Incidents

Sl. No.	Incident		Financial deductions from the Contractor in Indian Rupees
1.	Injury and Incidence reporting	i) Fatal accidents	i) Rs.1,000,000 for first fatality and Rs.1500,000 for every subsequent fatality.
		ii) Injury accident	ii) Rs.300,000 for first grievously injured person and Rs.500,000 for every subsequent grievously injured person (Grievous Injury as defined by Workmen's Compensation Act)
		iii) Abnormal delay in reporting accidents or willful suppression of information about any accidents / dangerous occurrence as per Sub-Clause 2.15.	iii) Rs.1,00,000 for first violation and Rs.2,00,000 for subsequent violations

7.2. Withholding and deduction of payments from Contractor

7.2.1. The Engineer may issue a notice to the Contractor in accordance with Sub-Clause 3.5 [Engineer's Instruction] of the General Conditions of Contract to rectify any unsafe act or condition (including but not limited to error, default or omission) upon discovery of same on the Site by the Engineer, in a form of Nonconformity Report.

7.2.2. Table No. 2 below indicates Contractor's non-conformances from the ESHS requirements of the Contract and the corresponding amounts to be withheld and deducted by the Engineer from payment due to the Contractor under Sub-Clause 14.3 [Application for Interim Payment], Sub-Clause14.6 [Issue of Interim Payment Certificates(IPC)] and Sub-Clause 14.7 [Payment] of the General Conditions of Contract.

7.2.3. The Engineer shall have the right to withhold and deduct charges for any other unsafe act and/or condition depending upon the gravity of the situation on a case-to-case basis. The charge shall be comparable to that, which is the closest to the unsafe act/condition, indicated in Table 2.

7.2.4. Except as may be required otherwise by the Laws of the Republic of India, upon receipt of the Engineer's notification concerning an unsafe act or condition as described in Table No. 2, the Contractor shall promptly comply with such notification, investigate the cause of the unsafe act or condition and as soon as possible (but no later than 7 days, or within such other period from receipt of the Engineer's notification as may be approved by the Engineer), submit to the Engineer for review full details of the proposed correction, prevention and any other measures (hereinafter referred to as the "measures") to be taken by the Contractor to rectify and close-out the matter and to prevent re-occurrence. Such measures shall be to the satisfaction of the Engineer.

7.2.5. The Engineer is entitled to withhold amounts from the Contractor's payment until the Engineer has verified the Contractor's measures, submitted to the Engineer for review as above, and accepted them after a joint inspection in response to the RFI for the same.

7.2.6. Should the Contractor default in implementing any measures within the time previously agreed between the Contractor and the Engineer or the Contractor makes subsequent violations as specified in Table No. 2, the Engineer shall be entitled to the deduction to be recovered from the Contractor under Sub-Clause 20.1 [Employer's Claims] of the General Conditions of Contract. Such deductions shall be made via the certification and payment process provided for in the Contract, including Sub-Clauses 14.3 [Application for Interim Payment], Sub-Clause 14.6 [Issue of Interim Payment Certificates] and Sub-Clause 14.7 [Payment] of the General Conditions of Contract without limiting to the unsafe acts and or conditions mentioned above in Table 2.

7.2.7. The release or deduction of amount shall happen in the next payment process.

7.3. Suspension of work

7.3.1. The Engineer may issue a notice to the Contractor in accordance with Sub-Clauses 3.5 [Engineer's Instruction] and Sub-Clause 8.9 [Suspension of Work] of the General Conditions of Contract to suspend the progress of part of the Works in a form of Nonconformity Report, if in the Engineer's opinion such work is non-compliant with the ESHS requirements of the Contract. Such notification shall include details of the cause of the suspension. During such suspension, the Contractor shall protect, store and secure such part of the Works against any deterioration, loss or damage.

7.3.2. The Contractor shall not proceed with the affected Works until its measures are accepted by the Engineer.

7.3.3. Suspension of part of the Works as described in Sub-Clause 7.3.1 above and withholding of the amount from the Contractor's payment Sub-Clause 7.2 above shall continue together or independently until the Engineer has verified the Contractor's correction and close-out of any such non-conformity.

7.3.4. The Contractor shall not be entitled to any extension of time or to the payment of any cost or profit due to any suspension in accordance with the Sub-Clause 7.2.

7.3.5. The maximum amount of delay damages set out in Sub-Clause 8.8 [Delay Damages] of the Conditions of Contract shall not be applicable where the cause of delay to completion is suspension of part of the Works due to the Contractor's non-compliianceas described in this Clause 7.

Table No. 2: Unsafe Acts/Conditions

Sl. No	Unsafe Act/Condition		Deductible amount from the Contractor in Indian Rupees
1.	ESHS Management Policy & Plan	1) ESHS Policy Non-compliance of Sub-Clause 2.4.1	Rs.25,000 per month
		2) ESHS plan: a) Delay in submission (Sub-Clause 2.4.3.) b) Not updated as per employer's instruction as per Sub-Clause 2.4.4. c) Copies not provided to all required supervisors / engineers (Sub-Clause 2.4.5)	Rs.50,000 per month.
2.	ESHS Organization	i) Not filling up the vacancies created due to ESHS personnel before leaving the Contractor (Sub-Clause 2.6.3.) ii) ESHS organization not provided with required Audio-visual and other equipment as per General Instruction ESHS/GI/ 001 (Clause 8. Attachment-4) Sub-clause-2.6.4	i) Rs.200,000 per month. ii) Rs.50,000 per month
3.	ESHS Committee	i) Failed to formulate or conduct ESHS Committee meeting for any month (Sub-Clause 2.8.1) ii) The Contractor and Subcontractor representatives not attending ESHS Committee meetings (Sub-Clause 2.8.6.) iii) Failed to conduct Site inspection before conducting ESHS Committee meeting (Sub-Clause 2.8.2 (h). iv) Failed to send Agenda to Employer in time or ESHS	Deduction of amount i) Rs.100,000 per violation ii) Rs.5,000 per member not attending the meeting For item iii) & iv) Rs.25,000 per violation

Sl. No	Unsafe Act/Condition		Deductible amount from the Contractor in Indian Rupees
		Committee Minutes of Meeting (Sub-Clauses 2.8.4 & 2.8.7.)	
4.	ID Card	i) Non-adherence of Clause 2.9.	Rs. 1,000/- per ID card per month
5.	ESHS Training	i) Not complying to the requirements as mentioned in Sub-Clause 2.10.1, 2.10.2, 2.10.3 & 2.10.5.	Deduction of Rs.1,00,000 per violation
6.	ESHS Inspection	i) Not complying to the requirements as mentioned in Clause 2.11.	Rs.1,00,000 per violation
7.	ESHS Audit	Internal Audit, MARS & External Audit i) Not conducted as per ESHS Plan (Sub-Clauses 2.12.4) ii) Report not sent to Employer (Sub-Clause 2.12.9) iii) Corrective action not taken for any month (Sub-Clause 2.12.9) iv) Not conducted as per ESHS plan (Sub- Clauses 2.12.10)	Rs.1,00,000 per violation
8.	ESHS Communication	i) Important days to be observed for ESHS awareness as furnished by employer not observed (Sub-Clause 2.13.2) ii) Posters as directed by Employer not printed and displayed (Sub-Clause 2.13.2)	i) Rs.10,000 per violation and ii) 50,000 per month
9.	ESHS Submittals	Non-compliance of Clause 2.14	Rs.1,00,000 per month
10.	Traffic Management & Site Barricading	a) Non-compliance of Clause4.31	Rs.25,000 per single violation.
11.	Emergency Preparedness Plan	Non-compliance of Clause 2.16	Rs.1,00,000 per month

Sl. No	Unsafe Act/Condition		Deductible amount from the Contractor in Indian Rupees
12.	Permit to work	Non-compliance of Clause 4.30	Rs.1,00,000 per violation.
13.	OccupationalHealth	Non-compliance of Clause 5.1 & 5.2	Rs. 50,000 per month.
14.	Labour Welfare Measures	Non-compliance of Clause 5.4	Rs.50,000 per month .
15.	Environmental Management	i) Containment of air pollution (Sub-Clause 6.3.1) ii) Containment of water pollution (Sub-Clause 6.3.2) iii) Containment of noise pollution (Sub-Clause 6.3.3) iv) Containment of waste pollution (Sub-Clause 6.3.4) v) Preservation of trees (Sub-Clause 6.3.6 (b)) vi) Environment monitoring (Sub-Clause 6.4) vii) Non-adherence to statutory agencies (SPCB, CPCB NGT etc.) environment management guidelines	Rs.50,000 per violation Actual penalty imposed by statutory agency
16	Housekeeping (Clause 4.2)	i) Surrounding areas of drinking water tanks / taps not hygienically cleaned / maintained ii) Office, stores, toilet / urinals not properly cleaned and maintained. iii) Required garbage bins at appropriate places not provided / not cleaned. iv) Stairways, gangways, passageways blocked.	Rs.50,000 per violation.

Sl. No	Unsafe Act/Condition		Deductible amount from the Contractor in Indian Rupees
		v) Lumber with protruding nails left as such vi) Openings unprotected vii) Excavated earth not removed within a reasonable time. viii) Truck carrying excavated earth not covered/tyres not cleaned. ix) After close of work Vehicles / equipment not parked at designated place x) Unused surplus cables / steel scraps lying scattered xi) Wooden scraps, empty wooden cable drums lying scattered xii) Water stagnation leading to mosquito breeding	
17.	Working at Height / Ladders and Scaffolds	Non-compliance of Clause 4.3.	Rs.50,000 per violation
18.	Lifting Appliances and Gear	Non-compliance of Clause 4.6	Rs.50,000 per violation
19.	Launching Operation	Non-compliance of Clause 4.7	Rs.50,000 per violation
20.	Construction Machinery	Non-compliance of Clause 4.8	Rs.50,000 per violation
21.	Site Electricity	Non-compliance of Clause 4.10	Rs.10,000 per violation.
22.	Power Tools (Sub-Clause 4.10.13)		
23.	Welding and Cutting (Clause 4.12)	i) Wrong colour coding of cylinder. ii) Cylinders not stored in upright position. iii) Flash back arrester, non-return valve and regulator not present	Rs. 10,000 per violation.

Sl. No	Unsafe Act/Condition		Deductible amount from the Contractor in Indian Rupees
		or not in working condition. iv) Fail to put cylinders in a cylinder trolley. v) Damaged hose and fail to use hose clamps vi) Using domestic LPG cylinders vii) Fail to store cylinder 6.6m away from fire prone materials viii) Fire extinguisher not placed in the vicinity during operation Voltmeter and Ammeter not working. ix) Non-availability of separate switch in the transformer x) Improper grounding and return path. xi) Damaged and bare openings in the welding cable. xii) Damaged holder xiii) Fire extinguisher not placed in the vicinity during operation	
24.	Fire Precaution (Clause 4.27)	i) Smoking and open flames in fire prone area ii) Using more than 24V portable electrical appliances in the fire prone area iii) Not proper ventilation in cylinder storage area. iv) Absence of fire extinguishers v) Fire extinguishers not refilled once in a year. vi) Fire extinguisher placed in a not easily accessible location	Rs. 10,000 per violation.

Sl. No	Unsafe Act/Condition		Deductible amount from the Contractor in Indian Rupees
25.	Excavation, Tunneling and Confined Space	Non-compliance (Clauses 4.13, 4.14, 4.26)	Rs. 10,000 per violation
26.	Batching plant and Casting yard	Non-compliance of Clause 4.18	Rs. 10,000 per violation.
27.	Personal Protection Equipment	Non-compliance of Clause 4.34. Items of attention are as under – i) Not having ii) Not wearing (or) using and kept it elsewhere iii) Using damaged one iv) Using wrong type v) Using wrong colour helmet or helmet without logo vi) Using for other operation (e.g. Using safety helmet for storingmaterials or carrying water from one place to other)	Rs. 200 per person per violation.
28.	Working near Railway	Non-compliance of Clause 4.32.	Rs. 1,00,000 per violation

8. ATTACHMENT

Attachment -1 Contents of ESHS Management Plan

1.0 General

1.1 The Contractor shall prepare an Environment, Social, Health and Safety (ESHS) Management Plan, which provides measures to protect the Environment, Health and Safety of workers and the public.

1.2 The Contractor's ESHS Management Plan shall be based on Environment, Social, Health and Safety considerations submitted with the Tender and shall have the content shown in the following section [Contents of ESHS Management Plan].

1.3 The Contractor shall submit his ESHS Management Plan for review by the Engineer within 28 days after the Commencement Date and shall amend the ESHS Management Plan to address any comments made by the Engineer and submit a Final ESHS Management Plan within 14 days of receipt of comments.

1.4 The Final ESHS Management Plan shall be binding on the Contractor for the duration of the Contract.

2.0 Content of ESHS Management Plan

2.1 The Contractor's ESHS Management Plan shall cover the following aspects:

Site ESHS Management Plan	
Contract No.	
Contractor Name	
Project Name	
1	Project Highlights i) Title of the content; ii) Contract number; iii) Brief scope of work; iv) Location map/key plan; v) Period of the project;
2	ESHS Management Policy with senior management responsibility;
3	Site organization chart Chart indicating reporting of ESHS Management personnel, appointment, duties, and responsibilities
4	Roles &responsibility Individual responsibility of the i) The Contractor's representative

	ii) ESHS Manager iii) Environment manager iv) Social expert v) Chief accident prevention officer vi) Construction manager vii) Construction Supervisors viii) ESHS Committee members ix) ESHS in charge x) Site engineers xi) First line supervisors xii) Subcontractors
5	ESHS Site Committee xiii) Details - Chairman, secretary, members, and employer's representative xiv) Procedures for effective conduct of meeting
6	ESHS Training
7	Subcontractor Safety and Health procedures for Subcontractors;
8	ESHS Inspection and audit
10	Accident, diseases investigation reporting procedures
11	Health, First Aid, and emergencies measures
12	Staff and labour welfare measures at site
13	Policy for identifying hazards and risks with risk assessment and mitigation procedures
14	Safe Work Procedures e.g. i) Excavation ii) Structural steel erection iii) Form works iv) Concrete placement v) Work at height vi) Switch-over works vii) Floor, wall openings and stairways viii) Welding, cutting and bracing ix) Lifting appliances x) Electrical equipment

	xi) Mechanical equipment xii) Fire prevention xiii) Hazardous chemicals and solvent xiv) Lighting xv) Abrasive blasting
15	Work permit system
16	List of standard job specific PPEs to be used in the site
17	Maintenance of regime for construction equipment and machinery
18	Traffic management
19	Housekeeping
20	i) Environmental and Social Management ii) Applicable National and State legislation and regulations iii) Specific procedures for achieving environmental and social performance requirements as given in the Employer's requirements on Environment. iv) Details on air monitoring and noise monitoring control plan which details mitigation measures / corrective action / preventive action and monitoring schedule. v) The ESHS Management Plan must contain procedures on prevention and control of water pollution, storage, handling and disposal of waste, including municipal, C&D, plastic, bio-medical, chemical and hazardous wastes, reuse/recycle of waste, selling to authorised recyclers and records thereof, preservation of landscape disturbed due to construction, housekeeping/Environmental sanitation and traffic management as required under the contract. vi) Procedures for recording environmental complaints and response process. vii) HIV prevention and control plan viii) Gender Based Violence (GBV) and sexual Exploitation and Abuse (SEA) prevention and response plan ix) COVID-19 Response and management plan
21	Visitors and security arrangement
22	Disciplinary Procedures
23	Safety and Health promotion and awareness;
24	Safety and Health equipment and Safety and Health of the Contractor's construction and office equipment;

Note: -The Environment, Social, Health and Safety (ESHS) Management Plan shall beincorporated in the relevant sections.

3.0 Training

3.1 The Contractor shall describe the training program and content he will provide for workers and staff to:

a) Raise awareness of the role and importance of Environment, Social, Health and Safety matters; the potential negative impacts of construction work in general and the ways in which impacts can be prevented; and the expected constructionimpacts and long-term environmental and social benefits of the applicable project;

b) Disseminate the philosophy and approach of the ESHS Management Planthroughout the workforce, and explain the roles of all parties in implementing the ESHS Management Plan; and

c) Inform all employees of the Environment, Social, Health and Safety activitiesthey are required to comply with when conducting their work, and the penaltiesfor non-compliance.

3.2 Training to raise the awareness and capacity of the Subcontractors and their employees shall also be incorporated where necessary.

3.3 The Contractor shall prepare the following plans to supplement the ESHS Management Plan:

a) Emergency Response Plan; and

b) Fire Evacuation Plan.

Attachment -2 Workplace Policy (on HIV/AIDS Prevention & Control)

Haryana Rail Infrastructure Development Corporation Limited (HRIDC) recognizes HIV/AIDS as a developmental challenge and realizes the need to respond to it by implementing regular HIV/AIDS prevention programmes and creating a non- discriminatory work environment for HIV infected workmen engaged by Contractors. For the purpose of making conscientious, sensitive and compassionate decision in addressing the realities of HIV/AIDS, HRIDC has established these guidelines based on ILO code of practice on HIV/AIDS.

- Creating awareness through professional agency using IEC (Information, Education and Communication) package specially designed for migrant workers.
- Institutional capacity building by training the project implementation team, Environmental, Social, Health & Safety (ESHS) Managers, establishing linkages for deficient diagnosis and treatment of the affected workers, effective monitoring of implementation and documentation for further learning.
- Establishing peer educators by selecting them in consultation with Contractors and training them through professional agencies so that they become focal point for any information, education and awareness campaigns among the workmen throughout the contract period.
- Promotion of social marketing of condom

Attachment -3 Work Place Policy on COVID-19 Prevention and Control

It is likely that Corona virus Disease 2019 (COVID-19) will continue to occur in the community in the foreseeable future. It is therefore necessary to have a plan/policy in place to prevent the spread of this virus within the workplace. In order to reduce the risk of infection, Haryana Rail Infrastructure Development Corporation Limited (HRIDC) recommends to the Contractor to consider the following measures:

a) The Contractor shall ensure that the latest guidelines issued by Ministry of Health and Family Welfare (MoHFW), local government and the district administration are strictly followed at the construction works site.

b) On day 0, before resuming the work on sites post lockdown period, mandatory medical check-up will be arranged for all workers.

c) The workers coming from outside shall observe home-quarantine for at least 14 days as per the guidelines issued by MoHFW.

d) Only medically fit workers will be deployed at site and medical assistance will be arranged for unfit workers.

e) A unique photo identity card with serial number will be issued to all the workers and their family members staying at site.

f) All the essential items will be made available to them at site only. If necessary, they can go out wearing face masks, after informing the supervisor.

g) No outside worker will be allowed to stay at site without following proper procedure and instructions.

h) Start time on site will be staggered to avoid congestion at the entry gates.

i) As in most cases, workers reside at the Sites, hence no travel arrangements are required for them.

j) The workers staying outside (which are always nearby) shall reach the site either by walking or by their individual mode of transport (bicycle, two-wheeler etc.).

k) During attendance, training and other sessions, social distancing guidelines will be followed along with provision of no-touch attendance.

l) All workers may be advised to take care of their own health and look out for respiratory symptoms/fever and, if feeling unwell, shall leave the workplace immediately after informing their reporting officers.

m) They shall observe home-quarantine as per the guidelines issued by MoHFW and shall immediately inform the nearest health centre or call 011-23978046.

n) Workers shall not shake hands when greeting others and while working on the site.

o) Mandatorily wear face masks while working on site. While not wearing masks, cover your mouth and nose with tissues if you cough/sneeze or do so in the crook of your arm at your elbow.

p) Avoid large gatherings or meetings. Maintain at least 1 metre (3 feet) distance from persons, especially with those having flu-like symptoms, during interaction.

q) Not more than 2/4 persons (depending on size) shall be allowed to travel in lifts or hoists.

r) Use of the staircase for climbing shall be encouraged.

s) Workers shall clean hands frequently by washing them with soap and water for at least 40 seconds.

t) Workers shall not share their belongings like food, water bottles, utensils, mobile phones etc. with others.

u) The utensils shall be washed properly post use at designated places.

v) Post work, workers shall change their clothes before leaving the site and clothing shall not be shook out.

w) Avoid touching your eyes, nose, or mouth with unwashed hands.

Attachment -4 Reference for ESHS Activities

General Instruction: ESHS/GI/001

Minimum Requirements of ESHS Monitoring and Audio-Visual Equipment's

a) Every Contractor shall provide the following audio-visual aids for conducting weekly review, monthly safety committee and other post review meeting of all fatal and major incidences effectively. This audio-visual equipment is a must for conducting periodical in-house safety presentations in the training programs; and

b) In addition to the above, portable hand held Type I or Type II digital sound level meter (SLM) and portable hand held digital Lux meter are also to be provided.

c) The minimum requirement of the quantity to be provided in ESHS management Plan and approved by the Engineer.

Sl. No	ESHS Monitoring and Audio-Visual Equipment details
1.	Portable hand-held Type I or Type II Digital Sound Level Meter (SLM)
2.	Portable hand-held Digital Lux Meter
3.	Laptop computer with standard configuration including multimedia facilities
4.	Colour printer
5.	Computer projector with screen
6.	Overhead projector
7.	Smartphone for taking photos and recording of video
8.	Portable loudspeaker (for tool-box talk and emergency purpose)
9.	Communication facility like mobile phone, walky-talky etc.
10.	Accident investigation Kit containing the following:
a)	Chalk piece for marking
b)	Measuring tape for measuring Flexible tape – 2m length Metal Foot long scale and Metal tape – 30m
c)	Equipment tags
d)	Multipurpose Flash light
e)	Barrier tape
f)	Accident investigation Forms and checklists
g)	Enough Paper for witness recording and other noting
h)	Emergency Phone Numbers list

General Instruction: ESHS/GI/002

Topics for ESHS Orientation Trainings for Workmen for First Day at Work

1) **Hazard Identification Procedure**

Hazards on site:

- Falls;
- Earthing work;
- Electricity;
- Machinery;
- Handling materials;
- Transport;
- Site housekeeping;
- Fire;
- Safety of nearby located structures;
- Works close to railway tracks or roads.

2) **Personal Protective Equipment**

- What is available?
- How to obtain it?
- Correct use and care.

3) **Health**

- Site welfare facilities;
- Potential health hazards;
- First Aid/Cardiopulmonary Resuscitation (CPR). /Automated External defibrillator(AED)

4) **Duties of the Contractor**

- Brief outline of the responsibilities of the Contractor by law;
- Details of the Contractor's accident prevention policy;
- The Employer SHE Management Manual (if any);
- Building and other Constructions Welfare Law.

5) **Employee's Duties**

- Brief outline of responsibilities of employee under law
- Explanation of how new employees fit into the Contractor's plan for accident prevention (induction and orientation).

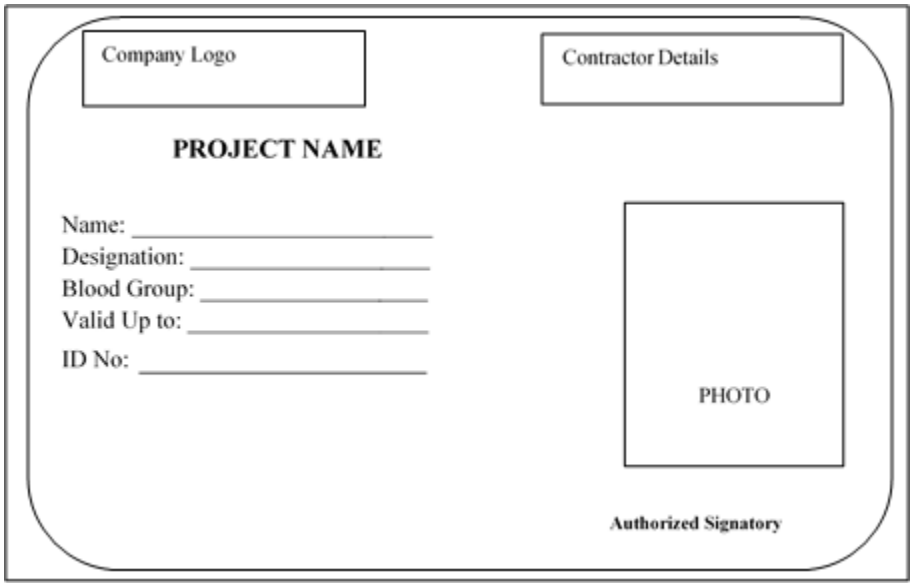
6) **Environment And Social**

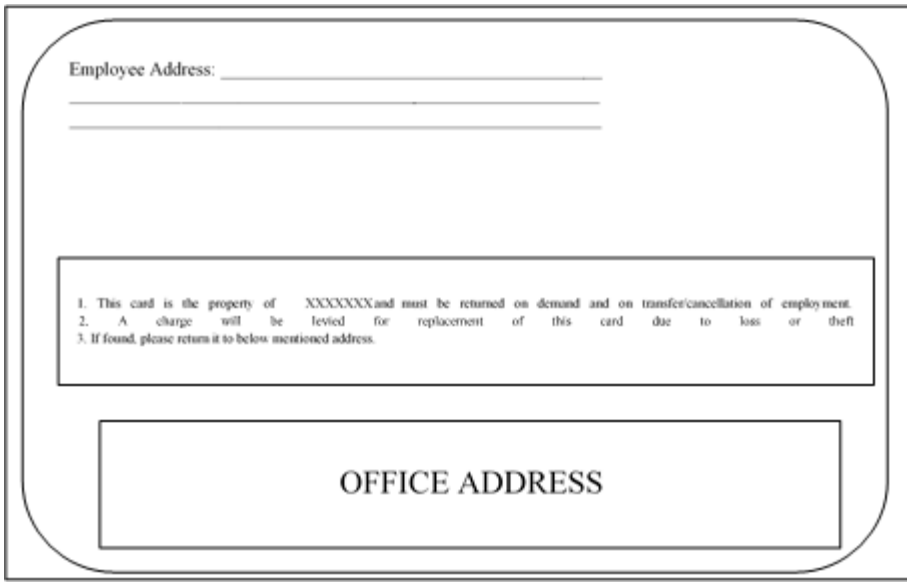
- Contractor's Environment Policy
- Key legal requirements
- Avoidance of Nuisance
- Environmental Sanitation

- Dust Control Measures
- Water Pollution and Control
- Occupational noise mitigation
- Waste Management and Disposal
- Gender Based Violence and Sexual Exploitation and abuse (GBV/SEA)
- HIV/AIDS prevention
- Grievance Redressal Mechanism for GBV/SEA

General Instruction: ESHS/GI/003

ID CARD FORMAT (85 mm x 55mm) FRONT SIDE OF ID CARD:





General Instruction: ESHS/GI/004 [ESHS Training Matrix]

ESHS Supervisors	ESHS Manager	Medical Officer	Clerical Staff	Security Officers	Transportation Drivers	Electrical workers	Mechanical Workers	Steel Workers	Station Building Workers	Material Handlers	Machinery Operators	Construction Foreman	Construction Supervisors	Construction Managers	Planning Engineer	Quality Manager	Sr. Construction Managers	Contractor Representative	Types of Training
*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	ESHS orientation
		*												*	*	*	*	*	ESHS leadership
*	*	*										*	*	*	*	*	*	*	ESHS plan
*	*												*	*		*	*	*	ESHS improvement plan
*	*												*	*	*	*	*	*	Management of change
*	*												*	*	*		*	*	ESHS audit and inspection
*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	ESHS emergency response & preparedness
*	*	*		*									*	*	*	*	*	*	Incident/Accident investigation & reporting
*	*											*	*	*	*	*	*	*	ESHS communication
*	*													*	*		*	*	ESHS promotion & incentives
*	*			*	*						*		*	*		*	*	*	Traffic management
*	*			*						*		*	*	*	*	*	*	*	Hazard identification & risk analysis & Aspect Impact
*	*			*				*	*	*		*	*	*		*	*	*	Permit to work system
*	*													*	*	*	*	*	Confined space entry
*	*	*		*				*	*	*				*		*	*	*	Scaffolding
*	*	*	*	*	*	*	*	*	*		*		*	*		*	*	*	Waste management
*	*											*	*	*			*	*	Environment monitoring
*	*	*										*	*	*		*	*	*	Labour welfare measures
*	*											*	*	*		*	*	*	Behavior Based Safety Management (BBSM)
*	*	*	*	*	*	*	*	*	*	*	*	*	*	*		*	*	*	Industrial First Aid and CPR
*	*		*	*	*	*	*	*	*	*	*	*	*						Fire fighting
*	*					*	*	*		*	*	*	*	*			*		Rigging
*	*											*	*	*					Wire rope inspection
*	*											*	*	*					Crane inspection
*	*											*	*	*					Electrical/Mechanical isolation
*	*											*	*						Explosive handling and control
*	*					*	*	*	*			*	*						Heavy lifting operation
*	*							*				*	*						Welding, cutting and bracing
*	*								*			*	*						Power actuated hand tool
*	*					*	*	*	*			*	*						Roofing work
*	*							*				*	*						Steel erection work
*	*					*	*	*	*			*	*						Scaffold erection/dismantling

General Instruction: ESHS/GI/005

ESHS Training Details for Managers and Supervisors

1. The Law and Safety	**2. Policy and Administration**
Statutory requirement Appropriate regulations Duties of employee	Effect of incentive on accident prevention ESHS Policy Industrial relations Safety Officer: duties, aims, objectives
3. Safety and the Supervisor	**4. Principles of Accident Prevention**
Safety and efficient production Accidents affect morale and public relations	Attitudes of management, supervision and operations Methods of achieving safe operations Accident and injury causes
5. Site Inspection	**6. Human Behaviour**
The role of management Hazard Identification Procedure Records results Follow-up procedures Feedback	Motivating agencies Individual behaviour Environmental effects Techniques of persuasion
7. Site housekeeping	**8. Health**
Site organization Relationship of site housekeeping to accident occurrence Site access Equipment storage Material stacking Materials handling	Medical examination Hazard to health on site Sanitation and welfare Protective clothing First Aid/CPR
9. Personal Protective Equipment	**10. Electricity**
Eye, face, hands, feet and legs Respiratory protective equipment Protection against ionizing radiation	Appreciation of electrical hazards Power tools Arc welding Low voltage system Lighting and power system on sites ELCB, RRCB, Grounding/Ground fault circuit interrupters (GFCIs)
11. Oxygen and Acetylene Equipment	**12. Equipment**

Cylinder storage and maintenance Condition and maintenance of valves, regulators, and gauges Condition and maintenance of hoses and fittings Pressures	Accidents related to moving parts of machinery Appreciation of principles of guarding Importance of regular maintenance
13. Transportation Transport to and from site Hazard connected with site transport Competent drivers Dumpers Tipping trucks Movement near excavations	**14. Excavations** Method of shoring Precautions while shoring Precautions at edge of excavations Removal of shoring Sheet steel piling
15. Working platforms, Ladders, and Scaffolding	**16. Cranes and other Lifting Machines**
Hazards connected with the use of ladders Maintenance and inspection Type of scaffold Overloading Work on roofs Fragile material Openings in walls and floors Use of Full Body Harness and nets	Licensing, certification and training required for operation of cranes Slinging Methods Signalling Access to crane(s) Maintenance and examination Ground conditions Hazards and accident prevention methods connected with the use of different types of cranes/heavy equipment Crane Lift Plan for all lifts
17. Lifting Tackle	**18. Fire Prevention and Control**
Slings - single and multi-legged Safe working loads (SWLs) Safety hooks and eyebolts Cause of failure Maintenance and examination	Principle causes determining fire Understanding fire chemistry Firefighting equipment Firefighting training
19. Communications	
Effective methods of communication (interest to non-English speaking workers) Method and preparation of reports Safety committees Safety meeting	

20. **Environment and Social**
Environment Policy Regulatory requirements • Central • State • Judicial • Environmental requirements of funding agency Overview of Environmental issues at construction sites and funding agency's requirements. Avoidance of nuisance Environmental sanitation Dust control measures Overview of impact of construction on Climate change Contractual requirements to reduce construction related impacts Monitoring of environmental parameters and their significance Waste Management Occupational Noise and its mitigation Health impacts of construction industry Resource minimization ISO requirement (as applicable) Gender Based Violence and Sexual Exploitation and abuse (GBV/SEA) HIV/AIDS prevention Grievance Redressal Mechanism for GBV/SEA

General Instruction: ESHS/GI/006

WEEK/DAYS TO BE OBSERVED FOR CREATING ESHS AWARENESS

1st Monday to Sunday of January	Road Safety Week (Subjected to confirmation from Ministry of Road Transport, Govt. of India every year.)
16th February	Kyoto Protocol Day
March	Red Cross Month
4th March	National Safety Day
22ndMarch	World Water Day
7th April	World Health Day
14th April	Fire Safety Day
18th to 22nd April	Earth Week
20th April	Earth Day
20th April	Noise Awareness Day
28th April	ILO World Day for Safety and Health at Work Day
1st to 7th May	Emergency Preparedness Week
5th June	World Environmental Day
12th June	World Day against Child Labours
21st June	World Yoga Day
9th July	Occupational Health Day
17th October	World Trauma Day
1st December	World AIDS Day

General Instruction: ESHS/GI/007

Minimum Requirements of ESHS Communication Posters/Signage/Video:

a) Every Contractor shall prepare a ESHS Communication Plan as a part of site specific ESHS Management Plan and shall include the following minimum requirement of Posters/Signage/Video as applicable. In case readymade posters are available in any of the category from National Safety Council or any other safety related organizations they may procure the same and display it. In case the same is not available, then the Contractors shall make necessary arrangements to get the posters designed and printed on their own. All posters shall each be in Hindi, English and the regional language; and

b) All the above is to be detailed in the Contractor's ESHS Management Plan and he shall obtain the Engineer's prior consent for the numbers, contents, locations, etc.

Table No.: 1 - Minimum No. of Posters

Sl. No	ESHS Poster Title	Minimum No. of concepts in each title	No. of Posters/Signage/Video
1.	Safety Culture	5	Each 10
2.	Daily Safety Oath	1English, 1 Hindi	Each 50
3. a)	Signage to display the messages like PPE ZONE, NO PPE ZONE, HARD HAT AREA etc.	2 types of sizes made up of metal sheet to be mounted at different locations	Each 25
b)	Helmet	5	Each 25
c)	Shoe	5	Each 25
d)	Goggles & Ear Protection	5	Each 25
e)	Full Body Harness	5	Each 25
f)	Hi-Vi Jacket	5	Each 25
4.	Emergency Management Plan	5	Each 25
5.	Working at Heights	10	Each 25
a)	Ladder, Stairway, Scaffold - Signage to display the messages like SAFE, UNSAFE, FIT FOR USE,	5 types of sizes made up of metal sheet to be mounted at different locations	Each 25

Sl. No	ESHS Poster Title	Minimum No. of concepts in each title	No. of Posters/Signage/Video

	AVOID USE etc.		
6.	Site Electricity	5	Each 25
7.	Crane Safety	5	Each 25
8.	Slings	5	Each 25
9.	Rigging Procedures	5	Each 25
10.	Excavation	5	Each 25
11.	Occupational Health (Mosquito Control, HIV/AIDS awareness, Dust Control, Noise Control, No Smoking/Spitting, etc.)	10	Each 25
12.	First – Aid	3	Each 25
13.	Labour Welfare Measures (Payment of Minimum Wages, Avoidance of Child labour, signing in the Muster Roll, in case of accidents- what to do? Etc.	5	Each 25
14.	Importance of "Safety Handbook"	1	25
15.	Traffic Safety (Speed limit, safe crossing and working within barricaded area etc.)	5	Each 25
16.	Environmental Monitoring (Spillage of Muck, hazardous material, Improper drainage, water spray for dust containment etc.)	5	Each 25
17.	Video in Hindi on PPE usage – 15 minutes duration	1	-

Note 1: Items mentioned under 17 is video. Items under 3 (a) and 5 (a) are metal signage boards and all other items are posters.

Note 2: The above minimum numbers are for guidance only. The actual number will depend on the project's specific requirements. The Contractor shall propose and obtain Engineer's prior consent to the final numbers, locations, etc.

Table No.: 2 – Size of Posters/Signage

Sl. No	Item	Size
1.	Posters – Standard	17"x22" –135 GSM 4 Colour Printing
2.	Posters – Special (Wherever required)	17"x22" card laminated FA Poster
3.	Posters - Mega size (Wherever required)	32"x40" Flex FA Poster
4.	First-Aid Booklet	6"x4"
5.	Safety Handbook	6"x4"
6.	Signage	Small: 12"x6" Big: 24"x12"
7.	Road Traffic Sign Boards	Strictly as per Indian Road Congress (IRC) specifications

Table No.: 3 – Safety Signage Colour (as per IS: 9457)

Sl. No	Type of signage	Colour
1	Mandatory	Blue
2	Danger	Yellow
3	Prohibitory	Red
4	Safe conditions	Green

General Instruction: ESHS/GI/008

Environment, Social Formats/Checklist

1. Weekly Environmental Inspection Summary

1.0 Major issues of non-conformity in the past week are:

	Issue	Reason
I.	Air (Specify)	
II.	Water (Specify)	
III.	Noise (Specify)	
IV.	Water (Specify)	
V.	Storage (Specify)	
VI.	Housekeeping (Specify)	
VII.	Roads (Specify)	

2.0 Over the last week have been able to implement environmental management requirement as per contract

Yes ☐ ☐ No if not yes reasons are:

(i)

(ii)

(iii)

3.0 Following issues have not been resolved for more than past two weeks

(i)

(ii)

(iii)

4.0 Support/Clarification from Employer's Representative required in the following:

(i)

(ii)

(iii)

5.0 Complaint received in the past week:

From	Action Taken	Reasons for Delay
(i) Public		
(ii) Client		
(iii)Statutory Agency		

Auditor: Project Manager

Contact Number: Contractor:

Environmental Manager	**Project Manager**	**Document No.:**

2. Weekly Environmental Inspection

Report No.:	Inspection Date:	Inspected by:
Inspection Area:		
Participants:		

S.No.	Item	Observation	Remarks	Action	
				By Date	By Whom
1.0	**Air Pollution**				
1.1	Dust (approach roads, adjacent road, working area, cement handling etc.)	☐ Satisfactory ☐ Site Dusty ☐ Sprinkling carried out as required ☐ Excavated soil removed within 2 days			
1.2	Generators	☐ Satisfactory ☐ Maintenance regime followed ☐ Black smoke ☐ Leaking oil ☐ Drip pans not available			
1.3	Vehicles	☐ Satisfactory ☐ PUC certificate available ☐ Black smoke ☐ Wheel washed/cleaned ☐ Leaking oil ☐ Side of vehicle clean of mud ☐ Material transported in closed manner			
1.4	Air monitoring	☐ Carried out as per contract ☐ Results reported as per contract			

S.No.	Item	Observation	Remarks	Action	
				By Date	By Whom
		☐ Remedial measures in place where required			
2.0	**Water Pollution**				
2.1	Site Drains	☐ Drainage system functional ☐ No Contamination ☐ Not blocked by debris/ garbage ☐ No indications of Oil spilled in drains ☐ Storage of chemical waste not nearby			
2.2	Adjacent Drains	☐ Not damaged ☐ No signs of pouring bentonite ☐ No signs of pouring Chemicals ☐ Signs of discharging Silt/ debris			
2.3	Separator Tanks	☐ Tank not full of silt ☐ Tank regularly emptied			
3.0	**NOISE POLLUTION**				
3.1	Noise control measures	☐ All powered mechanical equipment's are sound reduced ☐ Acoustic / enclosures constructed in areas of excessive noise ☐ Equipment located and directed away from noise receptors			
3.2	Generators provided with acoustic enclosures	☐ Effective ☐ Not effective ☐ Not provide			
3.3	Noise Monitoring	☐ Carried out as per contract ☐ Not exceeded baseline values ☐ Remedial measures in place ☐ Results evaluated statistically for inclusion in Monthly report			

S.No.	Item	Observation	Remarks	Action	
				By Date	By Whom
4.0	**WASTE MANAGEMENT**				
4.1	Waste Identified	☐ Chemical Flammable Corrosive Construction related/ oil/ Filters/ Batteries ☐ Hazardous ☐ Other (Specify)			
4.2	Storage Containers & Bins	☐ Adequate number and properly place ☐ Proper quality ☐ Emptied regularly ☐ Labelling proper ☐ No spillage on container ☐ surface noticed			
4.3	Storage Containers & Bins	☐ Pollutants (e.g. waste chemical), not dumped in bins ☐ Recyclable (e.g. metal) not dumped in garbage bins			
4.4	Oil Waste	☐ Drip pans available ☐ No oil stains on ground ☐ Spill absorption material available ☐ Waste oil poured in to designated waste drums ☐ Used oil filters not dumped in garbage bins			
4.5	Excavated soil	☐ Storage satisfactory/ properly secured ☐ Dumping in authorized areas ☐ No interference with nearby drainage			
5.0	**STORAGE**				
5.1	Diesel Storage	☐ Extensive diesel spillage on ground not visible ☐ Drip pans used when pumping diesel ☐ Pipes / connectors/ pumps not leaking			

S.No.	Item	Observation	Remarks	Action	
				By Date	By Whom
		☐ Not located close to storm water drains ☐ Transfer arrangement satisfactory			
6.0	**AESTHETICS & CLEANLINESS**				
6.1	Housekeeping & Hygiene	☐ Designated storage area for materials ☐ Scraps/brickbats/rubbish scattered at site ☐ Proper space for handling waste ☐ Area Clean and dry ☐ Stagnant water treated weekly ☐ Proper stacking of drums ☐ Barricades are clean, in line, firmly secured and proper earthling ☐ Water not allowed to accumulate in work area for any reason			
7.0	**Roads**				
7.1	Access Roads	☐ Satisfactory Maintenance ☐ In urgent need of Maintenance			
7.2	Public Roads used by Contractor	☐ Satisfactory maintenance ☐ Repair not carried out			

3. Air and Noise Monitoring Report Format

Air Monitoring Report

Parameter:
Unit :

CPCB Standard Value:

Location	Monitoring Date	Measured Value	Base line value if any

Noise Monitoring Report
Day Time

Location	Category of Area/Zone	National Standard (Day time) Leq dB(A)	Baseline value (Day time), Leq dB(A)	Noise levels (Day time) Leq dB(A)

Night Time

Location	Category of Area/Zone	National Standard (Night time) Leq dB(A)	Baseline value (Night time), Leq dB(A)	Noise levels (Night time) Leq dB(A)

4. Monthly Waste Management Record

S.No	Waste Type	Unit	Quantity Generated		Quantity Disposed off		Adopted/Proposed disposal method
			For the month	Till date	For the month	Till date	
1	**Construction and Demolition Waste**						
	a. Concrete waste	MT					
	b.Demolition Waste	MT					
	c. Bentonite/Polymer mixed soil	CUM					
	d. Good earth	CUM					
2	**Hazardous Waste**						
	a. Waste oil	Litres					
	b. Oil filters	Nos					
	c. Air filters,	Nos					
	d. Cartridges etc.	Nos					
	e. Other (if any)						
3	**Recyclable waste**						
	Paper, plastic, wood, bottles, rubber etc.	Kg					
4	**Bio-degradable waste**						
	Food waste, vegetable waste etc	Kg					
5	**Metal Scrap**	Ton					
6	**E -Waste**	Nos/ Ton					
7	**Miscellaneous (any other)**						

Prepared by:	**Reviewed by: (Environment Manager)**	**Approved by: (Project Manager)**

5. Water Consumption Details

S. No	Source of Water	Quantity Consumed for the month (KL)	Quantity Consumed till date (KL)
1	Ground Water Extracted		
2	Municipal Supply		
3	Water Tanker		
4	Water bottles		
Total (A)			
Breakup of Raw Water Consumption Detail			
S. No.	**Particular**	**Quantity Consumed for the month (KL)**	**Quantity Consumed till date (KL)**
1	**Raw Water**		
	a. Consumed in RO Plant		
	b. Sprinkling		
	c. Wheel washing		
	d. Domestic purpose like drinking, toilets, labour camps, office cleaning		
	e. Curing		
	f. Stone cutting		
	g. TM washing		
	h. Any other use		
	Total (B)		
2	**R O treated water**		
	Total (C)		
3	**R O Reject Water**		
	Total (D)		

Prepared by: **Reviewed by:** **Approved by:**
Environment Manager **Project Manager**

6. Details on Fly Ash (If Applicable)

The Employer shall give his consent to the civil Contractor for using Fly Ash in concrete or brick works. The Contractor shall record all relevant details on the consumption of Fly Ash from the data of initial consumption to date of final use.

Fly Ash utilization in tonnes in Building Materials and Products for the FY-
Contract No. :
Name of Contractor :
Details regarding utilization of fly ash in road/flyover construction projects:

S. No.	Item of work	Total quantity of material used (tonnes)	Quantity of Fly ash used (tones)	Quantity of Soil/Earth any other material used (tones)	% fly ash used against total quantity of material used	Source of fly ash
Remarks:						

Prepared by: **Reviewed by:** **Approved by:**
Environment Manager **Project Manager**

7. Material Consumption Details

S.No.	Particular	Unit	Quantity Consumed	
			For the month	Till date
1	Concrete	CUM		
2	Cement	MT		
3	Sand	MT		
4	Coarse Aggregate	MT		
5	Reinforcement	MT		
6	Admixtures	Litres		
7	Diesel	Litres		
8	Electricity	kWh		

Prepared by:	Checked by: (Environment Manager)

8. Records of Complaints

S.No	Nature of Complaints	Date of Complaints Received	Impact Location	Name of Complainant	Address of Complainant	Remarks	Status		
							Solved	On going	Pending

General Instruction: ESHS/GI/009

MARS Audit Rating

Contractor No.:	Contractor:	
Audit No.:	Date:	
For the month of:		
Audit team	Contractor representatives	HRIDC/GC Representatives
Headed by:		
Assisted by:		

Contract No.:		**Contractor:**	
For the month of:			
Audit date:			
Sl. No.	**Section**	**% score attained By Contractor**	**% Score given By HRIDC-GC**
1	ESHS Administration		
2	ESHS Training and ESHS Communication		
3	ESHS Inspection and Audit		
4	Hazard Identification, Risk Assessment and Emergency Preparedness		
5	Reporting of Accidents and Dangerous Occurrences and investigations		
6	Housekeeping		
7	Working at Height		
8	Lifting Operations and Gears		
9	Construction Machinery / Hand tools and power tools		
10	Site Electricity		
11	Fire prevention		
12	Welding & Cutting		
13	Excavations and Trenching		
14	Tunnelling and Confined Space operations		
15	Traffic management		
16	Personal Protective Equipment		
17	Industrial Health & Hygiene and Lighting & Ventilation		
18	Welfare amenities		
19	Environmental management		
20	Batching Plant and Casting Yard		
Overall audited score attained			

Team Head / Contractor Name:	**Designation**	**Signature**	**Date**
Team Head / HRIDC/GC Name:	**Designation**	**Signature**	**Date**

MONTHLY AUDIT RATING SCORE (MARS)

HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LTD.

Contract No.:	Contractor's Name:

1.0 ESHS Administration

1.1 ESHS Organisation	A	B	C
Adequacy of ESHS personnel	10		
Is ESHS personal professionally qualified	10		
Employer's approval for each ESHS personal	10		
Intimation of ESHS personals vacancy to Employer	10		
ESHS personal lies with the main contractor	10		
Sub total	**50**		

1.1a ESHS Organisation	A	B	C
ESHS manpower from outsourcing agency	10		
ESHS personals reports to ESHS manager	10		
ESHS manager reports to Project Manager	10		
Facilities and equipment gave to the ESHS personnel	10		
ESHS personnel can stop any unsafe act	10		
Sub total	**50**		

1.2 ESHS Committee	A	B	C
Is site and construction ESHS Committee formed	10		
Does PM Chairman of ESHS Committee	10		
Committee members under gone monthly inspection	10		
Does site ESHS committee meet at least monthly with 21 days time gap	10		
Are Incident Reports discussed	10		
Sub total	**50**		

1.3 Construction ESHS Committee	A	B	C
Does construction ESHS committee meet at least weekly	10		
Do all sub contractors attend	10		
Is agenda cover all the points	10		
Minutes of the meeting send to all committee members	10		
Minutes displayed in the notice board	10		
Sub total	**50**		

1.4 ID card and first day at work	A	B	C
Is ID card issued to all persons	10		
Is ID card as per standard	10		
Authority signed all ID cards	10		
All worker undergone orientation training	10		
ESHS hand book issued to all personnel	10		
Sub total	**50**		

1.5 Designer's role	A	B	C
Whether designers were informed about clause 5.0 of Conditions of Contract on ESHS	10		
Whether designers provide ESHS risk at the drawing itself.	10		
Whether hierarchy of risk control is indicated by the designer	10		
Participation of designer in monthly SCM	10		
Detailed supplementary information about ESHS risk of the design given by designer.	10		
Sub total	**50**		

1.6 ESHS submittals to Employer	A	B	C
Daily reporting of workmen	10		
Monthly ESHS report	10		
ESHS committee meeting minutes	10		
ESHS inspection report	10		
Monthly internal ESHS audit score report	10		
Sub total	**50**		

1.6a ESHS submittals to Employer	A	B	C
External ESHS audit report	10		
Electrical safety audit report	10		
Air monitoring report	10		
Noise monitoring report	10		
Accident, Incident and dangerous occurrence reporting	10		
Sub total	**50**		

1.7 Visitors to site	A	B	C
Visitor got the permission from Employer	10		
Contractor have visitor PPEs	10		
Responsible accompanied with visitor	10		
Does visitor entering hazardous area	10		
Visitor register maintain at site office	10		
Sub total	**50**		

	A	B	C
Sub total			

Contractor's Observations:	Employer's Observations:

Section Scores	450			Section % Score	100		

A – Total score B – To be Awarded by contractor C – To be awarded by Employer

MONTHLY AUDIT RATING SCORE (MARS)

HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LTD.								
Contract No.:	Contractor's Name:							
2.0 ESHS Training and ESHS Communication								
2.1 Training Policy	**A**	**B**	**C**	**2.2 Induction Training**	**A**	**B**	**C**
Is training policy in ESHS Plan	10			Does training take place in first week	10		
Is policy implemented	10			Induction Handout	10		
Does it includes sub contractors	10			Project related syllabus	10		
Is training policy published	10			Management participation	10		
Does PM understand training policy	10			Attendance records kept	10		
Sub total	**50**			**Sub total**	**50**		
2.3 Toolbox Talks	**A**	**B**	**C**	**2.4 Supervisor Training**	**A**	**B**	**C**
Are they held at least weekly	10			Is there a recognized programme	10		
Presented by supervisor/safety officer	10			Project related	10		
System monitored by management	10			Senior management participation	10		
Employee involvement	10			Achievement test	10		
Attendance records kept	10			Attendance records kept	10		
Sub total	**50**			**Sub total**	**50**		
2.5 Follow up training	**A**	**B**	**C**	**2.6 Driver/Plant Operator Training**	**A**	**B**	**C**
Is follow up training organized	10			Does Driver/PO training take place	10		
Does it take place after six months	10			Are all drivers undergone for defensive training at IDTR.	10		
Is syllabus project related	10			Are all Drivers and Operators certificated	10		
Attendance records kept	10			Are records kept	10		
Workers participation towards training	10			Are all Drivers Operators retained	10		
Sub total	**50**			**Sub total**	**50**		
2.7 Promotional activities	**A**	**B**	**C**	**2.8 ESHS posters**	**A**	**B**	**C**
Is there a safety promotional programme	10			Are posters adequate no's	10		
Are any incentive schemes used	10			Are posters separately numbered	10		
Are subcontractors included in promotion	10			Are posters cover all topics	10		
Had any worker rewarded so far.	10			Are safety posters visible on site	10		
Management's participation towards this	10			Are posters maintaining regularly	10		
Sub total	**50**			**Sub total**	**50**		
2.9 ESHS Signage	**A**	**B**	**C**	**2.10 Important days to be observed**	**A**	**B**	**C**
Is signage in correct colours	10						
Adequate number of signs	10						
Suitable positioning of signs	10						
Signs in Hindi and English	10						
Are signage maintaining regularly	10						
Sub total	**50**			**Sub total**			
Contractor's Observations:				**Employer's Observations:**			
Section Scores	**450**			**Section % Score**	**100**		

MONTHLY AUDIT RATING SCORE (MARS)

HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LTD.								
Contract No.:	**Contractor's Name:**							
3.0 ESHS Inspection and Audit								
3.1 Planned General Inspection	**A**	**B**	**C**	**3.2 Routine Inspection**	**A**	**B**	**C**
Monthly contractor and subcontractors' site ESHS committee Inspection	10			Operator Daily Inspection of plant and equipment	10		
Weekly ESHS inspection by supervisors	10			Monthly Inspection of electrical hand tools	10		
Daily ESHS inspection by site ESHS team	10			Quarterly Inspection of temporary electrical systems	10		
Employer's and contractor's representative involved in this ESHS inspection	10			Weekly Inspection of scaffold by scaffolding supervisor	10		
Records maintenance	10			Half-yearly inspection of lifting appliances and gears by competent person	10		
Sub total	**50**			**Sub total**	**50**		
3.3 Specific Inspection	**A**	**B**	**C**	**3.4 ESHS Inspection**	**A**	**B**	**C**
Before a heavy lifting operation	10			Is Contractor prepare checklist for all activity	10		
Before & after entry into confined space	10			Checklist mentioned in contractor ESHS plan	10		
Before & after a welding & gas cutting	10			All inspection reports registered	10		
Before concreting formwork	10			Inspection reports sent to Employer	10		
All high-risk processes inspected by competent supervisor	10			Planned and Routine Inspection used for discussion in ESHS Committee Meeting	10		
Sub total	**50**			**Sub total**	**50**		
3.5 MARS	**A**	**B**	**C**	**3.6 Electrical safety audit**	**A**	**B**	**C**
Performed once in a month	10			Covered all areas	10		
Project Manager accompanied this audit	10			Performed once in a month	10		
Conducted at least 7 days prior to Monthly ESHS Committee meeting	10			Team comprising of senior ESHS (Elect) engineer	10		
Audit Report will be sent to Employer	10			Audit Report will be sent to Employer	10		
Corrective actions taken	10			Corrective actions taken	10		
Sub total	**50**			**Sub total**	**50**		
3.7 External Audit (General)	**A**	**B**	**C**	**3.8 External Audit**	**A**	**B**	**C**
Conducted by external agencies	10			Contents and coverage	10		
Auditors ISO qualified and competent	10			Available documents	10		
Approval of the Employer	10			Qualification of audit team members	10		
Audit report as per ISO/ILO standard	10			Had checklist prepared	10		
Conducted on a quarterly basis	10			Status of NCR of external audit	10		
Sub total	**50**			**Sub total**	**50**		
3.9 Audit Report	**A**	**B**	**C**		**A**	**B**	**C**
Audit report as per ISO/ILO standard	10						
Audit conformity / non-conformity report to the Employer	10						
Report contents and coverage	10						
Corrective action by contractors	10						
Initial audit for checking the adequacy of implementation	10						
Sub total	**50**			**Sub total**			
Contractor's Observations:				**Employer's Observations:**			
Section Scores	**450**			**Section % Score**	**100**		

A – Total score B – To be Awarded by contractor C – To be awarded by Employer

HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LTD.								
Contract No.:	Contractor's Name:							
4.0 Hazard Identification, Risk Assessment and Emergency Preparedness								
4.1 Policy for Identifying Hazards	**A**	**B**	**C**	**4.2 Risk Assessment**	**A**	**B**	**C**
Procedure for identifying hazards	10			Are risk assessment carried out	10		
Is there a list of significant hazards	10			Is there a formal process	10		
Procedure for Risk Assessment	10			Are worksheets used	10		
Whether any schedule or hierarchy made	10			Are records kept in site office	10		
Ranking of hazards	10			Whether control measures are planned	10		
Sub total	**50**			**Sub total**	**50**		
4.3 Method Statements	**A**	**B**	**C**	**4.4 Permit to work in use**	**A**	**B**	**C**
Are Method Statements produced	10			Is there a procedure for Permits to work	10		
Dot hey contain clear instruction	10			Issued by Authorized person	10		
Are they given to work supervisors	10			Issued for defined period	10		
Is correct information given to workers	10			Workers instructed	10		
Step by step description of task	10			Are records kept of Permits issue	10		
Sub total	**50**			**Sub total**	**50**		
4.5 Emergency Preparedness Plan	**A**	**B**	**C**	**4.6 Emergency control centre**	**A**	**B**	**C**
Is there description within Safety Plan	10			Available of first-aid box	10		
Is it up to date	10			Public addressing system	10		
Is it well published	10			Emergency phone numbers	10		
Does Project Manager have copy	10			Emergency alarm	10		
Exercise within past three months	10			Employees name list	10		
Sub total	**50**			**Sub total**	**50**		
4.7 Communication system	**A**	**B**	**C**	**4.8 Plan Details**	**A**	**B**	**C**
Public addressing system	10			Details of emergency co-ordinator	10		
Emergency power supply	10			Designated personnel with Tel. Nos.	10		
Mobile phone in Emergency care centre	10			Are telephone numbers up to date	10		
Warning boards	10			Emergency response team identified	10		
Records maintained for usage and maintenance of communication systems	10			Functions of Team identified	10		
	50			**Sub total**	**50**		
4.9 Requirements	**A**	**B**	**C**	**4.10 First Aid**	**A**	**B**	**C**
Link to Police	10			Is First Aid included in Safety Plan	10		
Link to Fire Services	10			Are adequate no. of First aiders appointed	10		
Link to Ambulance and Hospital	10			Record keep of qualification	10		
Communication to employees	10			First aid boxes supplied	10		
Displayed on Notice Boards	10			First aid boxes properly equipped	10		
Sub total	**50**			**Sub total**	**50**		
Contractor's Observations:				**Employer's Observations:**			
Section Scores	**500**			**Section % Score**	**100**		

HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LTD.							
Contract No.:	Contractor's Name:						
5.0 Reporting of Accidents and Dangerous Occurrences and Accident Investigations							
5.1 Reporting to Employer	**A**	**B**	**C**	**5.2 Reporting to Govt. organisation**	**A**	**B**	**C**
Verbal information	10			Reporting to Regional Labour Commissioner	10		
Written information within 24 hrs	10			Reporting to welfare board	10		
Delay in reporting	10			Reporting to director general	10		
Are all accidents identified and recorded	10			Reporting to police station	10		
Are AFR rates calculated	10			Reporting to District Magistrate	10		
Sub total	50			**Sub total**	50		
5.3 Incident Reporting	**A**	**B**	**C**	**5.4 Follow up Action**	**A**	**B**	**C**
Is there a proper reporting procedure	10			Does Senior Manger review all reports	10		
Is the procedure communicated to all	10			Is result of investigation published	10		
Are reports available for inspection	10			Are workers advised of remedial action	10		
Do reports accurately describe incident	10			Are failure in Management recognized	10		
Is standardised form used	10			Whether statistics report prepared	10		
Sub total	50			**Sub total**	50		
5.5 Procedure for investigation	**A**	**B**	**C**	**5.6 Incident Investigation**	**A**	**B**	**C**
Made Photographs and sketches	10			Are witness statement taken	10		
Examine involved equipment	10			Is the chain of events identified	10		
Interviewed the eye-witnesses	10			Is specific sub contractor identified	10		
Consulted expert opinion	10			Investigation kit available	10		
Environmental conditions	10			Investigation report made available to Employer	10		
Sub total	50			**Sub total**	50		
	A	**B**	**C**		**A**	**B**	**C**
Sub total				**Sub total**			
	A	**B**	**C**		**A**	**B**	**C**
Sub total				**Sub total**			
Contractor's Observations:				**Employer's Observations:**			
Section Scores	300			**Section % Score**	100		

HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LTD.

Contract No.:	Contractor's Name:

6.0 Housekeeping

6.1 Procedure	A	B	C	6.2 Organisation	A	B	C
Is it mentioned in ESHS plan	10			Adequacy of housekeeping personnel	10		
Responsibility classified	10			Is housekeeping personnel trained	10		
Housekeeping round the clock	10			Employer's approval for housekeeping personnel	10		
Reporting of housekeeping personals to ESHS Manager	10			Intimation of vacancy to Employer	10		
Housekeeping persons provided no. / badge	10			Persons provided with suitable logistics / aid	10		
Sub total	50			**Sub total**	50		

6.3 Housekeeping squad	A	B	C	6.4 Barricades	A	B	C
Housekeeping plan	10			Dimension of the board	10		
Member list	10			HRIDC logo	10		
Job allocation and time allocation	10			Sequential Numbering	10		
Periodicity of housekeeping	10			Availability of protruding parts	10		
Documentation of housekeeping	10			Regular cleaning and painting	10		
Sub total	50			**Sub total**	50		

6.5 Access / Egress way	A	B	C	6.6 Dustbins	A	B	C
Free from debris	10			Lumbar with protruding nails	10		
Unprotected opening	10			Unprotected projection	10		
Free from obstructions	10			Scattered unused materials	10		
Slippery condition	10			Spill of bentonite	10		
Spillage of water or oil	10			Fencing and guarding of equipments	10		
Sub total	50			**Sub total**	50		

6.7 Housekeeping at worksites	A	B	C	6.8 Housekeeping at roads	A	B	C
Lumbar with protruding nails	10			Tyre cleaning of vehicles	10		
Unprotected projection	10			Parking of construction vehicles at road	10		
Scattered unused materials	10			Water logging or bentonite spill on road	10		
Fencing and guarding of equipments	10			Roads kept clean	10		
Stacking and storing of materials	10			Position of barricades lying at roads	10		
Sub total	50			**Sub total**	50		

6.9 Storage of cylinders	A	B	C		A	B	C
Full / empty separated	10						
Gases separated	10						
Protected from weather	10						
Contents labelled	10						
MSDS available for each gas	10						
Sub total	50			**Sub total**			

Contractor's Observations:	Employer's Observations:

Section Scores	450			Section % Score	100		

MONTHLY AUDIT RATING SCORE (MARKS)

HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LTD.

Contract No.:	Contractor's Name:

7.0 Working at Height

7.1 Organisation and planning	A	B	C
Adequate number of trained personnel	10		
Supervision	10		
Planning emergency and rescue	10		
Work permit system	10		
Refresher training	10		
Sub total	50		

7.2 Fragile surface	A	B	C
Suitable working platform	10		
Guard rails	10		
Crawling boards	10		
Warning notice	10		
Work permit system to work	10		
Sub total	50		

7.3a Scaffolding	A	B	C
Is scaffolding included in ESHS Plan	10		
Are scaffolding erected and dismantled by competent workmen	10		
Are records kept of inspections	10		
Security fixed or buttressed	10		
Working platforms free from rubbish	10		
Sub total	50		

7.3b Scaffolding	A	B	C
Scaffolds constructed for correct use	10		
Are scaffolds constructed of sound material without patent defect	10		
No unsuitable material	10		
Working platforms fully boarded	10		
Guardrails and mid rails fitted	10		
Sub total	50		

7.3c Scaffolding	A	B	C
Secure ladder access provided	10		
Toe board provided	10		
'Safe for Use' board erected	10		
Availability of base plate	10		
Free from rust / corrosion / debris	10		
Sub total	50		

7.4a Ladders	A	B	C
Are ladders specified in Safety Plan	10		
Is there a system for checking ladders	10		
Are records kept of weekly checks	10		
Using of Bamboo ladders	10		
Painting of ladders	10		
Sub total	50		

7.4b Ladders	A	B	C
Safety procedure followed	10		
Rubber bush in aluminium ladder	10		
Landing properly	10		
Climbing procedure	10		
Rungs at proper intervals	10		
Sub total	50		

7.5 Guardrails	A	B	C
Present at all working platforms	10		
Securely attached	10		
Sound material	10		
Designed as per standard	10		
Maintained properly	10		
Sub total	50		

7.6 Harnesses	A	B	C
Is use of harnesses specified in ESHS Plan	10		
Are harnesses of full body type	10		
Are secure anchorage points used	10		
Has instruction on correct use been given	10		
Maintenance and inspection	10		
Sub total	50		

7.7 Safety net	A	B	C
Approved type	10		
Good construction	10		
Adequate number to issue	10		
Testing	10		
Maintenance	10		
Sub total	50		

Contractor's Observations:	Employer's Observations:

Section Scores	500			Section % Score	100		

MONTHLY AUDIT RATING SCORE (MARKS)

HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LTD.

Contract No.:	Contractor's Name:

8.0 Lifting Operations and Gears

8.1 Certification	A	B	C
Procedure is available in ESHS Plan	10		
Fitness / Test Certificates available	10		
Daily inspection records maintained	10		
Load chart for lifting appliances	10		
Employer's approval for lifting appliances	10		
Sub total	50		

8.2 ASLI / Other Indicators	A	B	C
Free from damage	10		
In operable conditions	10		
Overload device tested	10		
Overload device operable	10		
Bypass key made available to I/C	10		
Sub total	50		

8.3 Wire Ropes	A	B	C
Free from damage	10		
Lubricated	10		
Correctly anchored	10		
Splicing method	10		
Inspection & Testing	10		
Sub total	50		

8.4 Safety Hooks	A	B	C
Free from damage	10		
Safety latch fitted	10		
Safety latch in operable condition	10		
Other form of hook closure	10		
Test certificates	10		
Sub total	50		

8.5 Slings, Chains & Shackles	A	B	C
Properly stored when not in use	10		
In good condition without defects	10		
Market with safe working load	10		
Bulldog clips correct fit/number	10		
Correctly used	10		
Sub total	50		

8.6 Outriggers (Mobile Cranes)	A	B	C
Outriggers locked in position	10		
Jacks in good condition	10		
Jacks firmly supported	10		
Wheels clear/not supporting load	10		
Chassis level	10		
Sub total	50		

8.7 Operator and Operator cabin	A	B	C
Licence for HMV	10		
Competent & skilled	10		
Medical fitness certificate	10		
Portable fire extinguisher	10		
Defensive driving at IDTR	10		
Sub total	50		

8.8 Rigging requirement	A	B	C
Rigger qualification & experience	10		
Load assessment	10		
Type of slings to be used	10		
Hocks & lifting assessment	10		
Overhead power line	10		
Sub total	50		

8.9 Alarms & signals	A	B	C
Overload alarm	10		
Over hoist alarm	10		
Reverse horn	10		
Pressure indicators	10		
Outrigger extension alarm	10		
Sub total	50		

8.10 Accessories & controls	A	B	C
Side & rear view mirror	10		
Clutch & brake	10		
Swing & Extension control	10		
Illumination	10		
Maintenance	10		
Sub total	50		

Contractor's Observations	Employer's Observations:

Section Scores	500			Section % Score	100		

MONTHLY AUDIT RATING SCORE (MARKS)

HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LTD.								
Contract No.:	Contractor's Name:							
9.0 Construction Machinery / Hand tools and power tools								
9.1 Machinery Fencing	**A**	**B**	**C**	**9.2 Maintenance**	**A**	**B**	**C**
All moving parts effectively guarded	10			All maintenance properly maintained	10		
Fencing not removed	10			No maintenance whilst M/c in motion	10		
Is procedure in ESHS Plan	10			Records of maintenance kept	10		
Warning board	10			Work Permit System	10		
Emergency stop switch	10			Use of 'Lock Out and Tag Out' (LOTO)	10		
Sub total	**50**			**Sub total**	**50**		
9.3 Air Receivers	**A**	**B**	**C**	**9.4 Wood working machines**	**A**	**B**	**C**
Fitted with pressure relief valve	10			Top guard fitted	10		
Annual test carried out	10			Working space	10		
All couplers with safety chains/wired	10			Guards to protect all drive belts	10		
Condition of hoses	10			Emergency stop switch	10		
Noise level under permissible limit	10			Push stick used	10		
Sub total	**50**			**Sub total**	**50**		
9.5 Grinding machine	**A**	**B**	**C**	**9.6 General**	**A**	**B**	**C**
Appropriate guards fitted	10			Is procedure in ESHS plan	10		
Correct size wheel/disc fitted	10			All operator medically fir and above 21 yrs	10		
Spindle speed marked on M/s	10			Unauthorized riding on plant	10		
Name plate for equipment specification	10			Inspection and maintenance record	10		
Test and maintenance	10			Portable fire extinguisher	10		
Sub total	**50**			**Sub total**	**50**		
9.7 Safe Operating Procedure	**A**	**B**	**C**	**9.8 Requirements**	**A**	**B**	**C**
Available for all machines	10			Manufacturer specification	10		
Available in the working area	10			Control switch	10		
Operator trained	10			GFCI / RCCB and other safety devices	10		
Operator know the same	10			IP 44 plugs, sockets & connectors	10		
Updated regularly	10			Guarding	10		
Sub total	**50**			**Sub total**	**50**		
9.9 Maintenance and Inspection	**A**	**B**	**C**	**9.10 PPE**	**A**	**B**	**C**
Daily inspection	10			Ear protection	10		
Lubrication	10			Hand Protection	10		
Pneumatic and hydraulic pressure	10			Eye protection	10		
Record maintenance	10			Apron	10		
Label displayed in the equipment itself.	10			Nose / face mask	10		
Sub total	**50**			**Sub total**	**50**		
Contractor's Observations:				**Employer's Observations:**			
Section Scores	**500**			**Section % Score**	**100**		

MONTHLY AUDIT RATING SCORE (MARKS)

HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LTD.								
Contract No.:	Contractor's Name:							
10.0 Site Electricity								
10.1 Power assessment	**A**	**B**	**C**	**10.2 Distribution Panels**	**A**	**B**	**C**
Load calculation for power requirement	10			Panel secure box to IP 44	10		
Employer's approval for execution of the job	10			All cables enter box through glands	10		
Is small capacity diesel generator present	10			ELCB or RCCB/ GFCI fitted	10		
Noise from diesel generator	10			Proper earth connection and earth pit	10		
Sub-contractor's power requirement by main contractor	10			Warning signs in appropriate position	10		
Sub total	**50**			**Sub total**	**50**		
10.3 Cables	**A**	**B**	**C**	**10.4 Work on site**	**A**	**B**	**C**
All cables free from damage	10			Site electricity covered in the ESHS Plan	10		
Cables lying on the ground / water	10			Name posted on Main Distribution Board	10		
Cable joints made by IP 44 connectors	10			Single line & Schematic diagram submitted	10		
Correct storage when not in use	10			Employer's Approval for execution	10		
Colour coding	10			GFCI provided	10		
Sub total	**50**			**Sub total**	**50**		
10.5 Electrical professional	**A**	**B**	**C**	**10.6 Earth Pit**	**A**	**B**	**C**
Sufficient numbers	10			As per standard	10		
Professionally qualified	10			Wet condition	10		
Roles and responsibilities defined	10			Pouring 5 litre water per days	10		
Valid license to electrical persons	10			Earth pipe free from corrosion	10		
Training	10			Earth resistance	10		
Sub total	**50**			**Sub total**	**50**		
10.7 Plugs, Sockets and outlets	**A**	**B**	**C**	**10.8 Voltage / Current**	**A**	**B**	**C**
Are all plugs, sockets and outlets IP 44 type	10			Check voltage / current limit	10		
Colour coding of plugs and sockets	10			Rating clearly marked on all equipments	10		
All cables fitted with IP 44 Plugs	10			Monitored continuously	10		
All equipments connected with plugs	10			Mismatch of cable and equipments ratings	10		
All equipments free from defects	10			Properly earthed	10		
Sub total	**50**			**Sub total**	**50**		
10.9 Maintenance	**A**	**B**	**C**	**10.10 Correct Disc. / Revolutions**	**A**	**B**	**C**
Regular inspections carried out	10			Information plate on tool	10		
Records kept	10			Information on Disc/Cutter	10		
Suitable guards/security fenced	10			Compatibility between Tool and Disc	10		
Faults actioned	10			Operator trained/competent to fit Disc	10		
Record maintaining	10			Safety check on condition	10		
Sub total	**50**			**Sub total**	**50**		
Contractor's Observations:				**Employer's Observations:**			
Section Scores	**500**			**Section % Score**	**100**		

MONTHLY AUDIT RATING SCORE (MARKS)

HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LTD.

Contract No.:	Contractor's Name:

11.0 Fire prevention

11.1 Fire fighting personnel	A	B	C
Adequacy of Fire fighting personnel	10		
Professionally qualified	10		
Employer's approval	10		
Intimation of vacancy to Employer	10		
Adequate no of trained persons	10		
Sub total	50		

11.2 Requirements	A	B	C
Emergency plan	10		
Fire excavation plan	10		
Mock drill	10		
Nearest fire brigade phone numbers	10		
Reporting of fire accident to Employer	10		
Sub total	50		

11.3 Combustible material	A	B	C
Used in site	10		
Handling of combustible material	10		
Stored in separate place	10		
Spillage of materials	10		
Location of burning site	10		
Sub total	50		

11.4 Fire Extinguisher	A	B	C
Adequate numbers	10		
Appropriate type	10		
Easily accessible	10		
Frequency of recharge	10		
Maintenance and inspection	10		
Sub total	50		

11.5 Fir fighting equipments	A	B	C
Sufficient quantity of water supply	10		
Fire hose and nozzle	10		
Fire alarm	10		
Condition of fire hydrants	10		
Sufficient no. available	10		
Sub total	50		

	A	B	C
Sub total			

	A	B	C
Sub total			

Contractor's Observations:	Employer's Observations:

Section Scores	250			Section % Score	100		

MONTHLY AUDIT RATING SCORE (MARKS)

HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LTD.								
Contract No.:	Contractor's Name:							
12.0 Welding & Cutting								
12.1 Gas Welding / Cutting	**A**	**B**	**C**	**12.2 storage of cylinders**	**A**	**B**	**C**
Is procedure in ESHS Plan	10			Is procedure in ESHS Plan	10		
Are cylinders in cylinder-trolley	10			Storage in upright position	10		
Are pressure gauges fitted and operable	10			Full/empty segregated	10		
Are flashback arresters fitted	10			Different gases separated	10		
Are non return valves fitted	10			Contents labelled	10		
Sub total	50			**Sub total**	50		
12.3 Condition of cylinders	**A**	**B**	**C**	**12.4 Hose**	**A**	**B**	**C**
No damage by misuse	10			Colour coding	10		
No rust/corrosion	10			Hose clip and clamp	10		
Protected from weather	10			Is it free from leak and damage	10		
Colour coding proper	10			Hose lying on the ground	10		
MSDS available	10			Joints if any	10		
Sub total	50			**Sub total**	50		
12.5 Electric Arc Welding	**A**	**B**	**C**	**12.6 Transformer**	**A**	**B**	**C**
Are welding machines in good order	10			Presence of voltmeter and ammeter	10		
Welding leads free form defect	10			Separate main power switch	10		
Welding return free from defect	10			Ground connection	10		
Electrode holder properly insulated	10			Specification plate or board	10		
Dipping electrode in water when it is hot	10			Protected from weather	10		
Sub total	50			**Sub total**	50		
12.7 Electrical Cable	**A**	**B**	**C**	**12.8 Work Area**	**A**	**B**	**C**
Cable lying on ground / water	10			Area clear of flammable substances	10		
IP 44 cable connectors instead of insulation tape	10			Smoking inside the work area	10		
Damaged and exposed wires	10			Fire extinguisher fitted	10		
Separate earthing connection from work piece to transformer	10			Welding screens available	10		
Electrical protection devices ELCB, RCCB,etc	10			Ventilation and fume extraction	10		
Sub total	50				50		
12.9 PPE for welder, cutter and helper	**A**	**B**	**C**		**A**	**B**	**C**
Face and eye protection	10						
Gauntlet gloves	10						
Safety footwear	10						
Nose mask	10						
Ear muff / plug	10						
Sub total	50			**Sub total**			
Contractor's Observations:				**Employer's Observations:**			
Section Scores	450			**Section % Score**	100		

MONTHLY AUDIT RATING SCORE (MARKS)

HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LTD.								
Contract No.:	Contractor's Name:							
13.0 Excavations and Trenching								
13.1 Planning	**A**	**B**	**C**	**13.2 Access/Egress**	**A**	**B**	**C**
Are excavations covered in ESHS Plan	10			Suitable ladders provided	10		
Examined by competent person	10			Ladders properly secured	10		
Records of inspection maintained	10			Alternative ladders available	10		
Underground cable and pipelines	10			Staircase for excavation more 1.5 m depth	10		
Backfilling and removal of trench	10			Guardrail for staircase.	10		
Sub total	**50**			**Sub total**	**50**		
13.3 Shoring	**A**	**B**	**C**	**13.4 Barriers and Warnings**	**A**	**B**	**C**
Shoring as soon as earth is removed	10			Rigid barrier around excavation	10		
Suitable support	10			Suitable warning notices	10		
Regular monitoring	10			Regularly checked by supervisor	10		
Proper repair under taken	10			Warning light & signs	10		
Material stacked properly on removal	10			Emergency exit board	10		
Sub total	**50**			**Sub total**	**50**		
13.5 Soil	**A**	**B**	**C**	**13.6 Underground Services**	**A**	**B**	**C**
Not closer than 1 metre	10			Checks made with Utility providers	10		
Properly stacked	10			Safe digging procedures in use	10		
Excavator clear of personnel	10			Supervision has service plans	10		
Storage of Excavated materials	10			Dewatering procedures	10		
Logistics for excavated soil	10			Line of dewatering	10		
Sub total	**50**			**Sub total**	**50**		
13.7 Undermining Nearby Structures	**A**	**B**	**C**	**13.8 Portable Electrical Equipment**	**A**	**B**	**C**
Survey carried out	10			Are as per standard	10		
Temporary support provided if required	10			Proper repair and condition	10		
Vibration measured	10			Rating voltage more than 24 V	10		
Regular monitoring	10			Double insulation	10		
Sufficient clearance provided	10			Open bare wires	10		
Sub total	**50**			**Sub total**	**50**		
13.9 Ventilation and Illumination	**A**	**B**	**C**	**13.10 Signals & Communication**	**A**	**B**	**C**
Are as per standard	10			Audio, Video signals	10		
Exhaust fan arrangement	10			Walkie-talkie / radio /mobile phones	10		
Temperature management	10			Head protection	10		
Gas monitoring systems	10			Arm protection	10		
Lighting arrangement	10			Leg protection	10		
Sub total	**50**			**Sub total**	**50**		
Contractor's Observations:				**Employer's Observations:**			
Section Scores	**500**			**Section % Score**	**100**		

HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LTD.								
Contract No.:	Contractor's Name:							
14.0 Tunnelling and Confined Space operations								
14.1 Procedure	**A**	**B**	**C**	**14.2 Equipments**	**A**	**B**	**C**
Procedure in ESHS Plan	10			Gas monitoring equipment	10		
Permit Work system in use	10			Rescue BA equipment	10		
Only properly trained operatives	10			Full body harness for each worker	10		
Existing underground cables and pipelines	10			Tripod and lifeline	10		
Refresher training	10			Resuscitation Equipment	10		
Sub total	**50**			**Sub total**	**50**		
14.3 Access and Egress	**A**	**B**	**C**	**14.4 Procedure**	**A**	**B**	**C**
Proper staircase and lift	10			Inform to Director General before 30 days	10		
Guardrail for staircase	10			Emergency power generator	10		
Staircase made of sound material	10			Watertight bulkhead doors at entrance	10		
Free from defects	10			Reflective jackets for workers	10		
Emergency exit	10			Dewatering procedures	10		
Sub total	**50**			**Sub total**	**50**		
14.5 Warning / Communication systems	**A**	**B**	**C**	**14.6 Electrical equipment**	**A**	**B**	**C**
Telephone / walkie-talkie	10			Flame proof electrical equipment	10		
Emergency Alarm	10			Portable tools more than 24 V	10		
Warning for Exit way and electrical panel boards	10			Double insulation / earthing condition of portable equipment	10		
High visibility waist	10			Transformer used in without compressed air	10		
Warning lights	10			Bare conductor or semi enclosed fuse	10		
Sub total	**50**			**Sub total**	**50**		
14.7 Illumination and Ventilation	**A**	**B**	**C**	**14.8 Compressed air**	**A**	**B**	**C**
Illumination / ventilation levels	10			Adequacy of air supply	10		
Air circulation	10			Emergency power supply	10		
Level of oxygen / other toxic gas	10			Flame proof equipment	10		
Temperature level (not more than 29° C)	10			Available in man-locks and medical-locks	10		
Emergency power supply for luminaries	10			Hoses free from damage	10		
Sub total	**50**			**Sub total**	**50**		
14.9 Fire Prevention	**A**	**B**	**C**	**14.10 Health and Welfare**	**A**	**B**	**C**
Adequate water supply	10			Man-lock and medical-lock	10		
Fire alarm	10			Drinking water	10		
Flammable materials inside work areas	10			Medical officer	10		
Water outlet points	10			First-aid room	10		
Inspection and maintenance	10			Shelter room	10		
Sub total	**50**			**Sub total**	**50**		
Contractor's Observations:				**Employer's Observations:**			
Section Scores	**500**			**Section % Score**	**100**		

MONTHLY AUDIT RATING SCORE (MARKS)

HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LTD.

Contract No.:	Contractor's Name:

15.0 Traffic management

15.1 Traffic marshals	A	B	C
Sufficient numbers	10		
Professionally qualified or trained	10		
Medically fit	10		
Driving licence	10		
Familiar with traffic signs	10		
Sub total	50		

15.2 Vehicle operators	A	B	C
Driving licence	10		
Medically fitness	10		
Defensive driving training	10		
Refresher training	10		
Fire fighting training	10		
Sub total	50		

15.3 Traffic control devices	A	B	C
Cons	10		
Drums	10		
Delineators	10		
Traffic cylinders	10		
Traffic signs and barricades	10		
Sub total	50		

15.4 Barricades	A	B	C
Erected around the construction site	10		
Free from defects and protruding parts	10		
Numbered	10		
Painted and maintained in good condition	10		
Barricade register	10		
Sub total	50		

15.5 Barricades	A	B	C
Barricade inspector & supervisor appointed	10		
Retro reflective strips shape and size	10		
Reflective strips placed at a angle at bottom	10		
Minimum gap between retro reflective strips 1000mm	10		
One red light / blinker per barricade	10		
Sub total	50		

15.6 Regulatory Signs	A	B	C
Approval from police and traffic authorities	10		
Warning signs	10		
Red light / flag indicator	10		
Design as per employer's approval	10		
Material made of reflective type.	10		
Sub total	50		

15.7a Vehicle	A	B	C
Vehicle number and company name	10		
Inspection stickers & license plate	10		
Seat belts	10		
Two reflective triangles on rear side	10		
Fog lights (front & rear)	10		
Sub total	50		

15.7b Vehicle	A	B	C
Brakes in good working order	10		
Are wiper blades in good condition	10		
Rear view mirrors	10		
Speedometer	10		
Vehicle's horn and reverse alarm	10		
Sub total	50		

15.8 Heavy motor vehicles	A	B	C
Automatic safe load indicator	10		
Load chart of the vehicle	10		
Fitness certificate	10		
Manufacturer details	10		
Marking of safe working load	10		
Sub total	50		

15.9 Operator cabin	A	B	C
Made of fire resistance material	10		
Protection from vibration	10		
Weather protection	10		
Adequate ventilation	10		
Suitable fire extinguisher	10		
Sub total	50		

Contractor's Observations:	Employer's Observations:

Section Scores	500			Section % Score	100		

MONTHLY AUDIT RATING SCORE (MARKS)

HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LTD.

Contract No.:	Contractor's Name:

16.0 Personal Protective Equipment

16.1 Head Protection	A	B	C
Use enforced	10		
As per standard	10		
In good condition	10		
Colour and company logo	10		
Available for issue	10		
Sub total	50		

16.2 Foot Protection	A	B	C
Use enforced	10		
Suitable type	10		
Toecaps effective	10		
Fair condition	10		
Available for issue	10		
Sub total	50		

16.3 Eye protection	A	B	C
Use enforced	10		
As per standard	10		
Suitable type	10		
Good condition	10		
Available for issue	10		
Sub total	50		

16.4 Hearing Protection	A	B	C
Use enforced	10		
As per standard	10		
Suitable type	10		
Available for issue	10		
Noise levels monitored	10		
Sub total	50		

16.5 Respiratory Protection	A	B	C
Use enforced	10		
As per standard	10		
Suitable type	10		
Good condition	10		
Available for issue	10		
Sub total	50		

16.6 Protective Gloves	A	B	C
Use enforced	10		
As per standard	10		
Correct type for operation	10		
Good condition	10		
Available for issue	10		
Sub total	50		

16.7 High-Visible Waist	A	B	C
Use enforced	10		
As per standard	10		
In good condition	10		
Warning signs displayed	10		
Available for issue	10		
Sub total	50		

16.8 Fall Protection	A	B	C
Use enforced	10		
As per standard	10		
In good condition	10		
Warning signs displayed	10		
Available for issue	10		
Sub total	50		

16.9 PPE for visitors	A	B	C
Use enforced	10		
10% PPEs for visitors in site office	10		
In good condition	10		
Colour and company logo	10		
Available for issue	10		
Sub total	50		

	A	B	C
Sub total			

Contractor's Observations:	Employer's Observations:

Section Scores	450			Section % Score	100		

MONTHLY AUDIT RATING SCORE (MARKS)

HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LTD.

Contract No.:	Contractor's Name:

17.0 Industrial Health & Hygiene and Lighting & Ventilation

17.1 Medical examination	A	B	C
All worker under gone	10		
Covered all testes as per standard	10		
Conducted by qualified person	10		
Confidential report for all workers	10		
Frequency of medical test maintained	10		
Sub total	**50**		

17.2 Occupational Health Centre	A	B	C
Construction medical officer & qualification	10		
Availability nurse & sweeper	10		
Floor area minimum 15 m^2 with two rooms	10		
Adequate equipment	10		
Medical emergency equipments	10		
Sub total	**50**		

17.3 First-aid	A	B	C
Equipped with all items as per standard	10		
Sufficient numbers	10		
First-aid room facility	10		
First-aider & his qualification	10		
Register for first-aid	10		
Sub total	**50**		

17.4 Ambulance van and room	A	B	C
Equipped with all items as per standard	10		
Availability and numbers	10		
Maintained in good repair	10		
Equipped with standard facilities	10		
Record of all cases of accident & sickness	10		
Sub total	**50**		

17.5 Mosquito breeding	A	B	C
Water retain on the site	10		
Periodic interval	10		
Still waters	10		
Posters	10		
Usage of insecticides	10		
Sub total	**50**		

17.6 Alcohol and drugs & HIV / AIDS prevention	A	B	C
Employee working under the influence of alcohol / drugs	10		
Smoking at public worksites	10		
Smoking at public worksites	10		
HIV / AIDS awareness training provided	10		
Workers participation / co-operation	10		
Sub total	**50**		

17.7 Noises	A	B	C
Are procedures for noise evaluation in the Safety Plan	10		
Are noise assessments carried out	10		
Are noise zones identified	10		
Is correct PPE provided	10		
Usage of PPE	10		
Sub total	**50**		

17.8 Vibration	A	B	C
Monitoring method	10		
Frequency of monitoring	10		
Vibration limits	10		
Report maintenance	10		
Control plan	10		
Sub total	**50**		

17.9 Radiation	A	B	C
Method statement	10		
Approval from Employer	10		
Use and storage of radioactive substance	10		
Disposal of radioactive substance	10		
Appropriate PPE	10		
Sub total	**50**		

	A	B	C
Sub total			

Contractor's Observations:	Employer's Observations:

Section Scores	450			Section % Score	100		

HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LTD.							
Contract No.:	Contractor's Name:						
18.0 Welfare amenities							
18.1 Toilets / Urinals	**A**	**B**	**C**	**18.1a Toilets / Urinals**	**A**	**B**	**C**
Enough no available	10			Is it properly illuminated	10		
Separate for men and women	10			Is it having separate and ample water facility	10		
Access within 500m from worksite	10			Is it having proper drainage system	10		
Is it properly cleaned	10			Water leaking or spillage	10		
Is it washed regularly	10			Records kept and available	10		
Sub total	**50**			**Sub total**	**50**		
18.2 Drinking water	**A**	**B**	**C**	**18.3 Canteen**	**A**	**B**	**C**
Quantity is sufficient	10			Is canteen available	10		
Quality is good	10			Is it neat and clean	10		
Laboratory test done	10			Is the flooring dust free	10		
Access within 200m from worksite	10			Is the cost 'no loss and no gain' basis	10		
Is it 6m away from toilets and urinals	10			Lighting, ventilation and water facility	10		
Sub total	**50**			**Sub total**	**50**		
18.4 Labour Accommodation	**A**	**B**	**C**	**18.5 Creaches**	**A**	**B**	**C**
Cooking, bathing, washing and lavatory facilities	10			Is it free from mosquito and other biological agent	10		
Is it free from mosquito and biological agent	10			In-charge to keep the children.	10		
Is it properly illuminated and ventilated	10			Is it properly illuminated and ventilated	10		
Is it adequate for all	10			Is it adequate for all	10		
Is it neat, clean and hygiene	10			Is it neat, clean and hygiene	10		
Sub total	**50**			**Sub total**	**50**		
18.6 Shelter	**A**	**B**	**C**	**18.7 Illumination**	**A**	**B**	**C**
Adequate to all workers	10			Minimum illumination requirement	10		
Is it properly illuminated and ventilated	10			Minimum 50 lux at work place	10		
Is it neat, clean and hygiene	10			Minimum 30 lux on trolley tracks	10		
Is it free from mosquito and biological agent	10			Minimum 10 lux elsewhere	10		
Drinking water and Toilet facilities	10			Adequate Emergency lighting provided	10		
Sub total	**50**			**Sub total**	**50**		
18.8 Ventilation	**A**	**B**	**C**		**A**	**B**	**C**
Oxygen level less than 19.5	10						
Air circulation of $6m^3$/min for each building Worker employed underground	10						
Free air flow movement in work place	10						
Ventilation system in operation	10						
Maintenance records kept and available	10						
Sub total	**50**			**Sub total**			
Contractor's Observations:				**Employer's Observations:**			
Section Scores	**450**			**Section % Score**	**100**		

HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LTD.								
Contract No.:	Contractor's Name:							
19.0 Environmental management								
19.1 Air quality	**A**	**B**	**C**	**19.2 Water quality**	**A**	**B**	**C**
Monitoring by competent person	10			Monitoring by competent person	10		
Monitoring equipment as per standard	10			Monitoring equipment as per standard	10		
Monitoring method	10			Monitoring method	10		
Report to Employer	10			Report to Employer	10		
Control plan	10			Control plan	10		
Sub total	50			**Sub total**	50		
19.3 Noise monitoring	**A**	**B**	**C**	**19.4 Illumination monitoring**	**A**	**B**	**C**
Monitoring by competent person	10			Monitoring by competent person	10		
Monitoring equipment as per standard	10			Monitoring equipment as per standard	10		
Monitoring method	10			Monitoring method	10		
Report to Employer	10			Report to Employer	10		
Control plan	10			Control plan	10		
Sub total	50			**Sub total**	50		
19.5 Temperature monitoring	**A**	**B**	**C**	**19.6 Dust control**	**A**	**B**	**C**
Monitoring by competent person	10			Water sprinkler arrangement	10		
Monitoring equipment as per standard	10			Frequency water sprinkler inside the site	10		
Monitoring method	10			Dust screens	10		
Report to Employer	10			Dust level under permissible limit	10		
Control plan	10			Environmental monitoring	10		
Sub total	50			**Sub total**	50		
19.7 Waste Management	**A**	**B**	**C**	**19.8 Felling of Trees**	**A**	**B**	**C**
Dustbin in construction site	10			Approval from forest department	10		
Temporary dumping area	10			Trees used for anchorage.	10		
Separate dumping pit for disposable and non-disposable wastes	10			Trees exposed or injured by construction equipment	10		
Frequency of removal of waste	10			Protective barriers around tree	10		
Burning of waste	10						
Sub total	50			**Sub total**	40		
19.10 Energy Management	**A**	**B**	**C**		**A**	**B**	**C**
Uniform illumination	10						
Size and length of cable and wires	10						
Efficient luminaries	10						
Efficient motors and pumps	10						
Efficient air-conditions	10						
Sub total	50			**Sub total**			
Contractor's Observations:				**Employer's Observations:**			
Section Scores	440			**Section % Score**	100		

HARYANA RAIL INFRASTRUCTURE DEVELOPMENT CORPORATION LTD..								
Contract No.:	Contractor's Name:							
20.0 Batching Plant and Casting Yard								
20.1 General	**A**	**B**	**C**	**20.2 Layout**	**A**	**B**	**C**
Is procedure in ESHS Plan	10			Plan of layout	10		
All operators medically fit/over 21	10			Drainage system	10		
No unauthorized riding on plant	10			Welfare amenities	10		
Daily inspections / recorded	10			Plan for vehicle moving area	10		
Equipped with all	10			Barrication	10		
Sub total	**50**			**Sub total**	**50**		
20.3 Material Handling & dust protection	**A**	**B**	**C**	**20.4 PPE**	**A**	**B**	**C**
Handling of cement bag	10			Hand protection	10		
Loading and unloading cement	10			Respiratory protection	10		
Handling of launching segments	10			Head protection	10		
Is dust level under permissible limit	10			Foot protection	10		
Environmental monitoring	10			Ear protection	10		
Sub total	**50**			**Sub total**	**50**		
20.5 Traffic management	**A**	**B**	**C**	**20.6 Welfare facilities**	**A**	**B**	**C**
Barricades	10			Toilet	10		
Warning boards	10			Drinking water	10		
Traffic marshals	10			Canteen	10		
Delineators	10			Shelter	10		
Lane warning	10			Labour accommodation	10		
Sub total	**50**			**Sub total**	**50**		
20.7 Fitness certificate	**A**	**B**	**C**		**A**	**B**	**C**
Crane	10						
Hydra and all equipment	10						
Ropes and chains	10						
Hooks and shackles	10						
Rigger & Operator	10						
Sub total	**50**			**Sub total**			
	A	**B**	**C**		**A**	**B**	**C**
Sub total				**Sub total**			
Contractor's Observations:				**Employer's Observations:**			
Section Scores	**350**			**Section % Score**	**100**		

Attachment -5 Safe Work Procedure for Work Near Railway Track

1.0 Safety precautions and measures to be observed during execution of ROB/ RUB/ Viaduct/ any other works in Railway and adjoining areas:

1.1 The Contractor(s) shall not allow any road vehicle belonging to him or his suppliers, etc. to ply in HRIDC/railway land next to the running line. If for execution of certain works viz. earthwork for parallel railway line and supply of ballast for new or existing rail line gauge conversion, etc. road vehicles are necessary to be used in railway/HRIDC land next to the railway line, the Contractor(s) shall apply to the Engineer-in-Charge for permission giving the type and number of individual vehicles, names and license particulars of the drivers, location, duration and timings for such work/movement. The Engineer-in-Charge or his authorized representative will personally counsel, examine and certify the road vehicle drivers, Contractor(s)' flagmen and supervisors and will give written permission giving names of road vehicle drivers, Contractor(s)' flagmen and supervisors to be deployed on the work, location, period and timing of the work. This permission will be subject to be following obligatory conditions:

1.2 Construction Activities and Safety:

a) The 'Methodology of Working' shall be incorporated in GAD and Temporary Arrangement Drawings.

b) The activities of work to be taken up during the railway traffic block/under speedrestriction, etc. should be clearly mentioned in such drawings. If at any stage of execution, any discrepancy is found in the drawing with respect to the site condition affecting safety or some new activity of work is required to be done, the same should be brought to the notice of Railway & HRIDC Engineers and such works should be done only after approval by Railways & HRIDC representative. In such cases, scheme may be modified and, if required, fresh CRS sanction shall have to be obtained.

1.2.1 The works required to be done under traffic block protection, are to be carried out only in the presence of Railway & HRIDC Engineering Officials. The Railway's and HRIDC's Supervisor has to certify safe conditions for passage of trains before resumption of traffic. The works to be done under traffic shall be carried out under the provision of banner flag and protection by Engineering Flagman.

1.2.2 Following important activities of works shall be carried out under supervision of Railway/HRIDC Engineer or his nominated Supervisor:

a) Excavation at foundation/ground level near to railway track

b) Concrete casting and/or masonry work very close to railway track

c) Erection of temporary structures near to running lines.

d) Casting of structures like girder/slab over railway track

e) Stage-prestressing of girders when placed across railway tracks properly supported

f) Launching of precast/pre-assembled girders across railway tracks

g) Any work of lifting, side shifting and slewing of girders over the railway track

h) Dismantling of temporary structures, shuttering, scaffolding, etc. adjacent to and above the railway track. For carrying out activities of casting, erection, launching, handling, and dismantling as listed above, the Contractor's Engineer shall furnish the Construction Programme in advance to HRIDC Supervising Engineer & Engineer representative. No such work should be taken up in absence of the HRIDC Supervising Engineer & Engineer representative. For the activities which are to be done in presence

of the HRIDC Engineer and prior intimation shall be given in writing and acknowledgement obtained from HRIDC's representative.

1.2.3 To ensure 'Safety' during construction activities, HRIDC Site Engineer & Engineer representative may direct the Contractor's Supervisor/Engineer or their nominated representative for safe working procedures/ instructions, notwithstanding the contractual or MOU conditions prevailing between/ among Railways/other Departments like NHAI/Contractors/ Concessionaire.

1.2.4 All the records of Quality Assurance/Quality Control, testing of the materials and satisfactory completion of an activity shall be maintained at site by the Contractor's Engineer and Supervisor. On the basis of these records, HRIDC Site Engineer shall do stage-wise clearance of the works at following stages:

i) Completion of foundation

ii) Completion of substructure

iii) Completion of superstructure

Without such stage clearance, the work in next stage of construction shall not be allowed by the HRIDC Supervisor, unless proper system of check and exercise is followed at the site.

1.2.5 Normally, the high beam PSC girders are designed with wider top flange and shorter bottom flange with very high beam which makes the girder unsuitable during lowering, slewing and launching time.

1.2.6 During launching of girders and subsequent adjustments for placement of bearing, special attention and precautions are required at site to be followed rigorously without resorting to shortcut practice or leaving the work at site to untrained or inexperienced Engineers. Normally, end diaphragms are not cast for the extreme both side girders. These shall be cast minimum 300mm on both sides for all 'I' beam girders to provide temporary supports for ensuring stability.

"OR"

For side adjustments and bearing placements below 'I' section girders, end brackets made of steel angles should be provided for all 'I' beams sequentially to avoid side titling of individual girders. End brackets shall be removed only after placing girders on bearing and casting of diaphragms.

1.2.7 During lowering, the jacks shall be operated duly keeping wooden packing of various thicknesses fixing the amount of lowering to the barest minimum, so that even if the jack fails, the wooden packing will take load and further stability of girder is not endangered.

1.2.8 Temporary crib support staging shall be interlaced with clamps and angles. Adequate base width shall be maintained proportionate to the height of stage, which is very essential for avoiding the oblong effect during launching of girders. During launching by RH girder method, the movement of the PSC girders shall be controlled both from front and rear with sync mechanism having simultaneous operation, so that the speed of the launching is always under the control. Spare hydraulic jacks shall always be kept at site. Lowering of girder shall always be carried out at one end only. Further, other end should be adequately secured by wire ropes, end brackets, etc. Thereafter, the process shall be continued alternately.

1.2.9 As far as possible, launching of girders by temporary staging shall be avoided and launching by heavy capacity cranes, wherever feasible, shall be adopted.

1.2.10 Steel girder launcher if used for launching of PSC girders should be pre-tested for the

critical loading (likely to be encountered during actual launching) before deployment on the approaches regarding its strength as well as amount of permissible deflection using actual test PSC girder as a testing load. Connections at supports shall be inspected and certified prior to actual launching. It shall be adequately secured to the base support system on the pier cap.

1.3 General Construction Safety:

1.3.1 General safety precautions as applicable for civil works shall be adopted in field.

1.3.2 Working near running line: Safe practices at site and at all times non-infringement to moving trains shall be ensured. Road vehicles, material trolleys, dollies with any tendency to roll off towards the running lines to be checked by providing chains, locking arrangements, blocks, etc. shall be ensured and the Site-in-Charge of the Contractor shall be primarily responsible, secondary responsibility being of Contractor's Consultant.

1.3.3 Testing of cranes, lifting jacks and other equipment: All equipment like cranes, lifting jacks shall be tested, duly calibrated and certified prior to the use at construction site.

1.3.4 Routine safety checks, validity of test certificates for load bearing equipment especially for cranes outsourced from third party shall be ensured prior to deployment.

1.3.5 Construction workers at site shall be provided with personal safety gear like reflective vest, helmet, Safety shoes, gloves & eyewear approved as per construction industry standards. For persons working at pier top/girder level, temporary supports, hand railing, protection with help of ropes, slings and temporary railings shall be provided.

2.0 Safety Guidelines and Precautions for working close to Railway tracks

2.1 A large number of men and machinery are deployed by the contractors for track renewals, gauge conversions, doublings, bridge rebuilding etc. It is therefore essential that adequate safety measures are taken for safety of the trains as well as the work force. The following measures should invariably be adopted.

A. The contractor shall not start any work without the presence of HRIDC Engineer at site.

B. Wherever the road vehicles and/or machinery are required to work in the close vicinity of railway line, the work shall be so carried out that there is no infringement to the Railway's schedule of dimensions. For this purpose, the area where road vehicles and/or machinery are required to ply, shall be demarcated and acknowledged by the contractor. Special care shall be taken for turning/ reversal of road vehicles/machinery withoutinfringing the running track. Barricading shall be provided wherever justified and feasibleas per site conditions.

C. The look out and whistle caution orders shall be issued to the trains and speed restrictions imposed where considered necessary. Suitable flagmen/detonators shall be provided where necessary for protection of trains.

D. The supervisor/workmen should be counseled about safety measures. A competency certificate to the contractor's supervisor as per Performa annexed shall be issued by DGM/HRIDC, which will be valid only for the work for which it has been issued.

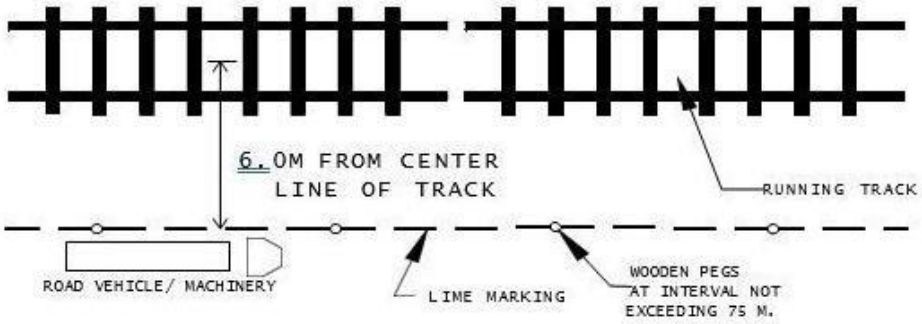
E. The unloaded ballast/rails/sleepers/other P-Way materials after unloading along track should be kept clear off moving dimensions and stacked as per the specified heights and distance from the running track.

F. Supplementary site-specific instructions, wherever considered necessary shall be issued by the HRIDC's representative.

2.2 PLYING OF ROAD VEHICLES AND WORKING OF MACHINERIES CLOSE TO RUNNING TRACKS

A. Normally, the road vehicles shall be run, or machinery shall be worked so as not to come closer than 6.0m from centre line of nearest running track.

B. The land strip adjacent to running tracks, where road vehicle is to ply or machinery is to work, shall be demarcated by lime in advance in consultation with the Railway's & HRIDC's Engineer. Wooden pegs at interval not exceeding 75mtr. shall be provided along the line marking as permanent marks. The road vehicles shall ply or machinery shall work so as not to infringe the line of demarcation.



C. If a road vehicle or machinery is to work closer to 6.0m due to site conditions or requirement of work, following precautions shall be observed:

a) In no case the road vehicle shall run or machinery shall work at distance less than 3.5m from centre line of track.

b) Demarcation of land shall be done by bright colored ribbon/nylon cord suspended on 120 cm high wooden/bamboo posts at distance of 3.5 m from centre line of nearest running track.

c) Presence of an authorized HRIDC's representative shall be ensured before plying of vehicle or working of machinery.

d) Railway's Supervisor shall issue suitable caution order to Drivers of approaching train about road vehicles plying or machineries working close to running tracks. The train drivers shall be advised to whistle freely to warn about the approaching train. Whistle boards shall be provided wherever considered necessary.

e) Lookout men shall be posted along the track at a distance of 800m from suchlocations who will carry red flag and whistles to warn the road vehicle/machinery users about the approaching trains.

f) On curves where visibility is poor, additional lookout men shall be posted.

D. If vehicle/machinery is to be worked closer to 3.5m from running track - Under unavoidable conditions, if road vehicles is to ply or machinery is to work closer to 3.5m due to site conditions or requirement of work, following precautions shall be observed:

a) Plying of vehicles or working of machinery closer to 3.5m of running track shall be done only under protection of track. Traffic block shall be imposed wherever considered necessary. The site shall be protected as per provisions of Para No. 806 & 807 of P-Way Manual as case may be.

b) Presence of a Railway's/, HRIDC's Supervisor shall be ensured at worksite.

c) Railway's& HRIDC's Supervisor shall issue suitable caution order to Drivers of approaching train about road vehicles plying or machineries working close to running tracks. The train drivers shall be advised to whistle freely to warn about the approaching train.

E. Precaution to be taken while reversing road vehicle alongside the track

The location where vehicle will take a turn shall be demarcated duly approved by Railway's/HRIDC's representative. The road vehicle driver shall always face the Railway track during the course of turning/reversing his vehicle. Presence of an authorized Railway/HRIDC representative shall be ensured at such location.

F. Road vehicle shall not be allowed to run along the track during night hours generally. In unavoidable situations, however, vehicles shall be allowed to work during night hours only in the presence of an authorized Railway's/HRIDC's representative and whereadequate lighting arrangements are made and where adequate precautions as mentioned earlier have been ensured.

G. Road vehicles/machinery/plant etc. when stabled near running tracks shall be properly secured against any possible roll off and always be manned even during off hours.

2.3 EXECUTION OF WORKS CLOSE TO OR ON RUNNING LINES

A. Any work close to or on running tracks shall be executed under the presence of a HRIDC's Supervisor only.

B. **Precaution to be taken to ensure safety of trains while execution of work close to the running line or on running lines**.

a) Such works shall be planned and necessary drawings particularly with regard to infringement to moving dimensions shall be finalized duly approved by competent authority before execution of work. The work shall be executed only as per approved procedure and drawings.

b) All temporary arrangements required to be made during execution of work shall be made in such a manner that moving dimension do not infringe.

c) Suitable speed restriction shall be imposed, or Traffic block shall be ensured as required. *The requirement of Traffic and Power Blocks shall be submitted by the Contractor to the Engineer for approval. The Traffic and Power Blocks will be finalized in consultation with Delhi Division of Northern Railway. No cost shall be charged for Traffic and Power Blocks from the Contractor.*

d) Necessary equipment for safety of trains during emergency shall be kept ready at site.

C. Precaution to be taken to ensure safety of electrical/signal/ telephone cables while excavating near tracks.

a) Particular care shall be taken to mark the locations of buried electrical/signal/telephone cables on the plans jointly with S & T/Electric supervisor and also at site so that these are not damaged during excavation.

b) Copy of the cable plan should be given to the contractor's authorized representative before handing over the site to start the work.

c) Due care shall be taken to ensure that any part of the equipment or machinery or temporary arrangement does not come close to cables while working.

d) Joint procedure order No. 17/2013 issued by Railway Board vide letter No.2003/Tele/RCIL/1 Pt IX dated 24.06.2013 shall be followed for undertaking digging work in the vicinity of underground signaling, electrical and telecommunication cables.

D. Precaution to be taken during execution of works requiring traffic blocks.

a) Any work, which infringes the moving dimensions, shall be started only after the traffic block has been imposed.

b) Before closing the work, the track shall be left with the proper track geometry so that the trains run safely.

c) After completion of work the released sleeper and fittings should be properly stacked away from the track to be kept clear of moving dimensions.

d) Block shall be removed only when all the temporary arrangement, machineries, tools, plants etc. have been kept clear of moving dimensions.

E. Precaution to be taken during execution of works during night:

The work close to running line, generally, shall be carried out only during day hours. At locations, however, where night working is unavoidable, proper lighting arrangement should be made. The engineering indicator boards shall be lighted during night hours as per the provisions of IRPWM. The staff deputed for night working should have taken adequate rest before deploying them in night shift. We can specify duration of night shift from 20.00 hrs to 04.00 hrs. All other safety precautions applicable for daytime work should be strictly observed during night working.

F. Precautions to be taken to ensure safety of workers while working close to running lines:

a) Necessary lookout men with red flags and whistles shall be provided to warn the workmen about the approaching train.

b) Railway's/HRIDC's supervisor shall issue suitable caution order to Drivers of approaching train for whistling to warn the workers about the approaching train. Whistle boards shall be provided wherever considered necessary.

c) A "First aid kit" shall always be kept ready at site

G. Precaution shall be taken for safety of public or passengers, while executing works at locations, used by passengers and public

The worksite shall be suitably demarcated to keep public and passengers away from work area. Necessary signage boards such as "Work in progress. Inconvenience is regretted" etc. shall be provided at appropriate locations to warn the public/ passengers. Adequate lighting arrangement of worksite wherever required shall be done to ensure safety of public/passengers during night.

H. Precaution to be taken before stacking materials alongside the track to ensure that safety of trains is not affected –

The following precautions shall be taken before stacking the materials along the track for stacking of ballast, rails, sleepers etc.

a) The sites for material stacking should be selected in advance in such a manner as to ensure that no part of the material to be stacked is infringing the Standard Moving Dimensions. A plan of proposed stacking locations be made and signed jointly by an authorized HRIDC's/Railway's representative and contractor's representative.

b) The selected locations shall be marked by lime in advance.

c) Presence of an authorized HRIDC's/Railway's representative while unloading and stacking shall be ensured.

d) The material shall be stacked in such a height so as to not to infringe SOD in case of accidental roll off.

I. Precaution for handling of departmental material trains –

Instructions for working of material trains are contained in Chapter VIII of IRPWM which should be brought to the notice of the supervisors and other staff working on the material trains. In addition to this,following precautions should be taken:

a) Issue of 'fit to run' certificate:

As per Para 848 before a material train is allowed to work, the complete rake should be examined by the Carriage and Wagon staff and a 'fit to run' certificate issued tothe Guard.

b) As per Para 849 of IRPWM, a qualified Engineering official should be deputed on the train to ensure working of the material train as the Guard is not qualified to carry out such duties like Supervising of loading and unloading of materials.

c) As per Para 845 of IRPWM, the material train should not be permitted to work during the period of poor visibility due to fog, storm or any other cause except with the permission of the ADEN/DEN. Working of the material trains carrying labour should not be permitted between sunset and sunrise except in an emergency.

d) While unloading rail panels by the side of the running track, placement of the panels, clear of the maximum moving dimensions should be ensured.

e) Unloading of rail panels should be done by a team of trained staff under the active supervision of competent Supervisor/Officer.

f) Before unloading of rail panels, site should be prepared by way of leveling/removing extra ballast, if any, from the crib and shoulder with the objective to ensure requisite lateral and vertical clearances so as to prevent slippage of rail panels due to vibration during the passage of trains.

g) Reasonably adequate block should be asked and provided for unloading of the material and the work should be done preferably in day light to avoid shortcut in haste which may infringe the safety requirements.

J. Safety aspects to be observed while working in OHE area

a) No electrical work close to running track shall be carried out without permission of HRIDC representative.

b) A minimum distance of 2m has to be maintained between live OHE wire and body part of worker or tools or metallic supports etc.

c) No electric connection etc. can be tapped from OHE.

d) Authorized OHE staff should invariably be present when the relaying work or any major work is carried out.

e) Power block is correctly taken and 'permit to work' is issued.

f) The structure bonds, track bonds, cross bonds, longitudinal rail bonds are not disturbed and if disconnected for the work, they are reconnected properly when the work is completed.

g) The track level is not raised beyond the permissible limit during the work

2.4 PROTECTION OF TRACK DURING EMERGENCY

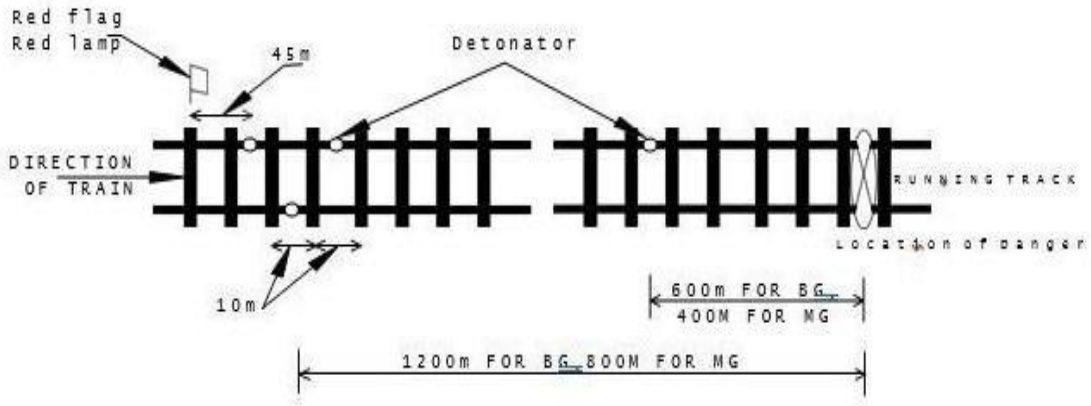
A. Action to be taken when a contractor's supervisor or vehicle operator apprehends any unusual circumstances likely to infringe the track and endanger safe running of trains.

a) At any time if a contractor's supervisor or vehicle operator observes any unusual circumstances likely to infringe the track and apprehend danger to safe running of track, he shall take immediate steps to advise a HRIDC official of such danger and assist him in protection of track.

b) The track shall be protected as under. One person shall immediately plant a red flag

(red lamp during night) at the spot and proceed with all haste in the direction of approaching train with a red flag in hand (red lamp during night) and plant a detonator on rail at a distance of 600m from the place of obstruction of BG track (400m for MG track) after which he shall further proceed for not less than 1200m from the place of obstruction from BG track (800m for MG track) and plant three detonators at 10m apart on rails. After this he shall display the red flag (red lamp during night) at a distance of 45m from the detonators.

c) Attempts shall also be made to send an advice to nearest Railway/HRIDC station about the incident immediately.



B. Action to be taken if train is seen approaching to site of danger and there is no time to protect the track as per guidelines mentioned above.

In such a case the detonators shall be planted on rails immediately at distance away from place of danger as far as possible and attention of driver of approaching train shall be invited by whistling, waving the red flag vigorously, gesticulating and shouting.

C. What action shall be taken if more than one track is obstructed.

a) In case of single line protection as above shall be done in both the directions from place of danger.

b) In case of double line or multiple lines, if other tracks are also obstructed, theprotection as above shall be done for other track also.

c) The protection shall be done in that direction and on that track first on which train is likely to arrive first.

d) The Contractor's Supervisors, Operators and lookout men shall be properly explained about the direction of trains on running tracks.

D. Equipment required for protection of track.

Minimum compliment of protection equipment i.e. 10 detonators, 4 red hand flags, 4 red hand lamps, 4 banner flags and whistles etc. shall always be kept ready at worksites for use in case of emergency. HRIDC will arrange to provide detonators, whereas Contractor shall arrange other equipment at his own cost.

E. Arrangement of lookout men and competency required for lookout man to warn labour about approaching train.

a) Contractor will provide lookout men.

b) The lookout men shall be properly trained in warning to staff at worksite about approaching train.

c) Only those lookout men shall be provided at site who have been issued with a competency certificate by the Railway's/HRIDC's Supervisor.

d) In case, it is felt necessary to provide lookout men by Contractor, the charges for the same as fixed by HRIDC Administration shall be recovered from Contractor.

2.5 Training to Supervisors and Operators of Contractor

The Supervisors and Operators of the contractor proposed to be deployed at wok site, which is close to the running track, shall be imparted mandatory training by the HRIDC at site free of cost about the safety measures to be adopted while working in the vicinity of running track. HRIDC's Engineer-in charge of the work shall decide the scale, extent & adequacy of training. In case training is imparted at a recognized Railway training institute, the charges for the same, as decided by HRIDC, shall be recovered from the Contractor. A competency certificate to this effect to the individual Supervisor/Operator shall be issued as given below,by a HRIDC Officer not below the rank of DGM/HRIDC. No Supervisor/Operator of the Contractor shall work or allowed to work in the vicinity of running track that is not in possession of valid competency certificate.

All the labour, materials, tools, plants etc. except detonators, required for ensuring safe running of trains shall be provided by Contractor at his own cost. Wherever lookout men are provided by HRIDC, charges at the rate of Rs. 1000/- per man day shall be recovered from Contractor.

A sample of training competency certificate is provided below for reference:

Competency Certificate

Certified that Shri …… Supervisor/Operator of M/s. ……has been trained and examined in safety measures to be followed while working in the vicinity of running railway track for the work. His knowledge has been found satisfactory and he is capable of supervising the work safely.

This certificate is valid only for the work mentioned in this certificate only.

Signature and designation of the officer

Final Tender Document for Works

(Two-Envelope Tendering Process Without Prequalification)

Procurement of:

Contract Package C-23: Design and Construction of Civil Works (Earthwork, Bridges, Station Buildings, Retaining Walls and other miscellaneous Works) from km 29.68 to km 49.70 & from km 55.60 to km 61.50 and its connectivities to IR network from New Patli to Patli station & New Patli to Sultanpur station including modifications/civil works at Sultanpur Station in connection with laying of New BG Double Railway line of HORC project.

Summary

Specific Procurement Notice (SPN)

PART 1 – TENDERING PROCEDURES

Section I - Instructions to Tenderers (ITT)

Section II - Tender Data Sheet (TDS)

Section III - Evaluation and Qualification Criteria

Section IV - Tender Forms

Section V - Eligible Countries

Section VI - Prohibited Practices

PART 2 – EMPLOYER'S REQUIREMENTS

Section VII - Employer's Requirements

PART 3 – CONDITIONS OF CONTRACT AND CONTRACT FORMS

Section VIII - General Conditions of Contract (GCC)

Section IX - Particular Conditions of Contract (PCC)

Section X - Contract Forms

PART 3 – Conditions of Contract and Contract Forms

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Section VIII - General Conditions of Contract (GCC)

The General Conditions of Contract governing this Contract shall be the "Conditions of Contract for Plant & Design Build, ("Yellow book, Second Edition 2017", published by the Federation Internationale Des Ingenieurs – Conseils (FIDIC).

An original copy of the above FIDIC publication i.e. "*Conditions of Contract for Plant & Design Build* ", ("Yellow book , Second Edition 2017", (must be obtained from the following address of FIDIC:

International Federation of Consulting Engineers (FIDIC)
FIDIC Bookshop – Box- 311 – CH – 1215 Geneva 15 Switzerland
Fax: +41 22 799 49 054
Telephone: +41 22 799 49 01
E-mail: fidic@fidic.org
www.fidic.org
FIDIC code: ISBN13: 978-2-88432-084-9

Section IX - Particular Conditions of Contract (PCC)

The following Particular Conditions of Contract (PCC) shall supplement the GCC. Whenever there is a conflict, the provisions herein shall prevail over those in the GCC.

The PCC consists of three parts:

- Part A – Contract Data
- Part B – Specific Provisions
- Part C – Prohibited Practices

The references to Clauses and Sub-clauses provided in the PCC given below are applicable to the General Conditions of Contract i.e. "Conditions of Contract for Plant & Design Build, ("Yellow Book"), Second Edition 2017" published by the Federation Internationale Des Ingenieurs – Conseils (FIDIC).

Particular Conditions of Contract (PCC)

Part A - Contract Data

S. No.	Conditions	GCC Sub-Clause	Data
1.	Defects Notification Period	1.1.27	365 days calculated from the date of issue of Taking-Over Certificate for the Works or part of the Works
2.	Employer's name and address	1.1.30	Haryana Orbital Rail Corporation Limited (HORCL), Plot No 143, 5th Floor, Railtel Tower, Sector-44, Gurugram, Haryana-122003 E-mail: shivomd_irse@yahoo.com
3.	Engineer's name and address	1.1.35	RITES Limited in Consortium with SMEC International Pty Ltd, 4th Floor, Plot No.144, RITES Limited, Sector-44, Gurugram, Haryana-122003
4.	Sections	1.1.76	Nil
5.	Time for Completion	1.1.86	*910 days*
6.	Bank's name	1.1.91	Asian Infrastructure Investment Bank (AIIB)
7.	Borrower/Recipient's name	1.1.92	Haryana Orbital Rail Corporation Limited (HORCL) through Government of Haryana
8.	Electronic transmission system	1.3 (a) (ii)	By e-mail
9.	Address of Employer for communications:	1.3(d)	Plot No 143, 5th Floor, Railtel Tower, Sector-44, Gurugram, Haryana-122003 E-mail: gmphridc@gmail.com
10.	Address of Engineer for communications:	1.3(d)	4th Floor, Plot No.144, RITES Limited, Sector-44, Gurugram, Haryana-122003
11.	Address of Contractor for communications:	1.3(d)	To be filled in at the time of preparation of Contract Agreement
12.	Governing Law	1.4	The laws of Republic of India
13.	Ruling language	1.4	English
14.	Language for communications	1.4	English

S. No.	Conditions	GCC Sub-Clause	Data
15.	Time for the Parties to sign a Contract Agreement	1.6	35 days after issue of the Letter of Acceptance
16.	Number of additional paper copies of Contractor's Documents	1.8	NIL
17.	Total liability of the Contractor to the Employer under or in connection with the Contract	1.15	Equal to the Accepted Contract Amount
18.	Time for access to the Site	2.1	***Land for Formation*** *i. Land for formation for about 60% of the project length (main line and connectivities) will be handed over within 7 days after the Commencement Date.* *ii. In the balance 40% of the project length, LT/HT lines run parallel to the HORC. Action for shifting of the same has been taken by the Employer. The land in this portion shall be handed over in a phased manner within 180 days of the Commencement Date.* *iii. In case, the Employer is not able to hand over the complete land at a few isolated locations due to any reasons within 180 days of the Commencement Date and such isolated patches do not affect the progress of work at other locations, no claims shall be accepted by the Employer for delay in handing over of such isolated patches of land. The Contractor shall plan his works taking this aspect into consideration.*
19.	Employer's Financial Arrangements	2.4	A loan from AIIB Bank and counterpart funds through equity partners.

S. No.	Conditions	GCC Sub-Clause	Data
20.	Engineer's Duties and Authority	3.2	Cumulative variations resulting in an increase of the Accepted Contract Amount in excess of 5% shall require written consent of the Employer.
21.	Performance Security	4.2	The Performance Security will be in the form of a "demand guarantee" in the amount(s) of **5%** of the Accepted Contract Amount and in the same currency (ies) of the Accepted Contract Amount. *Demand guarantee for the Performance Security shall be in the form as specified in Sub-Clause 4.2, Part B-Specific Provisions, PCC.*
22.	Maximum allowable accumulated value of work subcontracted (as a percentage of the Accepted Contract Amount)	4.4(a)	30%
23.	Parts of the Works for which subcontracting is not permitted	4.4(b)	NIL
24.	Period for notification of errors in the items of reference	4.7.2 (a)	28 Days
25.	Number of additional paper copies of progress reports	4.20	One (1)
26.	Normal working hours	6.5	From 8:00 AM to 5:00 PM
27.	Number of additional paper copies of program	8.3	One (1)
28.	Delay Damages payable for each week of delay or part thereof	8.8	0.05% of the Accepted Contract Amount, less Provisional Sum in the currencies and proportions in which the Contract Price is payable for each week or part thereof which shall elapse between the Time for Completion and actual Date of Completion of the Works. Delay Damages for not achieving Key Dates shall be levied as given in Appendix 2, Section VII-12, Part 2- Employer's Requirements for each week or part thereof which shall elapse between the relevant Key Date and actual date of achieving Key Date.

S. No.	Conditions	GCC Sub-Clause	Data
29.	Maximum amount of Delay Damages	8.8	5% of the Accepted Contract Amount, less Provisional Sum.
30.	Percentage rate to be applied to Provisional Sums for overhead charges and profit	13.4(b)(ii)	5%
31.	Total advance payment	14.2	05% of the Accepted Contract Amount less Provisional Sum payable in the currencies and proportions in which the Accepted Contract Amount is payable. The advance payment shall be released against Advance Bank Guarantee in two equal instalments, each of two and half percent (2.5%), of the Accepted Contract Amount. i. The first instalment shall be paid against an Advance Payment Certificate, under Sub-Clause 14.2.2. ii. Upon satisfactory utilization of first instalment, the second instalment shall be paid after the Engineer's approval of the Programme (GCC Sub-Clause 8.3), mobilization of Contractor's Representative (GCC Sub_Clause 4.3) and Key Personnel (GCC Sub-Clause 6.12) as per the Employer's Requirements. The Contractor shall submit utilization statement mentioning detailed particulars of expenses made with supporting documents to demonstrate that such amounts are utilized in a purposeful manner in relation to the Works. This shall be supported or endorsed by certified Chartered Accountant under their seal and stamp. It shall be paid against an Advance Payment Certificate, under Sub-Clause 14.2.2.
32.	Number of additional paper copies of Statements	14.3(b)	One (1)
33.	Percentage of retention	14.3 (iii)	10%

S. No.	Conditions	GCC Sub-Clause	Data
34.	Limit of Retention Money (as a percentage of Accepted Contract Amount less Provisional Sum)	14.3 (iii)	5%
35.	Plant and Materials	14.5(b)(i)	Plant and Materials for payment when shipped - NIL
		14.5(c) (i)	Plant and Materials for payment when delivered to the Site: Reinforcement Steel
36.	Minimum Amount of Interim Payment Certificates	14.6.2	NIL
37.	Period of payment of Advance Payment to the Contractor	14.7(a)	07 days
38.	Delayed Payment	14.8	The financing charges shall be calculated at an interest rate equal to "State Bank of India's (SBI) Marginal Cost of fund-based Lending Rate (MCLR)" applicable for the tenure of 01year prevailing on the due date plus three percent.
39.	Number of additional paper copies of draft Final Statement	14.11.1(b)	Two (2)
40.	Forces of nature, the risks of which are allocated to the Contractor	17.2(d)	Earthquake, Floods, rain, wind/storm
41.	Periods for submission of evidence(s) and relevant policy (ies) of insurance (s)	19.2	**Evidence(s):** Within twenty-eight (28) days from the date of receipt of Letter of Acceptance. **Policy(ies):** Within forty-two (42) days from the date of receipt of the Letter of Acceptance.
42.	List of Exceptional Risks which shall not be excluded from the insurance cover for the Works	19.2.1 (iv)	Earthquake, Floods, Rain, wind/storm

S. No.	Conditions	GCC Sub-Clause	Data
43.	Liability for breach of professional duty	19.2.3	AOA (Any One Accident) limit equal to four percent (4%) of the total Contract value against Schedule 'A' of Price Schedule in respect of 'design and construct' with AOY (any one year) limit of 2 accidents in a year. In the Professional Indemnity Insurance Policy, the deductible amount shall not be more than five percent (5%) of the AOA limit. This PII policy shall be valid from the date of commencement of Works, until 5 years after the date of issue of Performance Certificate. Alternatively, the Contractor shall renew the insurance before the expiry of the Yearly Insurance in such a way that the entire validity period is covered. Wherever the Contractor submits policy for shorter period / annual renewable policy, the same shall be renewed before its expiry date. In such situation, the Performance Guarantee shall be retained till required validity period. The Contractor's submission of such shorter period / renewable policy shall be construed as their irrevocable consent for retention of the Performance Guarantee. The Engineer will not issue Final Payment Certificate until the Contractor has produced evidence that coverage of the professional indemnity insurance has been provided for the aforesaid period.
44.	Amount of insurance required for injury to persons and damage to property	19.2.4	INR 0.50 million for any one incident, with number of incidents unlimited
45.	Insurance required for injury to employees	19.2.5	INR 20,000,000/- (Twenty million)
46.	Time for appointment of DAAB	21.1	180 days after signature by both parties of the Contract Agreement
47.	The DAAB shall be comprised of	21.1	Three Members

S. No.	Conditions	GCC Sub-Clause	Data
48.	List of proposed members of DAAB	21.1	NIL
49.	Appointment (if not agreed) to be made by	21.2	(i) In case of Indian firms- President of Indian Council of Arbitration, New Delhi, India (ii) In case of foreign firm- Singapore International Arbitration Centre (SIAC).
50.	Rules of arbitration	21.6	Sub-Clause 21.6 of PART B – Specific Provisions shall apply.

Particular Conditions of Contract (PCC)

Part B - Specific Provisions

Sub-Clause 1.1.9 Contract	"the Contractor's Proposal" is deleted.
Sub-Clause 1.1.27 "Defects Notification Period" or "DNP"	Add the following at the end of **Sub-Clause 1.1.27 "Defects Notification Period" or "DNP" is synonymous with "Defects Liability Period" or "DLP"**
Sub-Clause 1.1.28 "Delay Damages"	Add the following at the end of **Sub-Clause 1.1.28 "Delay Damages"** is synonymous with **"Liquidated Damages".**
Sub-Clause 1.1.30 Employer	The following is added at the end of this Sub-Clause: Haryana Rail Infrastructure Development Corporation Limited (HRIDC) has been nominated as the implementing agency for Haryana Orbital Rail Corridor (HORC) Project by the Employer i.e. Haryana Orbital Rail Corporation Limited.
Sub-Clause 1.1.49 Laws	The Sub-Clause is replaced with: "**Laws**" means all national (or state) legislation, statutes, ordinances and other laws, and regulations and by-laws of any legally constituted public authority."
Sub-Clause 1.1.77 Site	The Sub-Clause is replaced with: "**Site**" means the places where the Permanent Works are to be executed, including storage and working area, and to which Plant and Materials are to be delivered, and any other places specified in the Contract as forming part of the Site."
Sub-Clause 1.1.79 Statement	On the second line after "Payment Certificate under…", add "Sub-Clause14.2.1 [Advance Payment Guarantee] (if applicable),".
Sub-Clause 1.1.83 Tender	"the Contractor's Proposal" is deleted.
Sub-Clause1.1.86 Time for Completion	Replace the entire Sub-Clause 1.1.84 with the following: "**Time for Completion**" means the time for completing the Works, a Section (as the case may be) or a Key Date (as the case may be) under Sub-Clause 8.2 [Time for Completion], as stated in the Contract Data (with any extension under Sub-Clause 8.5 [Extension of Time for Completion]), calculated from the Commencement Date

Sub-Clause 1.1.91 to 1.1.98 are added after Sub-Clause 1.1.90	
Sub-Clause 1.1.91 **Bank**	"**Bank**" means the financing institution (if any) named in the Contract Data.
Sub-Clause 1.1.92 **Borrower**	"**Borrower**" or "**Recipient**" means the person (if any) named as the borrower/recipient in the Contract Data.
Sub-Clause 1.1.93 **ESHS**	"**ESHS**" means Environmental, Social, Health and Safety.
Sub-Clause 1.1.94 **Sexual Exploitation and Assault (SEA)**	"Sexual Exploitation and Assault" "(SEA)" stands for the following: Sexual exploitation is defined as any actual or attempted abuse of position of vulnerability, differential power or trust, for sexual purposes, including, but not limited to, profiting monetarily, socially or politically from the sexual exploitation of another. In Bank financed operations/projects, sexual exploitation occurs when access to or benefit from a Bank financed Goods, Works, Non-consulting Services or Consulting Services is used to extract sexual gain. Sexual assault is defined as sexual activity with another person who does not consent. It is a violation of bodily integrity and sexual autonomy and is broader than narrower conceptions of "rape", especially because (a) it may be committed by other means than force or violence, and (b) it does not necessarily entail penetration.
Sub-Clause 1.1.95 **Milestone Certificate**	"Milestone Certificate" means the certificate issued by the Engineer under Sub-Clause 4.26 [Milestone].
Sub-Clause 1.1.96 **Milestone**	"Milestone" means stage of completion of works in a given Cost Centre based on which payment will be made to the Contractor.
Sub-Clause 1.1.97 **Key Date**	"Key Date" means the time for completion for a part of the Plant and/or a part of the Works as described in detail in the Appendix 2 of Part 2 of the Employer's Requirements.
Sub-Clause 1.1.98 **Principal Employer**	Principal Employer means 'Haryana Orbital Rail Corporation Limited".
Sub-Clause 1.2 **Interpretation**	Sub-paragraph (a) is replaced with the following: (a) "Words indicating one gender include all genders;

	"he/she" is replaced with "it"; "him/her" is replaced with "it"; "his" and "his/her" are replaced with "its"; "himself/herself" are replaced with "itself"." Further, "and" is deleted from the end of sub-paragraph (i) and added at the end of sub-paragraph (j). sub-paragraph (k) is added: (k) "The word "tender" is synonymous with "bid" or "proposal", the word tenderer with "bidder" or "proposer" and the words "tender documents" with "bidding documents" or "request for bids documents" or "request for proposal documents", as applicable."
Sub-Clause 1.5 Priority of Documents	Replace subparagraphs from (a) to (k) with the following: (a) the Contract Agreement (if any), (b) the Letter of Acceptance, (c) the Addenda & Corrigenda issued before opening of the Tender, (d) the Letter of Tender-Financial Part, (e) the Letter of Tender-Technical Part, (f) the Particular Conditions -Part A (Contract Data), (g) the Particular Conditions -Part B (Specific Provisions), (h) the Particular Conditions Part C- Prohibited Practices (i) these General Conditions, (j) the Employers' Requirements, (k) the Schedules, (l) the Reference Information/ Report, and (m) any other documents forming part of the Contract.

Sub-Clause 1.12 Confidentiality	The following is added at the end of the second paragraph: "The Contractor shall be permitted to disclose information required to establish its qualifications to compete for other projects." "or" at the end of (b) is deleted. "or" at the end of (c) is added. The following is then added as (d): "is being provided to the Bank ."
Sub-Clauses 1.17 and 1.18 are added after Sub-Clause 1.16	
Sub-Clause 1.17 Inspections & Audit by the Bank	"The Contractor shall permit and shall cause its agents (whether declared or not), subcontractors, subconsultants, service providers, suppliers, and their personnel, to permit the Bank and/or persons appointed by the Bank to inspect the site and/or the accounts, records and other documents relating to the procurement process, tender submission, proposal submission, and contract execution, and to have such accounts, records and other documents audited by auditors appointed by the Bank."
Sub-Clause 1.18 **Change in Control**	The Contractor or its constituents shall inform the Employer about any change in "Control" during the execution of the Contract.
Sub-Clause 2.4 Employer's Financial Arrangements	The first paragraph is replaced with: "The Employer shall submit, before the Commencement Date, reasonable evidence that financial arrangements have been made for financing the Employer's obligations under the Contract." The following sub-paragraph is added at the end of Sub-Clause 2.4: "In addition, if the Bank has notified to the Recipient that the Bank has suspended disbursements under its loan, which finances in whole or in part the execution of the Works, the Employer shall give notice of such suspension to the Contractor with detailed particulars, including the date of such notification, with a copy to the Engineer, within 7 days of the Recipient having received the suspension notification from the Bank. If alternative funds will be available in appropriate currencies to the Employer to continue making payments to the Contractor beyond a date 60 days after the date of Bank notification of the

	suspension, the Employer shall provide reasonable evidence in its notice of the extent to which such funds will be available."
Sub-Clause 3.1 The Engineer	The following is added at the end of the first sub-paragraph: "The Engineer's staff shall include suitably qualified engineers and other professionals who are competent to carry out these duties."
Sub-Clause 3.2 Engineer's Duties and Authority	The third paragraph of Sub-Clause 3.2 is replaced with: The Engineer may exercise the authority attributable to the Engineer as specified in or necessarily to be implied from the Contract. However, the Engineer shall obtain the consent in writing of the Employer before taking action under the following Sub-Clauses of these Conditions: (a) Sub-Clause 4.12 [Unforeseeable Physical Conditions]: agreeing or determining an extension of time and/or additional cost. (b) Sub-Clause 8.5 [Extension of Time for Completion]: agreeing or determining extension of time. (c) Sub-Clause 11.9 [Performance Certificate]: issue of Performance Certificate. (d) Clause 20.1: [Claims]: agreeing or determining extension of time and/or additional payment. Notwithstanding anything to the contrary contained in this Sub-Clause 3.2, as set out above, if in the opinion of the Engineer, an emergency occurs which adversely affects safety of, (a) life, (b) Works, or (c) any adjoining property, the Engineer may, without obtaining prior approval of the Employer and without relieving the Contractor of any of its duties and responsibilities under the Contract, instruct the Contractor to execute all such work or to do all such things as may, in the opinion of the Engineer, be necessary to abate or reduce the aforesaid risk(s). The Contractor shall forthwith comply with such directions of the Engineer despite the absence of Employer's specific approval in this regard. The Engineer shall determine an addition to the Contract Price, in respect of such instruction(s), in accordance with Clause 13 [Variations and Adjustments],

	and shall notify the Contractor accordingly, with a copy to the Employer. However, in case the concerned emergency as specified in the above para occurs on account of any failure by the Contractor to comply with the terms and conditions of the Contract, including but not limited to, (a) not adhering to the approved scheme of work (b) not taking adequate safety precautions, or (c) by any other reason attributable to the Contractor, no additional amounts shall be paid to the Contractor for attending to such emergencies and the Contractor shall be liable for Employer's claims in this regard".
Sub-Clause 3.3 Engineer's Representative	The following is added at the end of Sub-Clause 3.3: "The Engineer shall obtain the consent of the Employer before appointing or replacing an Engineer's Representative."
Sub-Clause 3.4 Delegation by the Engineer	The following is added at the end of the second paragraph: "If any assistants are not fluent in this language, the Engineer shall make competent interpreters available during all working hours, in a number sufficient for those assistants to properly perform their assigned duties and/or exercise their delegated authority."
Sub-Clause 3.6 Replacement of the Engineer	In the first paragraph, "42 days" is replaced with "21 days"; In the third para, "shall" is replaced with "should".
Sub-Clause 4.1 **Contractor's General Obligations**	The following is inserted after the second paragraph "The Contractor shall provide the Plant (and spare parts, if any)…": "All equipment, material, and services to be incorporated in or required for the Works shall have their origin in any eligible source country as defined by the Bank." The following is inserted after the fifth paragraph "The Contractor shall, whenever required by the Engineer...": The Contractor shall not carry out mobilization to Site (e.g. limited clearance for haul roads, site accesses and work site establishment, geotechnical investigations or investigations to

	select ancillary features such as quarries and borrow pits) unless the Engineer gives consent, a consent that shall not be unreasonably delayed, that appropriate measures are in place to address environmental and social risks and impacts, which at a minimum shall include applying the Management Strategies and Implementation Plans (MSIPs) and Code of Conduct for Contractor's Personnel as part of the Contract. The Contractor shall submit, to the Engineer for Review any additional MSIPs as are necessary to manage the ESHS risks and impacts of ongoing Works (e.g. excavation, earth works, bridge and structure works, stream and road diversions, quarrying or extraction of materials, concrete batching and asphalt manufacture). These MSIPs shall be included in the Contractor's Environmental and Social Management Plan (C-ESMP). The Contractor shall review the C-ESMP, periodically (but not less than every six (6) months), and update it as required to ensure that it contains measures appropriate to the Works. The updated C-ESMP shall be submitted to the Engineer for Review. The C-ESMP shall be part of the Contractor's Documents. The procedures for Review of the C-ESMP and its updates shall be as described in Sub-Clause 5.2 .1 *[Preparation by Contractor]* and Sub-Clause 5.2.2 *[Review by Engineer]*. If so stated in the Employer's Requirements, the Contractor shall: (i) design structural elements of the Works taking into account climate change considerations; and (ii) apply the concept of universal access (the concept of universal access means unimpeded access for people of all ages and abilities in different situations and under various circumstances. "The Contractor shall provide relevant contract- related information, as the Employer and/or Engineer may reasonably request to conduct Stakeholder engagements. "Stakeholder" refers to individuals or groups who: (i) are affected or likely to be affected by the Contract; and (ii) may have an interest in the Contract.

	The Contractor may also directly participate in Stakeholder engagements, as the Employer and/or Engineer may reasonably request." "The Contractor shall require that it's subcontractors execute the Works in accordance with the Contract, including complying with the relevant ESHS requirements."
Sub-Clause 4.2 **Performance Security**	**Replace Sub-Clause 4.2.1 with the following:** The Contractor shall, within 28 days of the date of receiving the Letter of Acceptance, provide to the Employer, the Performance Security in a sum equal to the amount specified in the Contract Data, for the due observance and performance by the Contractor of the Contract. In the event the Contractor fails to provide the Performance Security within 28 days from the date of issue of the LOA, it may seek an extension of time for providing the performance security for a period not exceeding a further 14 days on payment of damages for such extended period in a sum calculated at the rate of 0.005% of the Accepted Contract Amount for each day until the Performance Security is provided. The Contractor shall maintain the said Performance Security at its own expense, so that it shall remain in full force and effect until the date/period set out in the Contract. In the event of a revision of the Contract Price, the value of the Performance Security shall be increased proportionately by the Contractor, if required by the Employer. The cost of obtaining the Performance Security shall be at the expense of the Contractor. The Contractor shall submit the Performance Security in any of the following forms: (a) Unconditional and irrevocable Bank Guarantee from the specified banks in the form appearing in Section X [Contract Forms] as under: (i) a scheduled bank (excluding co-operative banks) in India, or (ii) a Foreign Bank having arrangement with a nationalized bank or scheduled banks (excluding co-operative banks) in India;

	(b) Banker's Cheque or Demand Draft drawn on a scheduled bank (excluding co-operative banks) or nationalized bank in India. The scheduled bank issuing the bank guarantee shall be on "Structure Financial Messaging System (SFMS)" platform. A separate advice of the bank guarantee shall invariably be sent by the issuing bank to Employer's Bank through SFMS and only of the same by the Employer's Bank, the bank guarantee shall become operative and acceptable to the Employer. Further, the bank guarantees in original form along with a copy of "MT760COV (in case of bank guarantee message)/ MT767COV (in case of bank guarantee amendment message) Report" sent by the concerned issuing bank sealed in an envelope shall be submitted to the Employer. The Issuing Bank shall send the SFMS to: Beneficiary: Haryana Rail Infrastructure Development Corporation Limited Bank Name: IFSC Code: Note: All the instruments mentioned in (a) & (b) above should be in favour of Haryana Rail Infrastructure Development Corporation Limited, Plot No 143, 5th Floor, Railtel Tower, Sector-44, Gurugram. The Contractor shall ensure that the Performance Security is valid and enforceable until the Contractor has executed and completed the Works and remedied defects, if any. If, (a) the Contractor does not complete the Works for any reasons whatsoever, and (b) the Contractor has not become entitled to receive the Performance Certificate by 28 days prior to the expiry date of the Performance Security, the Contractor shall be bound to extend the validity of the Performance Security until the Works have been completed and the defects have been remedied. If the Performance Security is or becomes invalid or unenforceable for any reason whatsoever, or if such security is withdrawn or expires, the Contractor must

	immediately notify the Employer and obtain within 3 days a replacement guarantee in the form appearing in Section X [Contract Forms] and which is acceptable to the Employer in its absolute discretion. The provision, maintenance and renewal by the Contractor of the Performance Security in accordance with this Sub-Clause 4.2 [Performance Security] shall be a condition precedent to any payment by the Employer to the Contractor under the Contract. If the Contractor fails to provide, maintain and renew the Performance Security in accordance with the Contract, the Employer shall, without prejudice to any other rights and remedies to which it may be entitled, shall have the right to invoke the Performance Security for the value equal to the damages to the Employer as a result of the Contractor's failure and/or by written notice terminate the Contract in accordance with Clause 15.
Sub-Clause 4.3 Contractor's Representative	The following is added at the end of the last paragraph: "If any of these persons is not fluent in this language, the Contractor shall make competent interpreters available during all working hours in a number deemed sufficient by the Engineer."
Sub-Clause 4.8 Health and Safety Obligations	The following are included after deleting "and" at the end of (f) and replacing "." with ";" at the end of (g): " (i) provide health and safety training of Contractor's Personnel as appropriate and maintain training records; (ii) actively engage the Contractor's Personnel in promoting understanding, and methods for, implementation of health and safety requirements, as well as in providing information to Contractor's Personnel, training on occupational safety and health, and provision of personal protective equipment without expense to the Contractor's Personnel; (iii) put in place workplace processes for Contractor's Personnel to report work situations that they believe are not safe or healthy, and to remove themselves from a work situation which they have reasonable justification to believe presents an imminent and serious danger to their life or health. (iv) Contractor's Personnel who remove themselves from such work situations shall not be required to return to

	work until necessary remedial action to correct the situation has been taken. Contractor's Personnel shall not be retaliated against or otherwise subject to reprisal or negative action for such reporting or removal; (v) subject to Sub-Clause 4.6, where the Employer's Personnel, any other contractors employed by the Employer, and/or personnel of any legally constituted public authorities and private utility companies are employed in carrying out, on or near the site, of any work not included in the Contract, collaborate in applying the health and safety requirements, without prejudice to the responsibility of the relevant entities for the health and safety of their own personnel; and (vi) establish and implement a system for regular (not less than six-monthly) review of health and safety performance and the working environment." The second and third paragraphs are replaced with the following: "Within 21 days of the Commencement Date and before commencing any construction on the Site, the Contractor shall submit to the Engineer for Review a health and safety manual which has been specifically prepared for the Works, the Site and other places (if any) where the Contractor intends to execute the Works. The procedures for Review of the health and safety manual and its updates shall be as described in Sub-Clause 5.2.1 *[Preparation by Contractor]* and Sub-Clause 5.2.2 *[Review by Engineer]*. The health and safety manual shall be in addition to any other similar document required under applicable health and safety regulations and Laws. The health and safety manual shall set out all the health and safety requirements under the Contract, a) which shall include at a minimum: (i) the procedures to establish and maintain a safe working environment without risk to health at all workplaces, machinery, equipment and processes under the control of the Contractor, including control measures for chemical, physical and biological substances and agents; (ii) details of the training to be provided, records to be kept;

	(iii) the procedures for prevention, preparedness and response activities to be implemented in the case of an emergency event (i.e. an unanticipated incident, arising from both natural and man-made hazards, typically in the form of fire, explosions, leaks or spills, which may occur for a variety of different reasons including failure to implement operating procedures that are designed to prevent their occurrence, extreme weather or lack of early warning); (iv) remedies for adverse impacts such as occupational injuries, deaths, disability and disease; (v) the measures to be taken to avoid or minimize the potential for community exposure to water-borne, water-based, water-related, and vector-borne diseases, (vi) the measures to be implemented to avoid or minimize the spread of communicable diseases (including transfer of Sexually Transmitted Diseases or Infections (STDs), such as HIV virus) and non-communicable diseases associated with the execution of the Works, taking into consideration differentiated exposure to and higher sensitivity of vulnerable groups. This includes taking measures to avoid or minimize the transmission of communicable diseases that may be associated with the influx of temporary or permanent Contract-related labour; (vii) the policies and procedures on the management and quality of accommodation and welfare facilities if such accommodation and welfare facilities are provided by the Contractor in accordance with Sub-Clause 6.6; and b) any other requirements stated in the Specification. The paragraph starting with: "In addition to the reporting requirement of…" is replaced with the following: "In addition to the reporting requirement of sub-paragraph (g) of Sub-Clause 4.20 [*Progress Reports*] the Contractor shall inform the Engineer immediately of any allegation, incident or

	accident in the Site, which has or is likely to have a significant adverse effect on the environment, the affected communities, the public, Employer's Personnel or Contractor's Personnel. This includes, but is not limited to, any incident or accident causing fatality or serious injury; significant adverse effects or damage to private property; or any allegation of SEA. In case of SEA, while maintaining confidentiality as appropriate, the type of allegation (sexual exploitation, or sexual assault), gender and age of the person who experienced the alleged incident should be included in the information. The Contractor, upon becoming aware of the allegation, incident or accident, shall also immediately inform the Engineer of any such incident or accident on the Subcontractors' or suppliers' premises relating to the Works which has or is likely to have a significant adverse effect on the environment, the affected communities, the public, Employer's Personnel or Contractor's, its Subcontractors' and suppliers' personnel. The notification shall provide sufficient detail regarding such incidents or accidents. The Contractor shall provide full details of such incidents or accidents to the Engineer within the timeframe agreed with the Engineer. The Contractor shall require its Subcontractors and suppliers (other than Subcontractors) to immediately notify the Contractor of any incidents or accidents referred to in this Sub-clause."
Sub-Clause 4.10 **Use of Site Data**	**Add at the end of paragraph** 1 **of Sub-Clause 4.10.** "Accordingly, the Contractor shall have no claim in this regard." **In paragraph 2 of Sub-Clause 4.10.** Delete the words "To the extent which was practicable (taking account of cost and time)". **Start** the word "the" with a capital letter. Delete "To the same extent" from the fourth line and **Start** the word "the" with a capital letter. **Add following (f) after existing Sub-Clause 4.10 (e) as under:**

	"(f) damage to property adjacent to the Site and the risk of injury to the occupiers of such property due to execution of the Works." The following is added at the end of the Sub-Clause: The Geotechnical and other related data provided by the Employer are based on the investigation conducted by the Employer/Engineer and are for reference purposes only. The Contractor shall conduct further investigations if considered necessary by him at his own cost and should satisfy himself with the data furnished and make his own investigations if required for submitting his offer. Financial cost incurred due to any change in design or construction methodology later during execution on account of change in Geotechnical and other related data provided by the Employer shall be borne by the Contractor.
Sub-Clause 4.15 Access Route	The following is added at the end of Sub-Clause 4.15: "The Contractor shall take all necessary safety measures to avoid the occurrence of incidents and injuries to any third party associated with the use of Contractor's Equipment on public roads or other public infrastructure. The Contractor shall monitor road safety incidents and accidents to identify negative safety issues and establish and implement necessary measures to resolve them.
Sub-Clause 4.18 Protection of the Environment	Sub-Clause 4.18 Protection of the Environment is replaced with: "The Contractor shall take all necessary measures to: (a) protect the environment (both on and off the Site); and (b) limit damage and nuisance to people and property resulting from pollution, noise and other results of the Contractor's operations and/ or activities. The Contractor shall ensure that emissions, surface discharges, effluent and any other pollutants from the Contractor's activities shall exceed neither the values indicated in the Employer's Requirements, nor those prescribed by applicable Laws. In the event of damage to the environment, property and/or nuisance to people, on or off Site as a result of the Contractor's operations, the Contractor shall agree with the Engineer the appropriate actions and time scale to remedy, as practicable, the damaged environment to its former condition. The Contractor shall implement such remedies at its cost to the satisfaction of the Engineer.

	The Contractor shall comply with the Environmental and Social Management Plan, the Code of Conduct, and the Guidelines on Gender Based Violence as given in Appendix13 (ESHS Manual), Section VII-9: Appendices, Part 2, Employer's Requirements."
Sub-Clause 4.20 Progress Reports	Replace "4.20 (g) with: "the Environmental, Social, Health and Safety (ESHS) metrics set out in Appendix 13 (ESHS Manual), Section VII-9: Appendices, Part 2, Employer's Requirements.
Sub-Clause 4.21 Security of the Site	Sub-Clause 4.21 Security of the Site is replaced with: "The Contractor shall be responsible for the security of the Site, and: (a) for keeping unauthorized persons off the Site; (b) authorized persons shall be limited to the Contractor's Personnel, the Employer's Personnel, and to any other personnel identified as authorized personnel (including the Employer's other contractors on the Site), by a Notice from the Employer or the Engineer to the Contractor. The Contractor shall, within 21 days of the Commencement Date, submit for the Engineer's No-objection a security management plan that sets out the security arrangements for the Site. The Contractor shall (i) conduct appropriate background checks on any personnel retained to provide security; (ii) train the security personnel adequately (or determine that they are properly trained) in the use of force (and where applicable, firearms), and appropriate conduct towards Contractor's Personnel, Employer's Personnel and affected communities; and (iii) require the security personnel to act within the applicable Laws and any requirements set out in the Employer's Requirements. The Contractor shall not permit any use of force by security personnel in providing security except when used for preventive and defensive purposes in proportion to the nature and extent of the threat. In making security arrangements, the Contractor shall also comply with any additional requirements stated in the Employer's Requirements."

Sub-Clause 4.22 **Contractor's Operations on Site**	On the third line of the second paragraph before "4.17", "Sub-Clause" is added.
Sub-Clause 4.23 Archaeological and Geological Findings	The first paragraph is replaced with the following: "All fossils, coins, articles of value or antiquity, structures, groups of structures, and other remains or items of geological, archaeological, paleontological, historical, architectural or religious interest found on the Site shall be placed under the care and custody of the Employer. The Contractor shall: (a) take all reasonable precautions, including fencing-off the area or site of the finding, to avoid further disturbance and prevent Contractor's Personnel or other persons from removing or damaging any of these findings; (b) train relevant Contractor's Personnel on appropriate actions to be taken in the event of such findings; and (c) implement any other action consistent with the requirements of the Employer's Requirements and relevant Laws."
Sub-Clause 4.24 to 4.26 are added after Sub-Clause 4.23	
Sub-Clause 4.24 Suppliers (other than Subcontractors)	**4.24.1 Forced Labour** The Contractor shall take measures to require its suppliers (other than Subcontractors) not to employ or engage forced labour including trafficked persons as described in Sub-Clause 6.21. If forced labour/trafficking cases are identified, the Contractor shall take measures to require the suppliers to take appropriate steps to remedy them. Where the supplier does not remedy the situation, the Contractor shall within a reasonable period substitute the supplier with a supplier that is able to manage such risks. **4.24.2 Child labour** The Contractor shall take measures to require its suppliers (other than Subcontractors) not to employ or engage child labour as described in Sub-Clause 6.22. If child labour cases are identified, the Contractor shall take measures to require the suppliers to take appropriate steps to remedy them. Where the supplier does not remedy the situation, the Contractor shall within a reasonable period substitute the supplier with a supplier that is able to manage such risks.

	4.24.3 Serious Safety Issues The Contractor, including its Subcontractors (if any), shall comply with all applicable safety obligations, including as stated in Sub-Clauses 4.8, 5.1 and 6.7. The Contractor shall also take measures to require its suppliers (other than Subcontractors) to introduce procedures and mitigation measures to address safety issues related to their personnel. If serious safety issues are identified, the Contractor shall take measures to require the suppliers to take appropriate steps to remedy them. Where the supplier does not remedy the situation, the Contractor shall within a reasonable period substitute the supplier with a supplier that is able to manage such risks. **4.24.4 Obtaining natural resource materials in relation to supplier** The Contractor shall obtain natural resource materials from suppliers that can demonstrate, through compliance with the applicable verification and/ or certification requirements, that obtaining such materials is not contributing to the risk of significant conversion or significant degradation of natural or critical habitats such as unsustainably harvested wood products, gravel or sand extraction from river beds or beaches. **If a supplier cannot continue to demonstrate that obtaining such materials is not contributing to the risk of significant conversion or significant degradation of natural or critical habitats, the Contractor shall within a reasonable period substitute the supplier with a supplier that is able to demonstrate that they are not significantly adversely impacting the habitats.**
Sub-Clause 4.25 **Code of Conduct**	The Contractor shall have a Code of Conduct for the Contractor's Personnel. The Contractor shall ensure that each Contractor's Personnel is provided a copy of this Code of Conduct, written in a language comprehensible to that person, and shall seek to obtain that person's signature acknowledging receipt of the same. The Contractor shall also ensure that the Code of Conduct is visibly displayed in multiple locations on the Site and any other place where the Works will be carried out, as well as in areas outside the Site accessible to the local community and project affected people. The posted Code of Conduct shall be provided in languages comprehensible to Contractor's Personnel, Employer's Personnel and the local community.

Sub-Clause 4.26 **Milestone**	**Sub-Clause 4.26 Milestone** If no Milestones are specified in the Contract, this Sub-Clause shall not apply. The Contractor shall complete the works of each Milestone (including all work which is stated in the Employer's Requirements as being required for the Milestone to be considered complete). The Contractor shall apply, by notice to the Engineer, for a Milestone Certificate not earlier than 14 days before the works of a Milestone will, in the Contractor's opinion, be complete. The Engineer shall within 28 days after receiving the Contractor's notice: (a) issue the Milestone Certificate to the Contractor, stating the date on which the works of the Milestone were completed in accordance with the Contract, except for any minor outstanding work and defects (as shall be listed in the Milestone Certificate); or (b) reject the application, giving reasons and specifying the work required to be done and defects required to be remedied by the Contractor to enable the Milestone Certificate to be issued. The Contractor shall then complete the work referred to in sub-paragraph (b) of this Sub-Clause before issuing a further notice of application under this Sub-Clause.
Sub-Clause 5.1 **General Design Obligations**	**Add the following at the end of Sub-Clause 5.1** The Contractor shall furnish Contractor's Warranty in the in the form included in Section X [Contract Forms]. "All subcontracts relating to the Works shall include provisions which entitle the Employer to require the subcontract to be assigned to the Employer under subparagraph (a) of Sub-Clause 15.2.3 [After Termination]
Sub-Clause 6.1 **Engagement of Staff and Labour**	**The following paragraphs are added at the end of the Sub-Clause:** The Contractor shall provide the Contractor's Personnel information and documentation that are clear and understandable regarding their terms and conditions of employment. The information and documentation shall set out their rights under relevant labour Laws applicable to the

	Contractor's Personnel (which will include any applicable collective agreements), including their rights related to hours of work, wages, overtime, compensation and benefits, as well as those arising from any requirements in the Employer's Requirements; and shall also include the Code of Conduct for Contractor's Personnel as set forth in Sub-Clause 4.25. The Contractor's Personnel shall be informed when any material changes to their terms or conditions of employment occur. "The Contractor is encouraged, to the extent practicable and reasonable, to employ staff and labour with appropriate qualifications and experience from sources within the Country."
Sub-Clause 6.2 Rates of Wages and Conditions of Labour	The following paragraphs are added at the end of the Sub-Clause: "The Contractor shall inform the Contractor's Personnel about: (a) any deduction to their payment and the conditions of such deductions in accordance with the applicable Laws or as stated in the Employer's Requirements; and (b) their liability to pay personal income taxes in the Country in respect of such of their salaries, wages, allowances and any benefits as are subject to tax under the Laws of the Country for the time being in force. The Contractor shall perform such duties in regard to such deductions thereof as may be imposed on him by such Laws. Where required by applicable Laws or as stated in the Employer's Requirements, the Contractor shall provide the Contractor's Personnel written notice of termination of employment and details of severance payments in a timely manner. The Contractor shall have paid the Contractor's Personnel (either directly or where appropriate for their benefit) all due wages and entitlements including, as applicable, social security benefits and pension contributions, on or before the end of their engagement/ employment. If any amenity required to be provided under any Section of Contract Labour (Regulation and Abolition) Act of 1970 for the benefit of the contract labour employed in an establishment, is not provided by the Contractor within the time prescribed therein, such amenity shall be provided by the Principal Employer within such time as may be prescribed. All expenses incurred by the Principal Employer in providing the

	amenities will be recovered from the amount payable under the Contract. In case the Contractor fails to make payment of wages within the prescribed period or makes short payment, then the Principal Employer will make payment of wages in full or the unpaid balance due, as the case may be, to the contract labour employed by the Contractor and recover the amount so paid from the amount payable under the Contract. The Contractor shall keep the Employer indemnified in case any action is taken against the Employer by the competent authority on account of contravention of any of the provisions of applicable Laws. If the Employer is caused to pay or reimburse, such amounts as may be necessary to cause or observe, or for non-observance of the provisions stipulated in the notifications/bye laws/Acts/Rules/Regulations including amendments, if any, on the part of the Contractor, the Employer shall have the right to deduct any money due to the Contractor including his amount of Performance Security. The Employer shall also have right to recover from the Contractor any sum required or estimated to be required for making good the loss or damage suffered by the Employer. For the avoidance of any doubt, the Contractor shall be responsible for payment of applicable cess and making timely filings under the Building and Other Construction Workers (Regulation of Employment and Conditions of Service) Act, 1996."
Sub-Clause 6.5 Working Hours	The following paras are inserted at the end of the Sub-Clause: The Contractor shall provide the Contractor's Personnel annual holiday and sick, maternity and family leave, as required by applicable Laws or as stated in the Employer's Requirements." The Contractor, if required, shall take approval of Engineer for carrying out work during night hours or in shifts subject to compliance with applicable Laws and shall be responsible for all necessary safety arrangements with respect to the work being undertaken. However, the Contractor shall not be entitled to any claim for increase in rates or any additional cost and the same shall be deemed to be included in the Contract Price.
Sub-Clause 6.7 Health and Safety of Personnel	In the second paragraph, "The Contractor" is replaced with: "Except as otherwise stated in the Employer's Requirements, the Contractor…"

Sub-Clause 6.9 Contractor's Personnel	The Sub-Clause is replaced with: "The Contractor's Personnel (including Key Personnel, if any) shall be appropriately qualified, skilled, experienced and competent in their respective trades or occupations. The Engineer may require the Contractor to remove (or cause to be removed) any person employed on the Site or Works, including the Contractor's Representative and Key Personnel (if any), who: (a) persists in any misconduct or lack of care; (b) carries out duties incompetently or negligently; (c) fails to comply with any provision of the Contract; (d) persists in any conduct which is prejudicial to safety, health, or the protection of the environment; (e) based on reasonable evidence, is determined to have engaged in Prohibited Practice during the execution of the Works; (f) has been recruited from the Employer's Personnel in breach of Sub-Clause 6.3 [Recruitment of Persons]; (g) undertakes behaviour which breaches the Code of Conduct for Contractor's Personnel (ESHS). If appropriate, the Contractor shall then promptly appoint (or cause to be appointed) a suitable replacement with equivalent skills and experience. In the case of replacement of the Contractor's Representative, Sub-Clause 4.3 [*Contractor's Representative*] shall apply. In the case of replacement of Key Personnel (if any), Sub-Clause 6.12 [*Key Personnel*] shall apply Subject to the requirements in Sub-Clause 4.3 [*Contractor's Representative*] and 6.12 [*Key Personnel*], and notwithstanding any requirement from the Engineer to remove or cause to remove any person, the Contractor shall take immediate action as appropriate in response to any violation of (a) through (g) above. Such immediate action shall include removing (or causing to be removed) from the Site or other places where the Works are being carried out, any Contractor's Personnel who engages in (a), (b), (c), (d), (e) or (g) above or has been recruited as stated in (f) above."
Sub-Clause 6.12 Key Personnel	The following is inserted at the end of the last paragraph: "If any of the Key Personnel are not fluent in this language, the Contractor shall make competent interpreters available during

	all working hours in a number deemed sufficient by the Engineer."
The following Sub-Clauses 6.13 to 6.27 are added after sub-clause 6.12	
Sub-Clause 6.13 **Foreign Personnel**	The Contractor may bring into the Country any foreign personnel who are necessary for the execution of the Works to the extent allowed by the applicable Laws. The Contractor shall ensure that these personnel are provided with the required residence visas and work permits. The Employer will, if requested by the Contractor, use its best endeavors in a timely and expeditious manner to assist the Contractor in obtaining any local, state, national, or government permission required for bringing in the Contractor's personnel. The Contractor shall be responsible for the return of these personnel to the place where they were recruited or to their domicile. In the event of the death in the Country of any of these personnel or members of their families, the Contractor shall similarly be responsible for making the appropriate arrangements for their return or burial.
Sub-Clause 6.14 **Supply of Foodstuffs**	The Contractor shall arrange for the provision of a sufficient supply of suitable food as may be stated in the Employer's Requirements at reasonable prices for the Contractor's Personnel for the purposes of or in connection with the Contract.
Sub-Clause 6.15 **Supply of Water**	The Contractor shall, having regard to local conditions, provide on the Site an adequate supply of drinking and other water for the use of the Contractor's Personnel.
Sub-Clause 6.16 **Measures against Insect and Pest Nuisance**	The Contractor shall at all times take the necessary precautions to protect the Contractor's Personnel employed on the Site from insect and pest nuisance, and to reduce the danger to their health. The Contractor shall comply with all the regulations of the local health authorities, including use of appropriate insecticide.
Sub-Clause 6.17 **Alcoholic Liquor or Drugs**	The Contractor shall not, otherwise than in accordance with the Laws of the Country, import, sell, give, barter or otherwise dispose of any alcoholic liquor or drugs, or permit or allow importation, sale, gift, barter or disposal thereto by Contractor's Personnel.
Sub-Clause 6.18 **Arms and Ammunition**	The Contractor shall not give, barter, or otherwise dispose of, to any person, any arms or ammunition of any kind, or allow Contractor's Personnel to do so.

Sub-Clause 6.19 Festivals and Religious Customs	The Contractor shall respect the Country's recognized festivals, days of rest and religious or other customs.
Sub-Clause 6.20 Funeral Arrangements	The Contractor shall be responsible, to the extent required by local regulations, for making any funeral arrangements for any of its local employees who may die while engaged upon the Works.
Sub-Clause 6.21 Forced Labour	The Contractor, including its Subcontractors, shall not employ or engage forced labour. Forced labour consists of any work or service, not voluntarily performed, that is exacted from an individual under threat of force or penalty, and includes any kind of involuntary or compulsory labour, such as indentured labour, bonded labour or similar labour-contracting arrangements. No persons shall be employed or engaged who have been subject to trafficking. Trafficking in persons is defined as the recruitment, transportation, transfer, harbouring or receipt of persons by means of the threat or use of force or other forms of coercion, abduction, fraud, deception, abuse of power, or of a position of vulnerability, or of the giving or receiving of payments or benefits to achieve the consent of a person having control over another person, for the purposes of exploitation.
Sub-Clause 6.22 Child Labour	The Contractor, including its Subcontractors, shall not employ or engage a child (as defined in Child Labour (Prohibition & Regulation) Act, 1986). The Contractor, including its Subcontractors, shall not employ or engage a child between the minimum age and the age of 18 in a manner that is likely to be hazardous, or to interfere with, the child's education, or to be harmful to the child's health or physical, mental, spiritual, moral, or social development. The Contractor including its Subcontractors, shall only employ or engage children between the minimum age and the age of 18 after an appropriate risk assessment has been conducted by the Contractor with the Engineer's consent. The Contractor shall be subject to regular monitoring by the Engineer that includes monitoring of health, working conditions and hours of work. Work considered hazardous for children is work that, by its nature or the circumstances in which it is carried out, is likely to jeopardize the health, safety, or morals of children. Such work activities prohibited for children include work:

	(a) with exposure to physical, psychological or sexual abuse; (b) underground, underwater, working at heights or in confined spaces; (c) with dangerous machinery, equipment or tools, or involving handling or transport of heavy loads; (d) in unhealthy environments exposing children to hazardous substances, agents, or processes, or to temperatures, noise or vibration damaging to health; or under difficult conditions such as work for long hours, during the night or in confinement on the premises of the employer.
Sub-Clause 6.23 Employment Records of Workers	The Contractor shall keep complete and accurate records of the employment of labour at the Site. The records shall include the names, ages, genders, hours worked, and wages paid to all workers. These records shall be summarised on a monthly basis and submitted to the Engineer. These records shall be included in the details to be submitted by the Contractor under Sub-Clause 6.10 [Records of Contractor's Personnel and Equipment].
Sub-Clause 6.24 Workers' Organisations	In countries where the relevant labour laws recognise workers' rights to form and to join workers' organisations of their choosing and to bargain collectively without interference, the Contractor shall comply with such laws. In such circumstances, the role of legally established workers' organizations and legitimate workers' representatives will be respected, and they will be provided with information needed for meaningful negotiation in a timely manner. Where the relevant labour laws substantially restrict workers' organisations, the Contractor shall enable alternative means for the Contractor's Personnel to express their grievances and protect their rights regarding working conditions and terms of employment. The Contractor shall not seek to influence or control these alternative means. The Contractor shall not discriminate or retaliate against the Contractor's Personnel who participate, or seek to participate, in such organisations and collective bargaining or alternative mechanisms. Workers' organisations are expected to fairly represent the workers in the workforce.
Sub-Clause 6.25 Non-Discrimination and Equal Opportunity	The Contractor shall not make decisions relating to the employment or treatment of Contractor's Personnel on the basis of personal characteristics unrelated to inherent job requirements. The Contractor shall base the employment of Contractor's Personnel on the principle of equal opportunity and fair treatment, and shall not discriminate with respect to

	any aspects of the employment relationship, including recruitment and hiring, compensation (including wages and benefits), working conditions and terms of employment, access to training, job assignment, promotion, termination of employment or retirement, and disciplinary practices. Special measures of protection or assistance to remedy past discrimination or selection for a particular job based on the inherent requirements of the job shall not be deemed discrimination. The Contractor shall provide protection and assistance as necessary to ensure non-discrimination and equal opportunity, including for specific groups such as women, people with disabilities, migrant workers and children (of working age in accordance with Sub-Clause 6.22). The Contractor shall give preference to local people including Project Affected Persons (PAPs) for employment opportunity during construction and enhance female work force participation.
Sub-Clause 6.26 Contractor's Personnel Grievance Mechanism	The Contractor shall have a grievance mechanism for Contractor's Personnel, and where relevant the workers' organizations stated in Sub-Clause 6.24, to raise workplace concerns. The grievance mechanism shall be proportionate to the nature, scale, risks and impacts of the Contract. The mechanism shall address concerns promptly, using an understandable and transparent process that provides timely feedback to those concerned in a language they understand, without any retribution, and shall operate in an independent and objective manner. The Contractor's Personnel shall be informed of the grievance mechanism at the time of engagement for the Contract, and the measures put in place to protect them against any reprisal for its use. Measures will be put in place to make the grievance mechanism easily accessible to all Contractor's Personnel. The grievance mechanism shall not impede access to other judicial or administrative remedies that might be available, or substitute for grievance mechanisms provided through collective agreements. The grievance mechanism may utilize existing grievance mechanisms, providing that they are properly designed and implemented, address concerns promptly, and are readily accessible to such project workers. Existing grievance mechanisms may be supplemented as needed with Contract-specific arrangements.
Sub-Clause 6.27	The Contractor shall provide appropriate training to relevant Contractor's Personnel on ESHS aspects of the Contract,

Training of Contractor's Personnel	including appropriate sensitization on prohibition of SEA, Gender Based Violence (GBV) and health & safety training referred to in Sub-Clause 4.8. As stated in the Employer's Requirements or as instructed by the Engineer, the Contractor shall also allow appropriate opportunities for the relevant Contractor's Personnel to be trained on ESHS aspects of the Contract by the Employer's Personnel. The Contractor shall provide training on SEA, GBV including its prevention, to any of its personnel who has a role to supervise other Contractor's Personnel.
Sub-Clause 7.3 Inspection	The following is added in the first paragraph after "Employer's Personnel" "(including the Bank staff or consultants acting on the Bank's behalf, stakeholders and third parties, such as independent experts, local communities, or non-governmental organizations)" The following is added as (b) (iv): "(iv) carryout environmental and social audit, and"
Sub-Clause 7.7 Ownership of Plant and Materials	The following is added before the first paragraph: "Except as otherwise provided in the Contract,"

Sub-Clause 8.1 Commencement of Work	The Sub- Clause is replaced in its entirety with the following: "The Engineer shall give a Notice to the Contractor stating the Commencement Date, not less than 07 days before the Commencement Date. The Notice shall be issued promptly after the Engineer determines the fulfilment of the following conditions: (a) signature of the Contract Agreement by both Parties, and if required, approval of the Contract by relevant authorities of the Country; (b) delivery to the Contractor of reasonable evidence of the Employer's financial arrangements (under Sub-Clause 2.4 [Employer's Financial Arrangements]); (c) except if otherwise specified in the Contract Data, effective access to and possession of the Site given to the Contractor together with such permission(s) under (a) of Sub-Clause 1.13 [Compliance with Laws] as required for the commencement of the Works; Subject to Sub-Clause 4.1 on the Management Strategies and Implementation Plans and the C-ESMP and Sub-Clause 4.8 on the health and safety manual, the Contractor, shall commence the execution of the Works as soon as is reasonably practicable after the Commencement Date, and shall then proceed with the Works with due expedition and without delay."
Sub-Clause 8.2 Time for Completion	The following paragraph shall be added at the end of Sub-Clause 8.2: The Contractor shall complete each Key Date (if any) within the Time for Completion for the Key Date (as the case may be), including completing all work which is stated in the Contract as being required for the Key Date to be considered to be completed for the issuance of key date completion certificate.
Sub-Clause 8.3 Programme	Replace the first sentence of the of the first paragraph of Sub-Clause 8.3 with the following: The Contractor shall submit an Initial Programme for the execution of the Works to the Engineer within 28 days after issue of Letter of Acceptance.
Sub-Clause 8.5 Extension of Time for Completion	Replace the entire first paragraph of Sub-Clause 8.5 with the following:

	The Contractor shall be entitled subject to Sub-Clause 20.1 [Claims] to an extension of the Time for Completion if and to the extent that completion for the purpose of Sub-Clause 10.1 [Taking Over of the Works and Sections] or for the completion of Key Date specified in Appendix 2, Section VII-9: Appendices of Part 2 Employer's requirements is or will be delayed by any of the following causes:"
Sub-Clause 8.8 Delay Damages	Replace the entire Sub-Clause 8.8 with the following: Time is the essence of the contract and if the Contractor fails to comply with Sub-Clause 8.2 [Time for Completion], the Contractor shall subject to notice under Sub-Clause 20.1 Claims] pay delay damages to the Employer for this default. These delay damages shall be the sum stated in the Contract Data, which shall be charged for every week of delay or part thereof which shall elapse between the Time for Completion and actual Date of Completion of the Works. Delay damages for not achieving Key Dates stated in Appendix 2 Section VII-9, Part 2 of the Employer's Requirements, shall be the sum stated in the Contract Data. However, the total amount due under this Sub-Clause shall not exceed the maximum amount of delay damages stated in the Contract Data. These delay damages shall be the only damages due from the Contractor for such default, other than in the event of termination under Sub-Clause 15.2 [Termination for Contractor's Default] prior to completion of the Works. These damages shall not relieve the Contractor from his obligation to complete the Works, or from any other duties, obligations or responsibilities which he may have under the Contract. Delay Damages may be recovered by the Employer from any amount of money due from the Contractor under the Contract. The Delay Damages may also be recovered from the amount of Performance Security Bank Guarantee and in that case the Contractor would be liable to replenish the amount of Performance Security Bank Guarantee. The Delay Damages recovered corresponding to any key date will be provisional and would be refunded by the Employer on achievement of subsequent key date on time.
Sub-Clause 11.7 Right of Access after Taking Over	In the second paragraph, "Whenever the Contractor intends to access any part of the Works during the relevant DNP:" is replaced with:

	"Whenever, until the date 28 days after issue of the Performance Certificate, the Contractor intends to access any part of the Works:"
Sub-Clause 13.2 Value Engineering	Not applicable
Sub-Clause 13.3.1 Variation by Instruction	Subparagraph 13.3.1 (a) is replaced with: "a description of the varied work performed or to be performed, including details of the resources and methods adopted or to be adopted by the Contractor, and sufficient ESHS information to enable an evaluation of ESHS risks and impacts;"
Sub-Clause 13.3.1 Variation by Instruction	**Following is added to GC Clause 13.3.1** **Variation in the accepted Contract Amount & deriving rates of new items** **A.** The quantities of items shown in Price Schedule 'B' and estimated cost shown in Price Schedule 'C' are approximate, and are liable to vary during the actual execution of the work. Some items may have to be added or deleted. The Contractor shall be bound to carry out and complete the stipulated Work as instructed by the Engineer, irrespective of the magnitude of variations including additions or deletion in the Price Schedule. Variations in Price Schedule 'A', Price Schedule 'B', Price Schedule 'C' and Price Schedule 'D' shall be paid as follows: **(I)Price Schedule 'A'** **a)** For Bridges involving pile foundations, the quoted price of Schedule 'A' shall include providing piles, upto a pile depth of 20 m (below bottom of pile cap). Any increase or decrease in pile depth above/below the value of 20 m shall be payable/recoverable at the accepted rate of relevant item in *Schedule 'B'.* **b**) For any variation in the Scope of the Works in Schedule 'A', cost of additional quantities/items shall be worked out based on the accepted rates of items provided in Schedule 'B' *or* Schedule 'D'. In case, items involving variation are not covered in Schedule 'B' *or* Schedule 'D', rates of such items shall be taken from North Western Railway Unified Standard Schedule of Rates (NWR USSOR)-2019 (for Formation and Bridge works) duly adjusted for escalation @5% per annum from Nov' 2019 and Delhi Schedule of Rates (DSR)-2021 Vol I & II (for items other than Formation and Bridge works) duly adjusted for escalation @ 5% per annum from Apr' 2021. In cases where items involving variation are not covered in DSR or NWR USSOR,

	the rates of such items shall be worked out based on the rates available for similar items in DSR/NWR USSOR. **c) Deriving Rates for New Items / Negotiation** In case Engineer introduces an item for which the Contract does not contain any rates or prices applicable to the varied Works, the rate of such items shall be derived, wherever possible, from rate for similar items available in the Price Schedules of the Accepted Contract Amount. In case this is not possible, the rate shall be decided on the following basis: i) Cost of Materials at current market price, as actually utilized in the final finished Permanent Works, including a reasonable percentage for wastage and transportation. ii) Cost of enabling works if any (unless provided for separately) worked out on the above basis but with less stringent quality. Specifications minus salvage value of serviceable material released after completion of Work and cost of material released as scrap. iii) Cost of labour actually used at the site of Work at rates under Payment of Minimum Wages Act for the area of Work for each category of worker, further enhanced by a percentage of 10% of the aforesaid rates to account for labour not directly utilized at Site and other ancillary and incidental expenses on labour. iv) Hire charges for Plant & Machinery, scaffolding, shuttering, forms, etc., required to be used at the site of the work. The tools used by the various trades shall not be counted as Plant & Machinery for this purpose. v) An amount of 15% of items c) (i), (ii), (iii) and (iv) above to allow for Contractor's overheads including water/electricity charges and labour cess etc., profits and corporate taxes etc. No such percentage shall be applicable to the estimated cost of Materials supplied free of cost to the Contractor. vi) In all cases where extra items of Work are involved, for which there are no rates in the Accepted Contract Amount, the Contractor shall give a notice to the Engineer, of at least 7 days before the need for its execution arises. **(II) Price Schedule 'B' having items rates with quantities:**

	a) At the accepted rates of the Contract for Positive variation in quantities of items to the extent of *50%*. In case of variation in quantities on minus side, Contract rates will be payable at the accepted rates of the Contract for the executed quantities. For the purpose of variation for quantity of items of all types of cement given in Schedule 'B' shall be considered as on item. *b)* In case the Variation in individual items (except for items under Para c), below) as stipulated above: is more than 50% on plus side, the rate for the varied quantity beyond 50% shall be negotiated between the Engineer and the Contractor and mutually agreed rates arrived at before execution of the extra quantity. c) Variation in the quantity of items individually costing upto 1% of Accepted Contract Amount (i.e. total of Schedule 'A' and Schedule 'B' and Schedule 'C') or Rs. 1 crore, whichever is less, shall be payable at the accepted rates of the Contract, till the value of such individual item on account of Variation reaches upto 2% of the Accepted Contract Amount or Rs. 2 crore, whichever is less. Negotiation of rates for such items shall be conducted only for the exceeded quantity beyond 2% of the Accepted Contract Amount or Rs. 2 crore, whichever is less. **d) Deriving Rates for New Items / Negotiation** In case Engineer introduces an item for which the Contract does not contain any rates or prices applicable to the varied Works, the rate of such items shall be derived, wherever possible, from rate for similar items available in the Price Schedules of the Accepted Contract Amount. In case this is not possible, the rate shall be decided on the following basis: i) Cost of Materials at current market price, as actually utilized in the final finished Permanent Works, including a reasonable percentage for wastage and transportation. ii) Cost of enabling works if any (unless provided for separately) worked out on the above basis but with less stringent quality. Specifications minus salvage value of serviceable material released after completion of Work and cost of material released as scrap. iii) Cost of labour actually used at the site of Work at rates under Payment of Minimum Wages Act for the area of

	Work for each category of worker, further enhanced by a percentage of 10% of the aforesaid rates to account for labour not directly utilized at Site and other ancillary and incidental expenses on labour. iv) Hire charges for Plant & Machinery, scaffolding, shuttering, forms, etc., required to be used at the site of the work. The tools used by the various trades shall not be counted as Plant & Machinery for this purpose. v) An amount of 15% of items d) (i), (ii), (iii) and (iv) above to allow for Contractor's overheads including water/electricity charges and labour cess etc., profits and corporate taxes etc. No such percentage shall be applicable to the estimated cost of Materials supplied free of cost to the Contractor. vi) In all cases where extra items of Work are involved, for which there are no rates in the Accepted Contract Amount, the Contractor shall give a notice to the Engineer, of at least 7 days before the need for its execution arises. **(III) Price Schedule 'C' having items rates with quantities:** a) At the accepted rates of the Contract for Positive variation in quantities of items to the extent of *50%*. In case of variation in quantities on minus side, Contract rates will be payable at the accepted rates of the Contract for the executed quantities. *b)* In case the Variation in individual items (except for items under Para c), below as stipulated above is more than 50% on plus side, the rate for the varied quantity beyond 50% shall be negotiated between the Engineer and the Contractor and mutually agreed rates arrived at before execution of the extra quantity. c) Variation in the quantity of items individually costing upto 1% of Accepted Contract Amount (i.e. total of Schedule 'A', Schedule 'B', Schedule 'C' and Schedule 'D') or Rs. 1 crore, whichever is less, shall be payable at the accepted rates of the Contract, till the value of such individual item on account of Variation reaches upto 2% of the Accepted Contract Amount or Rs. 2 crore, whichever is less. Negotiation of rates for such items shall be conducted only for the exceeded quantity

	beyond 2% of the Accepted Contract Amount or Rs. 2 crore, whichever is less. d) **Deriving Rates for New Items / Negotiation** In case Engineer introduces an item for which the Contract does not contain any rates or prices applicable to the varied Works, the rate of such items shall be derived, wherever possible, from rate for similar items available in the Price Schedules of the Accepted Contract Amount. In case this is not possible, the rate shall be decided on the following basis: i) Cost of Materials at current market price, as actually utilized in the final finished Permanent Works, including a reasonable percentage for wastage and transportation. ii) Cost of enabling works if any (unless provided for separately) worked out on the above basis but with less stringent quality. Specifications minus salvage value of serviceable material released after completion of Work and cost of material released as scrap. iii) Cost of labour actually used at the site of Work at rates under Payment of Minimum Wages Act for the area of Work for each category of worker, further enhanced by a percentage of 10% of the aforesaid rates to account for labour not directly utilized at Site and other ancillary and incidental expenses on labour. iv) Hire charges for Plant & Machinery, scaffolding, shuttering, forms, etc., required to be used at the site of the work. The tools used by the various trades shall not be counted as Plant & Machinery for this purpose. v) An amount of 15% of items d) (i), (ii), (iii) and (iv) above to allow for Contractor's overheads including water/electricity charges and labour cess etc., profits and corporate taxes etc. No such percentage shall be applicable to the estimated cost of Materials supplied free of cost to the Contractor. vi) In all cases where extra items of Work are involved, for which there are no rates in the Accepted Contract Amount, the Contractor shall give a notice to the Engineer, of at least 7 days before the need for its execution arises.

	(IV) Price Schedule 'D' (containing only rates of items but without quantities) /: a) At the accepted rates of the Contract for varied cost of Schedule 'D' upto INR 4 Cr. In case of Variation on minus side, Contract rates will be payable at the accepted rates of the Contract for the executed quantities. **b)** In case the varied cost of Schedule 'D' is more than INR 4 Cr., the rates of individual items shall be negotiated between the Engineer and the Contractor and mutually agreed rates arrived at, before its execution. **B. Disagreement in Rates for New Items /** In the event of disagreement of rates of new items/negotiations in respect of items A (I) c), A (II) d) and A (III) d) above, the Engineer shall fix such rates of price as are, in his opinion appropriate and shall notify the Contractor accordingly, with a copy to the Employer. Until such time as rates or prices are agreed or fixed, the Engineer shall determine provisional rates or prices to enable on-account payments to the Contractor. Alternatively, in the event of disagreement, the Contractor shall have no claim to execute extra quantities/new items and the Engineer shall be free to get such additional quantities beyond 50% / new items executed through any other Agency. However, if the Engineer or the Employer so directs the Contractor shall be bound to carry out any such additional quantities beyond the limits stated above original quantities and/or new items and the disagreement or the difference regarding rates to be paid for the same shall be settled in the manner laid down under the conditions for the settlement of dispute.
Sub-Clause 13.4 Provisional Sums	The following is inserted as the penultimate paragraph: "The Provisional Sum shall be used to cover the Employer's share of the DAAB members' fees and expenses, in accordance with Clause 21. No prior instruction of the Engineer shall be required with respect to the work of the DAAB. The Contractor shall submit the DAAB members' invoices and satisfactory evidence of having paid 100% of such invoices as part of the substantiation of those Statements submitted under Sub-Clause 14.3.
Sub-Clause 13.6 Adjustments for Changes in Laws	The following paragraph is added at the end of the Sub-Clause:

	"Notwithstanding the foregoing, the Contractor shall not be entitled to an extension of time if the relevant delay has already been taken into account in the determination of a previous extension of time and such Cost shall not be separately paid if the same shall already have been taken into account in the indexing of any inputs to the Table of Adjustment Data in accordance with the provisions of Sub-Clause 13.7 [Adjustments for Changes in Cost]."
Sub-Clause 13.7 Adjustments for Changes in Cost	The following paragraph is added at the end of Sub-Clause 13.7 Price adjustment will also be applicable during the extended period of Time for Completion where such extension has been granted under Sub-Clause 8.5 [Extension of Time for Completion] or it is specifically mentioned that extension is with Price Adjustment.
Sub-Clause 14.2.1 Advance Payment Guarantee	**Replace the first para of Sub-Clause 14.2.1 with the following:** The Contractor shall obtain (at the Contractor's cost) an Advance Payment Guarantee or Security in amounts and currencies equal to the advance payment and shall submit it to the Employer with a copy to the Engineer. The Guarantee in accordance to the form attached to the Contract can be split up in four (4) Guarantees to be released on repayment. The Contractor shall submit the Advance Payment Guarantee in any of the following forms: (a) Unconditional and irrevocable Bank Guarantee from the specified banks in the form appearing in Section X [Contract Forms] as under: (i) a scheduled bank (excluding co-operative banks) in India, or (ii) a Foreign Bank having arrangement with a nationalized bank or scheduled banks (excluding co-operative banks) in India; (b) Banker's Cheque or Demand Draft drawn on a scheduled bank (excluding co-operative banks) or nationalized bank in India. The scheduled bank issuing the bank guarantee shall be on "Structure Financial Messaging System (SFMS)" platform. A

	separate advice of the bank guarantee shall invariably be sent by the issuing bank to Employer's Bank through SFMS at the address given below and only after receipt of the same by the Employer's Bank, the bank guarantee shall become operative and acceptable to the Employer. Further, the bank guarantees in original form along with a copy of "MT760COV (in case of bank guarantee message)/ MT767COV (in case of bank guarantee amendment message) Report" sent by the concerned issuing bank sealed in an envelope shall be submitted to the Employer. The Issuing Bank shall send the SFMS to: Beneficiary: Haryana Orbital Rail Corporation Limited Bank Name: Account No. IFSC Code: Note: All the instruments mentioned in (a) & (b) above should be in favour of *Haryana Orbital Rail Corporation Limited*, Plot No 143, 5th Floor, Railtel Tower, Sector-44, Gurugram. Such Advance Payment guarantee shall remain effective until the Advance Payment has been repaid pursuant to provision of this Sub-Clause 14.2, but the amount thereof shall be progressively reduced by the amount repaid by the Contractor as indicated in the Interim Payment Certificate issued in accordance with this Clause 14.
Sub-Clause 14.2.3 Repayment of Advance Payment	**Replace the Sub-Clause 14.2.3 with the following:** **a.** The recovery of Advances shall commence when 30% of the Accepted Contract Amount of the Work has been paid and it will be completed by the time, 90% of the Accepted Contract Amount has been paid or the original completion date whichever is earlier. However, minimum recovery of advances shall be at the rate of 10% (ten percent) of on-account bill. **b.** The Contractor shall always have the option to have the recoveries commenced and/or completed earlier, and/or to have recoveries affected in installments of higher amount and also to repay part or whole of the Advance by direct payment rather than through on-account Bills. However, the

	recovery of Advances shall be limited to 30% of on-account bill. **c.** In case the Contract is terminated due to default of the Contractor or rescinded / foreclosed, due to any other reason, the Contractor shall return the unrecovered amount of all Advances within 15 days of issue of notice of termination / rescission / foreclosure of the Contract and if the Contractor fails to do so due to any reason whatsoever, then interest at rate equal to State Bank of India's Marginal Cost of fund based Lending Rate (MCLR) applicable for the tenure of 01 year prevailing on the date of issue of notice of termination / rescission / foreclosure plus 3% Penal Interest per annum shall be charged on the unrecovered amount of such Advances from 16th day onwards compounded quarterly till the same is returned by the Contractor. **Interest in case of Delay in repayment of Advances** Should there be delay in the progress and completion of Work, as a result of which it is not possible to recover the Advances and interest thereon, before the date of completion stipulated in the Contract, then the interest to be charged from the Contractor on the remaining portion of the Advances beyond the original completion date specified in the Contract, shall be equal to State Bank of India's Marginal Cost of fund based Lending Rate (MCLR) applicable for the tenure of 01 year prevailing on the original completion date specified in the Contract plus 3% Penal Interest per annum. **Advances to be used only for this work** The advances shall be used by the Contractor strictly for the purpose of the Contract, and for the purpose for which they are paid. Under no circumstances, shall the advances be diverted for other purposes. Any such diversion shall be construed as a breach of the Contract and the Contractor shall be asked to return the advance at once and pay interest at 15% per annum till the advance is recovered back from him. The Contractor shall return the advance and pay the interest in one go without demur. Employer retains the right for any other remedy prescribed for breach of Contract in this regard.
Sub-Clause 14.3 Application for Interim Payment	The following is inserted at the end of (vi) after: *[Agreement or Determination]*: "any reimbursement due to the Contractor under the Dispute Avoidance/ Adjudication Agreement. (Appendix General Conditions of Dispute Avoidance/ Adjudication Agreement)."

Sub-Clause 14.3 Application for Interim Payment	**Add the following at the end, below Sub paragraph '(x)'** (xi) an amount to be deducted for the payments demanded by relevant competent authorities of the Central Government and/or State Government and/or local bodies from the Employer as due payments/ liability of the Contractor as mandated by relevant laws. (xii)Stage Completion/Milestone Certificate issued by the Engineer.
Sub-Clause 14.6.1 The IPC	**Replace the Sub-Clause 14.6.1 with the following:** The Engineer shall, within 07 days after receiving a Statement and supporting documents, issue an IPC to the Employer, with a copy to the Contractor: (a) stating the amount which the Engineer fairly considers to be due; and (b) including any additions and/or deductions which have become due under Sub-Clause 3.7 [Agreement or Determination] or under the Contract or otherwise, with detailed supporting particulars (which shall identify any difference between a certified amount and the corresponding amount in the Statement and give the reasons for such difference).
Sub-Clause 14.6.2 Withholding (amounts in) an IPC	"and/or" from subparagraph (b) is deleted. The following is then added as subparagraph (c) and sub-paragraph (c) of the Sub-Clause is renumbered as (d): "(c) if the Contractor was, or is, failing to perform any ESHS obligations or work under the Contract, the value of this work or obligation, as determined by the Engineer, may be withheld until the work or obligation has been performed, and/or the cost of rectification or replacement, as determined by the Engineer, may be withheld until rectification or replacement has been completed. Failure to perform includes, but is not limited to the following: (i) failure to comply with any ESHS obligations or work described in the Works' Requirements which may include: working outside site boundaries, excessive dust, damage to offsite vegetation, pollution of water courses from oils or sedimentation, contamination of land e.g. from oils, human waste, damage to archaeology or cultural heritage features, air pollution as a result of unauthorized and/or inefficient combustion;

	(ii) failure to regularly review C-ESMP and/or update it in a timely manner to address emerging ESHS issues, or anticipated risks or impacts; (iii) failure to implement the C-ESMP e.g. failure to provide required training or sensitization; (iv) failing to have appropriate consents/permits prior to undertaking Works or related activities; (v) failure to submit ESHS report/s (as described in general specifications, or failure to submit such reports in a timely manner; (vi) failure to implement remediation as instructed by the Engineer within the specified timeframe (e.g. remediation addressing non-compliance/s)."
Sub-Clause 14.7 Payment	At the end of sub-paragraph (b): "and" is replaced with "or" and the following inserted as (iii): "(iii) at a time when the Bank's loan (from which part of the payments to the Contractor is being made) is suspended, the amount shown on any statement submitted by the Contractor within 14 days after such statement is submitted, any discrepancy being rectified in the next payment to the Contractor; and" At the end of sub-paragraph (c): "." is replaced with ";" and the following inserted: "or, at a time when the Bank's loan (from which part of the payments to the Contractor is being made) is suspended the undisputed amount shown in the Final Statement within 56 days after the date of notification of the suspension in accordance with Sub-Clause 16.2 [Termination by Contractor]."

Sub-Clause 14.7 Payment	After the sub-paragraphs (c), add (d) with the following: (d) Provisional amount against the Statement specified in Sub-Clause 14.3: i) The Employer shall pay 80% of such amount as provisional payment within 7 days from the receipt of evaluated statement from the Engineer. The balance 20% shall be paid within 28 days from the receipt of evaluated statement from the Engineer. Next 80% amount of provisional payment shall be made only after 100% payment of preceding interim payment certified has been completed. ii) It shall be the responsibility of the Contractor to claim an amount for the performed services as admissible as per the Contract. If at any time it is observed by the Engineer that the amount claimed in the Statement are higher than the actual admissible performance, the facility of provisional payment will be withheld until such time the excess payment paid is adjusted in the subsequent Interim Payment Certificate. In such a case, warning letter will be issued to the Contractor. iii) If at any time, the Engineer/Employer observes for the second time that the amount claimed in the Statement are higher than the actual admissible performance, the facility of provisional payment will be liable to be withdrawn. *(*e) Payment of GST: The Contractor is responsible for paying all the taxes [including Goods and Service Tax (GST)], duties, cess, etc. as per the Statutory requirements. However, GST levied on the invoices raised by the Contractor will be temporarily withheld at the time of making payment for the invoice. GST withheld will be released by HRIDC/ HORCL on submission of proof, i.e. copy of Form GSTR-1 (reflecting the particular invoice) after due verification from the GST portal by the Employer.

Sub-Clause 14.9 **Release of Retention Money**	The following is added at the end of Sub-Clause 14.9: "Unless otherwise stated in the Contract, when the Taking-Over Certificate has been issued for the Works and the first half of the Retention Money has been certified for payment by the Engineer, the Contractor shall be entitled to substitute a guarantee, in the form annexed to the Particular Conditions of Contract or in another form approved by the Employer for the second half of the Retention Money. The Contractor shall submit unconditional and irrevocable Bank Guarantee from the specified banks in the form appearing in Section X [Contract Forms] as under: (i) a scheduled bank (excluding co-operative banks) in India, or (ii) a Foreign Bank having arrangement with a nationalized bank or scheduled banks (excluding co-operative banks) in India; The scheduled bank issuing the bank guarantee shall be on "Structure Financial Messaging System (SFMS)" platform. A separate advice of the bank guarantee shall invariably be sent by the issuing bank to Employer's Bank through SFMS at the address given below and only after receipt of the same by the Employer's Bank, the bank guarantee shall become operative and acceptable to the Employer. Further, the bank guarantees in original form along with a copy of "MT760COV (in case of bank guarantee message)/ MT767COV (in case of bank guarantee amendment message) Report" sent by the concerned issuing bank sealed in an envelope shall be submitted to the Employer. The Issuing Bank shall send the SFMS to: Beneficiary: Haryana Orbital Rail Corporation Limited Bank Name: Account No. IFSC Code: Note: Bank Guarantee should be in favour of *Haryana Orbital Rail Corporation Limited*, Plot No 143, 5th Floor, Railtel Tower, Sector-44, Gurugram.

	The Contractor shall ensure that the guarantee is in the amounts and currencies of the second half of the Retention Money and is valid and enforceable until the Contractor has executed and completed the Works and remedied any defects, as specified for the Performance Security in Sub-Clause 4.2. On receipt by the Employer of the required guarantee, the Engineer shall certify, and the Employer shall pay the second half of the Retention Money. The release of the second half of the Retention Money against a guarantee shall then be in lieu of the release after the latest of the expiry dates of the Defects Notification Periods. The Employer shall return the guarantee to the Contractor within 21 days after receiving a copy of the Performance Certificate. If the Performance Security required under Sub-Clause 4.2 is in the form of a demand guarantee, and the amount guaranteed under it when the Taking-Over Certificate is issued is more than half of the Retention Money, then the Retention Money guarantee will not be required. If the amount guaranteed under the Performance Security when the Taking-Over Certificate is issued is less than half of the Retention Money, the Retention Money guarantee will only be required for the difference between half of the Retention Money and the amount guaranteed under the Performance Security."
Sub-Clause 14.12 Discharge	On the seventh line of the first paragraph, "Sub-Clause 21.6 [*Arbitration]*" is replaced with: "Clause 21 *[Disputes and Arbitration]'.*
Sub-Clause 14.15 Currencies of Payment	Throughout Sub-Clause 14.15, "Contract Data" is replaced with: "Schedule of Payment Currencies".
Sub-Clause 15.1 Notice to Correct	"and" is deleted from (b) and "." is replaced by: "; and" in (c). The following is then added as (d) "(d) specify the time within which the Contractor shall respond to the Notice to Correct." In the third para., "shall immediately respond" is replaced with: "shall respond within the time specified in (d)". Further, in the third para., "to comply with the time specified in the Notice to

	Correct." is replaced with: "to comply with the time specified in (c)."
Sub-Clause 15.2.1 Notice	Sub-paragraph (h) is replaced with: "based on reasonable evidence, has engaged in Prohibited Practice as defined in paragraph 2 of the Particular Conditions - Part C –Prohibited Practices, in competing for or in executing the Contract."
Sub-Clause 15.8 Part(s) termination of the Contract	Add New Sub-Clause 15.8 "**Part(s) termination of the Contract**" after Sub-Clause 15.7; **For Part(s) termination of the Contract** If the Contractor fails to demonstrate to the satisfaction of Engineer that they will be able to achieve a specified Key Date(s)/Date of Completion/ remedying any notified defect under the contract, the Engineer may give the Contractor a notice to correct under Sub-Clause 15.1 in writing to expedite such identified work(s) immediately, so as to achieve the Key Date(s)/Date of Completion/ remedying any notified defect under the contract. If the Contractor fails to comply with such notice, the Employer, in his sole discretion, shall be entitled to carry out such identified part of works (Maximum upto 10% original Accepted Contract Amount) under Sub Clause 13.1 (Right to vary) as is necessary to achieve the key Date(s)/Date of completion by his own workmen or by other contractors without prejudice to any other right or remedy(ies). Engineer shall proceed in accordance with Sub clause 3.7.2 (Engineer's Determination) the value of the part work(s) decided to be part terminated. The Engineer shall as soon as practicable after taking such decision, notify the Contractor thereof in writing of the value of the identified Works for the encashment of Performance Security as specified in Sub clause 15.4
Sub-Clause 15.9 Prohibited Practices	Add New Sub-Clause 15.9 "Prohibited Practices" after Sub-Clause 15.8; " 15.9.1 The Bank requires compliance with the Bank's Policy on Prohibited Practices as set forth in Particular Conditions - Part C- Prohibited Practices.

	15.9.2 The Employer requires the Contractor to disclose any commissions or fees that may have been paid or are to be paid to agents or any other party with respect to the tendering process or execution of the Contract. The information disclosed must include at least the name and address of the agent or other party, the amount and currency, and the purpose of the commission, gratuity or fee."
Sub-Clause 16.1 Suspension by Contractor	The following paragraph is inserted after the first paragraph: "Notwithstanding the above, if the Bank has suspended disbursements under the loan from which payments to the Contractor are being made, in whole or in part, for the execution of the Works, and no alternative funds are available as provided for in Sub-Clause 2.4 [Employer's Financial Arrangements], the Contractor may by notice suspend work or reduce the rate of work at any time, but not less than 7 days after the Recipient having received the suspension notification from the Bank."
Sub-Clause 16.2.1 Notice	Sub-paragraph (j) is deleted in its entirety. At the end of sub-paragraph (i): "; or" is replaced with: "." sub-paragraph (f) is replaced with: "(f) the Contractor does not receive a Notice of the Commencement Date under Sub-Clause 8.1 [*Commencement of Works*] within 180 days after receiving the Letter of Acceptance, for reasons not attributable to the Contractor."
Sub-Clause 16.2.2 Termination	The following is added at the end of Sub-Clause 16.2.2: "In the event the Bank suspends the loan from which part or whole of the payments to the Contractor are being made, if the Contractor has not received the sums due to him upon expiration of the 14 days referred to in Sub-Clause 14.7 [Payment] for payments under Interim Payment Certificates, the Contractor may, without prejudice to the Contractor's entitlement to financing charges under Sub-Clause 14.8 [Delayed Payment], take one of the following actions, namely (i) suspend work or reduce the rate of work under Sub-Clause 16.1 above, or (ii) terminate the Contract by giving notice to the Employer, with a copy to the Engineer, such termination to take effect 14 days after the giving of the notice."

Sub-Clause 17.1 Responsibility for Care of the Works	On the fourth and fifth lines of the first paragraph, replace "Date of Completion of the Works" with "issue of the Taking-Over Certificate for the Works".
Sub-Clause 17.3 Intellectual and Industrial Property Rights	On the first line of the second paragraph, replace "notice" is replaced with "a Notice".
Sub-Clause 17.4 Indemnities by the Contractor	Replace the sub-paragraph 17.4(b) (i) of Sub-Clause 17.4 with the following: (i) arises out of or in the course of or by reason of the design, execution, completion and the remedying of any defects of the Works, and
Sub-Clause 17.7 Use of Employer's Accommodation/Facilities	The following Sub-Clause is added as 17.7: "The Contractor shall take full responsibility for the care of the Employer-provided accommodation and facilities, if any, as detailed in the Employer's Requirements, from the respective dates of hand-over to the Contractor until cessation of occupation (where hand-over or cessation of occupation may take place after the date stated in the Taking-Over Certificate for the Works) If any loss or damage happens to any of the above items while the Contractor is responsible for their care arising from any cause whatsoever other than those for which the Employer is liable, the Contractor shall, at its own cost, rectify the loss or damage to the satisfaction of the Engineer."
Sub-Clause 18.1 **Exceptional Events**	Sub-paragraph (c) is substituted with: "(c) riot, commotion, disorder or sabotage by persons other than the Contractor's Personnel and other employees of the Contractor and Subcontractors;"
Sub-Clause 18.4 Consequences of an Exceptional Event	The following is added at the end of sub-paragraph (b) after deleting the ".": ", including the costs of rectifying or replacing the Works and/or Goods damaged or destroyed by Exceptional Events, to the extent they are not indemnified through the insurance policy referred to in Sub-Clause 19.2 [Insurance to be provided by the Contractor]."
Sub-Clause 18.5 Optional Termination	In sub-paragraph (c), "and necessarily" is inserted after "was reasonably".

Sub-Clause 19.1 **General Requirements**	The following paragraphs are added after the first: "Wherever the Employer is the insuring Party, each insurance shall be effected with insurers and in terms acceptable to the Contractor. These terms shall be consistent with terms (if any) agreed by both Parties before the date of the Letter of Acceptance. This agreement of terms shall take precedence over the provisions of this Clause."
Sub-Clause 19.2 **Insurance to be provided by the Contractor**	The following is inserted as the first sentence in Sub-Clause 19.2: "The Contractor shall be entitled to place all insurances relating to the Contract (including, but not limited to the insurance referred to Clause 19) with insurers from any eligible source country through an insurance provider that is authorized to provide such insurance coverage in India. The Contractor shall submit all evidence(s) of insurances and policies within the period stated in the Contract Data."
Sub-Clause 19.2.1 **The Works**	On the last line of the second paragraph, "Clause 12 *[Tests after completion]*" is deleted.
Sub-Clause 19.2.5 **Injury to employees**	The second paragraph is replaced with: "The Employer and the Engineer shall also be indemnified under the policy of insurance, against liability for claims, damages, losses and expenses (including legal fees and expenses) arising from injury, sickness, disease or death of any person employed by the Contractor or any other of the Contractor's Personnel, except that this insurance may exclude losses and claims to the extent that they arise from any act or neglect of the Employer or of the Employer's Personnel."
Sub-Clause 20.1 **Claims**	In a): "any additional payment" is replaced with "payment".
Sub-Clause 20.2 **Claims for Payment and/or EOT**	The first paragraph is replaced with: "If either Party considers that it is entitled to claim under 20.1 (a) or (b), the following claim procedure shall apply:"

Sub-Clause 21.1 **Constitution of the DAAB**	Replace the entire first paragraph of Sub-Clause 21.1 with the following: Dispute shall be referred to a DAAB for decision in accordance with Sub-Clause 21.4 [Obtaining DAAB's Decision]. The Parties shall appoint a DAAB by the date stated in the Contract Data. The date may be changed if both the Parties agree, in writing, to change the date, up to one hundred eighty (180) days after the Commencement Date. In the second paragraph, at the end of the first sentence after deleting: ".", the following is added: ", each of whom shall meet the criteria set forth in Sub-Clause 3.3 of Appendix- General Conditions of Dispute Avoidance/ Adjudication Agreement." After the second paragraph insert the following paragraph: "If the Contract is with a foreign Contractor, the DAAB members shall not have the same nationality as the Employer or the Contractor."
Sub-Clause 21.2 **Failure to Appoint DAAB Member(s)**	For both (a) and (b): "by the date stated in the first paragraph of Sub-Clause 21.1 [*Constitution of the DAAB*]" is replaced with: "within 42 days from the date the Contract is signed by both Parties"

Sub-Clause 21.6 Arbitration	**This clause stands amended and restated in its entirety as follows:** **21.6.1 Disputes shall be settled by arbitration in accordance with the following provisions:** **(A) In case of the Contractor or the Lead member of the Contractor (in the case of a Joint Venture or Consortium) being of foreign origin** If the efforts to resolve all or any of the disputes through amicable settlement fails, then such disputes or differences, whatsoever arising between the parties, arising out of the Contract or relating to effect of the Contract or the breach thereof shall be referred to Arbitration in accordance with the following provisions: **1. Selection of Arbitrators** -Each dispute submitted by a Party to arbitration shall be heard by a sole arbitrator or an arbitration panel comprising three (3) arbitrators, in accordance with the following provisions: (a) Where the Parties agree that the dispute concerns a technical matter, they may agree to appoint a sole arbitrator or, failing agreement on the identity of such sole arbitrator within thirty (30) days after receipt by the other Party of the proposal of a name for such an appointment by the Party who initiated the proceedings, either Party may apply to Singapore International Arbitration Centre (SIAC) for a list of not fewer than five (5) nominees and, on receipt of such list, the Parties shall alternately strike names therefrom, and the last remaining nominee on the list shall be the sole arbitrator for the matter in dispute. If the last remaining nominee has not been determined in this manner within sixty (60) days of the date of receipt of the list by the Parties, SIAC shall appoint, upon the request of either Party and from such list or otherwise, a sole arbitrator for the matter in dispute. (b) Where the Parties do not agree that the dispute concerns a technical matter, the Client and the Contractor shall each appoint one (1) arbitrator, and these two arbitrators shall jointly appoint a third arbitrator, who shall chair the arbitration panel. If the arbitrators named by the Parties do not succeed in appointing a third arbitrator within thirty (30) days after the latter of the two (2) arbitrators named by the Parties has been

	appointed, the third arbitrator shall, at the request of either Party, be appointed by SIAC. (c) If, in a dispute subject to paragraph (b) above, one Party fails to appoint its arbitrator within thirty (30) days after the other Party has appointed its arbitrator, the Party which has named an arbitrator may apply to the SIAC to appoint a sole arbitrator for the matter in dispute, and the arbitrator appointed pursuant to such application shall be the sole arbitrator for that dispute. **2. Rules of Procedure** - Except as otherwise stated herein, arbitration proceedings shall be conducted in accordance with the rules of procedure for arbitration of the United Nations Commission on International Trade Law (UNCITRAL) as in force on the date of this Contract. **3. Substitute Arbitrators** -If for any reason an arbitrator is unable to perform his/her function, a substitute shall be appointed in the same manner as the original arbitrator. **4. Nationality and Qualifications of Arbitrators -** The sole arbitrator or the third arbitrator appointed pursuant to paragraphs 1(a) through 1(c) above shall be an internationally recognized legal or technical expert with extensive experience in relation to the matter in dispute and shall not be a national of the Contractor's home country or of the home country of any of their members or Parties or of the Government's country. For the purposes of this Clause, "home country" means any of: (a) the country of incorporation of the Contractor or of any of their members or Parties; or (b) the country in which the Contractor's or any of their members' or Parties' principal place of business is located; or (c) the country of nationality of a majority of the Contractor's or of any members' or Parties' shareholders; or (d) the country of nationality of the Sub-Contractor concerned, where the dispute involves a subcontract. **5. Miscellaneous -** In any arbitration proceeding hereunder:

	(a) proceedings shall, unless otherwise agreed by the Parties, be held at Gurugram, India or such place as mutually agreed by both parties. The cost of Arbitration including the fees of the Arbitrator shall be borne equally by both the parties. (b) the English language shall be the official language for all purposes; and (c) the decision of the sole arbitrator or of a majority of the arbitrators (or of the third arbitrator if there is no such majority) shall be final and binding and shall be enforceable in any court of competent jurisdiction, and the Parties hereby waive any objections to or claims of immunity in respect of such enforcement. **(B) In case of the Contractor or the Lead member of the Contractor (in the case of a Joint Venture or Consortium) being of Indian origin** If the efforts to resolve all or any of the disputes through amicable settlement fail, then such disputes or differences, whatsoever arising between the parties, arising out of the Contract or relating to effect of the Contract or the breach thereof shall be referred to Arbitration in accordance with the following provisions: (a) The Arbitration proceedings shall be assumed to have commenced from the day, a written and valid demand for arbitration is received by Managing Director of the Employer (MD/HRIDC). (b) The disputes so referred to arbitration shall be settled in accordance with the Indian Arbitration & Conciliation Act, 1996 and amended by the Arbitration and Conciliation (Amendment) Act, 2015 and any statutory modification or re-enactment thereof. Further, it is agreed between the parties as under: Number of Arbitrators - The Arbitral tribunal shall consist of 3 (three) arbitrators **1. Procedure for Appointment of Arbitrators** The arbitrators shall be appointed as per following procedure: a) Within 30 days from the day when a written and valid demand for Arbitration is received by MD/HRIDC, the

	Employer will forward a panel of not fewer than five (05) nominees to the Contractor. The Contractor will then give his consent for any one name out of the panel to be appointed as one of the arbitrators within 30 days of dispatch of the request by the Employer. b) The Employer will decide the second Arbitrator. MD/HRIDC shall appoint the two Arbitrators, including the name of one Arbitrator for whom consent was given by the Contractor, within 30 days from the receipt of the consent for one name of the Arbitrator from the Contractor. In case ~~the~~ Contractor fails to give his consent within 30 days of the request of the Employer, MD/HRIDC shall nominate both the Arbitrators from the panel. The third Arbitrator shall be chosen by the two Arbitrators so appointed by the parties out of the panel of Arbitrators provided to Contractor or from the larger panel of Arbitrators to be provided to them by the Employer at the request of two appointed Arbitrators (if so desired by them) and who shall act as presiding Arbitrator. In case of failure of the two appointed Arbitrators to reach upon consensus within a period of 30 days from their appointment, then, upon the request of either or both parties, the presiding Arbitrator shall be appointed by the MD/HRIDC within 14 days of receipt of request from either party or both parties. c) If one or more of the Arbitrators appointed as above refuses to act as Arbitrator, withdraws from his office as Arbitrator, or vacates his/their office/offices or is/are unable or unwilling to perform his functions as Arbitrator for any reason whatsoever or dies or in the opinion of the MD/HRIDC fails to act without undue delay, the MD/HRIDC shall appoint new Arbitrator/Arbitrators to act in his/their place except in case of new presiding Arbitrator who shall be chosen following the same procedure as mentioned in para (b) above. Such reconstituted Tribunal may, at its discretion, proceed with the reference from the stage at which it was left by the previous Arbitrator(s). d) The Employer at the time of offering the panel of Arbitrator(s) to be appointed as Arbitrator shall also supply the information with regard to the qualifications of the said Arbitrators nominated in the panel along with their professional experience, phone nos. and addresses to the Contractor. The minimum qualification and experience of the arbitrators which

	may be appointed by the Parties in accordance with the contract is set out below: (i) A working/retired officer (not below E-8 grade in a central public sector undertaking in India, with which the Employer has no direct business relationship), of engineering or accounts/finance discipline, having experience in management of construction contracts; or (ii) A retired officer (not below the SAG level in Indian Railways) of any Engineering Services of Indian Railways or Indian Railway Accounts Service, having experience in management of construction contracts; **2. Miscellaneous:** In any arbitration proceeding hereunder: (a) The language of arbitration shall be English. This arbitration shall be governed in accordance with the laws of India. (b) The venue of the arbitration shall be Gurugram, India. The cost of Arbitration including the fees of the Arbitrator shall be borne equally by both the parties. (c) The decision of the sole arbitrator or of a majority of the arbitrators (or of the third arbitrator if there is no such majority) shall be final and binding and shall be enforceable in High court at Chandigarh, and the Parties hereby waive any objections to or claims of immunity in respect of such enforcement. 21.6.2 In the event that the Contractor wishes to refer a dispute to arbitration in accordance with this Sub-Clause, it shall be required to serve a notice in this regard to the Managing Director, of the Employer for commencement of arbitration. 21.6.3 Pending the submission of and/or decision on a dispute and until the arbitral award is published, the Parties shall continue to perform their respective obligations under the contract without prejudice to a final adjustment in accordance with such award. 21.6.4 The arbitrators shall have full power to open up, review and revise any certificate, determination, instruction, opinion or valuation of the Engineer, and any decision of the DB, relevant to the dispute. Nothing shall disqualify representatives of the Parties and the Engineer from being called as a witness and giving evidence before the arbitrators on any matter whatsoever relevant to the dispute. However, Conciliator cannot be present as a witness by either party in the arbitral proceedings.

	21.6.5 Neither Party shall be limited in the proceedings before the arbitrators to the evidence or arguments previously put before the DB to obtain its decision, or to the reasons for dissatisfaction given in its Notice of Dissatisfaction. 21.6.6 Neither party shall be limited in the proceedings before such arbitrators to the evidence or arguments put before the Engineer to obtain his decision. No decision given by the Engineer in accordance with the contract shall disqualify him from being called as a witness and giving evidence before the arbitrators on any matter, whatsoever, relevant to dispute referred to arbitration. 21.6.7 Arbitration may be commenced prior to or after completion of the Works. The obligations of the Parties, the Engineer and the DB shall not be altered by reason of any arbitration being conducted during the progress of the Works.

Appendix- General Conditions of Dispute Avoidance/Adjudication Agreement

Title	"General Conditions of Dispute Avoidance/Adjudication Agreement" is replaced with "General Conditions of DAAB Agreement".
1. Definitions	Sub-Clause 1.2: In both the first and third lines, "DAA Agreement" is replaced with "DAAB Agreement". Sub-Clause 1.3: -In the first line, "Dispute Avoidance/Adjudication Agreement" or "DAA Agreement" means" is replaced with: "DAAB Agreement" is as defined under the Contract and is". - In the first line of sub-paragraph (c), "DAA Agreement" is replaced with "DAAB Agreement". - In sub-paragraph (c)(ii), "chairman" is replaced with "chairperson". Sub-Clause 1.3 "DAAB Activities" is replaced with Sub-Clause 1.4 "DAAB Activities" and the subsequent Sub-Clauses under Clause 1 "Definitions" renumbered: Sub-Clause 1.7 to 12: Replace all instances of "DAA Agreement" with "DAAB Agreement". In Sub-Clause 1.8 a(i):" authorised representative of the contractor or of the Employer" is replaced with: "Contractor's Representative or authorised representative of the Employer".
3. Warranties	Sub-Clause 3.3 is deleted and replaced with the following: "When appointing the DAAB Member, each Party relies on the DAAB Member's representations, that he/she; a) has at least a bachelor's degree in relevant disciplines such as law, engineering, construction management or contract management; b) has at least ten years of experience in contract administration/management and dispute resolution, out of which at least five years of experience as an

arbitrator or adjudicator in construction-related disputes;

c) has received formal training as an adjudicator from an internationally recognized organization;

d) has experience and/or is knowledgeable in the type of work which the Contractor is to carry out under the Contract;

e) has experience in the interpretation of construction and/or engineering contract documents;

f) has familiarity with the forms of contract published by FIDIC since 1999, and an understanding of the dispute resolution procedures contained therein; and

g) is fluent in the language for communications stated in the Contract Data (or the language as agreed between the Parties and the DAAB)."

7. Confidentiality

In Sub-Clause 7.3: "or" is deleted after sub-paragraph (b), and the following added:

"or (d) is being provided to the Bank."

9. Fees and Expenses

In Sub-Clause 9.1 (c): "business class or equivalent" is replaced with: "in less than first class".

In Sub-Clause 9.4: "and air fares" and "other" are deleted from the first and second sentences respectively.

10. Resignation and Termination

In Sub-Clause 10.3: "the DAA Agreement" is replaced with: "a DAAB member's DAAB Agreement".

Annex- DAAB Procedural Rules

Rule 4.2 On the fourth line, "chairman" is replaced with "chairperson".

Rule 8.3 On the sixth line, "chairman" is replaced with "chairperson".

Form of Dispute Avoidance/Adjudication Agreement

All instances of "DAA Agreement" are replaced with: "DAAB Agreement".

In C (b): "chairman" is replaced with "chairperson".

Particular Conditions of Contract (PCC)

Part C – Prohibited Practices

1. The Bank requires that the Recipient (and all other beneficiaries of the Bank financing), as well as tenderers, suppliers, contractors, concessionaires and consultants under Bank-financed contracts for the Project, observe the highest standard of transparency and integrity during the procurement, execution and implementation of such contracts.

2. Definitions. In pursuance of this policy, the Bank defines the terms set forth below as Prohibited Practices:

   (a) "**coercive practice**" means impairing or harming, or threatening to impair or harm, directly or indirectly, any party or the property of a party to influence improperly the actions of a party;
   (b) "**collusive practice**" means an arrangement between two or more parties designed to achieve an improper purpose, including to influence improperly the actions of another party;
   (c) "**corrupt practice**" means the offering, giving, receiving or soliciting, directly or indirectly, of anything of value to influence improperly the actions of another party;
   (d) "**fraudulent practice**" means any act or omission, including a misrepresentation, that knowingly or recklessly misleads, or attempts to mislead, a party to obtain a financial or other benefit or to avoid an obligation.
   (e) "**misuse of resources**" means improper use of the Bank's resources, carried out either intentionally or through reckless disregard;
   (f) "**obstructive practice**" means any of the following practices: (i) deliberately destroying, falsifying, altering or concealing of evidence material to a Bank investigation; (ii) making false statements to investigators in order to materially impede a Bank investigation into allegations of a Prohibited Practice; (iii) failing to comply with requests to provide information, documents or records in connection with a Bank investigation; (iv) threatening, harassing or intimidating any party to prevent it from disclosing its knowledge of matters relevant to a Bank investigation or from pursuing the investigation; or (v) materially impeding the exercise of the Bank's contractual rights of audit or inspection or access to information; and
   (g) "**theft**" means the misappropriation of property belonging to another party.

3. Any occurrence, or suspected occurrence, of a Prohibited Practice in the procurement, award, or implementation of a Bank-financed contract is dealt with in accordance with the provisions of the Bank's Policy on Prohibited Practices. Suppliers, contractors, service providers and consultants selected pursuant to the provisions of Section II and concessionaires selected pursuant to paragraph 14.3 of the Bank's Procurement Instructions for Recipients, as well as the Recipient shall fully cooperate with the Bank (or a cofinancier undertaking an investigation

pursuant to paragraph 6.1 of the Bank's Procurement Instructions for Recipients) in any investigation into an alleged Prohibited Practice to be carried out pursuant to the Policy on Prohibited Practices, and permit the Bank or its representative (including such co-financier) to inspect such of their accounts and records as may be relevant for such investigation and to have such records and accounts audited by the auditors appointed by the Bank.

4. Provisions to this effect are included in the Legal Agreements and the procurement contracts with such entities.

5. If the Project is financed by a sovereign-backed loan, the Bank (or, where relevant, a co-financier having undertaken an investigation pursuant to paragraph 6.1 of the Bank's Procurement Instructions for Recipients):

   (a) may take any of the following additional actions in connection with a Prohibited Practice under the Project:

      (i) reject a proposal for award if it determines that the tenderer recommended for award, or any of its personnel, or its agents, or its sub-consultants, subcontractors, service providers, suppliers or their employees, has, directly or indirectly, engaged in a prohibited practice in competing for the contract in question; and

      (ii) cancel the undisbursed portion of the loan allocated to a contract (and require reimbursement of the disbursed portion of the loan allocated to the contract) if it determines at any time that representatives of the Recipient or of a recipient of any part of the proceeds of the loan engaged in a prohibited practice during the procurement, administration or implementation of the contract in question; and

   (b) requires that a clause be included in tender documents and in contracts financed by the Bank loan, requiring tenderers, suppliers and contractors, and their subcontractors, agents, personnel, consultants, service providers, or suppliers, to permit the Bank (and a co-financier undertaking an investigation pursuant to paragraph 6.1 of the Bank's Procurement Instructions for Recipients) to inspect all accounts, records, and other documents relating to the submission of tenders and contract performance, and to have them audited by auditors appointed by the Bank.

Section X - Contract Forms

Table of Forms

Notification of Intention to Award

[*This Notification of Intention to Award shall be sent to each Tenderer that submitted a Tender.*]

[*Send this Notification to the Tenderer's Authorized Representative named in the Tenderer Information Form*]

For the attention of Tenderer's Authorized Representative

Name: *[insert Authorized Representative's name]*

Address: *[insert Authorized Representative's Address]*

Telephone/Fax numbers: *[insert Authorized Representative's telephone/fax numbers]*

Email Address: *[insert Authorized Representative's email address]*

[IMPORTANT: insert below the date that this Notification is transmitted to Tenderers. The Notification must be sent to all Tenderers simultaneously. This means on the same date and as close to the same time as possible.]

DATE OF TRANSMISSION: This Notification is sent by: [*email/fax*] on [*date*] (local time)

Notification of Intention to Award

Employer: *[insert the name of the Employer]*
Project: *[insert name of project]*
Country: *[insert country where Tender is issued]*
Loan No.: *[insert reference number for loan]*
Tender No: *[insert Tender reference number from Procurement Plan]*
Contract Title: *[insert the name of the contract]*

This Notification of Intention to Award (Notification) notifies you of our decision to award the above contract. The transmission of this Notification begins the Standstill Period. During the Standstill Period you may:

a) request a debriefing in relation to the evaluation of your Tender, and/or

b) submit a Procurement-related Complaint in relation to the decision to award the contract.

1. The successful Tenderer

Name:	[*insert name of successful Tenderer*]
Address:	[*insert address of the successful Tenderer*]
Contract Price:	[*insert contract price of the successful Tender*]

2. List of all Tenderers *[INSTRUCTIONS: insert names of all Tenderers that submitted a Tender including the successful Tenderer, together with the corresponding Tender price*

as read out at tender opening and the evaluated Tender price (when rated criteria are not used).]

Name of Tenderer	Tender Price	Evaluated Tender Price (if applicable)
[*insert name*]	[*insert Tender price*]	[*insert evaluated price*]
[*insert name*]	[*insert Tender price*]	[*insert evaluated price*]
[*insert name*]	[*insert Tender price*]	[*insert evaluated price*]
[*insert name*]	[*insert Tender price*]	[*insert evaluated price*]
[*insert name*]	[*insert Tender price*]	[*insert evaluated price*]

Or

List of all Tenderers ***[INSTRUCTIONS: insert names of all Tenderers that submitted a Tender including the successful Tenderer, together with the corresponding Tender price as read out at tender opening and the evaluated Tender price, respective technical and financial scores, combined technical and financial score (when rated criteria are used).]***

Name of Tenderer	Tender Price	Evaluated Tender Price	Technical Score	Financial Score	Combined Score
[*insert name*]	[*insert Tender price*]	[*insert evaluated price*]			
[*insert name*]	[*insert Tender price*]	[*insert evaluated price*]			
[*insert name*]	[*insert Tender price*]	[*insert evaluated price*]			
[*insert name*]	[*insert Tender price*]	[*insert evaluated price*]			
[*insert name*]	[*insert Tender price*]	[*insert evaluated price*]			

3. Reason/s why your Tender was unsuccessful

[INSTRUCTIONS: State the reason/s why <u>this</u> Tenderer's Tender was unsuccessful. Do NOT include: (a) a point by point comparison with another Tenderer's Tender, or (b) information that is marked confidential by the Tenderer in its Tender.]

4. How to request a debriefing

DEADLINE: The deadline to request a debriefing expires at midnight on [*insert date*] (local time).

You may request a debriefing in relation to the results of the evaluation of your Tender. If you decide to request a debriefing your written request must be made within three (3) Business Days of receipt of this Notification of Intention to Award.

Provide the contract name, reference number, name of the Tenderer, contact details; and address the request for debriefing as follows:

Attention: [*insert full name of person, if applicable*]

Title/position: [*insert title/position*]

Agency: [*insert name of Employer*]

Email address: [*insert email address*]

Fax number: [*insert fax number*] ***delete if not used***

If your request for a debriefing is received within the 3 Business Days deadline, we will provide the debriefing within five (5) Business Days of receipt of your request. If we are unable to provide the debriefing within this period, the Standstill Period shall be extended by five (5) Business Days after the date that the debriefing is provided. If this happens, we will notify you and confirm the date that the extended Standstill Period will end.

The debriefing may be in writing, by phone, video conference call or in person. We shall promptly advise you in writing how the debriefing will take place and confirm the date and time.

If the deadline to request a debriefing has expired, you may still request a debriefing. In this case, we will provide the debriefing as soon as practicable, and normally no later than fifteen (15) Business Days from the date of publication of the Contract Award Notice.

5. How to make a complaint

Period: Procurement-related Complaint challenging the decision to award shall be submitted by midnight, [*insert date*] (local time).

Provide the contract name, reference number, name of the Tenderer, contact details; and address the Procurement-related Complaint as follows:

Attention: [*insert full name of person, if applicable*]

Title/position: [*insert title/position*]

Agency: [*insert name of Employer*]

Email address: [*insert email address*]

Fax number: [*insert fax number*] ***delete if not used***

At this point in the procurement process, you may submit a Procurement-related Complaint challenging the decision to award the contract. You do not need to have requested, or received, a debriefing before making this complaint. Your complaint must be submitted within the Standstill Period and received by us before the Standstill Period ends.

For more information see the Procurement Instructions for Recipients (Annex IV, Complaint Monitoring).

6. Standstill Period

DEADLINE: The Standstill Period is due to end at midnight on [*insert date*] (local time).

The Standstill Period lasts ten (10) Business Days after the date of transmission of this Notification of Intention to Award.

The Standstill Period may be extended as stated in Section 4 above.

If you have any questions regarding this Notification, please do not hesitate to contact us.

For and on behalf of the Employer:

Signature: _____

Name: _____

Title/Position: _____

Telephone: _____

Email: _____

Beneficial Ownership Disclosure Form

INSTRUCTIONS TO TENDERERS: DELETE THIS BOX ONCE YOU HAVE COMPLETED THE FORM

This Beneficial Ownership Disclosure Form ("Form") is to be completed by the successful Tenderer. In case of joint venture, the Tenderer must submit a separate Form for each member. The beneficial ownership information to be submitted in this Form shall be current as of the date of its submission.

For the purposes of this Form, a Beneficial Owner of a Tenderer is any natural person who ultimately owns or controls the Tenderer by meeting one or more of the following conditions:

- *directly or indirectly holding 25% or more of the shares*
- *directly or indirectly holding 25% or more of the voting rights*
- *directly or indirectly having the right to appoint a majority of the board of directors or equivalent governing body of the Tenderer*

Tender No.: [*insert number of Tender process*]

To: **Haryana Rail Infrastructure Development Corporation Limited**

In response to your request in the Letter of Acceptance *dated [insert date of letter of Acceptance]* to furnish additional information on beneficial ownership: *[select one option as applicable and delete the options that are not applicable]*

(i) we hereby provide the following beneficial ownership information.

Details of beneficial ownership

Identity of Beneficial Owner	Directly or indirectly holding 25% or more of the shares (Yes / No)	Directly or indirectly holding 25 % or more of the Voting Rights (Yes / No)	Directly or indirectly having the right to appoint a majority of the board of the directors or an equivalent governing body of the Tenderer (Yes / No)
[include full name (last, middle, first), nationality, country of residence]			

OR

(ii) *We declare that there is no Beneficial Owner meeting one or more of the following conditions:*

- directly or indirectly holding 25% or more of the shares
- directly or indirectly holding 25% or more of the voting rights
- directly or indirectly having the right to appoint a majority of the board of directors or equivalent governing body of the Tenderer

OR

(iii) We declare that we are unable to identify any Beneficial Owner meeting one or more of the following conditions. [If this option is selected, the Tenderer shall provide explanation on why it is unable to identify any Beneficial Owner]

- directly or indirectly holding 25% or more of the shares
- directly or indirectly holding 25% or more of the voting rights
- directly or indirectly having the right to appoint a majority of the board of directors or equivalent governing body of the Tenderer]"

Name of the Tenderer: *[*insert complete name of the Tenderer*] _____

Name of the person duly authorized to sign the Tender on behalf of the Tenderer: **[*insert complete name of person duly authorized to sign the Tender*] _____

Title of the person signing the Tender: [*insert complete title of the person signing the Tender*] _____

Signature of the person named above: [*insert signature of person whose name and capacity are shown above*] _____

Date signed [*insert date of signing*] **day of** [*insert month*], [*insert year*]_____

* In the case of the Tender submitted by a Joint Venture specify the name of the Joint Venture as Tenderer. In the event that the Tenderer is a joint venture, each reference to "Tenderer" in the Beneficial Ownership Disclosure Form (including this Introduction thereto) shall be read to refer to the joint venture member.

** Person signing the Tender shall have the power of attorney given by the Tenderer. The power of attorney shall be attached with the Tender Schedules.

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Letter of Acceptance

[letterhead paper of the Employer]

[date]

To: *[name and address of the Contractor]*

This is to notify you that your Tender dated *[date]* for execution of the **"C-23: Design and Construction of Civil Works (Earthwork, Bridges, Station Buildings, Retaining Walls and other miscellaneous Works) from km 29.68 to km 49.70 & from km 55.60 to km 61.50 and its connectivities to IR network from New Patli to Patli station & New Patli to Sultanpur station including modifications/civil works at Sultanpur Station in connection with laying of New BG Double Railway line of HORC project**" for the Accepted Contract Amount *[amount in numbers and words] [name of currency]*, as corrected and modified in accordance with the Instructions to Tenderers, is hereby accepted by our Agency.

You are requested to furnish (i) the Performance Security within 28 days in accordance with the Conditions of Contract, using, for that purpose, the Performance Security Form; and (ii) the additional information on beneficial ownership in accordance with TDS ITT 48.1, within eight (8) Business days using the Beneficial Ownership Disclosure Form, included in Section X, Contract Forms, of the Tender Document.

Authorized Signature: _____

Name and Title of Signatory: _____

Name of Agency: _____

Attachment: Contract Agreement

Contract Agreement

THIS AGREEMENT made the _____ day of _____, _____, between _____of _____ *[insert complete name of Employer and full business address]* (hereinafter "the Employer"), of the one part, and _____ of _____ *[insert complete name and nationality of Contractor as well as full business address]* (hereinafter "the Contractor"), of the other part:

WHEREAS the Employer invited tenders for the execution of the Works, described as **"C-23:** Design and Construction of Civil Works (Earthwork, Bridges, Station Buildings, Retaining Walls and other miscellaneous Works) from km 29.68 to km 49.70 & from km 55.60 to km 61.50 and its connectivities to IR network from New Patli to Patli station & New Patli to Sultanpur station including modifications/civil works at Sultanpur Station in connection with laying of New BG Double Railway line of HORC project.**"**

The Employer and the Contractor agree as follows:

1. In this Agreement words and expressions shall have the same meanings as are respectively assigned to them in the Contract documents referred to.

2. The following documents shall be deemed to form and be read and construed as part of this Agreement. This Agreement shall prevail over all other Contract documents.

    (a) the Letter of Acceptance;

    (b) the Letter of Tender;-Financial Part;

    (c) the Letter of Tender-Technical Part;

    (d) the Record of Meeting on Contract Negotiation (if any);

    (e) the addenda Nos _____ (if any);

    (f) the Particular Conditions of Contract;

    (g) the General Conditions of Contract;

    (h) the Employer's Requirements;

    (i) the Drawings*;*

    (j) the Contractor's Technical Proposal;

    (k) the Reference Information/Reports, and

(l) the completed Schedules and any other documents forming part of the contract, including, but not limited to:

i. the ESHS Management Strategies and Implementation Plans; and

ii. Code of Conduct (ESHS)**.**

3. In consideration of the payments to be made by the Employer to the Contractor as specified in this Agreement, the Contractor hereby covenants with the Employer to execute the Works and to remedy defects therein in conformity in all respects with the provisions of the Contract.

4. The Employer hereby covenants to pay the Contractor in consideration of the execution and completion of the Works and the remedying of defects therein, the Contract Price or such other sum as may become payable under the provisions of the Contract at the times and in the manner prescribed by the Contract.

IN WITNESS whereof the parties hereto have caused this Agreement to be executed in accordance with the laws of _____ *[insert the name of the Contract governing law country]* on the day, month and year specified above.

For and on behalf of the Employer

Signed: *[insert signature]*
in the capacity of *[insert title or other appropriate designation]*
In the presence of *[insert identification of official witness]*

For and on behalf of the Contractor

Signed: *[insert signature of authorized representative(s) of the Contractor]*
in the capacity of *[insert title or other appropriate designation]*
in the presence of *[insert identification of official witness]*

Performance Security

Demand Guarantee

[Guarantor letterhead or SWIFT identifier code]

Beneficiary:

Haryana Rail Infrastructure Development Corporation Limited,
Plot No 143, 5th Floor, Railtel Tower,
Sector-44, Gurugram,
Haryana-122003

Date: _____ *[Insert date of issue]*

PERFORMANCE GUARANTEE No.: _____

Guarantor: *[Insert name and address of place of issue, unless indicated in the letterhead]*

We have been informed that _____ (hereinafter called "the Applicant") has entered into Contract No. _____ *dated* _____ with the Beneficiary, for the execution of "C-23: Design and Construction of Civil Works (Earthwork, Bridges, Station Buildings, Retaining Walls and other miscellaneous Works) from km 29.68 to km 49.70 & from km 55.60 to km 61.50 and its connectivities to IR network from New Patli to Patli station & New Patli to Sultanpur station including modifications/civil works at Sultanpur Station in connection with laying of New BG Double Railway line of HORC project."

Furthermore, we understand that, according to the conditions of the Contract, a performance guarantee is required.

At the request of the Applicant, we as Guarantor, hereby irrevocably undertake to pay the Beneficiary any sum or sums not exceeding in total an amount of _____ (),[1] such sum being payable in the types and proportions of currencies in which the Contract Price is payable, upon receipt by us of the Beneficiary's complying demand supported by the Beneficiary's statement, whether in the demand itself or in a separate signed document accompanying or identifying the demand, stating that the Applicant is in breach of its obligation(s) under the Contract, without the Beneficiary needing to prove or to show grounds for your demand or the sum specified therein.

[1] *The Guarantor shall insert an amount representing the percentage of the Accepted Contract Amount specified in the Letter of Acceptance, less provisional sums, if any, and denominated either in the currency(cies) of the Contract or a freely convertible currency acceptable to the Beneficiary.*

This guarantee shall expire, no later than the …. Day of ……, 2…[2], and any demand for payment under it must be received by us at this office indicated above on or before that date.

This guarantee is subject to the Uniform Rules for Demand Guarantees (URDG) 2010 Revision, ICC Publication No. 758, except that the supporting statement under Article 15(a) is hereby excluded.

_____

[signature(s)]

Note: All italicized text (including footnotes) is for use in preparing this form and shall be deleted from the final product.

[2] *Insert the date twenty-eight days after the expected completion dateas described in GC Clause 11.9. The Employer should note that in the event of an extension of thisdate for completion of the Contract, the Employer would need to request an extension of this guarantee from the Guarantor. Such request must be in writing and must be made prior to the expiration date established in the guarantee. In preparing this guarantee, the Employer might consider adding the following text to the form, at the end of the penultimate paragraph: "The Guarantor agrees to a one-time extension of this guarantee for a period not to exceed [six months][one year], in response to the Beneficiary's written request for such extension, such request to be presented to the Guarantor before the expiry of the guarantee."*

Advance Payment Security

Demand Guarantee

[Guarantor letterhead or SWIFT identifier code]

[Guarantor letterhead or SWIFT identifier code]

Beneficiary:

Haryana Orbital Rail Corporation Limited,
Plot No 143, 5th Floor, Railtel Tower,
Sector-44, Gurugram,
Haryana-122003

Date: _____ *[Insert date of issue]*

ADVANCE PAYMENT GUARANTEE No.: *[Insert guarantee reference number]*

Guarantor: [*Insert name and address of place of issue, unless indicated in the letterhead]*

We have been informed that _____ (hereinafter called "the Applicant") has entered into Contract No. _____ *dated* _____ with the Beneficiary, for the execution of "C-23: Design and Construction of Civil Works (Earthwork, Bridges, Station Buildings, Retaining Walls and other miscellaneous Works) from km 29.68 to km 49.70 & from km 55.60 to km 61.50 and its connectivities to IR network from New Patli to Patli station & New Patli to Sultanpur station including modifications/civil works at Sultanpur Station in connection with laying of New BG Double Railway line of HORC project".

Furthermore, we understand that, according to the conditions of the Contract, an advance payment in the sum _____ ( ) is to be made against an advance payment guarantee.

At the request of the Applicant, we as Guarantor, hereby irrevocably undertake to pay the Beneficiary any sum or sums not exceeding in total an amount of _____ ()[1] upon receipt by us of the Beneficiary's complying demand supported by the Beneficiary's statement, whether in the demand itself or in a separate signed document accompanying or identifying the demand, stating either that the Applicant:

[1] *The Guarantor shall insert an amount representing the amount of the advance payment and denominated either in the currency(ies) of the advance payment as specified in the Contract, or in a freely convertible currency acceptable to the Employer.*

(a) has used the advance payment for purposes other than the costs of mobilization in respect of the Works; or

(b) has failed to repay the advance payment in accordance with the Contract conditions, specifying the amount which the Applicant has failed to repay.

A demand under this guarantee may be presented as from the presentation to the Guarantor of a certificate from the Beneficiary's bank stating that the advance payment referred to above has been credited to the Applicant on its account number _____ at _____..

The maximum amount of this guarantee shall be progressively reduced by the amount of the advance payment repaid by the Applicant as specified in copies of interim statements or payment certificates which shall be presented to us. This guarantee shall expire, at the latest, upon our receipt of a copy of the interim payment certificate indicating that ninety (90) percent of the Accepted Contract Amount, less provisional sums, has been certified for payment, or on the ___ day of _____, 2___,[2] whichever is earlier. Consequently, any demand for payment under this guarantee must be received by us at this office on or before that date.

This guarantee is subject to the Uniform Rules for Demand Guarantees (URDG) 2010 Revision, ICC Publication No. 758, except that the supporting statement under Article 15(a) is hereby excluded.

_____

[signature(s)]

Note: All italicized text (including footnotes) is for use in preparing this form and shall be deleted from the final product.

[2] *Insert the expected expiration date of the Time for Completion. The Employer should note that in the event of an extension of the time for completion of the Contract, the Employer would need to request an extension of this guarantee from the Guarantor. Such request must be in writing and must be made prior to the expiration date established in the guarantee. In preparing this guarantee, the Employer might consider adding the following text to the form, at the end of the penultimate paragraph: "The Guarantor agrees to a one-time extension of this guarantee for a period not to exceed [six months][one year], in response to the Beneficiary's written request for such extension, such request to be presented to the Guarantor before the expiry of the guarantee."*

Retention Money Security

Demand Guarantee

_____ *[Guarantor letterhead or SWIFT identifier code]*

Beneficiary:

Haryana Orbital Rail Corporation Limited,
Plot No 143, 5th Floor, Railtel Tower,
Sector-44, Gurugram,
Haryana-122003

Date: _____ *[Insert date of issue]*

RETENTION MONEY GUARANTEE No.: *[Insert guarantee reference number]*

Guarantor: [*Insert name and address of place of issue, unless indicated in the letterhead]*

We have been informed that _____ *[insert name of Contractor, which in the case of a joint venture shall be the name of the joint venture]* (hereinafter called "the Applicant") has entered into Contract No. _____ *[insert reference number of the contract]*dated _____ with the Beneficiary, for the execution of "**C-23:** Design and Construction of Civil Works (Earthwork, Bridges, Station Buildings, Retaining Walls and other miscellaneous Works) from km 29.68 to km 49.70 & from km 55.60 to km 61.50 and its connectivities to IR network from New Patli to Patli station & New Patli to Sultanpur station including modifications/civil works at Sultanpur Station in connection with laying of New BG Double Railway line of HORC project."

Furthermore, we understand that, according to the conditions of the Contract, the Beneficiary retains moneys up to the limit set forth in the Contract ("the Retention Money"), and that when the Taking-Over Certificate has been issued under the Contract and the first half of the Retention Money has been certified for payment, payment of *[*insert the second half of the Retention Money *or if the amount guaranteed under the Performance Guarantee when the Taking-Over Certificate is issued is less than half of the Retention Money,* the difference between half of the Retention Money and the amount guaranteed under the Performance Security is to be made against a Retention Money guarantee.

At the request of the Applicant, we, as Guarantor, hereby irrevocably undertake to pay the Beneficiary any sum or sums not exceeding in total an amount of _____ *[insert amount in*

figures]()*[amount in words]*[1] upon receipt by us of the Beneficiary's complying demand supported by the Beneficiary's statement, whether in the demand itself or in a separate signed document accompanying or identifying the demand, stating that the Applicant is in breach of its obligation(s) under the Contract, without your needing to prove or show grounds for your demand or the sum specified therein.

A demand under this guarantee may be presented as from the presentation to the Guarantor of a certificate from the Beneficiary's bank stating that the second half of the Retention Money as referred to above has been credited to the Applicant on its account number _____ at _____ *[insert name and address of Applicant's bank]*.

This guarantee shall expire no later than the …. Day of ……, 2…[2], and any demand for payment under it must be received by us at the office indicated above on or before that date.

This guarantee is subject to the Uniform Rules for Demand Guarantees (URDG) 2010 Revision, ICC Publication No. 758, except that the supporting statement under Article 15(a) is hereby excluded.

_____

[signature(s)]

Note: All italicized text (including footnotes) is for use in preparing this form and shall be deleted from the final product.

[1] *The Guarantor shall insert an amount representing the amount of the second half of the Retention Money or if the amount guaranteed under the Performance Guarantee when the Taking-Over Certificate is issued is less than half of the Retention Money, the difference between half of the Retention Money and the amount guaranteed under the Performance Security and denominated either in the currency(ies) of the second half of the Retention Money as specified in the Contract, or in a freely convertible currency acceptable to the Beneficiary.*

[2] *Insert the same expiry date as set forth in the performance security, representing the date twenty-eight days after the completion date described in GCC Clause 11.9.The Employer should note that in the event of an extension of this date for completion of the Contract, the Employer would need to request an extension of this guarantee from the Guarantor. Such request must be in writing and must be made prior to the expiration date established in the guarantee. In preparing this guarantee, the Employer might consider adding the following text to the form, at the end of the penultimate paragraph: "The Guarantor agrees to a one-time extension of this guarantee for a period not to exceed [six months][one year], in response to the Beneficiary's written request for such extension, such request to be presented to the Guarantor before the expiry of the guarantee."*

Contractor's Warranty

This Agreement is made on the .....… day of … … … … … … between

(1) [ ] of [ ] [and [see Note 1]] ([jointly] "the Contractor").

(2) the Haryana Orbital Rail Corporation Limited [of/[whose registered office is at] [XXX] Limited, together with its successors and assigns, "the Employer") _____,

WHEREAS

(A) By a contract [_____] dated [_____] ("the Contract") made between

(1) the Haryana Orbital Rail Corporation Limited ("the Employer") and

(2) [("the Contractor") has agreed to design, execute, complete, test and commission (including Integrated Testing and Commissioning) and remedy any defects in the works ("the Works") upon the terms and conditions contained in the Contract.

(B) [See Note 3]
(C) At the request of the Employer and pursuant to the terms of the Contract the Contractor has agreed to enter into this Warranty.

NOW IT IS AGREED as follows:

1. The Contractor hereby warrants and undertakes that:

(a) he will design, execute, complete, test and commission (including Integrated Testing and Commissioning) and remedy any defect in the Works in accordance with the terms of the Contract; and;
(b) he owes a duty of care to the Employer in relation to the performance of its duties under the Contract; and
(c) he will replace free of cost to the Employer any defect or failure of equipment /material/services provided in the Works for the duration of Defect Notification Period as per the Contract; and
(d) he agrees that should any design modification be required to any equipment or component as a consequence of failure analysis, for the duration of Defect Notification Period as per the Contract, shall recommence from the date when the modified part is commissioned into service, and such modification shall be carried out free of cost to the Employer in all sub-systems and systems for all sections; and
(e) he shall maintain the manufacture or spare of replacement parts for at least 10 years.

2. The liability of [the companies comprising [see Note 3]] the Contractor under this Warranty [shall be joint and several and [see Note 3]] shall not be released, diminished or in any way

affected by any independent inquiry or investigation into the Works or any matter related to the Contract whether carried out by or on behalf of the Employer or any liability or right of action which may arise out of such inquiry or investigation.

3. Insofar as the copyright or other intellectual property rights in any plans, calculations, drawings, documents, materials, plant, know-how and other information relating to the Works shall be vested in the Contractor, the Contractor grants to the Employer his successors and assigns a royalty free, non-exclusive and irrevocable licence (carrying the right to grant sub-licences) to use and reproduce any of the works designs or inventions incorporated and referred to in such documents or materials and any such know-how and information for all purposes relating to the Works or the Project including without limitation the design, manufacture, supply, installation, testing and commissioning (including Integrated Testing and Commissioning) reinstatement, extension and the remedy of any defect in the Works. To the extent that beneficial ownership of any such copyright or other intellectual property rights is vested in anyone other than the Contractor, the Contractor shall use best endeavours to procure that the beneficial owner thereof shall grant a like licence to the Employer. For the avoidance of doubt, any such licence granted shall not be determined if the Contractor shall for any reason cease to be employed in connection with the Works.
4. The provisions of this Warranty shall be without prejudice to and shall not be deemed or construed so as to limit or exclude any rights or remedies which the Employer may have against the Contractor, whether in tort or otherwise.
5. Nothing contained in this Warranty shall vary or affect the Contractor's rights and obligations under the Contract.
6. The address for service of all documents arising out of or in connection with this Warranty shall be:

(a) upon the Employer, at [_____] India [Note 4];
(b) upon the Contractor, at [_____] India [Note 4].

7. The Employer and the Contractor may change their respective nominated addresses for service of documents to another address in India but only by prior written notice to each other. All notices must be in writing.
8. This Warranty shall be governed by and construed according to the laws for the time being in force in India.
9.

   (1) Any dispute or difference of any kind whatsoever between the Employer and the Contractor arising under out of or in connection with this Warranty shall be referred to arbitration in accordance with the Conciliation and Arbitration rules set out in the General Conditions of Contract. “Dispute” as defined in the Contract shall be deemed to include any such dispute or difference between the Employer and Contractor.
   (2) In the event that the Employer is of the opinion that the issues in such a dispute or difference will or may touch upon or concern a dispute or difference arising under out of or in connection with the Contract (“the Contract Dispute”) then provided that an arbitrator has not already been appointed pursuant to Clause 9(1), the Employer may by notice in writing to the Contractor require and the Contractor shall be deemed to

have consented to the referral of such dispute or difference to the arbitrator to whom the Contract Dispute has been or will be referred.

(3) Save as expressly otherwise provided, the arbitrator shall have full power to open up, review and revise any decision, opinion, instruction, notice, order, direction, withholding of approval or consent, determination, certificate, statement of objections relating to the dispute.

(4) Subject to the foregoing provisions of this Clause 9, the Employer and the Contractor agree to submit to the jurisdiction of the Courts of India at Grurugram, Haryana.

IN WITNESS where of this Warranty has been executed as a deed on the date written at the head hereof.

THE COMMON SEAL of)

[_____])

was affixed hereto)

in the presence of:)

Notes: (for preparation of but not for inclusion in the engrossment of this Warranty)

(1) If the Contractor comprises more than one company, each such company shall be a party and liability under this warranty will be joint and several, with consequential grammatical changes.
(2) If Note 1 applies, that fact and the joint venture or other relevant agreement must be recited.
(3) Delete if Note 1 does not apply.
(4) The address for service shall be in India.

FINANCIAL PART (PDF FILE)

To be signed and uploaded with BOQ (MS Excel File) as FINANCIAL PART of the Tender by the Tenderer.

Letter of Tender – Financial Part

INSTRUCTIONS TO TENDERERS: DELETE THIS BOX ONCE YOU HAVE COMPLETED THE DOCUMENT

The Tenderer must prepare this Letter of Tender on stationery with its letterhead clearly showing the Tenderer's complete name and business address.

Note: All italicized text is to help Tenderers in preparing this form.

Date of this Tender submission: [*insert date (as day, month and year) of Tender submission*]
Tender No.: [*insert tender reference number*]
Alternative No.: [*insert reference number if this is a Tender for an alternative*]

To: **[*insert complete name of Employer*]**

We, the undersigned, hereby submit the second part of our Tender, the Tender Price and Price Schedule. This accompanies the Letter of Tender – Technical Part.

In submitting our Tender, we declare that:

(a) **Tender Validity Period**: Our Tender shall be valid for the period specified in TDS 18.1 (as amended, if applicable) from the date fixed for the Tender submission deadline specified in TDS 22.1 (as amended, if applicable), and it shall remain binding upon us and may be accepted at any time before the expiration of that period;

(b) ****Tender Price:** The total price of our Tender including Provisional Sum is: [*insert the total price of the Tender in words and figures in INR*];

(c) **Commissions, Gratuities, Fees:** We have paid, or will pay the following commissions, gratuities, or fees with respect to the Tendering process or execution of the Contract: *[insert complete name of each Recipient, its full address, the reason for which each commission or gratuity was paid and the amount and currency of each such commission or gratuity]*

Name of Recipient	Address	Reason	Amount

(If none has been paid or is to be paid, indicate "none.")

Name of the Tenderer: [*insert complete name of the Tenderer*]

Name of the person duly authorized to sign the Tender on behalf of the Tenderer: *[*insert complete name of person duly authorized to sign the Tender*]

Title of the person signing the Tender: [*insert complete title of the person signing the Tender*]

Signature of the person named above: [*insert signature of person whose name and capacity are shown above*]

Date signed [*insert date of signing*] **day of** [*insert month*], [*insert year*]

*: Person signing the Tender shall have the power of attorney given by the Tenderer. The power of attorney shall be attached with the Letter of Tender.

** The total price of Tender including Provisional Sums quoted in this Letter of Tender-Financial Part shall be same as given in Worksheet BOQ3 (Price Schedule –Summary Sheet) of MS-Excel File which includes cost of Schedule 'A" plus Schedule 'B' plus Schedule 'C' plus Schedule 'D' and plus Provisional Sum.

Appendix A to Financial Part: Schedule of Adjustment Data

1. Price adjustment

1.1 The amounts payable to the Contractor for Works shall be adjusted in accordance with the provisions of this Clause 1.0, Sub-Clause 13.7 of GCC and Sub-Clause 13.7, Specific Provision, Part B, Section IX-PCC.

1.2 The Contract Price shall be adjusted for increase or decrease in rates and prices of labour, materials, fuel and lubricants, equipment, Machinery, Plant and other Materials or inputs in accordance with the principles, procedures and formulae specified below:

a) Base month for the purpose of Price Adjustment shall be the month in which the Tender is opened for Civil Works and General Electrical Services Works. The 1st Quarter will start from Base month;

b) For Schedule-A, Price adjustment shall be applied on completion of the specified stage of the respective item of work.

c) Adjustment for each item of work/stage shall be made separately;

d) The following expressions and meanings are assigned to the value of the work done for Civil works:

EW = Value of work done for the completion of a stage under the Cost Centre 'CE' of Price Schedule 'A' ;

BR = Value of work done for the completion of a stage under the Cost Centre 'CB' of Price Schedule 'A';

STN = Value of work done for the completion of a stage under Cost Centre CS of Price Schedule 'A';

CW = Value of work done under Price Schedule 'B';

MISC = Value of work done under Price Schedule 'D';

The following expressions and meanings are assigned to the Cost Centre of Price Schedule 'A':

Cost Centre	Description of Cost Centre
1	**2**
CE	Earthwork and blanketing
CB	Bridges
CS	Station

e) Price adjustment for change in costs of civil works shall be paid in accordance with the following formula:

i) VEW= 0.85 EW x [PLB x (LBi – LBo)/LBo + PF x (Fi –Fo)/Fo + PMACH x (MACHi – MACHo)/MACHo + POTH x (OTHi - OTHo)/OTHo];

ii) VBR = 0.85 BR x [PLB x (LBi – LBo)/LBo + PC x (Ci – Co)/Co + PS x (Si – So)/So + PF x (Fi – Fo)/Fo + PMACH x (MACHi – MACHo)/MACHo + POTH x (OTHi - OTHo)/OTHo];

iii) VSTN = 0.85 STN x [PLB x (LBi – LBo)/LBo + PC x (Ci – Co)/Co + PS x(Si – So)/So + PF x (Fi – Fo)/Fo + PMACH x ((MACHi – MACHo)/MACHo + POTH x (OTHi - OTHo)/OTHo];

iv) VCW = 0.85 RW x [PLB x (LBi – LBo)/LBo + PC x (Ci – Co)/Co + PS x (Si – So)/So + PF x (Fi – Fo)/Fo + PMACH x (MACHi – MACHo)/MACHo + POTH x (OTHi - OTHo)/OTHo];

v) VMISC= 0.85 MISC x [PLB x (LBi – LBo)/LBo + PF x (Fi –Fo)/Fo + PMACH x (MACHi – MACHo)/MACHo + POTH x (OTHi - OTHo)/OTHo];

Where

VEW = Increase or decrease in the cost under the Cost Centre 'CE' of Price Schedule 'A' during the period under consideration due to changes in the rates for relevant components as specified in sub-paragraph (f);

VBR = Increase or decrease in the cost of Cost Centre 'CB' of Price Schedule 'A' during the period under consideration due to changes in the rates for relevant components as specified in sub-paragraph (f);

VSTN = Increase or decrease in the cost of Cost Centre 'CS' of Price Schedule 'A' during the period under consideration due to changes in the rates for relevant components as specified in sub-paragraph (f);

VCW = Increase or decrease in the cost of work done under Price Schedule 'B' during the period under consideration due to changes in the rates for relevant components as specified in sub-paragraph (f);

VMISC = Increase or decrease in the cost of work done under Price Schedule 'C' during the period under consideration due to changes in the rates for relevant components as specified in sub-paragraph (f);

PC, PF, PLB, PMACH, POTH and PS are the percentages of cement, fuel and lubricants, labour, Plant Machinery and tools, other materials, and steel/ steel components (including strands and steel cables), respectively for the relevant item as specified in sub-paragraph (f);

Co = The wholesale price index as published by the Ministry of Commerce and Industry, Government of India (hereinafter called "WPI") for sub-group Cement, Lime & Plaster for the Base Month;

Ci = The WPI for sub-group Cement, Lime & Plaster for the average price index of the 3 months of the quarter under consideration;

Fo = The wholesale price index as published by the Ministry of Commerce and Industry, Government of India (hereinafter called "WPI") for group Fuel & Power for the Base Month;

Fi = The WPI for group Fuel & Power for the average price index of the 3 months of the quarter under consideration

LBo = The consumer price index for industrial workers – All India, published by Labour Bureau, Ministry of Labour, Government of India, (hereinafter called "CPI") for the Base Month;

LBi = The CPI for industrial workers – All India for the average price index of the 3 months of the quarter under consideration;

MACHo = The wholesale price index as published by the Ministry of Commerce and Industry, Government of India (hereinafter called "WPI") for category- k "Manufacturing of Machinery for Mining, quarrying and construction' under (R) Manufacturing of Machinery and Equipment for the Base Month;

MACHi = The WPI for category- k "Manufacturing of Machinery for Mining, quarrying and construction' under (R) Manufacturing of Machinery and Equipment for the average price index of the 3 months of the quarter under consideration;

OTHo = The wholesale price index as published by the Ministry of Commerce and Industry, Government of India (hereinafter called "WPI") for all commodities for the Base Month;

OTHi = The WPI for all commodities for the average price index of the 3 months of the quarter under consideration;

So = Average Rate of RINL for Rebar 8 mm (coil) as published for Ludhiana Branch on their website for the Base Month;

Si = Average rate of RINL for Rebar 8 mm (coil) as published for Ludhiana Branch on their website for the 3 months of the quarter under consideration;

If only one rate is published for the 3 months of the quarter under consideration, the published rate for that quarter shall be considered for the quarter under consideration.

If no rate is published by RINL for Rebar 8mm (coil) for the 3 months of the quarter under consideration, the value of Si and So will be taken as under:

"So": Wholesale Price Index for 'MS Bright Bars' individual commodity of group item (d) Mild Steel- Long products under (N) MANUFACTURE OF BASIC METALS, published by Office of Economic Adviser, Government of India, Ministry of Commerce & Industry Department of Industrial Policy & Promotion (DIIP) for the Base Month;

"Si": Average Wholesale Price Index for 'MS Bright Bars' individual commodity of group item (d) Mild Steel- Long products under (N) MANUFACTURE OF BASIC METAL, published by Office of Economic Adviser, Government of India, Ministry of Commerce & Industry Department of Industrial Policy & Promotion (DIIP) for the 3 months of the quarter under consideration;

f) The following percentages shall govern the price adjustment of the Contract Price for costs of civil works:

Component	EW (Cost Centre CE of Price Schedule 'A')	BR (Cost Centre CB of Price Schedule 'A')	STN (Cost Centre CS of Price Schedule 'A')	CW (Price Schedule 'B')	MISC (Price Schedule 'D')
(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Cement (PC)	-	20%	15%	20%	-
Fuel and lubricants (PF)	30%	20%	15%	20%	30%
Labour (PLB)	20%	10%	25%	10%	20%
Machinery and Plants (PMACH)	40%	15%	05%	15%	40%
Other Materials (POTH)	10%	10%	20%	10%	10%
Steel (PS)	-	25%	20%	25%	-
Total	100%	100%	100%	100%	100%

g) The following expressions and meanings are assigned to the value of the work done for Various General Electrical Services works:

i) **ELEGWK** = Value of work done for General Electrical Services under Price Schedule 'C';

h) Price adjustment for changes in cost for various General Electrical Services works shall be paid in accordance with the following formula:

i) **VELEGWK** = 0.85 ELEGWK x [PLB x (LBi – LBo)/LBo + POTH x (OTHi – OTHo)/OTHo]

Where: -

VELEGWK = Increase or decrease in the cost of work done under Price Schedule 'C' of '**General Electrical Services works'** with complete accessories during the period under consideration due to changes in the rates for relevant components as specified in sub-paragraph (i);

PLB and POTH are the percentages of Labor and, All Other Commodities respectively for the relevant item as specified in sub-paragraph (i);

LBo = The consumer price index for industrial workers – All India, published by Labour Bureau, Ministry of Labour, Government of India, (hereinafter called "CPI") for the Base month;

LBi = The CPI for industrial workers – All India for the average price index of the 3 months of the quarter under consideration

OTHo = The wholesale price index as published by the Ministry of Commerce and Industry, Government of India (hereinafter called "WPI") for "All commodities" for the Base month;

OTHi = The WPI for all commodities for the average price index of the 3 months of the quarter under consideration;

i) The following percentages shall govern the price adjustment of the Contract Price for Various General Electrical Services works:

Component	**General Electrical**
Labour (PLB)	20%
All other commodities (POTH)	80 %
Total	100.00%

Table A. Foreign Currency (FC)

Not applicable as Tenderers are required to quote rates and prices only in INR.

Table B. Summary of Payment Currencies

For ……. [insert name of Works]

Name of Payment Currency	A Amount of Currency	B Rate of Exchange (local currency per unit of foreign)	C Local Currency Equivalent C = A x B	D Percentage of Net Tender Price (NTP) 100xC / NTP
For Schedule 'A'				
Local currency (INR)		**1.00**		
USD ($)				
EUR (€)				
JPY (¥)				
Schedule 'B'		**1.00**		
Schedule 'C'		**1.00**		
Schedule 'D'		**1.00**		
Net Tender Price				**100.00**
Provisional Sums Expressed in Local Currency (INR) in million	100,000,000.00	**1.00**	100,000,000.00	**Not Applicable**
TOTAL TENDER PRICE (including provisional sum)				

Note: *The Tenderer is required to propose and submit the schedules given in tables above as part of the Tender. The rates of exchange shall be the reference rate twenty-eight (28) days prior to the deadline for submission of Tenders published by the Reserve Bank of India (RBI) on its website https://www.rbi.org.in . In case the exchange rate of particular currency on given date is not available on RBI web site, it will be as per the web site https://www.fbil.org.in of Financial Benchmark India Private Limited (FBIL).*

Appendix B to Financial Part: Price Schedules

1 Preamble

1.1. The Price Schedules shall be read in conjunction with the Instructions to Tenderers, the General Conditions, the Particular Conditions and the Employer's Requirements (*General, Functional, Design (Civil), Construction (Civil), Outline Design Specifications (ODS)- Civil, Outline Construction Specifications (OCS)-Civil, General Electrical Services, Tender Drawings and Documents*) and the Addenda (if any).

1.2. **Schedule 'A'** comprises scope of work to be executed under lump sum contract as detailed in Part 2- Employers' Requirements of Tender Document. *Cost of Schedule 'A' also includes cost of tree cutting for entire package C-23 as per Sub-Clause 10.14 of Appendix 10, Section VII-9: Appendices, Part 2 -Employer's Requirements of Tender Documents.* The Tenderer has to quote a single lump sum amount against Schedule 'A'. Payment to the Contractor will be made in accordance with payment stages/Milestones defined for each Cost Centre detailed in Clause 5.0 below unless otherwise specified in the Contract.

1.3. **Schedule 'B' -**Retaining Wall, Bridges and other civil works:

Schedule 'B' comprises *of four parts i.e. Schedule B1, B2, B3 and B4. Schedule 'B1' comprises items based on NWR USSOR-2019. Schedule B2 comprises items based on NR USSOR-2010 mainly for building works. Schedule B3 comprises items based on DSR 2021. Schedule B4 contains Non-Schedule items. Cost of design and drawings of all the temporary works, temporary road diversion is deemed to be included in the rates quoted for the relevant item of Schedule 'B' unless otherwise specified in the Contract.* The Tenderer has to quote the percentage Excess (+) or Less (-) over the total Estimated amount of Schedule 'B' *(which is shown as "Estimated Rate" against Schedule 'B' in BOQ2 of MS excel file on e- procurement portal)*. The payment against this Schedule 'B' will be made on the basis of quantities executed, measured and certified. Under this Schedule, the Contractor is required to carry out all works of retaining walls, bridges and other civil works, which are not covered in Schedule 'A', as per site requirements and as per the direction of the Engineer.

1.4. **Schedule 'C'** comprises of percentage rate for "General Electrical Services works". The Tenderer has to quote the percentage Excess (+) or Less (-) over the total Estimated amount of Schedule 'C' *(which is shown as "Estimated Rate" against Schedule 'C' in BOQ2 of MS excel file on e procurement portal). The quoted rate includes the cost of design and drawings of relevant systems and items as specified in the Contract Documents.* The payment against this Schedule 'C' will be made on the basis of quantities executed, measured and certified. Under this Schedule, the Contractor is required to carry out all works of General Electrical Services works, which are not covered in Schedule 'A' or Schedule 'B', as per site requirements and as per the direction of the Engineer.

1.5. **Schedule 'D'** comprises "Item rates for miscellaneous works". Under this Schedule, the Contractor has to undertake items or works not covered in Schedule ´A' or Schedule ´B' or

Schedule ´C'. Execution of items under this Schedule shall be carried out only after specific instructions of the Engineer. This Schedule consists of items for Civil works. The work has to be carried out as per Schedule of items given in this Schedule 'D'. This Schedule contains only Rate and Unit of items of the works. The basis of payment will be the actual quantities of work ordered and carried out, as measured by the Contractor and verified by the Engineer and valued at the rates and prices quoted in the Price Schedules. The Tenderer has to quote the percentage (%) Excess (+) or Less (-) *over the total Estimated Cost of Schedule 'D' (which is shown as "Estimated Rate" against Schedule 'D' in BOQ2 of MS excel file on e procurement portal)* for items to be executed against this head.

1.6. The Schedules may not generally give a full description of the works to be performed and the plant or equipment to be supplied under each item. Tenderers shall be deemed to have read the Employer's Requirements and the other sections of the Tender Documents and reviewed the Drawings to ascertain the full scope of the requirements included in each item prior to filling the rates and prices.

1.7. The price quoted in the Price Schedules for Schedule 'A', Schedule 'B' Schedule 'C' and Schedule 'D' are for complete and finished items of the work in all respects. The Price quoted in the Price Schedules shall, except otherwise specifically provided, shall include all design, include all necessary survey work, plants , tools, machinery, Contractor's equipment, labour, compliance of labour laws, supervision, materials, transportation, handling, loading & unloading, storage, sampling, testing, fuel, oil, consumables, electric power, water, all leads & lifts, dewatering, all temporary works including temporary accesses, staging, form works and false works, stacking, provision and maintenance of all temporary works area, construction of temporary store and buildings, fencing, barricading, lighting, drainage arrangements, erection & maintenance of inspection facilities above and below ground such as brick, concrete and steel etc., reinstatement, remedy of any defects during the Defects Notification Period, safety measures for workmen and road users, preparation of design and drawings pertaining to permanent and temporary works, & *temporary diversion works, temporary road widening,* traffic diversion works, mobilisation and demobilisation, establishment and overhead charges, labour camps, insurance cost for labour and works, contractor's profit, all taxes including Goods and Service Tax (GST), insurance, royalties, duties, cess, octroi, other levies and other charges together with all general risks, liabilities and obligations set out or implied in the Contract.

The price and rates quoted by Tenderer shall be deemed to have included GST at the rate of 18% as notified by 47th GST Council on 29th June 2022 ***and Item 18.5 of Circular No. 177/09/2022-TRU dated 03rd August 2022 issued by Ministry of Finance, Government of India*****.**

1.8. The whole cost of complying with the provisions of the Contract shall be included in the items provided in the Price Schedules, and where no items are provided, the cost shall be deemed to be distributed among the rates and prices entered for the related items of the Work.

1.9. To the extent acceptable to the Employer for the purpose of making payments or partial payments, valuing variations or evaluating claims, or for such other purposes as the Engineer may reasonably require, the Contractor may provide the Engineer with a breakdown of any composite or lump sum items included in the Schedules.

1.10. The Provisional Sums included and so designated in the Price Schedules shall be expended in whole or in part at the direction and discretion of the Engineer. The Provisional Sum shall be used to cover the Employer's share of the DAAB members' fees and expenses, in accordance with Clause 21. No prior instruction of the Engineer shall be required with respect to the work of the DAAB in accordance with Sub-Clause 13.4 of Part B-Specific Provisions - Particular Conditions of Contract. The Contractor shall submit the DAAB members' invoices and satisfactory evidence of having paid 100% of such invoices as part of the substantiation of those statements submitted under Sub-Clause 14.3. in accordance with Sub-Clauses 13.4 of the General Conditions.

1.11. The prices shall be quoted against Schedule 'A', Schedule 'B', Schedule 'C' and Schedule 'D' in the Price Schedule (Excel Workbook) uploaded on the e-Procurement portal.

1.12. The prices quoted shall be comprehensive and must include for complying in all respects with the Price Schedules, Instruction to Tenderers, the General Conditions, the Particular Conditions, Employer's Requirements, Specifications and Drawings and for all matters and things necessary for the proper construction, completion, and making good of any defect in part or of the whole of the Works.

1.13. No claims for additional payment shall be allowed for any error or misunderstanding by the Contractor of the work involved.

1.14. *The rates quoted by the Tenderer are for design and construction of the Works as per approved Alignment Plan & L-Section , approved GADs of bridges and approved drawings of other structures as per Scope of the Works.*

2 Variations in Price Schedule 'A', Schedule 'B' Schedule 'C' and Schedule 'D'

2.1 Variations in Price Schedules shall be dealt in accordance with Sub Clause 13.3.1 of Part B-Specific Provisions, Section IX- Particular Conditions of Contract.

2.2 The through Chainages mentioned in the Scope of the Works/Tender Drawings can undergo some minor corrections, without any impact on the overall length/Scope of the Works.

3 Measurement and Payment

3.1 The measurement shall be made as per Price Schedules i.e. Schedule 'A'. Schedule 'B' Schedule 'C' and Schedule 'D' and other relevant provisions of the Contract such as Employer's Requirements and the Drawings.

3.2 If during execution of the Contract, it is decided by the Employer/Engineer that one or more items of Work/Milestone of a Cost Centre in a particular Price Schedule is not required to be

executed, the proportionate amount against that particular Item of Work/Milestones shall not be paid. The Engineer's decision in this regard shall be final.

3.3 The Payment shall be made as per Clause 14 [Contract Price and Payment] of the General Conditions and Particular Conditions.

3.4 The Employer shall make interim payments to the Contractor in accordance with the provisions of Sub-Clause 14.6 [Issue of Interim Payment Certificates] of the General Conditions and Particular Conditions, as certified by the Engineer on the basis of the progress achieved for the items of works/stages/Milestones of the works.

3.5 The Contractor shall base its claim for interim payment in accordance with Sub-Clause 14.3 [Application for Interim Payment] of the General Conditions and Particular Conditions for each stage for various items of work on the basis of actual progress of work executed (i.e. Milestones achieved) till the end of the month for which the payment is claimed in relation to the Contractor's total executed quantity, supported with documents and updated programme in accordance with the Employer's Requirements.

3.6 The Employer may carry out necessary tests, either directly or through an independent agency, of the Works done by the Contractor for which payment has been accepted and certified by the Engineer. The payment shall depend upon the outcome of such tests.

3.7 Format for the Contractor's application for payment shall be agreed between the Engineer and the Contractor.

3.8 All necessary supplementary details to support progress claims, including all certified Request for Inspection in hard bound copy, shall be included with application for payment. Sketches, drawings, approvals, calculations, test reports etc. shall accompany an application for payment to be substantiated and certified by the Engineer and submitted to the Employer.

3.9 Even if no work is executed during the month, or the Contractor does not choose to issue an application for payment, a 'NIL' application shall be submitted.

3.10 For the purposes of payment, the Contractor shall submit to the Engineer a detailed Price Schedule indicating a further breakdown for each stage of payment contained in the Price Schedules within forty-two (42) days after the receipt of the Letter of Acceptance. Such cost breakdowns shall be subject to approval of the Engineer who shall review and evaluate with comments and/or issue approval within twenty-eight (28) days of receipt of same. The Contractor shall resubmit the cost breakdown structure corresponding to the Engineer's comments for review, if required.

3.11 The Engineer is not obliged to issue an Interim Payment Certificate until such breakdown structure of payment schedule has been submitted and accepted by the Engineer.

4 Methodology for Claiming Payment

4.1 The Contractor shall prepare his monthly application for payment in the agreed format in two hard copies and one soft copy. This shall be accompanied by supplementary details in accordance with Sub-Clause 14.3 [Application for Interim Payment Certificates] of the

General Conditions. All hard copies shall bear the original signatures of the Contractor's Representative and be submitted to the Engineer.

4.2 If these are found in order, in accordance with Sub-Clause 14.6 [Issue of Interim Payment Certificates] of the General Conditions, then the Engineer shall forward two certified copies of the application along with certified supplementary details to the Employer, with his recommendation for payment; otherwise, all documents shall be returned to the Contractor for rectification and resubmission.

***5* Price Schedule**

5.1 Schedule "A'- Breakup of Lump Sum cost of Works under various Sub-Heads shall be as follows:

Sub-Head	Description	Percentage of the quoted lump sum cost of Schedule 'A'	No. of Cost Centre	Total Cost of each Sub-Head
1	**2**	**3**	**4**	**5**
C	Civil works	100	4	C= 1xLS*

*LS = Total lump sum accepted cost of Works for Schedule 'A'

5.2 Apportionment of Contract Price for payments under various Cost Centre for Sub-Head 'C'- Civil Works

Cost Centre	Description of Cost Centre	Percentage of Cost Centre 'C'	Total Cost of Cost Centre	Total Cost of Sub-Head 'C'
1	**2**	**3**	**4**	**5**
CD	Design and As Built Drawing & Documents	*01.00%*	CD= *0.01*x 'C'	100% of SCH 'A'
CE	Earthwork and blanketing	*51.00%*	CE=*0.51*x 'C'	
CB	Bridges	*41.00%*	CE=*0.41*x 'C'	
CS	Station	*07.00%*	CE=*0.07*x 'C'	
	Total	100%		

Note: Value of 'C' shall be as defined in Sub-Clause 5.1 above.

The percentage figures as filled in column (3) for the apportionment of the Contract Price for completion of the Works corresponding to the various Sub-Heads and Cost Centres are fixed and payment will be released for different Cost centre as per above percentage break-up of Contract Price.

5.2.1 Stages of Payment i.e. Milestones of Cost Centre 'CD'- Design and As Built Drawing & Documents

Cost Centre			CD- Design and As Built Drawing & Documents	
Weightage of Cost Centre 'CD', (Y)			1%	
Sub Cost Centre	Item of Work		Milestone	Weightage (X)
	No.	Description		
1	2	3	4	5
CD1- Design	**CD1.1**	**Preliminary design**	Preliminary Design	7%
	CD1.2	**Formation**	Definitive design & Good for Construction Drawings (GFC)	7%
	CD1.3	**Minor Bridges**		
	CD1.3.1		Preparation & approval of GADs	10%
	CD1.3.2		Definitive Design	8%
	CD1.3.3		Good For Construction (GFC)	10%
	CD1.4	**Major Bridges**		
	CD1.4.1		Preparation & approval of GADs	6%
	CD1.4.2		Definitive Design	7%
	CD1.4.3		Good For Construction (GFC)	8%
	CD1.5	**Retaining Walls**		
	CD1.5.1		Definitive Design	3.5%
	CD1.5.2		Good For Construction (GFC)	3.5%
	CD1.6	**Stations**		
	CD1.6.1		Preparation & approval of Architectural Drawings	4%
	CD1.6.2		Definitive Design	3%
	CD1.6.3		Combined Services Drawings & MEP Drawings	5%
	CD1.6.4		Good For Construction (GFC) Drawings	3%
CD2- As Built Drawing & Documents	CD 2.1	As Built Drawings	Submission of As Built Drawings	10%
	CD 2.2	As Built Documents	Submission of As Built Documents	5%
			Total	**100%**

Note:

1. The value of each Milestones will be total lump sum accepted cost of Works for Schedule 'A' (LS) multiplied by X * Y. For example, the value of Milestone CD 1.3.2 will be equal to LS*X*Y= LSx0.08x0.01.
2. Adjustment to Contract Price pursuant to GCC 13.7 shall **NOT** be applicable to the payments of Works executed under this Cost Centre.
3. All minor bridges shall have equal weightage. Payment of each stage/Milestones shall be made on pro rata basis on completion of a stage for a bridge.
4. All major bridges shall have equal weightage. Payment of each stage/Milestones shall be made on pro rata basis on completion of a stage for a bridge.
5. All stations shall have equal weightage. Payment of each stage/Milestones shall be made on pro rata basis on completion of a stage for a station.
6. Payment will be made on Completion of each Milestones as per weightage given in this Cost Centre
7. *The Cost of Milestones include cost of design of the formation, Bridges, retaining wall, Structure, included in Schedule 'A' and Schedule 'B' as mentioned in Section VII-2, Employer's Requirements.*

5.2.2 Stages of Payment i.e. Milestones of Cost Centre 'CE'- Earthwork and Blanketing

Cost Centre			**CE-Earthwork and Blanketing**	
Weightage of Cost Centre 'CE', (Y)			**51.0%**	
Sub-Cost Centre	**Item of Work**		**Milestone**	**Weightage (X)**
	No.	**Description**		
1	2	3	4	5
CE.1- Earthwork	CE.1.1	Earthwork in formation from Ch 55600 to 56000 for double main line track.		
	CE.1.1.1		Earthwork in embankment / cutting including compaction.	2.16%
	CE.1.1.2		On cutting of extra width & dressing of slopes in profile, compaction, *providing vegetative cover including coir netting (where specified) and* drainage arrangement complete in all respects.	0.3%
	CE.1.1.3		On completion of maintenance *of slopes, drainage system & vegetative cover* for a period of 12 months *and after ensuring that vegetative cover* is properly rooted .	0.1%
	CE.1.2	Earthwork in formation from Ch 56000 to 57000 for double main line track.		
	CE.1.2.1		Earthwork in embankment/ cutting including compaction.	7.0%
	CE.1.2.2		On cutting of extra width & dressing of slopes in profile, compaction, *providing vegetative cover including coir netting (where specified) and* drainage arrangement complete in all respects.	0.7%
	CE.1.2.3		On completion of maintenance *of slopes, drainage system & vegetative cover* for a period of 12 months *and after ensuring that vegetative cover* is properly rooted .	0.18%

Cost Centre			CE-Earthwork and Blanketing	
Weightage of Cost Centre 'CE', (Y)			51.0%	
Sub-Cost Centre	Item of Work		Milestone	Weightage (X)
	No.	Description		
1	2	3	4	5
	CE.1.3	Earthwork in formation from Ch 57000 to 58000 for main line, loop line, connecting lines & platform area in New Patli station yard.		
	CE.1.3.1		Earthwork in embankment / cutting including compaction.	6.14%
	CE.1.3.2		On cutting of extra width & dressing of slopes in profile, compaction, *providing vegetative cover including coir netting (where specified) and* drainage arrangement complete in all respects.	0.4%
	CE.1.3.3		On completion of maintenance *of slopes, drainage system & vegetative cover* for a period of 12 months *and after ensuring that vegetative cover* is properly rooted .	0.2%
	CE.1.4	Earthwork in formation from Ch 58000 to 58700 in New Patli yard for main, loop & connecting lines and platform area		
	CE.1.4.1		Earthwork in embankment / cutting including compaction.	5.05%
	CE.1.4.2		On cutting of extra width & dressing of slopes in profile, compaction, *providing vegetative cover including coir netting (where specified) and* drainage arrangement complete in all respects.	0.3%
	CE.1.4.3		On completion of maintenance *of slopes, drainage system & vegetative cover* for a period of 12	0.15%

Cost Centre			CE-Earthwork and Blanketing	
Weightage of Cost Centre 'CE', (Y)			51.0%	
Sub-Cost Centre	Item of Work		Milestone	Weightage (X)
	No.	Description		
1	2	3	4	5
			months *and after ensuring that vegetative cover* is properly rooted .	
	CE.1.5	Earthwork in formation from Ch 58700 to 60000 for double main line & connecting line track.		
	CE.1.5.1		Earthwork in embankment / cutting including compaction.	4.21%
	CE.1.5.2		On cutting of extra width & dressing of slopes in profile, compaction, *providing vegetative cover including coir netting (where specified) and* drainage arrangement complete in all respects.	0.3%
	CE.1.5.3		On completion of maintenance *of slopes, drainage system & vegetative cover* for a period of 12 months *and after ensuring that vegetative cover* is properly rooted .	0.15%
	CE.1.6	Earthwork in formation from Ch 60000 to 61000 for double main line track.		
	CE.1.6.1		Earthwork in embankment / cutting including compaction.	3.21%
	CE.1.6.2		On cutting of extra width & dressing of slopes in profile, compaction, *providing vegetative cover including coir netting (where specified) and* drainage arrangement complete in all respects.	0.3%
	CE.1.6.3		On completion of maintenance *of slopes, drainage system & vegetative cover* for a period of 12	0.1%

Cost Centre			CE-Earthwork and Blanketing	
Weightage of Cost Centre 'CE', (Y)			51.0%	
Sub-Cost Centre	Item of Work		Milestone	Weightage (X)
	No.	Description		
1	2	3	4	5
			months *and after ensuring that vegetative cover* is properly rooted .	
	CE.1.7	Earthwork in formation from Ch 61000 to 61500 for doble main line track.		
	CE.1.7.1		Earthwork in embankment / cutting including compaction.	1.67%
	CE.1.7.2		On cutting of extra width & dressing of slopes in profile, compaction, *providing vegetative cover including coir netting (where specified) and* drainage arrangement complete in all respects.	0.25%
	CE.1.7.3		On completion of maintenance *of slopes, drainage system & vegetative cover* for a period of 12 months *and after ensuring that vegetative cover* is properly rooted .	0.1%
	CE.1.8	Earthwork in formation from Ch 29600 to 30000 for double main line track.		
	CE.1.8.1		Earthwork in embankment / cutting including compaction.	0.5%
	CE.1.8.2		On cutting of extra width & dressing of slopes in profile, compaction, *providing vegetative cover including coir netting (where specified) and* drainage arrangement complete in all respects.	0.36%
	CE.1.8.3		On completion of maintenance *of slopes, drainage system & vegetative cover* for a period of 12 months *and after ensuring that vegetative cover* is properly rooted .	0.09%

Cost Centre			CE-Earthwork and Blanketing	
Weightage of Cost Centre 'CE', (Y)			51.0%	
Sub-Cost Centre	Item of Work		Milestone	Weightage (X)
	No.	Description		
1	2	3	4	5
	CE.1.9	Earthwork in formation from Ch 30000 to 31000 for double main line track.		
	CE.1.9.1		Earthwork in embankment / cutting including compaction.	0.4%
	CE.1.9.2		On cutting of extra width & dressing of slopes in profile, compaction, *providing vegetative cover including coir netting (where specified) and* drainage arrangement complete in all respects.	0.65%
	CE.1.9.3		On completion of maintenance *of slopes, drainage system & vegetative cover* for a period of 12 months *and after ensuring that vegetative cover* is properly rooted .	0.13%
	CE.1.10	Earthwork in formation from Ch 31000 to 32000 for double main line track.		
	CE.1.10.1		Earthwork in embankment / cutting including compaction.	0.04%
	CE.1.10.2		On cutting of extra width & dressing of slopes in profile, compaction, *providing vegetative cover including coir netting (where specified) and* drainage arrangement complete in all respects.	0%
	CE.1.10.3		On completion of maintenance *of slopes, drainage system & vegetative cover* for a period of 12 months *and after ensuring that vegetative cover* is properly rooted .	0%
	CE.1.11	Earthwork in formation from Ch 32000 to 33000 for		

Cost Centre			CE-Earthwork and Blanketing	
Weightage of Cost Centre 'CE', (Y)			51.0%	
Sub-Cost Centre	Item of Work		Milestone	Weightage (X)
	No.	Description		
1	2	3	4	5
		main line, loop lines, including platform area in Dhulawat station yard.		
	CE.1.11.1		Earthwork in embankment / cutting including compaction.	0.9%
	CE.1.11.2		On cutting of extra width & dressing of slopes in profile, compaction, *providing vegetative cover including coir netting (where specified) and* drainage arrangement complete in all respects.	0.05%
	CE.1.11.3		On completion of maintenance *of slopes, drainage system & vegetative cover* for a period of 12 months *and after ensuring that vegetative cover* is properly rooted .	0.1%
	CE.1.12	Earthwork in formation from Ch 33000 to 34000 for main line, loop lines, including platform area in Dhulawat station yard.		
	CE.1.12.1		Earthwork in embankment / cutting including compaction.	1.62%
	CE.1.12.2		On cutting of extra width & dressing of slopes in profile, compaction, *providing vegetative cover including coir netting (where specified) and* drainage arrangement complete in all respects.	0.2%
	CE.1.12.3		On completion of maintenance *of slopes, drainage system & vegetative cover* for a period of 12 months *and after ensuring that vegetative cover* is properly rooted .	0.1%

Cost Centre			CE-Earthwork and Blanketing	
Weightage of Cost Centre 'CE', (Y)			51.0%	
Sub-Cost Centre	Item of Work		Milestone	Weightage (X)
	No.	Description		
1	2	3	4	5
	CE.1.13	Earthwork in formation from Ch 34000 to 35000 for main line track.		
	CE.1.13.1		Earthwork in embankment / cutting including compaction.	1.16%
	CE.1.13.2		On cutting of extra width & dressing of slopes in profile, compaction, *providing vegetative cover including coir netting (where specified) and* drainage arrangement complete in all respects.	0.15%
	CE.1.13.3		On completion of maintenance *of slopes, drainage system & vegetative cover* for a period of 12 months *and after ensuring that vegetative cover* is properly rooted .	0.1%
	CE.1.14	Earthwork in formation from Ch 35000 to 36000 for main line track.		
	CE.1.14.1		Earthwork in embankment / cutting including compaction.	0.75%
	CE.1.14.2		On cutting of extra width & dressing of slopes in profile, compaction, *providing vegetative cover including coir netting (where specified) and* drainage arrangement complete in all respects.	0.1%
	CE.1.14.3		On completion of maintenance *of slopes, drainage system & vegetative cover* for a period of 12 months *and after ensuring that vegetative cover* is properly rooted .	0.1%
	CE.1.15	Earthwork in formation from Ch		

Cost Centre			CE-Earthwork and Blanketing	
Weightage of Cost Centre 'CE', (Y)			51.0%	
Sub-Cost Centre	Item of Work		Milestone	Weightage (X)
	No.	Description		
1	2	3	4	5
		36000 to 37000 for main line track.		
	CE.1.15.1		Earthwork in embankment / cutting including compaction.	1.36%
	CE.1.15.2		On cutting of extra width & dressing of slopes in profile, compaction, *providing vegetative cover including coir netting (where specified) and* drainage arrangement complete in all respects.	0.15%
	CE.1.15.3		On completion of maintenance *of slopes, drainage system & vegetative cover* for a period of 12 months *and after ensuring that vegetative cover* is properly rooted .	0.1%
	CE.1.16	Earthwork in formation from Ch 37000 to 38000 for main line track.		
	CE.1.16.1		Earthwork in embankment / cutting including compaction.	1.39%
	CE.1.16.2		On cutting of extra width & dressing of slopes in profile, compaction, *providing vegetative cover including coir netting (where specified) and* drainage arrangement complete in all respects.	0.15%
	CE.1.16.3		On completion of maintenance *of slopes, drainage system & vegetative cover* for a period of 12 months *and after ensuring that vegetative cover* is properly rooted .	0.1%

Cost Centre			CE-Earthwork and Blanketing	
Weightage of Cost Centre 'CE', (Y)			51.0%	
Sub-Cost Centre	Item of Work		Milestone	Weightage (X)
	No.	Description		
1	2	3	4	5
	CE.1.17	Earthwork in formation from Ch 38000 to 39000 for main line track.		
	CE.1.17.1		Earthwork in embankment / cutting including compaction.	1.2%
	CE.1.17.2		On cutting of extra width & dressing of slopes in profile, compaction, *providing vegetative cover including coir netting (where specified) and* drainage arrangement complete in all respects.	0.14%
	CE.1.17.3		On completion of maintenance *of slopes, drainage system & vegetative cover* for a period of 12 months *and after ensuring that vegetative cover* is properly rooted .	0.1%
	CE.1.18	Earthwork in formation from Ch 39000 to 40000 for main line track.		
	CE.1.18.1		Earthwork in embankment / cutting including compaction.	0.87%
	CE.1.18.2		On cutting of extra width & dressing of slopes in profile, compaction, *providing vegetative cover including coir netting (where specified) and* drainage arrangement complete in all respects.	0.1%
	CE.1.18.3		On completion of maintenance *of slopes, drainage system & vegetative cover* for a period of 12 months *and after ensuring that vegetative cover* is properly rooted .	0.1%

Cost Centre			CE-Earthwork and Blanketing	
Weightage of Cost Centre 'CE', (Y)			51.0%	
Sub-Cost Centre	Item of Work		Milestone	Weightage (X)
	No.	Description		
1	2	3	4	5
	CE.1.19	Earthwork in formation from Ch 40000 to 41000 for main line track.		
	CE.1.19.1		Earthwork in embankment / cutting including compaction.	0.92%
	CE.1.19.2		On cutting of extra width & dressing of slopes in profile, compaction, *providing vegetative cover including coir netting (where specified) and* drainage arrangement complete in all respects.	0.1%
	CE.1.19.3		On completion of maintenance *of slopes, drainage system & vegetative cover* for a period of 12 months *and after ensuring that vegetative cover* is properly rooted .	0.1%
	CE.1.20	Earthwork in formation from Ch 41000 to 42000 for main line track.		
	CE.1.20.1		Earthwork in embankment / cutting including compaction.	1.24%
	CE.1.20.2		On cutting of extra width & dressing of slopes in profile, compaction, *providing vegetative cover including coir netting (where specified) and* drainage arrangement complete in all respects.	0.15%
	CE.1.20.3		On completion of maintenance *of slopes, drainage system & vegetative cover* for a period of 12 months *and after ensuring that vegetative cover* is properly rooted .	0.1%
	CE.1.21	Earthwork in formation from Ch		

Cost Centre			CE-Earthwork and Blanketing	
Weightage of Cost Centre 'CE', (Y)			51.0%	
Sub-Cost Centre	Item of Work		Milestone	Weightage (X)
	No.	Description		
1	2	3	4	5
		42000 to 43000 for main line including platform area in Chandla Dungerwas station.		
	CE.1.21.1		Earthwork in embankment / cutting including compaction.	1.95%
	CE.1.21.2		On cutting of extra width & dressing of slopes in profile, compaction, *providing vegetative cover including coir netting (where specified) and* drainage arrangement complete in all respects.	0.4%
	CE.1.21.3		On completion of maintenance *of slopes, drainage system & vegetative cover* for a period of 12 months *and after ensuring that vegetative cover* is properly rooted .	0.1%
	CE.1.22	Earthwork in formation from Ch 43000 to 44000 for main line track.		
	CE.1.22.1		Earthwork in embankment / cutting including compaction.	2.15%
	CE.1.22.2		On cutting of extra width & dressing of slopes in profile, compaction, *providing vegetative cover including coir netting (where specified) and* drainage arrangement complete in all respects.	0.4%
	CE.1.22.3		On completion of maintenance *of slopes, drainage system & vegetative cover* for a period of 12 months *and after ensuring that vegetative cover* is properly rooted .	0.15%

Cost Centre			CE-Earthwork and Blanketing	
Weightage of Cost Centre 'CE', (Y)			51.0%	
Sub-Cost Centre	Item of Work		Milestone	Weightage (X)
	No.	Description		
1	2	3	4	5
	CE.1.23	Earthwork in formation from Ch 44000 to 45000 for main line track.		
	CE.1.23.1		Earthwork in embankment / cutting including compaction.	4.94%
	CE.1.23.2		On cutting of extra width & dressing of slopes in profile, compaction, *providing vegetative cover including coir netting (where specified) and* drainage arrangement complete in all respects.	0.4%
	CE.1.23.3		On completion of maintenance *of slopes, drainage system & vegetative cover* for a period of 12 months *and after ensuring that vegetative cover* is properly rooted .	0.15%
	CE.1.24	Earthwork in formation from Ch 45000 to 46000 for main line track.		
	CE.1.24.1		Earthwork in embankment / cutting including compaction.	1.6%
	CE.1.24.2		On cutting of extra width & dressing of slopes in profile, compaction, *providing vegetative cover including coir netting (where specified) and* drainage arrangement complete in all respects.	0.3%
	CE.1.24.3		On completion of maintenance *of slopes, drainage system & vegetative cover* for a period of 12 months *and after ensuring that vegetative cover* is properly rooted .	0.1%

Cost Centre			CE-Earthwork and Blanketing	
Weightage of Cost Centre 'CE', (Y)			51.0%	
Sub-Cost Centre	Item of Work		Milestone	Weightage (X)
	No.	Description		
1	2	3	4	5
	CE.1.25	Earthwork in formation from Ch 46000 to 47000 for main line including platform area in Panchgaon station.		
	CE.1.25.1		Earthwork in embankment / cutting including compaction.	6.42%
	CE.1.25.2		On cutting of extra width & dressing of slopes in profile, compaction, *providing vegetative cover including coir netting (where specified) and* drainage arrangement complete in all respects.	0.55%
	CE.1.25.3		On completion of maintenance *of slopes, drainage system & vegetative cover* for a period of 12 months *and after ensuring that vegetative cover* is properly rooted .	0.2%
	CE.1.26	Earthwork in formation from Ch 47000 to 48000 for main line track.		
	CE.1.26.1		Earthwork in embankment / cutting including compaction.	4.31%
	CE.1.26.2		On cutting of extra width & dressing of slopes in profile, compaction, *providing vegetative cover including coir netting (where specified) and* drainage arrangement complete in all respects.	0.45%
	CE.1.26.3		On completion of maintenance *of slopes, drainage system & vegetative cover* for a period of 12 months *and after ensuring that vegetative cover* is properly rooted .	0.15%

Cost Centre			CE-Earthwork and Blanketing	
Weightage of Cost Centre 'CE', (Y)			51.0%	
Sub-Cost Centre	Item of Work		Milestone	Weightage (X)
	No.	Description		
1	2	3	4	5
	CE.1.27	Earthwork in formation from Ch 48000 to 49000 for main line track.		
	CE.1.27.1		Earthwork in embankment / cutting including compaction.	1.47%
	CE.1.27.2		On cutting of extra width & dressing of slopes in profile, compaction, *providing vegetative cover including coir netting (where specified) and* drainage arrangement complete in all respects.	0.2%
	CE.1.27.3		On completion of maintenance *of slopes, drainage system & vegetative cover* for a period of 12 months *and after ensuring that vegetative cover* is properly rooted .	0.1%
	CE.1.28	Earthwork in formation from Ch 49000 to 49700 for main line track.		
	CE.1.28.1		Earthwork in embankment / cutting including compaction.	0.2%
	CE.1.28.2		On cutting of extra width & dressing of slopes in profile, compaction, *providing vegetative cover including coir netting (where specified) and* drainage arrangement complete in all respects.	0.04%
	CE.1.28.3		On completion of maintenance *of slopes, drainage system & vegetative cover* for a period of 12 months *and after ensuring that vegetative cover* is properly rooted .	0.03%

Cost Centre			CE-Earthwork and Blanketing	
Weightage of Cost Centre 'CE', (Y)			51.0%	
Sub-Cost Centre	Item of Work		Milestone	Weightage (X)
	No.	Description		
1	2	3	4	5
	CE.1.29	Earthwork in formation from Ch 0614 to 1000 for New Patli - Patli connecting line		
	CE.1.29.1		Earthwork in embankment / cutting including compaction.	0.34%
	CE.1.29.2		On cutting of extra width & dressing of slopes in profile, compaction, *providing vegetative cover including coir netting (where specified) and* drainage arrangement complete in all respects.	0.15%
	CE.1.29.3		On completion of maintenance *of slopes, drainage system & vegetative cover* for a period of 12 months *and after ensuring that vegetative cover* is properly rooted .	0.05%
	CE.1.30	Earthwork in formation from Ch 1000 to 2000 for New Patli - Patli connecting line.		
	CE.1.30.1		Earthwork in embankment / cutting including compaction.	1.15%
	CE.1.30.2		On cutting of extra width & dressing of slopes in profile, compaction, *providing vegetative cover including coir netting (where specified) and* drainage arrangement complete in all respects.	0.2%
	CE.1.30.3		On completion of maintenance *of slopes, drainage system & vegetative cover* for a period of 12 months *and after ensuring that vegetative cover* is properly rooted .	0.1%
	CE.1.31	Earthwork in formation from Ch 2000 to Ch 2700 for		

Cost Centre			CE-Earthwork and Blanketing	
Weightage of Cost Centre 'CE', (Y)			51.0%	
Sub-Cost Centre	Item of Work		Milestone	Weightage (X)
	No.	Description		
1	2	3	4	5
		New Patli-Patli connecting line		
	CE.1.31.1		Earthwork in embankment / cutting including compaction.	0.15%
	CE.1.31.2		On cutting of extra width & dressing of slopes in profile, compaction, *providing vegetative cover including coir netting (where specified) and* drainage arrangement complete in all respects.	0.02%
	CE.1.31.3		On completion of maintenance *of slopes, drainage system & vegetative cover* for a period of 12 months *and after ensuring that vegetative cover* is properly rooted .	0.0%
	CE.1.32	Earthwork in formation from Ch 0703 to 2000 for New Patli-Sultanpur connecting line		
	CE.1.32.1		Earthwork in embankment / cutting including compaction.	1.52%
	CE.1.32.2		On cutting of extra width & dressing of slopes in profile, compaction, *providing vegetative cover including coir netting (where specified) and* drainage arrangement complete in all respects.	0.2%
	CE.1.32.3		On completion of maintenance *of slopes, drainage system & vegetative cover* for a period of 12 months *and after ensuring that vegetative cover* is properly rooted .	0.1%
	CE.1.33	Earthwork in formation from Ch 2000 to 3000 for		

Cost Centre			CE-Earthwork and Blanketing	
Weightage of Cost Centre 'CE', (Y)			51.0%	
Sub-Cost Centre	Item of Work		Milestone	Weightage (X)
	No.	Description		
1	2	3	4	5
		New Patli-Sultanpur connecting line		
	CE.1.33.1		Earthwork in embankment / cutting including compaction.	0.98%
	CE.1.33.2		On cutting of extra width & dressing of slopes in profile, compaction, *providing vegetative cover including coir netting (where specified) and* drainage arrangement complete in all respects.	0.1%
	CE.1.33.3		On completion of maintenance *of slopes, drainage system & vegetative cover* for a period of 12 months *and after ensuring that vegetative cover* is properly rooted .	0.1%
	CE.1.34	Earthwork in formation from Ch 3000 to 4190 for New Patli-Sultanpur connecting line and Sultanpur station yard (Km 0861 towards Garhi Harsaru side & Km 0530 towards Badsa side & Km 0689 towards Farukhnagar side)		
	CE.1.34.1		Earthwork in embankment / cutting including compaction.	0.3%
	CE.1.34.2		On cutting of extra width & dressing of slopes in profile, compaction, *providing vegetative cover including coir netting (where specified) and* drainage arrangement complete in all respects.	0.06%

Cost Centre			CE-Earthwork and Blanketing	
Weightage of Cost Centre 'CE', (Y)			51.0%	
Sub-Cost Centre	Item of Work		Milestone	Weightage (X)
	No.	Description		
1	2	3	4	5
	CE.1.34.3		On completion of maintenance *of slopes, drainage system & vegetative cover* for a period of 12 months *and after ensuring that vegetative cover* is properly rooted .	0.06%
CE.2-Blanketing	**CE.2.1**	Blanketing from Ch 55600 to 56000 for double main line track.	Blanketing on subgrade/ prepared subgrade as per design profile including compaction complete in all respects.	0.27%
	CE.2.2	Blanketing from Ch 56000 to 57000 for double main line track.	Blanketing on subgrade/ prepared subgrade as per design profile including compaction complete in all respects.	0.57%
	CE.2.3	Blanketing from Ch 57000 to 58000 for main line, loop lines & connecting lines in New Patli station yard.	Blanketing on subgrade/ prepared subgrade as per design profile including compaction complete in all respects.	1.03%
	CE.2.4	Blanketing from Ch 58000 to 58700 for main line, loop lines & connecting lines in New Patli station yard.	Blanketing on subgrade/ prepared subgrade as per design profile including compaction complete in all respects.	0.88%
	CE.2.5	Blanketing from Ch 58700 to 60000 for main line & connecting line.	Blanketing on subgrade/ prepared subgrade as per design profile including compaction complete in all respects.	1.2%
	CE.2.6	Blanketing from Ch 60000 to 61000 for double main line track	Blanketing on subgrade/ prepared subgrade as per design profile including compaction complete in all respects.	0.56%
	CE.2.7	Blanketing from Ch 61000 to 61500 for double main line track.	Blanketing on subgrade/ prepared subgrade as per design profile including compaction complete in all respects.	0.29%
	CE.2.8	Blanketing from Ch 29600 to 30000 for	Blanketing on subgrade/ prepared subgrade as per design profile	0.27%

Cost Centre			CE-Earthwork and Blanketing	
Weightage of Cost Centre 'CE', (Y)			51.0%	
Sub-Cost Centre	Item of Work		Milestone	Weightage (X)
	No.	Description		
1	2	3	4	5
		double main line track.	including compaction complete in all respects.	
	CE.2.9	Blanketing from Ch 30000 to 31000 for double main line track.	Blanketing on subgrade/ prepared subgrade as per design profile including compaction complete in all respects.	0.56%
	CE.2.10	Blanketing from Ch 31000 to 32000 for double main line track.	Blanketing on subgrade/ prepared subgrade as per design profile including compaction complete in all respects.	0.6%
	CE.2.11	Blanketing from Ch 32000 to 33000 for main line & loop lines in Dhulawat station yard.	Blanketing on subgrade/ prepared subgrade as per design profile including compaction complete in all respects.	0.81%
	CE.2.12	Blanketing from Ch 33000 to 34000 for main line & loop lines in Dhulawat station yard.	Blanketing on subgrade/ prepared subgrade as per design profile including compaction complete in all respects.	0.69%
	CE.2.13	Blanketing from Ch 34000 to 35000 for main line track.	Blanketing on subgrade/ prepared subgrade as per design profile including compaction complete in all respects.	0.58%
	CE.2.14	Blanketing from Ch 35000 to 36000 for double main line track.	Blanketing on subgrade/ prepared subgrade as per design profile including compaction complete in all respects.	0.56%
	CE.2.15	Blanketing from Ch 36000 to 37000 for double main line track.	Blanketing on subgrade/ prepared subgrade as per design profile including compaction complete in all respects.	0.56%
	CE.2.16	Blanketing from Ch 37000 to 38000 for double main line track.	Blanketing on subgrade/ prepared subgrade as per design profile including compaction complete in all respects.	0.56%
	CE.2.17	Blanketing from Ch 38000 to 39000 for	Blanketing on subgrade/ prepared subgrade as per design profile	0.56%

Cost Centre			CE-Earthwork and Blanketing	
Weightage of Cost Centre 'CE', (Y)			51.0%	
Sub-Cost Centre	Item of Work		Milestone	Weightage (X)
	No.	Description		
1	2	3	4	5
		double main line track.	including compaction complete in all respects.	
	CE.2.18	Blanketing from Ch 39000 to 40000 for double main line track.	Blanketing on subgrade/ prepared subgrade as per design profile including compaction complete in all respects.	0.57%
	CE.2.19	Blanketing from Ch 40000 to 41000 for double main line track.	Blanketing on subgrade/ prepared subgrade as per design profile including compaction complete in all respects.	0.57%
	CE.2.20	Blanketing from Ch 41000 to 42000 for double main line track.	Blanketing on subgrade/ prepared subgrade as per design profile including compaction complete in all respects.	0.56%
	CE.2.21	Blanketing from Ch 42000 to 43000 for double main line track.	Blanketing on subgrade/ prepared subgrade as per design profile including compaction complete in all respects.	0.48%
	CE.2.22	Blanketing from Ch 43000 to 4400 for double main line track.	Blanketing on subgrade/ prepared subgrade as per design profile including compaction complete in all respects.	0.57%
	CE.2.23	Blanketing from Ch 44000 to 45000 for double main line track.	Blanketing on subgrade/ prepared subgrade as per design profile including compaction complete in all respects.	0.57%
	CE.2.24	Blanketing from Ch 45000 to 46000 for double main line track.	Blanketing on subgrade/ prepared subgrade as per design profile including compaction complete in all respects.	0.62%
	CE.2.25	Blanketing from Ch 46000 to 47000 for double main line track.	Blanketing on subgrade/ prepared subgrade as per design profile including compaction complete in all respects.	0.49%
	CE.2.26	Blanketing from Ch 47000 to 48000 for double main line track.	Blanketing on subgrade/ prepared subgrade as per design profile including compaction complete in all respects.	0.57%

Cost Centre			CE-Earthwork and Blanketing	
Weightage of Cost Centre 'CE', (Y)			51.0%	
Sub-Cost Centre	Item of Work		Milestone	Weightage (X)
	No.	Description		
1	2	3	4	5
	CE.2.27	Blanketing from Ch 48000 to 49000 for double main line track.	Blanketing on subgrade/ prepared subgrade as per design profile including compaction complete in all respects.	0.51%
	CE.2.28	Blanketing from Ch 49000 to 49700 for double main line track.	Blanketing on subgrade/ prepared subgrade as per design profile including compaction complete in all respects.	0.45%
	CE.2.29	Blanketing from Ch 0614 to 1000 for New Patli - Patli connecting line	Blanketing on subgrade/ prepared subgrade as per design profile including compaction complete in all respects.	0.06%
	CE.2.30	Blanketing from Ch 1000 to 2000 for New Patli - Patli connecting line.	Blanketing on subgrade/ prepared subgrade as per design profile including compaction complete in all respects.	0.36%
	CE.2.31	Blanketing from Ch 2000 to Ch 2700 for New Patli-Patli connecting line	Blanketing on subgrade/ prepared subgrade as per design profile including compaction complete in all respects.	0.24%
	CE.2.32	Blanketing from Ch 0703 to 2000 for New Patli-Sultanpur connecting line	Blanketing on subgrade/ prepared subgrade as per design profile including compaction complete in all respects.	0.3%
	CE.2.33	Blanketing from Ch 2000 to 3000 for New Patli-Sultanpur connecting line	Blanketing on subgrade/ prepared subgrade as per design profile including compaction complete in all respects.	0.35%
	CE.2.34	Blanketing from Ch 3000 to 4119 for New Patli-Sultanpur connecting line and in Sultanpur Station yard (Km 0861 towards Garhi Harsaru side & Km 0530 towards Badsa side& Km 0689	Blanketing on subgrade/ prepared subgrade as per design profile including compaction complete in all respects.	1.00%

Cost Centre			CE-Earthwork and Blanketing	
Weightage of Cost Centre 'CE', (Y)			51.0%	
Sub-Cost Centre	Item of Work		Milestone	Weightage (X)
	No.	Description		
1	2	3	4	5
		towards Farukhnagar side)		
			Total	**100%**

Notes:

1. *The value of each Milestones will be total lump sum accepted cost of Works for Schedule 'A' (LS) multiplied by X * Y. For example, the value of Milestone CE1.1.1 will be equal to LS*X*Y= LSx0.0216 x 0.51.*
2. Adjustment to Contract Price pursuant to GCC 13.7 shall be applicable to the payments of Works executed under this Sub Heads / Price Schedule.
3. Payment will be made on Completion of each Milestones as per weightage given in this schedule.
4. *If owing to site conditions or any other reasons, locations of retaining walls are changed or new retaining walls are constructed or retaining walls are eliminated & normal bank is provided, the variation caused in quantity of earthwork in embankment on this account shall be payable/ recoverable under Item no. NS-1 of Schedule 'B4'.*

5.2.3 Milestones of Cost Centre 'CB'- for Bridges

Cost Centre			CB- Bridges	
Weightage of Cost Centre 'CB', (Y)			41%	
Sub-cost Centre	Item of Work		Milestone	Weightage (X)
	No.	Description		
1	2	3	4	5
CB1- Minor Bridges	CB1.1	Construction of minor bridge No. Nil between Ch 55600 to 56000 for main line track.		0%
	CB.1.2	Construction of minor bridge Nos. 137,138, 139 & 140 between Ch 56000 to 57000 for main line track.	On completion of bridge works in all respects	7.34%
	CB1.3	Construction of minor bridge No. 141, 141A,142, 143 & 144 between Ch 57000 to 58000 for main line and New Patli - Patli connecting line.	On completion of bridge works in all respects	9.85%
	CB1.4	Construction of minor bridge No. 145 & 146 between ch 58000 to 58700 in New Patli yard.	On completion of bridge works in all respects	2.58%
	CB.1.5	Construction of minor bridge No. 148 between ch 58700 to 60000 for main & New Patli-Sultanpur connecting lines.	On completion of bridge works in all respects	1.20%
	CB.1.6	Construction of minor bridge No. 149 & 149A between Ch 60000 to 61000 for main line.	On completion of bridge works in all respects	1.35%
	CB1.7	Construction of minor bridge No. 154 between Ch 61000 to 61500 for main line track.	On completion of bridge works in all respects	0.36%
	CB1.8	Construction of minor bridge No. Nil between ch 29600 to 30000 for main line track.	-	0%
	CB1.9	Construction of minor bridge No. Nil between Ch 30000 to 31000 for main line track.	-	0%
	CB1.10	Construction of minor bridge No. 77 between Ch 31000 to 32000 for main line track.	On completion of bridge works in all respects	1.64%
	CB1.11	Construction of minor bridge No. 78 between Ch 32000 to 33000 for main line, loop line & platform.	On completion of bridge works in all respects	0.33%

Cost Centre			CB- Bridges	
Weightage of Cost Centre 'CB', (Y)			41%	
Sub-cost Centre	Item of Work		Milestone	Weightage (X)
	No.	Description		
1	2	3	4	5
	CB1.12	Construction of minor bridge No. 80, 81, 82 & 83 between ch 33000 to 34000 for main line, loop line & platform.	On completion of bridge works in all respects	2.25%
	CB1.13	Construction of minor bridge No. Nil between Ch 34000 to 35000 for main line track.	-	0%
	CB1.14	Construction of minor bridge No. 87 & 88 between Ch 35000 to 36000 for main line track.	On completion of bridge works in all respects	3.23%
	CB1.15	Construction of minor bridge No. Nil between Ch 36000 to 37000 for main line track.	-	0%
	CB1.16	Construction of minor bridge No. 90 & 91 between Ch 37000 to 38000 for main line track.	On completion of bridge works in all respects	0.99%
	CB1.17	Construction of minor bridge No. Nil between Ch 38000 to 39000 for main line track.	-	0%
	CB1.18	Construction of minor bridge No. 94 between Ch 39000 to 40000 for main line track.	On completion of bridge works in all respects	0.68%
	CB1.19	Construction of minor bridge No. 96 & 97 between Ch 40000 to 41000 for main line track.	On completion of bridge works in all respects	0.55%
	CB1.20	Construction of minor bridge No. 98, 99 & 100 between Ch 41000 to 42000 for main line track.	On completion of bridge works in all respects	0.92%
	CB1.21	Construction of minor bridge No. 102 & 103 between Ch 42000 to 43000 for main line track.	On completion of bridge works in all respects	0.79%
	CB1.22	Construction of minor bridge No. 106 between ch 43000 to 44000 for main line track.	On completion of bridge works in all respects	0.62%
	CB1.23	Construction of minor bridge No. 108, 109 & 110 between	On completion of bridge works in all respects	2.22%

Cost Centre			CB- Bridges	
Weightage of Cost Centre 'CB', (Y)			41%	
Sub-cost Centre	Item of Work		Milestone	Weightage (X)
	No.	Description		
1	2	3	4	5
		Ch 44000 to 45000 for main line track.		
	CB1.24	Construction of minor bridge No. Nil between Ch 45000 to 46000 for main line track.	-	0%
	CB1.25	Construction of minor bridge No. 114, 115 & 116 between Ch 46000 to 47000 for main line track.	On completion of bridge works in all respects	2.91%
	CB1.26	Construction of minor bridge No. 117, 118 & 119 between Ch 47000 to 48000 for main line track.	On completion of bridge works in all respects	0.78%
	CB1.27	Construction of minor bridge No. 120, 121, 122 & 124 between Ch 48000 to 49000 for main line track.	On completion of bridge works in all respects	2.02%
	CB1.28	Construction of minor bridge No. 125 & 126 between Ch 49000 to 49700 for main line track.	On completion of bridge works in all respects	3.04%
	CB1.29	Construction of minor bridge No. Nil between Ch 0614 to 1000 for New Patli to Patli connecting line.	-	0%
	CB1.30	Construction of minor bridge No. 1, 2 & 3 between Ch 1000 to 2000 for New Patli to Patli connecting line.	On completion of bridge works in all respects	1.63%
	CB1.31	Construction of minor bridge No. 4 & 5 between Ch 2000 to 2700 for New Patli to Patli connecting line	On completion of bridge works in all respects	1.63%
	CB1.32	Construction of minor bridge No. 2 between Ch 0703 to 2000 for New Patli to Sultanpur connecting line	On completion of bridge works in all respects	0.21%
	CB1.33	Construction of minor bridge Nos. 4 & 5 between Ch 2000 to 3000 for New Patli to Sultanpur connecting line	On completion of bridge works in all respects	0.83%

Cost Centre			CB- Bridges	
Weightage of Cost Centre 'CB', (Y)			41%	
Sub-cost Centre	Item of Work		Milestone	Weightage (X)
	No.	Description		
1	2	3	4	5
	CB1.34	Construction of minor bridge No. Nil between Ch 3000 to 4119 for New Patli-Sultanpur connecting line and in Sultanpur Station yard (Km 0861 towards Garhi Harsaru side & Km 0530 towards Badsa side& Km 0689 towards Farukhnagar side)	-	0%
CB.2-Major Bridges	CB.2.1	Foundation	On completion of the foundation work including pile caps/ well caps and foundations for wing and return walls, and testing.	13.0%
	CB.2.2	Substructure	On Completion of Abutment/Piers including Abutment/Pier Cap without bearings.	
	CB.2.2.1		Pier/Abutment	3%
	CB.2.2.2		Pier/Abutment cap	1%
	CB.2.2.3		Completion of the wing walls, return walls in all respects	4%
	CB.2.3	Superstructure		
	CB.2.3.1		On completion of superstructure including launching in position.	18.5%
	CB.2.3.2		On fixing of bearings in position true to line & level and placement of superstructure on bearings including grouting of holding down bolts complete.	1.5%
	CB.2.4	Installation of Track on OWG	On completion of installation of track on H-beam sleepers including fixing of guard rails, gang pathway complete and supply of 10% spare fittings.	1.0%
	CB.2.5	Miscellaneous works		

Cost Centre			CB- Bridges	
Weightage of Cost Centre 'CB', (Y)			41%	
Sub-cost Centre	Item of Work		Milestone	Weightage (X)
	No.	Description		
1	2	3	4	5
	CB.2.5.1		On completion of Trolley refuge, Pathway on the sides, Inspection arrangement including access ladder etc.as per approved drawings and Employer's requirement,	2.0%
	CB.2.5.2		On completion of balance works as per drawing like- Protection works including Toe wall, Pitching, inspection steps, Bridge plaque, Bridge board, painting of HFL, Height Gauge, drainage arrangement in RUBs, and Testing on completion, if any, complete in all respect and fit for use.	6.05%.
			Total	**100%**

Notes:

1. *The value of each Milestones will be total lump sum accepted cost of Works for Schedule 'A' (LS) multiplied by X * Y. For example, the value of Milestone CB1.2 will be equal to LS*X*Y= LSx*0.0734 x 0.41.
2. Adjustment to Contract Price pursuant to GCC 13.7 shall be applicable to the payments of Works executed under this Sub Head / Price Schedule.
3. Payment will be made on Completion of each Milestones as per weightage given in this schedule.
4. CB2.2-Major Bridges:
   (i) For the purpose of stage payment/Milestones, cost of a bridge shall be taken in proportion to its linear length measured along the alignment to the total linear length of all major bridges.
   (ii) Payment of each stage/Milestones for a bridge will be made on completion of the relevant stage as per the weightage given in this schedule in proportion to the cost of the bridge.
5. Stages CB.2.1 to CB.2.2 will further be subdivided into the number of piers + 2 abutments, as applicable as per approved drawing by the Engineer, and Milestones for completed work for each pier and abutment shall be made as per the requirement of the stages stated above.

6. For steel Open Web Girder (OWG) and Composite girders payment against Cost centre CB.2.3.1 shall be released as per following schedule-

   (i) Receipt of material at approved location: 40%

   (ii) Fabrication of girder and transportation to site: 25%

   (iii)Erection/launching and completion of all other balance works: 35%,

and for PSC girder/slabs payment against sub cost centre 2.3.1 shall be released as per following schedule-

   (i) On casting of PSC girder/slabs: 50%

   (ii) On first stage prestressing: 20%

   (iii) On completion in all respect: 30%

7. *The Cost of Milestones include cost of all temporary works and temporary diversion of roads wherever required, for all bridges included in Schedule 'A' section VII-2, Employer's Requirements.*

8. *The Cost of Milestones include cost of all permanent roads diversion and regrading of roads, wherever required, for all bridges included in Schedule 'A' except for Br. No 150 & 153 which shall be paid under Schedule 'B'.*

5.2.4 Stages of Payment i.e. Milestones of Cost Centre 'CS'- Stations

Cost Centre			**'CS'- Stations**	
Weightage of Cost Centre 'CS', (Y)			**7.0%**	
Sub-Cost Centre	**Item of Work**		**Milestone**	**Weightage (X)**
	No.	**Description**		
1	2	3	4	5
CS.1- Sultanpur Station	**CS.1.1**	**Station building and service buildings**	*Construction of station buildings and S&T huts complete in all respects.*	3.0%
	CS.1.2	**Platform & *Passenger amenities***		
	CS.1.2.1		Dismantling of existing platform and construction of new platform including earthwork in filling above formation level and *cast-in-situ platform face wall* as per the Employer's requirements.	4.0%
	CS.1.2.2		Surfacing of platform, Precast *coping, tactile tiles, fencing at end platform etc*.	2.0%
	CS.1.2.3		PF shelters, Mini PF shelters.	0.9%
	CS.1.2.4		*Passenger amenities*	0.9%
	CS.1.3	**Subway**	*No work of Subway included in Schedule 'A'*	0%
	CS.1.4	**Water Supply System**	*Water supply works including bore well, pump house, underground & overhead water storage tanks, water supply distribution system*	1.2%
	CS.1.5	***Drainage, Sewerage and rainwater harvesting system***	On completion of drainage, s*ewerage and rainwater harvesting system.*	1.0%
	CS.1.6	**Miscellaneous works**	On completion of *station name boards at station building and platform, platform number boards* and other incidental works in station area.	0.7%
	CS.2.1	**Service buildings**		

Cost Centre			'CS'- Stations	
Weightage of Cost Centre 'CS', (Y)			7.0%	
Sub-Cost Centre	Item of Work		Milestone	Weightage (X)
	No.	Description		
1	2	3	4	5
CS.2 New Patli Station	CS.2.1.1		Construction of *S&T service building and S&T huts* complete in all respects.	5.25%
	CS.2.2	**Platform &** *Passenger amenities*		
	CS.2.2.1		Construction of platforms including earthwork in filling above formation level and *cast-in-situ platform face wall* as per the Employer's requirements.	3.0%
	CS.2.2.2		Surfacing of platforms, Precast *coping, tactile tiles, fencing at end platform etc*.	4.0%
	CS.2.2.3		PF shelters, Mini PF shelters.	1.5%
	CS.2.2.4		*Passenger amenities*	1.1%
	CS2.3	**Subway (Bridge No. 144A)**		
	CS2*.3.1*		On completion of barrel of RCC box.	4.2%
	CS2.3.2		On completion of stairs to platforms including shed and lift wells.	1.7%
	CS2.3.3		On completion of subway including flooring, dado, water proofing, drainage complete in all respects.	1.0%
	CS.2.4	**Water Supply System**	On completion of *water supply works including bore well, pump house, underground & overhead water storage tanks, water supply distribution system*	2.0%
	CS.2.5	***Drainage, Sewerage and rainwater harvesting system***	On completion of drainage, s*ewerage and rainwater harvesting system.*	2.5%
	CS.2.6	**Miscellaneous works**	On completion of *station name boards at station building and platforms, platform number boards* and other incidental works in station area.	0.89%
CS.3- Panchgaon Station	**CS.3.1**	**Station building and service buildings**	*No work of Station building and service buildings included in Schedule 'A'*	0%

Cost Centre			'CS'- Stations	
Weightage of Cost Centre 'CS', (Y)			7.0%	
Sub-Cost Centre	Item of Work		Milestone	Weightage (X)
	No.	Description		
1	2	3	4	5
	CS.3.2	**Platform & *Passenger amenities***		
	CS.3.2.1		Construction of platforms including earthwork in filling above formation level and *cast-in-situ platform face wall* as per the Employer's requirements.	2.5%
	CS.3.2.2		Surfacing of platforms, Precast *coping, tactile tiles, fencing at end platform etc*.	3.0%
	CS.3.2.3		PF shelters, Mini PF shelters.	1.20%
	CS.3.2.4		*Passenger amenities*	0.75%
	CS.3.3	**Subway (Bridge No. 113)**		
	CS3.*3.1*		On completion of barrel of RCC box.	2.90%
	CS3.3.2		On completion of covered stairs and ramps to platforms.	2.25%
	CS3.3.3		On completion of subway including flooring, dado, water proofing, drainage complete in all respects.	1.0%
	CS.3.4	**Water Supply System**	On completion of *water supply works including bore well, pump house, underground & overhead water storage tanks, water supply distribution system*	1.0%
	CS.3.5	***Drainage, Sewerage and rainwater harvesting system***	On completion of drainage, s*ewerage and rainwater harvesting system.*	1.40%
	CS.3.6	**Miscellaneous works**	On completion of *station name boards at station building and platforms, platform number boards* and other incidental works in station area.	0.85%
CS.4 Chandla Dungerwas station	**CS.4.1**	**Station building & Service buildings**	*No Work of Station building & Service building in Schedule 'A'.*	0.00%
	CS.4.2	**Platform &** *Passenger amenities*		

Cost Centre			'CS'- Stations	
Weightage of Cost Centre 'CS', (Y)			7.0%	
Sub-Cost Centre	Item of Work		Milestone	Weightage (X)
	No.	Description		
1	2	3	4	5
	CS.4.2.1		Construction of platforms including earthwork in filling above formation level and *cast-in-situ platform face wall* as per the Employer's requirements.	2.5%
	CS.4.2.2		Surfacing of platforms, Precast *coping, tactile tiles, fencing at end platform etc*.	3.0%
	CS.4.2.3		PF shelters, Mini PF shelters.	0.50%
	CS.4.2.4		*Passenger amenities*	0.75%
	CS4.3	**Subway (Bridge No. 104)**		
	CS4.*3.1*		On completion of barrel of RCC box.	2.90%
	CS4.3.2		On completion of covered stairs and ramps to platforms.	2.25%
	CS4.3.3		On completion of subway including flooring, dado, water proofing drainage complete in all respects.	1.0%
	CS.4.4	**Water Supply System**	On completion of *water supply works including bore well, pump house, underground & overhead water storage tanks, water supply distribution system*	1.0%
	CS.4.5	***Drainage, Sewerage and rainwater harvesting system***	On completion of drainage, s*ewerage and rain water harvesting system.*	1.20%
	CS.4.6	**Miscellaneous works**	On completion of *station name boards at station building and platforms, platform number boards* and other incidental works in station area.	0.70%
CS.5 Dhulawat Station	**CS.5.1**	**Station building & Service Buildings**		
	CS.5.1.1		Construction of Station Building *and S&T huts* complete in all respects.	5.25%
	CS.5.2	**Platform &** *Passenger amenities*		

Cost Centre			'CS'- Stations	
Weightage of Cost Centre 'CS', (Y)			7.0%	
Sub-Cost Centre	Item of Work		Milestone	Weightage (X)
	No.	Description		
1	2	3	4	5
	CS.5.2.1		Construction of platforms including earthwork in filling above formation level and *cast-in-situ platform face wall* as per the Employer's requirements.	2.8%
	CS.5.2.2		Surfacing of platforms, Precast *coping, tactile tiles, fencing at end platform etc*.	4.20%
	CS.5.2.3		PF shelters, Mini PF shelters.	1.5%
	CS.5.2.4		*Passenger amenities*	1.0%
	CS5.3	**Subway (Bridge No. 79)**		
	CS5*.3.1*		On completion of barrel of RCC box.	4.2%
	CS5.3.2		On completion of stairs and ramps to platforms including shed.	1.7%
	CS5.3.3		On completion of subway including flooring, dado, water proofing, drainage complete in all respects.	1.0%
	CS.5.4	**Water Supply System**	On completion of *water supply works including bore well, pump house, underground & overhead water storage tanks, water supply distribution system*	1.26%
	CS.5.5	***Drainage, Sewerage and rainwater harvesting system***	On completion of drainage, s*ewerage and rain water harvesting system.*	2.75%
	CS.5.6	**Miscellaneous works**	On completion of *station name boards at station building and platforms, platform number boards* and other incidental works in railway station area.	0.85%
			Total	**100%**

Notes:

1. The value of each Milestones will be total lump sum accepted cost of Works for Schedule 'A' (LS) multiplied by X * Y. For example, the value of Milestone CS1.1–will be equal to LS*X*Y= LSx 0.003 x 0.07
2. Adjustment to Contract Price pursuant to GCC 13.7 shall be applicable to the payments of Works executed under this Sub Head / Price Schedule.

3. Station Building- Unit of measurement is plinth area in square meters. For the buildings having more than one storey, the total area shall be found out by adding the area of each storey. Unit cost shall be determined on pro rata basis with respect to the total area of all stations and service buildings.
   - 50% Payment shall be paid after completion of structural works i.e beam, columns & slab in case of framed structure or walls & slabs in case of other buildings and
   - 30% Payment shall be paid after completion of finishing and
   - 20% Payment on final completion of works in all respects ready for use.

4. Platform- Unit of measurement is *area measured in square meter*. Unit cost shall be determined on pro rata basis with respect to the total area of all *platforms at the* station.

5. Payment will be made on Completion of each Milestones as per weightage given in this schedule.

6. Variation in 'Station *building*':
   In case of variation in the plinth area of any station *and service building* on either side i.e. increase or decrease with respect to the area shown in the Tender Drawings, the total value of station as mentioned in respective Sub-Cost Centres as applicable will get modified accordingly on pro rata basis of *plinth* area.

6 Schedule 'B': Retaining Wall, Bridges & other civil works

Schedule 'B' Retaining Wall, Bridges & other civil works							
S. No	Item No.	Description of Item	Quantity	Unit	USSOR/ DSR Rate in INR	Estimated Rate including GST@18% in INR	Estimated Amount in INR
Schedule B1:- NWR-USSOR 2019 BASED ITEMS (From S. No. 1 to 39)							
Chapter 1-Earthwork							
1	**011010**	Earthwork in cutting (classified) in formation, trolley refuges, side drains, level crossing approaches, platforms, catch water drains, diversion of nallah & finishing to required dimension and slopes to obtain a neat appearance to standard profile inclusive of all labour, machine & materials and removing & leading all cut spoils either to make spoil dumps beyond 10m from cutting edge or for filling in embankment with leads within 2 km on either side of cutting edge, lifts, ascent, descent, loading, unloading, all taxes / royalty, clearance of site and all incidental charges, bailing & pumping out water, if required, etc. complete as per directions of the Engineer-in-Charge. The work is to be executed as per latest / updated edition of "Guidelines for Earthwork in Railway Projects" issued by RDSO, Lucknow. Cut trees shall be property of HRIDC and to be deposited in the Employers' godown unless specified otherwise in the Special Conditions of Contract. {Note - (i) All usable earth arising from cut spoils shall be led into bank formation and Unusable spoils shall be dumped / stacked (ii) All hard rock /and					

Schedule 'B' Retaining Wall, Bridges & other civil works							
S. No	Item No.	Description of Item	Quantity	Unit	USSOR/ DSR Rate in INR	Estimated Rate including GST@18% in INR	Estimated Amount in INR
		boulders not fit for filling will be stacked by the contractor and will be property of HRIDC.}					
1a	**011011**	In all conditions and classifications of soil except rock	10,000	Cum	152.47	**172.32**	**17,23,200.00**
1b	**011012**	Soft rock not requiring blasting in all conditions	500	Cum	347.68	**392.94**	**1,96,470.00**
2	**012040**	Extra for mechanical compaction of soil in embankment with contractor's rollers of suitable capacity, type and size to achieve specified density as per specification, testing as per IS codes including cost of water, T&P, consumable and all labour as a complete job. The work is to be executed as per Latest edition of "Guidelines for Earthwork in Railway Projects" issued by RDSO, Lucknow.	5,000	Cum	17.23	**19.47**	**97,350.00**
3	**013100**	Providing and removing barricading with the help of portable fencing along running track where work is to be done in close vicinity of track. Fencing shall consist of self supporting steel angles of size 50mm x 50mm x 6mm, 1.5m long provided with hooks etc. and embedded in CC 1:2:4 block of size 0.23m x 0.23m x 0.23m placed at c/c distance of 2m along track. 12mm dia rods in three horizontal layers shall be tack welded with angle posts. {Note : Released material will be property of the contractor after completion of work. Cost of cement to be paid separately}					

Schedule 'B' Retaining Wall, Bridges & other civil works							
S. No	Item No.	Description of Item	Quantity	Unit	USSOR/ DSR Rate in INR	Estimated Rate including GST@18% in INR	Estimated Amount in INR
3a	**013101**	With provision of one 50mm wide retro-reflective tape in horizontal direction, duly secured/tight with vertical posts	3,000	Meter	225.23	**254.55**	**7,63,650.00**
3b	**013102**	With provision of painting verticals & horizontals with red luminous paints / strips of 30cm each with a gap of 30 cm	700	Meter	110.43	**124.80**	**87,360.00**
4	**013130**	Shoring with 'Z' section MS sheet piles side by side in all kinds of soil mechanically or manually as per approved drawing with contractor's own arrangement complete in all respects and removal of sheet piles after completion of the work as directed by engineer in-charge. {Note - Payment will be made as per actual driven length of pile}	400	Sqm	868.29	**981.32**	**3,92,528.00**
Chapter 2-Bridge Work Substructure							
5	**022010**	Earthwork in excavation by mechanical means (Hydraulic Excavator)/Manual Means for foundations and floors of the bridges, retaining walls etc. including setting out, dressing of sides, ramming of bottom, getting out the excavated material, back filling in layers with approved material and consolidation of the layers by ramming and watering etc. including all lift, disposal of surplus soil upto a lead of 300m, all types of shoring and strutting with all labour and material complete as per drawing and technical specification as directed by Engineer.					

Schedule 'B' Retaining Wall, Bridges & other civil works							
S. No	Item No.	Description of Item	Quantity	Unit	USSOR/ DSR Rate in INR	Estimated Rate including GST@18% in INR	Estimated Amount in INR
		Note: This item will be used for excavation work in connection with other miscellaneous works also like side drains, foundation for OHE masts and other miscellaneous structures in connection with Gauge Conversion, Doubling, New lines.					
5a	**022011**	All kinds of soils	60,013	Cum	195.57	**221.03**	**1,32, 64,673.39**
6	**022040**	Providing and laying in position machine batched, machine mixed and machine vibrated Design Mix Cement Concrete of specified grade **(M-20** Cast in-Situ) using 20mm graded crushed stone aggregate and coarse sand of approved quality in RCC raft foundation & Pile cap including finishing, using Admixtures in approved proportions (as per IS:9103), to modify workability & other properties without impairing strength and durability complete as per specifications and direction of the Engineer in charge. Payment for cement, reinforcement and shuttering shall be paid extra. **Note**-Cement concrete in levelling coarses, drainage and other miscellaneous works shall be paid under this item.	13,809	Cum	2,840.33	**3,210.06**	**4,43,27,718.54**
7	**022070**	Providing and fixing Weep Holes in Abutments, Wing walls and Return walls etc. of new bridges with 110mm dia UPVC pipe (IS :13592) Type A ISI marked with all contractor's men, material,	20,000	Rmt	242.28	**282.92**	**56,58,400.00**

Schedule 'B' Retaining Wall, Bridges & other civil works							
S. No	Item No.	Description of Item	Quantity	Unit	USSOR/ DSR Rate in INR	Estimated Rate including GST@18% in INR	Estimated Amount in INR
		transportation, all taxes as per specifications and as directed by Engineer-in-Charge.					
8	**022100**	Providing, fabricating and installing permanent casing pipe for bored piles for all diameters with specified thickness of steel plate including all labour, materials, pumping and bailing out water wherever required, complete as per technical specifications as directed by Engineer in charge. This will include the weight of plate only and no cognizance will be given for the fittings, i.e. rivets and welding etc	52	MT	86,647.55	**97,926.63**	**50,92,184.76**
9	**022120**	Conducting load testing of a single pile upto following capacity in accordance with IS:2911 (Part IV) including installation of loading platform and preparation of pile head or construction of test cap and dismantling of test cap after test etc. with all labour, material, tool & plants, equipment, machinery, etc. complete as per drawing and specification, as directed by the Engineer					
9a	**022123**	Initial load test above 100 ton capacity upto 250 ton capacity pile	2	Each	92,300.97	**1,04,315.97**	**2,08,631.94**
9b	**022124**	Extra for every increase of 50 ton in pile capacity or part thereof over 250 ton	52	Each	9,087.94	**10,270.94**	**5,34,088.88**
9c	**022127**	Routine Load Test above 100 ton capacity upto 250 ton capacity pile	8	Each	62,036.82	**70,112.28**	**5,60,898.24**

Schedule 'B' Retaining Wall, Bridges & other civil works							
S. No	Item No.	Description of Item	Quantity	Unit	USSOR/ DSR Rate in INR	Estimated Rate including GST@18% in INR	Estimated Amount in INR
10	**022130**	Lateral load testing of single pile in accordance with "IS Code of practice IS:2911 (Part-IV) for determining safe allowable lateral load of pile" with all labour, material, tool & plants, equipment, machinery, etc complete as per drawing and specification as directed by the Engineer					
10a	**022131**	Piles with lateral load capacity of upto 50 ton	8	Each	23,066.05	**26,068.60**	**2,08,548.80**
11	**022140**	Pulse Echo Test (PET) for integrity testing of piles with contractor's men, materials and machines. The rate includes cost of Inspection of site, preparation of pile head and any other unforeseen cost required for the test, submission of reports in triplicate as per satisfaction of the Engineer in Charge at site.	100	Each	3,291.33	**3,719.77**	**3,71,977.00**
12	**025020**	Providing and applying two coats of coal tar or bitumen confirming to IS:3117– latest version on the top and sides of RCC box/slabs @ 1.70 kg/sqm after cleaning the surface with all labour and materials complete job as directed by the Engineer	38,257	Sqm	155.67	**175.93**	**67,30,554.01**
13	**025030**	centering and shuttering including strutting, propping etc. and removal of form for :					
13a	**025031**	All types of bridge sub-structures, e.g. pier, abutment, wing wall, retaining wall, RCC box type foundations, Abutment cap, Pier Cap, Inspection Platform & Pedestal over Pier cap, Fender wall, Diaphragm wall etc. upto 5m above ground level	1,97,164	Sqm	671.94	**759.41**	**14,97,28,313.20**

Schedule 'B' Retaining Wall, Bridges & other civil works							
S. No	Item No.	Description of Item	Quantity	Unit	USSOR/ DSR Rate in INR	Estimated Rate including GST@18% in INR	Estimated Amount in INR
13b	**025032**	All types of bridge super-structures, e.g. slabs, I-girders, T-girders, Box girders etc. upto 5m above ground level	8,352	Sqm	874.49	**988.32**	**82,54,448.64**
13c	**025033**	Extra for additional height over item no. 025031 & 025032 wherever required with adequate bracing, propping etc. over initial height of 5 metres for every additional height of 1 metre or part thereof	14,020	Sqm	110.17	**124.51**	**17,45,630.20**
14	**025060**	Supply and using Cement at Worksite					
14a	**025062**	Ordinary Portland Cement 53 grade	1,500	MT	7,398.80	**9,019.52**	**1,35,29,280.00**
14b	**025063**	Pozzolana Portland Cement	4,035	MT	6,905.10	**7,657.41**	**3,08,97,649.35**
15	**025070**	Steel reinforcement for R.C.C. work including straightening, cutting, bending, placing in position and binding all complete	-				
15a	**025072**	Thermo-Mechanically Treated bars of grade Fe-500D or more.	75,49,462	Kg	78.01	**87.70**	**66,20,87,817.40**
Chapter 3- Bridge Work Super Structure -RCC							
16	**031020**	Providing and laying in position machine batched, machine mixed and machine vibrated Design Mix Cement Concrete of specified grade using 20mm graded crushed stone aggregate and coarse sand of approved quality for the Precast Prestressed (Post tensioned) concrete girder/Box (spans upto 30.5m) in contactor's casting yard, including finishing, using	37	Cum	2,840.33	**3,210.06**	**1,18,772.22**

Schedule 'B' Retaining Wall, Bridges & other civil works							
S. No	Item No.	Description of Item	Quantity	Unit	USSOR/ DSR Rate in INR	Estimated Rate including GST@18% in INR	Estimated Amount in INR
		Admixtures in approved proportions (as per IS:9103), to modify workability & other properties without impairing strength and durability, complete as per drawings, specifications and direction of the Engineer. Payment for Shuttering, Cement, reinforcement, HTS cables, anchorage cones, stressing of cables and grouting of the ducts will be done extra. Launching of girder/slab in position is not included in this item.					
16a	**031021**	Deduct from 0310220 for casting of Slab in place of Girder/Box	-37	Cum	42.48	**48.01**	**-1,776.37**
17	**031040**	Providing, fabricating & fixing in position to exact design profiles, prestressing H.T.S. cables of all classification made from Low Relaxation strands conforming to IS:14268– latest version in Prestressed (Post tensioned) Concrete girders/slabs etc. including supplying, cutting, making into cables with necessary spacers, colour coding, protecting with water soluble oil at all time, anchoring of cables, supplying and placing spiral corrugated type galvanized metal steel ducts sheathing made up of Cold Rolled Cold Annealed (CRCA) mild steel conforming to IS:513 of required diameter/ thickness, vent pipe, placing, bending, routing, fixing, stressing & grouting of cable ducts with cement grout, Anchorage sets in required number with provision for future prestressing if any	2	MT	1,79,099.63	**2,02,413.39**	**4,04,826.78**

Schedule 'B' Retaining Wall, Bridges & other civil works							
S. No	Item No.	Description of Item	Quantity	Unit	USSOR/ DSR Rate in INR	Estimated Rate including GST@18% in INR	Estimated Amount in INR
		including all lead and lift with contractor's own materials, labour, equipments etc. complete as per drawings & specifications. Rate also includes covering anchorage pads with epoxy mortar of approved quality to avoid corrosion. Cement for grouting to be paid separately. Payment shall be made in terms of weight of HTS cables as per drawing.					
18	**031090**	Design, manufacturing, supplying and fixing in position elastomeric bearing true to line and level conforming to IS:3400, IS:226, BS-5400 under prestressed concrete girders/ Steel Girders, for Precast as well as cast-in-situ girders as per approved drawing. The rate shall include cost of load test of one no. bearing from Railway approved firms and all fixing materials, equipments, machineries, labour, taxes, loading, unloading, leading, lifting etc. complete. Rates include getting the drawing approved from Railway and cost of inspection during manufacturing from railway approved organization. Notes: 1. The rate is for finished item complete and paid only after fixing in position below the girder. 2. The volume shall be given in the drawing and no deduction shall be made for inserted	37,56,245	Cu.Cm.	1.61	**1.82**	**68,36,365.90**

Schedule 'B' Retaining Wall, Bridges & other civil works							
S. No	Item No.	Description of Item	Quantity	Unit	USSOR/ DSR Rate in INR	Estimated Rate including GST@18% in INR	Estimated Amount in INR
19	**031140**	Providing and fixing in position GI Drainage Spouts of required length with Grating in RCC slab and filling bitumen along kerb as shown in drawing with contractor's pipes, bitumen, tools, equipment, lead, lifts etc. complete as per specifications and as directed by Engineer in-charge					
19a	**031142**	100mm dia. Drainage Spouts	882	Meter	1,202.50	**1,359.03**	**11,98,664.46**
Chapter 4- Bridge Work Super Structure -Steel							
20	**041010**	Supplying, fabrication, assembling of all types of steel girders of specified spans with structural steel conforming to Quality "B0" Grade Designation E250 conforming to IS:2062, erection / slewing / end launching of steel girders with cranes or any other approved launching methods as per site conditions (not requiring traffic block) on sub-structure including provision of trolley refuges etc., complete as per approved QAP and drawings conforming to IRS-B1-2001 and other relevant codes and specifications. Note: 1. Detailed fabrication and erection drawings & launching methodology will be prepared by the contractor and got approved from Railway. 2. The item includes fabrication of all types of battens, bracings, ties, stiffeners, packing, diaphragms, shop rivets / welding, T&F bolts, drifts, SAW, templates,					

Schedule 'B' Retaining Wall, Bridges & other civil works							
S. No	Item No.	Description of Item	Quantity	Unit	USSOR/ DSR Rate in INR	Estimated Rate including GST@18% in INR	Estimated Amount in INR
		jigs, fixtures, accessories, transporting various components from fabrication shop to site including loading & unloading, assembly of girders with drifts/bolts, field riveting /welding /HSFG Bolting, assembling of temporary support for side slewing, raising of girders to the bed block level, providing sliding arrangements and slewing the girder in position, lowering of girder on bearings and bed plates with all temporary arrangements or any other method of launching complete. 3. The bearing sets to be provided with the girders will be paid separately as per relevant item. 4. Payment for addition in weight for rivets / welds shall be made as per clause 45 of IRS B-1-2001. 5. In case of composite work (welding and HSFG bolts), addition in weight shall be 1% for					
20a	**041013**	Open Web Girder above 45.7m clear Span	1,593	MT	1,68,004.82	**1,89,874.34**	**30,24,69,823.62**

Schedule 'B' Retaining Wall, Bridges & other civil works							
S. No	Item No.	Description of Item	Quantity	Unit	USSOR/ DSR Rate in INR	Estimated Rate including GST@18% in INR	Estimated Amount in INR
21	**041020**	Supplying, fabrication, assembling of all types of steel Composite girders of specified spans with structural steel conforming to Quality "B0" Grade Designation E250 conforming to IS:2062, erection / slewing / end launching of steel girders with cranes or any other approved launching methods as per site conditions on sub-structure including provision of stud bolts / shear connectors, complete as per approved QAP and drawings conforming to IRS-B1-2001 and other relevant codes and specifications. Note:1. Detailed fabrication and erection drawings & launching methodology will be prepared by thecontractor and got approved from Railway. 2. Rate includes fabrication of all types of battens, bracings, ties, stiffeners, packing, diaphragms, shop rivets / welding, T&F bolts, drifts, SAW, templates, jigs, fixtures, accessories, transporting various components from fabrication shop to site including loading & unloading, assembly of girders with drifts/bolts, field riveting /welding /HSFG Bolting, assembling of temporary supportfor side slewing, raising of girders to the bed block level, providing sliding arrangements and slewing the girder in position, lowering of girder on bearings and bed plates with all temporary arrangements or any other method of launching complete. 3. The bearing sets to be provided with the					

Schedule 'B' Retaining Wall, Bridges & other civil works							
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		girders will be paid separately as per relevant item. 4. Payment for addition in weight for rivets / welds shall be made as per clause 45 of IRS B-1- 2001. 5. In case of composite work (welding and HSFG bolts), addition in weight shall be 1% for					
21a	**041021**	Composite steel girder of span length up to 36.0m	1,364	MT	1,23,733.20	**1,39,839.80**	**19,07,41,487.20**
22	**041030**	Supplying and fixing HSFG bolts of any dia and any length with suitable nuts including DTI washers conforming to IRS-B1-2001 for bridges and steel structures with contractors labour, tools and plants and lead and lift etc., complete.	62,106	Kg	305.32	**345.06**	**2,14,30,296.36**
23	**041050**	Metalizing of steel work of girders with sprayed aluminium after surface preparation by Sand/grit blasting, followed by one coat of etch primer (IS:5666) & one coat of Zinc Chrome primer (IS:104)and two coats of aluminium paint (IS:2339) with all labour, T&P and material as a complete job duly conforming to all relevant specifications and process given under Clause 39 of IRS-B1-2001 Note: Nominal Thickness of Aluminium coating shall be 150 microns. DFT of Zinc chrome primer shall be	27,931	Sqm	905.47	**1,023.34**	**2,85,82,909.54**

Schedule 'B' Retaining Wall, Bridges & other civil works							
S. No	Item No.	Description of Item	Quantity	Unit	USSOR/ DSR Rate in INR	Estimated Rate including GST@18% in INR	Estimated Amount in INR
		25-30 microns and DFT of each coat of Aluminium paint shall be 12-14 microns.					
24	**041060**	Providing and fixing railing used in rows for footpath or anti-crash barrier railing with B class G.I. pipe 65/50 mm nominal dia including cost of M.S. angle and channels in vertical posts, welding / bolting, priming painting with one coat ready mix Zinc Chromate conforming to IS:104 with DFT of 25-30Microns, followed by one coat of Zinc Chrome red oxide conforming to IS:2074 with DFT of 25 Microns with all material, labour, T&P as a complete job.	40,090	Kg	96.09	**108.60**	**43,53,774.00**
25	**041080**	Providing and fixing various size HTS holding down bolts conforming to IS:1364 in concrete column or in other structures with proper nuts, bolts, washers/plates, grouting of holes with all material, labour, T&P as a complete job. Note: Cement used in grouting will be paid separately under relevant item.	334	Kg	149.66	**169.14**	**56,492.76**

Schedule 'B' Retaining Wall, Bridges & other civil works							
S. No	Item No.	Description of Item	Quantity	Unit	USSOR/ DSR Rate in INR	Estimated Rate including GST@18% in INR	Estimated Amount in INR
26	**041180**	Design, supply and fixing 300MT capacity Spherical Bearing in position true to line and level consisting of set of concave and convex mating steel backing plate with a low friction sliding interface, flat sliding elements ,guides and restraining rings; with all components conforming to approved drawing and technical specifications & Bridge Code including grouting of holes for anchor bolts and underside of baseplate with approved non-shrink epoxy grout with all material, labour, T&P as a complete job. Note: Sliding surface with PTFE or UHMWPE low friction thermoplastic material and steel for backing plate of Mild steel in accordance to IS:2062 grade-B. Cast steel in accordance with IS 1030 Grade 280-520W. Stain less steel in accordance with AISI 304/316.Low friction thermo -plastic sliding PTFE material either pure polytetrafluroethalyne (PTFE) Or Ultra High Molecular weight Polythylene (UHMWPE). Austanitic steel is of stainless steel for the sliding interface shall be in accordance with AISI 316L or O2 Cr17 NI12 of IS-6911. The thickness of the stain less steel sheet shall be 3mm minimum. The stainless steel sheet shall be attached to its backing plate either by screwing/riveting or by continuous fillet weld. Hard chromium plated surface shall be entire curved surface of the convex steel plate mating					

Schedule 'B' Retaining Wall, Bridges & other civil works							
S. No	Item No.	Description of Item	Quantity	Unit	USSOR/ DSR Rate in INR	Estimated Rate including GST@18% in INR	Estimated Amount in INR
		with hard chromium plated concave sliding surface. The thickness of the hard chromium plating shall be at least 100 microns and the final surface roughness of the plated surface shall not exceed 3 microns. Bearing manufacturer shall give the guarantee for satisfactory performance of bearing for period specified					
26a	**041181**	Spherical Fixed Bearing	4	Each	1,16,994.18	**1,32,223.55**	**5,28,894.20**
26b	**041182**	Spherical Free Float Bearing	4	Each	1,27,739.32	**1,44,367.40**	**5,77,469.60**
26c	**041183**	Spherical Slide Guide (L) Bearing	4	Each	1,28,212.55	**1,44,902.23**	**5,79,608.92**
26d	**041184**	Spherical Slide Guide (T) Bearing	4	Each	1,27,962.01	**1,44,619.08**	**5,78,476.32**
27	**041240**	Surface preparation for painting of bridge plate/composite girders and other steel structures where the finishing coat shows signs of deterioration; but primer coat of paint is sufficiently in good condition and there are no signs of rusting etc. Surface shall be cleaned free from oil grease, scaling and other foreign matters without disturbing the primer coat {Rate includes cost of labour, consumables, tools & plants, scaffolding, jhoola, ladder etc.}	5,000	Sqm	25.53	**28.85**	**1,44,250.00**

Schedule 'B' Retaining Wall, Bridges & other civil works							
S. No	Item No.	Description of Item	Quantity	Unit	USSOR/ DSR Rate in INR	Estimated Rate including GST@18% in INR	Estimated Amount in INR
28	**041260**	Painting cleaned bridge plate/composite girders including all scaffolding, shuttering and strutting along with provision of Jhoola/hanging scaffolding ladders etc. where required					
28a	**041261**	With one coat ready mix Zinc Chromate conforming to IS:104 with DFT of 25-30 Microns followed by one coat of Zinc Chromate red oxide conforming to IS:2074 DFT of 25 Microns	5,000	Sqm	96.30	**108.84**	**5,44,200.00**
29	**041330**	Launching & fixing in specified Bridge location all types of Steel Plate girders / PSC girders / Slabs including loading/unloading and transport to the site of launching with a lead of five kilometres & lifting to any height as per site requirement, provision of approaches for leading, cleaning of bed block and minor repairs to bed block with epoxy if required, as directed by Engineer in charge with all labour, tools and plant, equipment etc., complete					
29a	**041331**	PSC girders / slabs	94	MT	6,346.14	**7,172.23**	**6,74,189.62**
30	**041390**	Supplying fabricating and erecting welded and/or bolted and/or riveted steel work in built up sections, trusses and framed work, staging, racks etc. for Steel Structures other than bridge girders, using RSJ, tees, angles and channels/flats, plates, gussets, round or square bars, cleats, bolts etc., with contractors own steel including cutting, bending, straightening,	475	MT	86,019.71	**97,217.07**	**4,61,78,108.25**

Schedule 'B' Retaining Wall, Bridges & other civil works							
S. No	Item No.	Description of Item	Quantity	Unit	USSOR/ DSR Rate in INR	Estimated Rate including GST@18% in INR	Estimated Amount in INR
		drilling, riveting, hoisting, fixing, erecting, welding, bolting etc., with Providing stiffeners wherever required as per approved drawing including applying a priming coat of a approved steel primer with all contractor's materials, labour, tools & plants, lead & lift including crossing of tracks if required etc., complete as per specification and as directed by Engineer-in-charge.					
Chapter 5- Bridge Works- Misc.							
31	**051120**	Stenciling of Girders with black / blue lettering over yellow background with ready mix paint w.r.t. details of executed inspection, greasing and painting, other details as directed by Engineer in charge	3,550	Each	41.09	**46.44**	**1,64,862.00**
32	**051170**	Providing and laying of filter media consisting of granular materials of GW, GP, SW groups as per IS:1498 (latest) in required profile behind boulder filling of abutments, wing walls / return walls etc. above bed level with all labour and material complete job as per drawing and technical specification of RDSO Guidelines.	1,25,900	Cum	2,658.72	**2,190.33**	**27,57,62,547.00**
33	**052220**	Painting the HFL mark and Danger level mark, year of HFL on bridge abutments and piers with ready mixed paint as per standard in two coats over one coat of primer with all materials, labour, tools, scaffolding, all lead and lift etc. including writing complete	3,550	Each	283.91	**320.87**	**11,39,088.50**

Schedule 'B' Retaining Wall, Bridges & other civil works							
S. No	Item No.	Description of Item	Quantity	Unit	USSOR/ DSR Rate in INR	Estimated Rate including GST@18% in INR	Estimated Amount in INR
34	**052230**	Providing cast in situ bridge number plaques as per Railway drawing in cement concrete 1:2:4 mix using 20mm hard stone aggregate embedded in 30mm notch in Bridge parapet coping duly engraving the letter and figures and an arrow indicating the direction of flow and finishing the top exposed surface with cement mortar 1:3, painting letters and figures with two coats of black enamel paint on two coats of white background with all labour, tools, cement, paint etc. with all leads and lifts.	6	Each	801.69	**906.05**	**5,436.30**
35	**052240**	Providing cast in-situ plaques for bridge foundations details of size 45cmx45cmx5cm in cement concrete 1:2:4 mix using 20mm hard stone aggregate embedded in 30mm deep notch over abutment & piers, engraving the letters & figures with CM 1:3 and finished smooth including painting letters and figures with 2 coats of black enamel and plaque with white enamel with all labour, tools, cement, paint, curing etc. as a complete job.	21	Each	1,049.88	**1,186.54**	**24,917.34**
36	**052250**	Providing & laying non pressure NP-4 Class RCC pipe with collars, jointing with 1:2 cement and ordinary sand mortar including testing of joints, but excluding earthwork with all labour and material as a complete job. Cement for mortar will be paid separately. (Pipes of 600mm dia and above will be laid using crane/hydra).					

Schedule 'B' Retaining Wall, Bridges & other civil works							
S. No	Item No.	Description of Item	Quantity	Unit	USSOR/ DSR Rate in INR	Estimated Rate including GST@18% in INR	Estimated Amount in INR
36a	**052252**	450mm dia.	282	Meter	2,609.92	**2,949.66**	**8,31,804.12**
37	**052260**	Supplying, spreading and filling coarse sand (no cohesive materials to be used) of approved quality including watering and ramming in foundation, plinth, behind the abutment, wing wall, retaining wall in layers not exceeding 150mm thick including its compaction as per direction of Engineer-incharge. The rate includes all lead, lift, ascent, descent, crossing of Railway line etc. complete with contractor's labour, materials, tools and plant.	2,921	Cum	2,194.63	**2,480.31**	**72,44,985.51**
Chapter 19- Bridge Related Activities							
38	**191260**	Supplying & fixing MS chequered plates 6 to 8mm thick between guard rails on unballasted deck bridge for gang pathway, overlapping at regular intervals of 2m to 2.5m with rail screws or bolts duly drilling holes in chequered plate, as directed [Note : Overlapping of chequered plates shall not fall in between sleepers]	26,000	Kg	80.87	**91.69**	**23,83,940.00**
39	**191310**	Fabrication, supplying and fixing 600mm x 450mm Bridge Board made from 16 SWG MS Sheet duly welded or rivited to back support of two 600mm long horizontal angles of size 25mm x 25mm x 3mm & two 2.5 metre long vertical support of MS Angle of size 50mm x 50mm x 5mm, welded /rivited to board. Vertical supports shall have split ends for proper	12	Each	2,571.26	**2,905.97**	**34,871.64**

Schedule 'B' Retaining Wall, Bridges & other civil works							
S. No	Item No.	Description of Item	Quantity	Unit	USSOR/ DSR Rate in INR	Estimated Rate including GST@18% in INR	Estimated Amount in INR
		fixing in ground. Vertical supports of board shall be embedded in ground in M 20 Cement Concrete blocks of size 300mm x300mm x 300mm, complete job including painting & writing of subject matter on bridge board, as directed by Engineer – In charge {Note : Excavation & concrete work will be paid separately}					
Schedule B2:- USSOR 2010 BASED ITEMS(For Building Works)- (From S. No. 40 to 124)							
Chapter -1 : Earth Work							
40	**012050**	Supplying and filling sand in plinth and under floors including watering, ramming, consolidating and dressing complete	45	cum	725.00	**1,158.13**	**52,115.85**
Chapter -2: Carriage of materials							
41	**021150**	Leading miscellaneous materials such as iron work, rails, fittings & fastenings, pipes, wooden logs, stones over pitching stone size, RCC/PCC beams/slabs etc. and all similar articles (each individual article or bundle being not more than 3.5m long in the longest direction) including all loading, unloading and stacking, lead over 500m and upto 10 km. Note: Lead under this item is payable when the same exceeds 500m.	80	MT	177.74	**271.85**	**21,748.00**
41a	**021151**	Additional lead for every subsequent km or part thereof, over 10 km and upto 100 km over item no. 021150	400	MT/Km	8.02	**12.27**	**4,908.00**

Schedule 'B' Retaining Wall, Bridges & other civil works							
S. No	Item No.	Description of Item	Quantity	Unit	USSOR/ DSR Rate in INR	Estimated Rate including GST@18% in INR	Estimated Amount in INR
Chapter -3: Plain Concrete except item no. 033060 to 033064							
42	**031010**	Providing and laying in position cement concrete of specified proportion excluding cost of cement, centering and shuttering - All works upto Plinth level :					
42a	**031012**	1:3:6 (1 cement : 3 sand : 6 graded stone aggregate 40mm nominal size)	425	Cum	1,882.49	**4,203.39**	**17,86,440.75**
43	**031060**	Centering and shuttering including strutting, propping etc. and removal of form work for :					
43a	**031061**	Foundations, footings, bases of columns	46	Sqm	121.03	**270.25**	**12,431.50**
43b	**031063**	Columns, pillars, posts and struts & miscellaneous parts	40	Sqm	240.45	**536.90**	**21,476.00**
44	**032050**	Providing and laying cement concrete 1:2:4 in damp-proof course (1 cement : 2 sand : 4 graded stone aggregate 12.5mm nominal size - excluding the cost of cement and including providing, fixing and removal of forms:.					
44a	**032053**	50mm thick (20 mm coarse aggregate instead of 12.5mm)	16	Sqm	155.36	**346.90**	**5,550.40**
Chapter -4 : Reinforced cement concrete (except item no. 045016)							

Schedule 'B' Retaining Wall, Bridges & other civil works							
S. No	Item No.	Description of Item	Quantity	Unit	USSOR/ DSR Rate in INR	Estimated Rate including GST@18% in INR	Estimated Amount in INR
45	**041010**	Providing and laying in position M-20 Grade concrete for reinforced concrete structural elements, but excluding cost of centering, shuttering, reinforcement and Admixtures in recommended proportion (as per IS:9103) to accelerate, retard setting of concrete, improve workability without impairing strength and durability as per direction of Engineer in charge					
45a	**041011**	All work upto plinth level, including raft foundation of washable aprons, HS tank, pile cap, footings of FOB, and Platform shelter etc.	338	cum	2,422.38	**5,263.83**	**17,79,174.54**
45b	**041012**	All work in buildings above plinth level upto floor two level.	447	cum	2,645.23	**5,748.08**	**25,69,391.76**
46	**042010**	Centering and shuttering including strutting, propping etc. and removal of form for :					
46a	**042013**	Suspended floors, roofs, landings, balconies, FOB slabs, walkway slabs and access platform	838	Sqm	185.57	**403.24**	**3,37,915.12**
46b	**042014**	Lintels, beams, plinth beams, bed blocks, girders, bressumers and cantilevers	28	Sqm	163.20	**354.63**	**9,929.64**
46c	**042015**	Columns, pillars, posts and struts	1,012	Sqm	240.50	**522.61**	**5,28,881.32**
47	**042020**	Centering and shuttering including strutting, propping etc. and removal of form for special shapes					
47a	**042029**	Weather shade, Chajjas, corbels etc. including edges	40	Sqm	331.42	**720.18**	**28,807.20**

Schedule 'B' Retaining Wall, Bridges & other civil works							
S. No	Item No.	Description of Item	Quantity	Unit	USSOR/ DSR Rate in INR	Estimated Rate including GST@18% in INR	Estimated Amount in INR
48	**042030**	Extra for additional height in centering, shuttering wherever required with adequate bracing, propping etc. including cost of de-shuttering and de-centering at all levels, over a height of 3.5m for every additional height of 1 metre or part thereof in suspended floors, roofs, landing, beams and balconies (plan area to be measured)	13,263	Sqm	74.40	**161.67**	**21,44,229.21**
49	**046010**	Extra for RCC work in superstructure above floor two level for every floor or part thereof	452	cum	280.18	**608.83**	**2,75,191.16**
50	**048100**	Keeping holes for holding down bolts in foundation blocks or bed blocks	100	Each	32.89	**71.47**	**7,147.00**
51	**048110**	Grouting of holding down bolts with cement mortar in foundation blocks or bed blocks	100	Each	31.69	**68.86**	**6,886.00**
Chapter -5 : Brick Work							
52	**051010**	Brick work with non-modular (FPS) bricks of class designation 7.5 in foundation and plinth in :					
52a	**051018**	Cement Mortar 1:6 (1cement : 6 coarse sand)	683	cum	2,218.87	**4,469.74**	**30,52,832.42**
53	**051040**	Extra over items 051010 & 051020 for brick work in superstructure beyond plinth level upto floor two level.	112	Cum	133.42	**268.76**	**30,101.12**
54	**051050**	Extra for brick work in superstructure beyond second floor level for every 3m or part thereof :	283	cum	264.82	**533.46**	**1,50,969.18**
Chapter -7 : Wood Work							

Schedule 'B' Retaining Wall, Bridges & other civil works							
S. No	Item No.	Description of Item	Quantity	Unit	USSOR/ DSR Rate in INR	Estimated Rate including GST@18% in INR	Estimated Amount in INR
55	**071010**	Providing wood work in frames of doors, windows, clerestory windows and other frames and trusses, wrought, framed and fixed in position:					
55a	**071013**	Hollock wood or locally available comparable species of country wood (to be listed by respective railway) - Kiln seasoned & chemically treated	3,727	Cudm	44.47	**72.99**	**2,72,033.73**
56	**072020**	Providing and fixing panelling/glazing or panelling & glazing in panelled/glazed or panelled & glazed shutters for doors, windows & clerestory windows (area of opening for panel inserts excluding portion inside grooves or rebates to be measured). Panelling/glazing for panelled/glazed or panelled & glazed shutters 25mm to 40mm thick					
56a	**072022**	Hollock wood or locally available comparable species of country wood (to be listed by respective railway). - Kiln seasoned & chemically treated - 15mm thick	124	Sqm	750.56	**1,231.98**	**1,52,765.52**
57	**072030**	Providing and fixing paneling and/or glazing in panelled and/or glazed shutters for doors, windows and clerestory windows (area of opening for panel inserts excluding portion inside grooves or rebates to be measured). Panelling/glazing for panelled/ glazed or panelled and glazed shutters 25mm to 40mm thick :					
57a	**072037**	Glazing with float glass panes 4mm thick (10kg/sqm)	40	Sqm	260.07	**426.88**	**17,075.20**

Schedule 'B' Retaining Wall, Bridges & other civil works							
S. No	Item No.	Description of Item	Quantity	Unit	USSOR/ DSR Rate in INR	Estimated Rate including GST@18% in INR	Estimated Amount in INR
58	**074230**	Providing and fixing M.S. grills of required pattern in frames of windows etc. with M.S. flats, square or round bars etc. all complete					
58a	**074232**	Fixed to opening / wooden frames with rawl plugs screws etc.	600	Kg	66.17	**108.61**	**65,166.00**
59	**074280**	Providing 40mmx5mm flat iron hold fast 40cm long including fixing to frame with 10mm diameter bolts, nuts and wooden plugs and embeddings in cement concrete block 30cmx10cmx15cm 1:3:6 mix (1 cement : 3 coarse sand : 6 graded stone aggregate-20mm nominal size)	90	Each	58.54	**96.09**	**8,648.10**
60	**076010**	Providing and fixing ISI:12817 marked stainless steel butt hinges with stainless steel screws etc. complete of size :					
60a	**076012**	100mmx58mmx1.9mm	80	Each	46.06	**75.60**	**6,048.00**
60b	**076013**	75mmx47mmx1.8mm	68	Each	25.63	**42.07**	**2,860.76**
61	**077090**	Providing and fixing bright finished brass 100mm mortice latch and lock with 6 levers and a pair of lever handles with necessary screws etc. complete (best make of approved quality)	101	Each	560.08	**919.32**	**92,851.32**
62	**077140**	Providing and fixing bright finished brass hanging type floor door stopper with necessary screws etc. complete	26	Each	69.75	**114.49**	**2,976.74**

Schedule 'B' Retaining Wall, Bridges & other civil works							
S. No	Item No.	Description of Item	Quantity	Unit	USSOR/ DSR Rate in INR	Estimated Rate including GST@18% in INR	Estimated Amount in INR
63	**077180**	Providing and fixing IS:3564 marked aluminium die cast body tubular type universal hydraulic door closer, hardwyn make (Classic Queen) or equivalent with necessary accessories and screws etc. complete	26	Each	669.45	**1,098.84**	**28,569.84**
64	**078020**	Providing and fixing aluminium sliding door bolts ISI marked anodised (anodic coating not less than grade AC 10 as per IS:1868) transparent or dyed to required colour or shade with nuts and screws etc. complete :					
64a	**078021**	300mmx16mm	34	Each	178.83	**293.53**	**9,980.02**
65	**078030**	Providing and fixing aluminium tower bolts ISI marked anodised (anodic coating not less than grade AC 10 as per IS:1868) transparent or dyed to required colour or shade with necessary screws etc. complete :					
65a	**078033**	200mmx10mm	34	Each	48.55	**79.69**	**2,709.46**
65b	**078035**	100mmx10mm	33	Each	29.60	**48.59**	**1,603.47**
66	**078060**	Providing and fixing aluminium handles ISI marked anodised (anodic coating not less than grade AC 10 as per IS:1868) transparent or dyed to required colour or shade with necessary screws etc. complete :					
66a	**078061**	125mm	58	Each	38.04	**62.44**	**3,621.52**
66b	**078062**	100mm	58	Each	33.96	**55.74**	**3,232.92**

Schedule 'B' Retaining Wall, Bridges & other civil works							
S. No	Item No.	Description of Item	Quantity	Unit	USSOR/ DSR Rate in INR	Estimated Rate including GST@18% in INR	Estimated Amount in INR
66c	**078063**	75mm	38	Each	30.14	**49.47**	**1,879.86**
Chapter -8 : Steel and Aluminium Work							
67	**081420**	Providing and fixing hand rail by welding etc. to steel ladders railing, balcony railing and staircase railing including applying a priming coat of approved steel primer					
67a	**081423**	G.I. pipes 40mm nominal bore (class B)	288	Kg	107.57	**178.55**	**51,422.40**
68	**082010**	Providing and fixing anodised aluminium work for doors, windows, ventilators and partitions with extruded built-up standard tubular and other sections of approved make conforming to IS:733 and IS:1285, anodised transparent or dyed to required shade according to IS:1868 (Minimum anodic coating of grade AC 15), fixed with rawl plugs and screws or with fixing clips, or with expansion hold fasteners including necessary filling up of gaps at junctions, at top, bottom and sides with required PVC/neoprene felt etc. Aluminium sections shall be smooth, rust free, straight, mitred and jointed mechanically wherever required including cleat angle. Aluminium snap beading for glazing/panelling, C.P. brass/stainless steel screws, all complete as per architectural drawings and directions of Engineer-in-charge. (Glazing & panelling to be paid for separately)					

Schedule 'B' Retaining Wall, Bridges & other civil works							
S. No	Item No.	Description of Item	Quantity	Unit	USSOR/ DSR Rate in INR	Estimated Rate including GST@18% in INR	Estimated Amount in INR
68a	**082011**	for Fixed portion	80	Kg	305.87	**507.70**	**40,616.00**
68b	**082012**	For openable/sliding portions and fixing hinges / pivots, PVC/neoprene gasket required and making provision for fixing of fittings. (Fittings shall be paid for separately)	80	Kg	317.67	**527.29**	**42,183.20**
Chapter -9 : Flooring, Paving & Dado							
69	**092010**	Cement concrete flooring 1:2:4 (1 cement : 2 coarse sand : 4 graded stone aggregate) finished with a floating coat of neat cement including cement slurry, but excluding the cost of nosing of steps etc. complete :					
69a	**092012**	40mm thick with 20mm nominal size stone aggregate	141	Sqm	120.99	**196.77**	**27,744.57**
70	**094070**	Providing and fixing 10mm thick heavy duty acid and/or alkali resistant factory made tiles conforming to Group V-RD series of approved make and colour using acid and/or alkali resisting mortar bedding and joints filled with acid and/or alkali resisting cement as per IS:4457 complete including cost of acid/alkali resistant cement					
70a	**094071**	In flooring on a bed of 10mm thick mortar 1:4 (1 appropriate cement : 4 coarse sand)	10	Sqm	1,252.14	**2,036.43**	**20,364.30**

Schedule 'B' Retaining Wall, Bridges & other civil works							
S. No	Item No.	Description of Item	Quantity	Unit	USSOR/ DSR Rate in INR	Estimated Rate including GST@18% in INR	Estimated Amount in INR
71	**095010**	Providing and fixing Ist quality ceramic tiles conforming to Group B-III (Ceramic Wall Tiles) of IS:15622 of manufacturers approved by railway in all colours, shades, and design as approved by the Engineer-in-Charge in skirting, risers of steps and dado over 12mm thick bed of cement mortar 1:3 (1 cement : 3 coarse sand) including pointing in white cement mixed with pigment of matching shade complete					
71a	**095011**	200x200 mm	175	Sqm	498.16	**810.19**	**1,41,783.25**
72	**095020**	Providing and fixing ceramic tiles conforming to IS:15622 of manufacturers approved by railway in all colours, shades, design and abrasion resistance class as approved by the Engineer-in-Charge in floors and landings over 20mm thick bed of cement mortar 1:4 (1 cement : 3 coarse sand) including pointing in white cement mixed with pigment of matching shade complete					
72a	**095024**	Providing and fixing ceramic tiles conforming to IS:15622 of manufacturers approved by railway in all colours, shades, design and abrasion resistance class as approved by the Engineer-in-Charge in floors and landings over 20mm thick bed of cement mortar 1:3 (1cement: 3coarse sand) including pointing in white cement mixed with pigment ofmatching shade	60	Sqm	754.29	**1,226.75**	**73,605.00**

Schedule 'B' Retaining Wall, Bridges & other civil works							
S. No	Item No.	Description of Item	Quantity	Unit	USSOR/ DSR Rate in INR	Estimated Rate including GST@18% in INR	Estimated Amount in INR
		complete: Of Group B-I-b of IS : 15622 (Ceramic Tiles) of size above 400x400mm					
72b	**095026**	Providing and fixing ceramic tiles conforming to IS:15622 of manufacturers approved by railway in all colours, shades, design and abrasion resistance class as approved by the Engineer-in-Charge in floors and landings over 20mm thick bed of cement mortar 1:3 (1cement: 3coarse sand) including pointing in white cement mixed with pigment of matching shade complete: Of Group B-I-a of IS : 15622 (Vitrified tiles) of size above 400x400mm upto 600x600 mm	487	Sqm	932.87	**1,517.18**	**7,38,866.66**
73	**096070**	40mm thick Kota stone slab flooring of size up to 60x60cm over 20mm (average) thick base of 1:4 cement mortar (1cement: 4coarse sand) and jointed with grey cement slurry mixed with pigment to match the shade of the slab including rubbing and polishing complete :					
73a	**096074**	40mm thick	174	Sqm	1,499.02	**2,437.94**	**4,24,201.56**
74	**096080**	Kota stone slabs 25mm thick in risers of steps, skirting, dado and pillars laid on 12mm (average) thick cement mortar 1:3 (1cement: 3coarse sand) and jointed with grey cement slurry mixed with pigment	166	Sqm	655.12	**1,065.46**	**1,76,866.36**

Schedule 'B' Retaining Wall, Bridges & other civil works							
S. No	Item No.	Description of Item	Quantity	Unit	USSOR/ DSR Rate in INR	Estimated Rate including GST@18% in INR	Estimated Amount in INR
		to match the shade of the slab, including rubbing and polishing complete					
75	**099080**	Polished stone tile work for wall lining (dado) over 12mm thick bed of cement mortar 1:3 including pointing in white cement with an admixture of pigment to match the stone shade with tiles of all size upto 300mm x 300mm					
75a	**099082**	8mm thick superior quality black granite tiles	188	Sqm	1,351.62	**2,198.22**	**4,13,265.36**
76	**099210**	Providing and fixing 10mm (± 0.2mm) thick heavy duty, full-body homogeneous, anti-algal, all weather resistant, exterior use Paving vitrified tiles of size upto 400mmx400mm in approved shade, colour & quality, having anti-skid matt finish surface with plain or projected texture. Tiles to be laid on 20mm average thick cement mortar bed of 1:4 (1 cement : 4 coarse sand) with all labour, material complete job	677	Sqm	670.49	**1,090.46**	**7,38,241.42**
Chapter -10 : Roof and Ceilings							
77	**106100**	Providing and fixing at all height false ceiling of 12.5mm thick tapered edge gypsum board conforming to IS:2095-Part I, including providing and fixing of frame work made of special sections power pressed from M.S. sheet and galvanised with zinc coating of grade 350 as per IS:277 and consisting of angle cleats of size 25mm x 1.6mm with flanges of 22mm and	295	Sqm	561.22	**916.49**	**2,70,364.55**

Schedule 'B' Retaining Wall, Bridges & other civil works							
S. No	Item No.	Description of Item	Quantity	Unit	USSOR/ DSR Rate in INR	Estimated Rate including GST@18% in INR	Estimated Amount in INR
		37mm at 1200mm centre to centre one flange fixed to the ceiling with stener 12.5mm dia x 40mm long with 6mm dia bolts to the angle hangers of 25mmx25mmx0.55mm of required length and other end of angle hanger being fixed with nut and bolts to G.I. channels 45mmx15mmx0.9mm running at the rate of 1200mm centre to centre to which the ceiling section 0.5mm thick bottom wedge of 80mm with tapered flanges of 26mm each having clips of 10.5mm at 450mm centre to centre shall be fixed in a direction perpendicular to G.I. channel with connecting clips made out of 2.64mm dia x 230mm long G.I. wire at every junction including fixing the gypsum board with ceiling section and perimeter channels 0.5mm thick 27mm high having flanges of 20mm and 30mm long, the perimeter of ceiling fixed to wall/partition with the help of rawl plugs at 450mm centre to centre with 25mm long drive-all screws @ 230mm interval including jointing and fixing to a flush finish of tapered and square edges of the gypsum board with recommended filler, paper tapes, finisher and two coats of primer suitable for gypsum board as per manufacturers specification and also including the cost of making openings for light fittings, grills, diffusers, cutouts made with frame of perimeter channels suitably fixed all complete as per drawing					

Schedule 'B' Retaining Wall, Bridges & other civil works							
S. No	Item No.	Description of Item	Quantity	Unit	USSOR/ DSR Rate in INR	Estimated Rate including GST@18% in INR	Estimated Amount in INR
		and specification and direction of the Engineer-in-Charge but excluding the cost of painting.					
78	**106110**	Providing 10mm thick Plaster of Paris (gypsum anhydrous) ceiling upto a height of 5m above floor level over 1st class kail or similar wood strips 25mmx6mm with 10mm gap in between and reinforced with rabbit wire mesh fixed to wooden frame (frame work to be paid separately)					
78a	**106111**	Flat surfaces	490	Sqm	562.62	**918.78**	**4,50,202.20**
79	**108190**	Providing and fixing unplasticised-PVC pipe clips of approved design to unplasticised-PVC rain water pipes by means of 50mmx50mmx50mm hard wood plugs, screwed with M.S. screws of required length including cutting brick work and fixing in cement mortar 1:4 (1 cement : 4 coarse sand) and making good the wall etc. complete					
79a	**108192**	110mm	6	Each	164.34	**268.37**	**1,610.22**
80	**108200**	Providing and fixing to the inlet mouth of rainwater pipe cast iron grating 15cm dia and weighing not less than 440 grams	6	Each	120.98	**197.56**	**1,185.36**
Chapter -11 : Finishing Masonary							

Schedule 'B' Retaining Wall, Bridges & other civil works							
S. No	Item No.	Description of Item	Quantity	Unit	USSOR/ DSR Rate in INR	Estimated Rate including GST@18% in INR	Estimated Amount in INR
81	**111040**	12 mm cement plaster of mix -					
81a	**111042**	1:6 (1 cement : 6 coarse sand)	833	Sqm	61.86	**108.04**	**89,997.32**
82	**111070**	12mm cement plaster finished with a floating coat of neat cement of mix -					
82a	**111072**	1:4 (1 cement : 4 fine sand)	11	Sqm	68.05	**118.85**	**1,307.35**
83	**111120**	18mm cement plaster in two coats under layer 12mm thick cement plaster 1:5 (1 cement : 5 coarse sand) and a top layer 6mm thick cement plaster 1:3 (1 cement : 3 coarse sand) finished rough with sponge/rubber pad	1,967	Sqm	92.68	**161.86**	**3,18,378.62**
84	**112040**	Providing and applying plaster of Paris putty of 2mm average thickness over plastered surface to prepare the surface even and smooth complete	2,589	Sqm	62.28	**108.77**	**2,81,605.53**
85	**115050**	Distempering two or more coats on new work with 1st quality acrylic washable distemper (ready mixed) of approved manufacturer and of required shade and colour complete as per manufacturer's specification	2,822	Sqm	30.45	**53.18**	**1,50,073.96**
86	**115110**	Finishing walls with water proofing cement paint of required shade two or more coats on new work applied @ 3.84 kg/10 sqm	1,294	Sqm	38.40	**67.06**	**86,775.64**
Chapter -12 : Painting, Polishing & Varnishing							
87	**121010**	Applying Priming Coat :					
87a	**121011**	With ready mixed pink or grey primer of approved brand and manufacture on woodwork (hard and soft wood)	363	Sqm	19.08	**35.81**	**12,999.03**

Schedule 'B' Retaining Wall, Bridges & other civil works							
S. No	Item No.	Description of Item	Quantity	Unit	USSOR/ DSR Rate in INR	Estimated Rate including GST@18% in INR	Estimated Amount in INR
87b	**121013**	With ready mixed red oxide zinc chromate primer of approved brand and manufacture on steel galvanized iron/steel works	474	Sqm	14.97	**28.09**	**13,314.66**
88	**121150**	Painting two coats (excluding priming coat) with chocolate, red, grey or buff ready mixed paint of approved quality on steel or wood work	286	Sqm	38.79	**72.80**	**20,820.80**
Chapter -13 : Water Supply							
89	**131150**	Providing and fixing medium grade G.I Pipes complete G.I fittings including trenching and refilling etc External work					
89a	**131151**	15mm dia nominal bore	72	Meter	128.42	**192.52**	**13,861.44**
89b	**131153**	25mm dia nominal bore	72	Meter	214.91	**322.18**	**23,196.96**
89c	**131156**	50mm dia nominal bore	232	Meter	384.78	**576.85**	**1,33,829.20**
89d	**131157**	65mm dia nominal bore	4	Meter	484.87	**726.90**	**2,907.60**
89e	**131158**	80mm dia nominal bore	4	Meter	629.12	**943.15**	**3,772.60**
90	**131160**	Making connection of medium grade G.I. distribution branch with G.I. main of following sizes by providing and fixing tee, including cutting and threading the pipe etc. complete					

Schedule 'B' Retaining Wall, Bridges & other civil works							
S. No	Item No.	Description of Item	Quantity	Unit	USSOR/ DSR Rate in INR	Estimated Rate including GST@18% in INR	Estimated Amount in INR
90a	**131161**	Making connection G.I. of size 25 to 40 mm	26	Each	208.98	**313.29**	**8,145.54**
90b	**131162**	Making connection G.I. of size 50 to 80 mm	68	Each	610.28	**914.91**	**62,213.88**
91	**132010**	Providing & fixing brass bib cock of approved quality					
91a	**132011**	15 mm nominal bore	21	Each	154.55	**231.69**	**4,865.49**
91b	**132013**	25mm nominal bore	10	Each	300.36	**450.29**	**4,502.90**
92	**132020**	Providing and fixing brass stop cock of approved quality					
92a	**132021**	15 mm nominal bore	23	Each	151.88	**227.69**	**5,236.87**
93	**136040**	Constructing masonry Chamber 120x120x100 cm, inside with 7.5 class designation brick work with FPS Bricks in cement mortar 1:4 (1 cement : 4 coarse sand) for sluice valve, with C.I. surface box 100mm top diameter, 160mm bottom diameter and 180mm deep (inside) with chained lid and RCC top slab 1:2:4 mix (1 cement : 2 coarse sand : 4 graded stone aggregate-20 mm nominal size) necessary excavation foundation concrete 1:5:10 (1 cement : 5 fine sand :10 graded stone aggregate 40mm nominal size) and inside plastering with cement mortar 1:3 (1 cement : 3 coarse sand) 12mm thick finished with a floating coat of neat cement complete as per standard design.	2	Each	5,887.89	**8,826.88**	**17,653.76**

Schedule 'B' Retaining Wall, Bridges & other civil works							
S. No	Item No.	Description of Item	Quantity	Unit	USSOR/ DSR Rate in INR	Estimated Rate including GST@18% in INR	Estimated Amount in INR
Chapter -14 : Drainage and sewerage							
94	**142010**	Providing and laying non-pressure NP2 class (light duty) R.C.C. pipes including bends etc with collars jointed with stiff mixture of cement mortar in the proportion of 1:2 (1 cement : 2 fine sand) including testing of joints etc. complete upto 800mm dia.					
94a	**142014**	300mm dia. R.C.C. pipe	20	Meter	721.21	**1,542.42**	**30,848.40**
Chapter -15 : Sanitary Installations							
95	**151010**	Providing and fixing water closet squatting pan (Indian type W.C. pan) with 100mm sand cast iron 'P' or 'S' trap, 10 litres low level white P.V.C. flushing cistern with manually controlled device (handle lever) conforming to IS:7231, with all fittings and fixtures complete including cutting and making good the walls and floors wherever required					
95a	**151011**	White Vitreous China Orissa pattern W.C. pan of size 580mmx440mm with integral type foot rests	3	Each	3,057.59	**4,439.91**	**13,319.73**
96	**151020**	Providing and fixing white vitreous china pedestal type water closet (European type W.C. pan) with seat and lid, 10 litres low level white, P.V.C. flushing cistern with manually controlled device (handle lever) conforming to IS:7231, with all fittings and fixtures complete including cutting and making good the walls and floors wherever required					

Schedule 'B' Retaining Wall, Bridges & other civil works							
S. No	Item No.	Description of Item	Quantity	Unit	USSOR/ DSR Rate in INR	Estimated Rate including GST@18% in INR	Estimated Amount in INR
96a	**151021**	W.C. pan with ISI marked white solid plastic seat and lid	11	Each	2,856.65	**4,148.12**	**45,629.32**
97	**151040**	Providing and fixing white vitreous china flat back or wall corner type lipped front urinal basin of 430mmx260mmx350mm and 340mmx410mmx 265mm sizes respectively with automatic flushing cistern, with standard flush pipe and C.P. brass spreaders with brass					
97a	**151041**	One urinal basin with 5 litres white P.V.C. automatic flushing cistern	5	Each	2,377.03	**3,451.67**	**17,258.35**
98	**151050**	Providing and fixing white, vitreous china flat back half stall urinal of 580mmx380mmx350mm with white P.V.C. automatic flushing cistern, with fittings, standard size C.P. brass flush pipe, spreaders with unions and clamps (all in C.P. brass) with waste fitting as per IS:2556, C.I. trap with outlet grating and other coupling in C.P. brass including painting of fittings and cutting and making good the walls and floors, wherever required					
98a	**151051**	Single half stall urinal with 5 litres P.V.C. automatic flushing cistern	5	Each	3,798.11	**5,515.21**	**27,576.05**
99	**151070**	Providing and fixing wash basin with C.I./M.S. brackets, 15mm C.P. brass pillar taps, 32mm C.P. brass waste of standard pattern, including painting of fittings and brackets, cutting and making good the walls, wherever required :					

Schedule 'B' Retaining Wall, Bridges & other civil works							
S. No	Item No.	Description of Item	Quantity	Unit	USSOR/ DSR Rate in INR	Estimated Rate including GST@18% in INR	Estimated Amount in INR
99a	**151071**	White, vitreous china wash basin size 630mm x 450mm with a pair of 15mm C.P brass pillars.	15	Each	1,942.55	**2,820.77**	**42,311.55**
100	**152020**	Providing and fixing Stainless Steel AISI-304 (18/8) kitchen sink with drain board as per IS:13983 with C.I. brackets and stainless steel plug 40mm including painting of fittings and brackets, cutting and making good the walls, wherever required:					
100a	**152021**	510mmx1040mm bowl depth 250mm	2	Each	2,558.56	**3,715.27**	**7,430.54**
101	**152080**	Providing and fixing P.V.C. waste pipe for sink or wash basin including P.V.C. waste fittings complete					
101a	**152084**	Flexible pipe 40mm dia.	40	Each	92.92	**134.93**	**5,397.20**
102	**152110**	Providing and fixing 600x450 mm beveled edge mirror of superior glass (of approved quality) complete with 6 mm thick hard board ground fixed to wooden cleats with C.P. brass screws and washers complete.	9	Each	706.70	**1,026.19**	**9,235.71**
103	**152120**	Providing and fixing mirror of 5.5mm thickness of float Glass (of approved Quality) required shape and size with plastic moulded frame of approved make and shade with 6mm thick hard board backing					
103a	**152124**	Rectangular shape 1500mmx450mm (outer dimension)	6	Each	1,750.45	**2,541.82**	**15,250.92**
104	**153010**	Providing and fixing soil, waste and vent pipes					

Schedule 'B' Retaining Wall, Bridges & other civil works							
S. No	Item No.	Description of Item	Quantity	Unit	USSOR/ DSR Rate in INR	Estimated Rate including GST@18% in INR	Estimated Amount in INR
104a	**153012**	100mm dia. centrifugally cast (spun) iron S&S pipe as per IS:3989	56	Meter	599.73	**870.86**	**48,768.16**
105	**153300**	Providing and fixing PTMT liquid soap container 109 mm wide, 125 mm high and 112 mm distance from wall of standard shape with bracket of the same materials with snap fittings of approved quality and colour, weighing not less than 105 gms.	8	Each	185.84	**269.86**	**2,158.88**
106	**153410**	Providing and fixing Towel rail (C.P.) brass 15mm dia. x 600mm long having approx. weight 500 gm	11	Each	413.49	**600.43**	**6,604.73**
107	**154010**	Providing and fixing 110mm dia PVC soil, waste and vent pipes including jointing and cost of spun yarn and sand etc. complete	100	Meter	205.50	**298.41**	**29,841.00**
108	**154100**	Providing and fixing 110mm PVC Plain bend of the required degree with access door inclusive of 3mm thick bitumastic felt washer, bolts and nuts, complete, including jointing and cost of spun yarn and sand etc. complete	100	Each	77.54	**112.60**	**11,260.00**
109	**154130**	Providing and fixing 110mm PVC collar (loose socket) including jointing and cost of spun yarn and sand etc. complete	20	Each	73.17	**106.25**	**2,125.00**
110	**154140**	Providing and fixing 75mm PVC soil, waste and vent pipes including jointing and cost of spun yarn and sand etc. complete	60	Meter	128.17	**186.11**	**11,166.60**
111	**154150**	Providing and fixing brackets comprising of aluminium painted steel clips and cast iron base for 75mm PVC pipes including cost of screws etc. and	40	Each	52.17	**75.76**	**3,030.40**

Schedule 'B' Retaining Wall, Bridges & other civil works							
S. No	Item No.	Description of Item	Quantity	Unit	USSOR/ DSR Rate in INR	Estimated Rate including GST@18% in INR	Estimated Amount in INR
		drilling of holes and making good the walls, including cost of sand etc. complete					
112	**155060**	Supplying and fixing pipe as outlet or waste pipe to wash basins sink and bowl type urinals etc. complete including providing clamps to hold the pipe, making holes in masonry and making it good to original condition when not included in the item					
112a	**155063**	PVC 50 mm bore 1.7mm thick	12	Meter	109.06	**158.37**	**1,900.44**
113	**155070**	Supplying and fixing granite stone superior quality black 20mm to 25mm thick in masonry or concrete as a Purdah to urinal range etc. stone to be machine cut & well polished on all faces and the edges to be moulded by semi-circular rounding and polishing. NOTE : The following percentage is to be added / deducted in case of granites other than superior quality black : i) For superior quality Red like "RBI" red add 15% extra; ii) For pink coloured granite deduct 25%; iii) For gray coloured granite deduct 18%.	40	sqm	2,449.89	**3,557.47**	**1,42,298.80**
114	**155200**	Providing and fixing Flush valve (C.P.) 25mm with 25mm size control cock having approx. weight 2.75 kg conforming to IS:9758-1981	10	Each	1,529.70	**2,221.27**	**22,212.70**

Schedule 'B' Retaining Wall, Bridges & other civil works							
S. No	Item No.	Description of Item	Quantity	Unit	USSOR/ DSR Rate in INR	Estimated Rate including GST@18% in INR	Estimated Amount in INR
115	**156010**	Cutting chases in brick masonry walls for following diameter sand cast iron/centrifugally cast (spun) iron or any other types of pipes and making good the same with cement concrete 1:3:6 (1 cement : 3 coarse sand : 6 graded stone aggregate 12.5mm nominal size) including necessary plaster and pointing in cement mortar 1:4 (1 cement : 4 coarse sand)					
115a	**156011**	100mm dia.	108	Meter	129.28	**187.73**	**20,274.84**
115b	**156012**	75mm dia.	68	Meter	92.25	**133.96**	**9,109.28**
115c	**156013**	50mm dia.	48	Meter	58.94	**85.59**	**4,108.32**
Chapter -17 : Misc Building Works							
116	**171100**	Providing and fixing 16mm MS Fan clamps of standard shape and size in existing R.C.C. slab including cutting chase and making good with 1:2 C:S mortar and painting (two coats) exposed portion of the clamps complete	20	Each	123.05	**186.41**	**3,728.20**
117	**171690**	Providing & applying Pre-Construction Anti-Termite treatment to proposed structure, with application of Imidacloprid 30.5% SC @ o.075% concentration mixed with water in ratio of 1:475, as per detailed specifications given in Indian Railways Standard Specifications, so as to create a chemical barrier below and around the structure by an approved	38	Sqm	70.81	**107.27**	**4,076.26**

Schedule 'B' Retaining Wall, Bridges & other civil works							
S. No	Item No.	Description of Item	Quantity	Unit	USSOR/ DSR Rate in INR	Estimated Rate including GST@18% in INR	Estimated Amount in INR
		agency. (plinth area/basement floor area shall be considered for payment)					
Chapter -18 : Dismantling and Demolishing							
118	**181030**	Demolishing R.C.C. work including cutting and stacking of steel bars and disposal of unserviceable material within 50m lead. (Extra payment for scraping, cleaning and straightening of bars to be made separately)	340	cum	603.12	**1,026.92**	**3,49,152.80**
119	**182010**	Demolishing brick work including stacking of serviceable material and disposal of unserviceable material within 50m lead					
119a	**182013**	In cement mortar	260	cum	348.90	**594.06**	**1,54,455.60**
120	**182030**	Demolishing stone rubble masonry including stacking of serviceable material and disposal of unserviceable material within 50m lead					
120a	**182033**	In cement mortar	20	cum	416.29	**708.81**	**14,176.20**
121	**182040**	Dismantling dressed stone work, ashlar face stone work, marble work, including stacking of serviceable and disposal of unserviceable material within 50m lead					
121a	**182042**	In cement mortar	20	cum	486.91	**829.05**	**16,581.00**

Schedule 'B' Retaining Wall, Bridges & other civil works							
S. No	Item No.	Description of Item	Quantity	Unit	USSOR/ DSR Rate in INR	Estimated Rate including GST@18% in INR	Estimated Amount in INR
122	**185010**	Dismantling doors, windows and clerestory windows (steel or wood) shutter including chowkhats, architrave, holdfasts in CC or masonry etc. complete and stacking within 50m lead	8	Each	84.12	**143.23**	**1,145.84**
123	**186010**	Dismantling steel work in single sections including dismembering & stacking within 50m lead in					
123a	**186011**	Dismantling steel work in single sections including dismembering & stacking within 50m lead in R.S. joists./ Rails	10,240	Kg	0.57	**0.97**	**9,932.80**
123b	**186012**	Channels, angles, tees and flats/ rounds or any other rolled shape	10,912	Kg	0.41	**0.70**	**7,638.40**
Chapter -25 : Supply of Material							
124	**257050**	Polyethylene Vinyl Chloride water storage tank with cover and suitable locking arrangement	4,000	litre	5.75	**8.70**	**34,800.00**
Schedule B3:- DSR-2021 BASED ITEMS (from S. No. 125 to 152)							
125	**3.8**	1:3 (1 Cement : 3 coarse sand (zone-III)) cement sand levelling mortar. Item will be used as below precast item. Note:- cost of cement is included in the item.	220	Cum	5,024.15	**5,502.88**	**12,10,633.60**
126	**10.16**	Steel work in built up tubular (round, square or rectangular hollow tubes etc.) trusses etc., including cutting, hoisting, fixing in position and applying a priming coat of approved steel primer, including welding and bolted with special shaped washers etc. complete.					

Schedule 'B' Retaining Wall, Bridges & other civil works							
S. No	Item No.	Description of Item	Quantity	Unit	USSOR/ DSR Rate in INR	Estimated Rate including GST@18% in INR	Estimated Amount in INR
126a	**10.16.2**	Hot finished seamless type tubes	2,088	Kg	168.95	**185.05**	**3,86,384.40**
127	**11.20**	Chequerred precast cement concrete tiles 22 mm thick in footpath & courtyard, jointed with neat cement slurry mixed with pigment to match the shade of tiles, including rubbing and cleaning etc. complete, on 20 mm thick bed of cement mortar 1:4 (1 cement: 4 coarse sand).					
127a	**11.20.1**	Light shade pigment using white cement	500	Sqm	1,233.05	**1,350.54**	**6,75,270.00**
128	**16.30**	Providing and applying tack coat using hot straight run bitumen of grade VG - 10, including heating the bitumen, spraying the bitumen with mechanically operated spray unit fitted on bitumen boiler, cleaning and preparing the existing road surface as per specifications					
128a	**16.30.2**	On bituminous surface @ 0.50 Kg / sqm	9,750	Sqm	36.60	**40.09**	**3,90,877.50**
129	**16.33**	2.5 cm premix carpet surfacing with 2.25 cum and 1.12 cum of stone chippings of 13.2 mm and 11.2 mm size respectively per 100 sqm and 52 kg and 56 kg of hot bitumen per cum of stone chippings of 13.2 mm and 11.2 mm size respectively, including a tack coat with hot straight run bitumen, including consolidation with road roller of 6 to 9 tonne capacity etc. complete (tack coat to be paid for separately).					

Schedule 'B' Retaining Wall, Bridges & other civil works							
S. No	Item No.	Description of Item	Quantity	Unit	USSOR/ DSR Rate in INR	Estimated Rate including GST@18% in INR	Estimated Amount in INR
129a	**16.33.2**	With paving Asphalt grade VG - 30 with no solvent	9,750	Sqm	254.80	**279.08**	**27,21,030.00**
130	**16.55**	Providing and laying bituminous macadam using crushed stone aggregates of specified grading premixed with bituminous binder, transported to site by tippers, laid over a previously prepared surface with paver finisher equipped with electronic sensor to the required grade, level and alignment and rolling with smooth wheeled, vibratory and tandem rollers as per specifications to achieve the desired compaction and density, complete as per specifications and directions of Engineer-in-Charge.					
130a	**16.55.1**	50 to 100 mm average compacted thickness with bitumen of grade VG-30 @ 3.50% (percentage by weight of total mix) prepared in Batch Type Hot Mix Plant of 100-120 TPH capacity.	2,100	Cum	7,756.40	**8,495.47**	**1,78,40,487.00**
131	**16.69**	Providing and laying at or near ground level factory made **kerb stone** of M-25 grade cement concrete in position to the required line, level and curvature, jointed with cement mortar 1:3 (1 cement: 3 coarse sand), including making joints with or without grooves (thickness of joints except at sharp curve shall not to more than 5mm), including making drainage opening wherever required complete etc. as per direction of Engineer-in-charge (length of finished kerb edging shall be measured for payment). (Precast	72	Cum	8,613.55	**9,434.29**	**6,79,268.88**

Schedule 'B' Retaining Wall, Bridges & other civil works							
S. No	Item No.	Description of Item	Quantity	Unit	USSOR/ DSR Rate in INR	Estimated Rate including GST@18% in INR	Estimated Amount in INR
		C.C. kerb stone shall be approved by Engineer-in-charge).					
132	**16.75**	Providing and laying C.C. pavement of mix M-25 with ready mixed concrete from batching plant. The ready mixed concrete shall be laid and finished with screed board vibrator , vaccum dewatering process and finally finished by floating, brooming with wire brush etc. complete as per specifications and directions of Engineer-in-charge. Note:- Cement content considered in this item is @ 330 kg/cum. Excess/less cement used as per design mix is payable/ recoverable separately).	4,000	Cum	8,277.55	**9,066.28**	**3,62,65,120.00**
133	**16.78**	Construction of granular sub-base by providing close graded Material conforming to specifications, mixing in a mechanical mix plant at OMC, carriage of mixed material by tippers to work site, for all leads & lifts, spreading in uniform layers of specified thickness with motor grader on prepared surface and compacting with vibratory power roller to achieve the desired density, complete as per specifications and directions of Engineer-in-Charge.					

Schedule 'B' Retaining Wall, Bridges & other civil works							
S. No	Item No.	Description of Item	Quantity	Unit	USSOR/ DSR Rate in INR	Estimated Rate including GST@18% in INR	Estimated Amount in INR
133a	**16.78.2**	With material conforming to Grade-II (size range 53 mm to 0.075 mm) having CBR Value-25	11,500	Cum	2,775.65	**3,040.13**	**3,49,61,495.00**
134	**16.79**	Providing, laying, spreading and compacting graded stone aggregate (size range 53 mm to 0.075 mm) to wet mix macadam (WMM) specification including premixing the material with water at OMC in for all leads & lifts, laying in uniform layers with mechanical paver finisher in sub- base / base course on well prepared surface and compacting with vibratory roller of 8 to 10 tonne capacity to achieve the desired density, complete as per specifications and directions of Engineer-in-Charge.	4,500	Cum	2,803.65	**3,070.80**	**1,38,18,600.00**
135	**16.80**	Construction of dry lean cement concrete sub base over a prepared sub-grade with coarse and fine aggregate conforming to IS:383, the size of coarse aggregate not exceeding 25 mm, aggregate cement ratio not to exceed 15:1, aggregate gradation after blending to be as per specifications, cement content not to be less than 150 Kg/cum, optimum moisture content to be determined during trial length construction, concrete strength not to be less than 10 Mpa at 7 days, mixed in a batching plant, transported to site, for all leads & lifts, laid with a mechanical paver, compacting with 8-10 tonne vibratory roller, finishing and curing etc. complete as per direction of Engineer-in- charge	3,000	Cum	4,130.55	**4,524.13**	**1,35,72,390.00**

Schedule 'B' Retaining Wall, Bridges & other civil works							
S. No	Item No.	Description of Item	Quantity	Unit	USSOR/ DSR Rate in INR	Estimated Rate including GST@18% in INR	Estimated Amount in INR
136	**16.90**	Providing and laying tactile tile (for vision impaired persons as per standards) of size 300x300x9.8mm having with water absorption less than 0.5% and conforming to IS:15622 of approved make in all colours and shades in for outdoor floors such as footpath, court yard, multi modals location etc., laid on 20mm thick base of cement mortar 1:4 (1 cement : 4 coarse sand) in all shapes & patterns including grouting the joints with white cement mixed with matching pigments etc. complete as per direction of Engineer-in-Charge.	500	Sqm	1,719.00	**1,882.79**	**9,41,395.00**
137	**16.91**	Providing and laying factory made chamfered edge Cement **Concrete paver blocks** in footpath, parks, lawns, drive ways or light traffic parking etc, of required strength, thickness & size/ shape, made by table vibratory method using PU mould, laid in required colour & pattern over 50mm thick compacted bed of sand, compacting and proper embedding/laying of inter locking paver blocks into the sand bedding layer through vibratory compaction by using plate vibrator, filling the joints with sand and cutting of paver blocks as per required size and pattern, finishing and sweeping extra sand. complete all as per direction of Engineer-in-Charge.					
137a	**16.91.1**	60 mm thick C.C. paver block of M-30 grade with approved color design and pattern.	1,840	Sqm	932.35	**1,021.19**	**18,78,989.60**

Schedule 'B' Retaining Wall, Bridges & other civil works							
S. No	Item No.	Description of Item	Quantity	Unit	USSOR/ DSR Rate in INR	Estimated Rate including GST@18% in INR	Estimated Amount in INR
137b	**16.91.2**	80 mm thick C.C. paver block of M-30 grade with approved color design and pattern.	300	Sqm	1,011.20	**1,107.55**	**3,32,265.00**
138	**18.8**	Providing and fixing Chlorinated Polyvinyl Chloride (CPVC) pipes, having thermal stability for hot & cold water supply, including all CPVC plain & brass threaded fittings, i/c fixing the pipe with clamps at 1.00 m spacing. This includes jointing of pipes & fittings with one step CPVC solvent cement and the cost of cutting chases and making good the same including testing of joints complete as per direction of Engineer in Charge. Concealed work, including cutting chases and making good the walls etc					
138a	**18.8.1**	15 mm nominal dia Pipes	50	Meter	441.15	**483.18**	**24,159.00**
138b	**18.8.2**	20 mm nominal dia Pipes	50	Meter	513.75	**562.70**	**28,135.00**
138c	**18.8.3**	25 mm nominal dia Pipes	50	Meter	626.05	**685.70**	**34,285.00**
138d	**18.8.4**	32 mm nominal dia Pipes	50	Meter	712.75	**780.66**	**39,033.00**
139	**19.1**	Providing, laying and jointing glazed stoneware pipes class SP-1 with stiff mixture of cement mortar in the proportion of 1:1 (1 cement : 1 fine sand) including testing of joints etc. complete :					

Schedule 'B' Retaining Wall, Bridges & other civil works							
S. No	Item No.	Description of Item	Quantity	Unit	USSOR/ DSR Rate in INR	Estimated Rate including GST@18% in INR	Estimated Amount in INR
139a	**19.1.2**	150 mm diameter	53	Rmt	591.40	**647.75**	**34,330.75**
140	**20.2**	Boring, providing and installation bored cast-in-situ reinforced cement concrete piles of grade M-25 of specified diameter and length below the pile cap, to carry a safe working load not less than specified, excluding the cost of steel reinforcement but including the cost of boring with bentonite solution and temporary casing of appropriate length for setting out and removal of same and the length of the pile to be embedded in the pile cap etc. by percussion drilling using Direct mud circulation (DMC) or Bailer and chisel technique by tripod and mechanical Winch Machine all complete, including removal of excavated earth with all its lifts and leads (length of pile for payment shall be measured up to bottom of pile cap). **Note:** Truck Mounted rotary/TMR/Tubewell boring machine shall not be used .					
140a	**20.2.1**	450 mm dia piles	1,174	Meter	1,916.40	**2,099.00**	**24,64,226.00**
141	**23.1**	Boring/drilling bore well of required dia for casing/ strainer pipe, by suitable method prescribed in IS: 2800 (part I), including collecting samples from different strata, preparing and submitting strata chart/ bore log, including hire & running charges of all					

Schedule 'B' Retaining Wall, Bridges & other civil works							
S. No	Item No.	Description of Item	Quantity	Unit	USSOR/ DSR Rate in INR	Estimated Rate including GST@18% in INR	Estimated Amount in INR
		equipments, tools, plants & machineries required for the job, all complete as per direction of Engineer-in-charge, upto 90 metre depth below ground level.					
141a	**23.1.1**	All types of soil					
141aa	**23.1.1.1**	300 mm dia	400	Meter	592.05	**648.46**	**2,59,384.00**
142	**23.3**	Supplying, assembling, lowering and fixing in vertical position in bore well, unplasticized PVC medium well casing (CM) pipe of required dia, conforming to IS: 12818, including required hire and labour charges, fittings & accessories etc. all complete, for all depths, as per direction of Engineer -in-charge.					
142a	**23.3.2**	150 mm nominal size dia	400	Meter	668.50	**732.20**	**2,92,880.00**
143	**23.4**	Supplying, assembling, lowering and fixing in vertical position in bore well unplasticized PVC medium well screen (RMS) pipes with ribs, conforming to IS: 12818, including hire & labour charges, fittings & accessories etc. all complete, for all depths, as per direction of Engineer-in-charge.					
143a	**23.4.2**	150 mm nominal size dia	50	Meter	681.90	**746.87**	**37,343.50**
144	**23.8**	Gravel packing in tubewell construction in accordance with IS: 4097, including providing gravel	100	CUM	1,479.25	**1,620.20**	**1,62,020.00**

Schedule 'B' Retaining Wall, Bridges & other civil works							
S. No	Item No.	Description of Item	Quantity	Unit	USSOR/ DSR Rate in INR	Estimated Rate including GST@18% in INR	Estimated Amount in INR
		fine/ medium/ coarse, in required grading & sizes as per actual requirement, all complete as per direction of Engineer-in-charge.					
145	**23.9**	Providing and fixing factory made precast RCC perforated drain covers, having concrete of strength not less than M-25, of size 1000 x 450x50 mm, reinforced with 8 mm dia four nos longitudinal & 9 nos cross sectional T.M.T. hoop bars, including providing 50 mm dia perforations @ 100 to 125 mm c/c, including providing edge binding with M.S. flats of size 50 mm x 1.6 mm complete, all as per direction of Engineer-in-charge.	100	each	1,213.25	**1,328.85**	**1,32,885.00**
146	**23.11**	Supplying, assembling, lowering and fixing in vertical position in bore well, ERW (Electric Resistance Welded) FE 410 plain slotted (having slot of size 1.6/3.2 mm) mild steel threaded and socketed/ plain bevel ended pipe (type A) of required dia, conforming to IS: 8110, of reputed and approved make, having wall thickness not less than 5.40 mm, including painted with outside surface with two coats of anticorrosive bitumestic paint of approved brand and manufacture, including hire & labour charges, fittings & accessories, all complete, for all depths, as per direction of Engineer -in-charge.					
146a	**23.11.2**	150 mm nominal size dia	50	Meter	1,790.00	**1,960.56**	**98,028.00**

Schedule 'B' Retaining Wall, Bridges & other civil works							
S. No	Item No.	Description of Item	Quantity	Unit	USSOR/ DSR Rate in INR	Estimated Rate including GST@18% in INR	Estimated Amount in INR
147	**23.12**	Development of tube well in accordance with IS : 2800 (part I) and IS: 11189, to establish maximum rate of usable water yield without sand content (beyond permissible limit), with required capacity air compressor, running the compressor for required time till well is fully developed, measuring yield of well by "V" notch method or any other approved method, measuring static level & draw down etc. by step draw down method, collecting water samples & getting tested in approved SUB HEAD: 23- RAIN WATER HARVESTING & TUBEWELLS 2022 laboratory, i/c disinfection of tubewell, all complete, including hire & labour charges of air compressor, tools & accessories etc., all as per requirement and direction of Engineer-in-charge.	200	Hour	916.80	**1,004.16**	**2,00,832.00**
148	**23.13**	Providing and fixing suitable size threaded mild steel cap or spot welded plate to the top of bore well housing/ casing pipe, removable as per requirement, all complete for borewell of:					
148a	**23.13.2**	150 mm dia	4	each	210.75	**230.83**	**923.32**
149	**23.14**	Providing and fixing M.S. clamp of required dia to the top of casing/ housing pipe of tubewell as per IS: 2800 (part I), including necessary bolts & nuts of required size complete.					

Schedule 'B' Retaining Wall, Bridges & other civil works							
S. No	Item No.	Description of Item	Quantity	Unit	USSOR/ DSR Rate in INR	Estimated Rate including GST@18% in INR	Estimated Amount in INR
149a	**23.14.2**	150 mm clamp	4	each	1,609.25	**1,762.59**	**7,050.36**
150	**23.15**	Providing and fixing Bail plug/ Bottom plug of required dia to the bottom of pipe assembly of tubewell as per IS:2800 (part I).					
150a	**23.15.2**	150 mm dia	4	each	281.75	**308.60**	**1,234.40**
151	-	Items included in Delhi Schedule of Rate-(Horticulture & Landscaping) 2020		LS			**10,00,000.00**
152	-	Any Other Items related to DSR		LS			**1,00,00,000.00**
Schedule B4:- NS BASED ITEMS (From S. No. 153 to 174)							
153	**NS-1**	Earthwork in embankment for 32.5t axle load and as per RDSO specification No. RDSO/2020/GE:004 September 2020 "Comprehensive Guidelines and Specification for Railway Formation" with contractor's own earth from borrow areas including all lead, lift, ascent, descent, royalty, taxes, cess, compensation, crossing of nallahs /stream and other obstructions including mechanical compaction in layers with watering, handling, re-handling, dressing of banks to the final profile with all labour, material, tools, plant, machinery and equipment, taxes, cess etc. as a complete job in accordance with the specification and drawings.Note: 10% of payment shall be withheld till the slopes are dressed to the required profile and	1,04,400	Cum	-	**342.37**	**3,57,43,428.00**

Schedule 'B' Retaining Wall, Bridges & other civil works							
S. No	Item No.	Description of Item	Quantity	Unit	USSOR/ DSR Rate in INR	Estimated Rate including GST@18% in INR	Estimated Amount in INR
		compacted mechanically with vibratory rollers as per RDSO guidelines					
154	**NS-2**	Supplying and laying blanketing material produced through mechanical means using crushers and pug mill for 32.5 T axle load as per RDSO specification No. RDSO/2020/GE:004 September 2020 "Comprehensive Guidelines and Specification for Railway Formation" over the top of subgrade including all lead, lift, ascent, descent, royalty, taxes, cess, crossing of nallahs /stream and other obstructions including mechanical compaction in layers not exceeding 300 mm thick with vibratory rollers, watering, handling, re-handling and dressing of formation to the final profile with all labour, material, tools, plants, machinery and equipment, taxes, cess, etc. as a complete job in accordance with the specification and drawings. Note: 10% of payment shall be withheld till the slopes are dressed to the required profile and compacted mechanically with vibratory rollers as per RDSO guidelines.	522	Cum	-	**2,480.58**	**12,94,862.76**

Schedule 'B' Retaining Wall, Bridges & other civil works							
S. No	Item No.	Description of Item	Quantity	Unit	USSOR/ DSR Rate in INR	Estimated Rate including GST@18% in INR	Estimated Amount in INR
155	**NS-3**	Supplying and laying in position **M-35 RCC** as per approved design mix with admixtures and manufactured in fully automatic batching plant and transported to site of work in transit mixer for all lifts & leads, having continuous agitated mixer, pumping concrete from transit mixer to site of laying, compacting, finishing & curing, with all labour, material, tools, plants, machinery and equipment, taxes, cess etc., as a complete job ,but excluding supplying & fixing form work (centring & shuttering),in accordance with the specification and drawings. Note –(i) Cost of cement is included in the above item. (ii) Cost of Reinforcement steel is not included in the above item and will be paid separately under relevant item of Schedule B1. (iii) Cost of supplying & fixing form work (centring & shuttering) is not included in the above item (except pile cap & open foundation) and will be paid separately under relevant item of Schedule B1					
155a	**NS-3A**	In Pile caps, open foundation & RCC Box/Sub way, well steining, well cap	21,657	Cum	-	**8,327.88**	**18,03,56,897.16**
155b	**NS-3B**	In Piers, abutments, box	804	Cum	-	**8,673.84**	**69,73,767.36**

Schedule 'B' Retaining Wall, Bridges & other civil works							
S. No	Item No.	Description of Item	Quantity	Unit	USSOR/ DSR Rate in INR	Estimated Rate including GST@18% in INR	Estimated Amount in INR
155c	**NS-3C**	Abutment cap & Pier Cap, pedestals, approach slab, Deck slab	2,704	Cum	-	**9,020.24**	**2,43,90,728.96**
155d	**NS-3D**	Retaining walls, wing walls, return walls, drop walls, curtain walls, toe walls etc. of all heights	23,775	Cum	-	**8,449.01**	**20,08,75,212.75**
156	**NS-4**	Boring 1200 mm diameter piles using Hydraulic Rig in all kinds of strata including boulder studded soil, underground structure like channel, sewer manholes, old foundation or any other obstruction, irrespective of sub-soil water level in all conditions whether dry or under water, shoe and temporary casing pipe, if required, with contractor plant, machinery & equipment for pile boring, use of bentonite slurry including all operations, cleaning of bore holes, supplying and laying in-situ with tremie pipe M-35 RCC in piles as per approved design mix with admixtures and manufactured in fully automatic batching plant and transported to site of work in transit mixer for all lifts & leads, having continuous agitated mixer, pumping concrete from transit mixer to site of laying including supplying & fixing form work (centering & shuttering), compacting, finishing, curing, chipping off pile top to remove laitance concrete above cut off level, removal and disposal of surplus excavated earth/debris/muck outside ROW including all lead, lift, ascends, descends, loading,	2,000	RMT	-	**12,366.49**	**2,47,32,980.00**

Schedule 'B' Retaining Wall, Bridges & other civil works							
S. No	Item No.	Description of Item	Quantity	Unit	USSOR/ DSR Rate in INR	Estimated Rate including GST@18% in INR	Estimated Amount in INR
		unloading handling, re-handling, crossing of stream, nallahs, railway track, level crossing etc. with all labour, material, tools, plants, machinery and equipment, taxes, cess etc. as a complete job in accordance with the Specification and the Drawings. Note – i. Cost of cement is included in the above item. ii. Cost of Reinforcement steel is not included in the above item and will be paid separately under relevant item of schedule-B1. iii. Cost of temporary casing pipe is included in the above item. However, the cost of permanent casing pipe is not included in this item and shall be paid separately under relevant item of schedule B1, if required and approved by the Engineer.					
157	**NS-5**	Earthwork in filling with contractor's own earth of approved quality from borrow areas including all lead all lead, lift, ascent, descent, royalty, taxes, cess, compensation, crossing of nallahs /stream and other obstructions including mechanical compaction in layers with watering to 95% of MDD (as per IS 2720 part 8), handling, re-handling, dressing to the final profile with all labour, material, tools, plant, machinery and equipment, taxes, cess etc. as a complete job in accordance with the specification and drawings	20,000	Cum	-	**287.75**	**57,55,000.00**

Schedule 'B' Retaining Wall, Bridges & other civil works							
S. No	Item No.	Description of Item	Quantity	Unit	USSOR/ DSR Rate in INR	Estimated Rate including GST@18% in INR	Estimated Amount in INR
		Note:- This item will be used for earthwork in filling for other than railway embankment work.					
158	**NS-6**	Providing, fabricating & laying of colour coated galvalume(Proflex system roofing)material for self supported roofing system, material shall be of following specification, BMT 0.90mm to 1.00mm,APT 0.95mm tolerance +/- 0.02mm thick ,Width 605 mm or as decided by railway (Tolerance +/- 2mm),including supplying, loading ,transporting, uploading & stacking at site ,fabricating and laying with all contractors tools, plants, machineries materials and fixtures labours including all lead and lift and laps/wastage if any etc. complete. The colour of sheet will be decided by Engineer. The rate is also inclusive of designing of roofing system, proof checking and providing execution drawing. Fabrication and installation of self supported roofing.	3,000	Sqm	-	**2,513.24**	**75,39,720.00**

Schedule 'B' Retaining Wall, Bridges & other civil works							
S. No	Item No.	Description of Item	Quantity	Unit	USSOR/ DSR Rate in INR	Estimated Rate including GST@18% in INR	Estimated Amount in INR
159	**NS-7**	Providing and fixing stainless steel (Grade 304) railing made of Hollow tubes, channels, plates etc., including welding, grinding, buffing, polishing and making curvature (wherever required) and fitting the same with necessary stainless steel nuts and bolts complete, i/c fixing the railing with necessary accessories & stainless steel dash fasteners , stainless steel bolts etc., of required size, on the top of the floor or the side of waist slab with suitable arrangement as per approval of Engineer-in-charge, (for payment purpose only weight of stainless steel members shall be considered excluding fixing accessories such as nuts, bolts, fasteners etc.).	500	Kg	-	**696.80**	**3,48,400.00**
160	**NS-8**	supplying, fabricating, transportation and fixing galvanized H-Beam sleepers as per RDSO drawing RDSO/B/1636/4/R & RDSO/B/1636/5 with latest alteration and specifications thereto complete with all fittings and fixtures including the cost of all steel sections, all fittings and fixtures ,elastomeric pad, galvanized bolts, nuts, washer, split pin, fish plates 1m and 0.6m long along with fish bolts and nuts for60Kg running rail and 52Kg guard rail respectively, track fittings and fastenings (Zero Toe Load Fastening) for 60 kg running rail and 52 Kg guard rail as per RDSO drg -RDSO/T-8759 to RDSO/T8765. labour, lead, lift, plants and equipment including galvanized work of	508	Each	-	**29,601.96**	**1,50,37,795.68**

Schedule 'B' Retaining Wall, Bridges & other civil works							
S. No	Item No.	Description of Item	Quantity	Unit	USSOR/ DSR Rate in INR	Estimated Rate including GST@18% in INR	Estimated Amount in INR
		full steel components complete in all respects as per approved drawing and technical specifications & as per direction of Engineer on Open Web Girder (OWG) bridges. The rate is also inclusive of the cost of supply of approved quality of epoxy/adhesive and fixing of elastomeric pads with different components of steel sleepers & girder in accordance with approved drawings. The steel to be supplied by the contractor for fabrication of steel H-Beam sleepers shall conform to IS-2062-2006, Grade B0 only. The rate is alsoinclusive of inspection charges of components of sleepers including all fixtures & fastening, galvanization etc. from the reputed laboratory/organization. Elastomeric pad plate and other track fittings shall be procured from RDSO approved source.Note: Payment under this item shall be made in following manner;i. 75% of the rate shall be paid after fabrication, galvanization and transportation of H beam sleepers tothe site and submission of material test certificate of manufacturer and inspection certificate of theagency nominated by Engineer.ii. 15% of the rate shall be paid after supply of fittings to the site and submission of inspection certificateof the agency nominated by Engineer. iii. 10% of the rate will be paid after fixing H Beam sleepers to the girder in satisfactory manner. iv. In					

Schedule 'B' Retaining Wall, Bridges & other civil works							
S. No	Item No.	Description of Item	Quantity	Unit	USSOR/ DSR Rate in INR	Estimated Rate including GST@18% in INR	Estimated Amount in INR
		case fixing is not required, then balance payment will be released on handing over of the sleepers after making recovery @ Rs.850/- per sleeper.					
161	**NS-9**	Supplying, fabrication and fixing pathway on Open Web Girder bridges with hollow steel, rolled and chequred plate including welding / bolting, priming painting with one coat ready mix Zinc Chromate conforming to IS:104 with DFT of 25-30Microns, followed by one coat of Zinc Chrome red oxide conforming to IS:2074 with DFT of 25 Microns with all material, labour, T&P as a complete job as RDSO drawing No. CBS 0045	82	MT	-	**1,17,633.50**	**96,45,947.00**
162	**NS-10**	Casting, supplying and installation of Pre-cast cement concrete blocks of size **25X25 X20cm**. or of required size as directed by the Engineer for protective works at bridges & banks like pitching, toe wall, flooring, drains etc. using M20 design concrete mix with 20mm aggregate size including Contractor's shuttering, leading to bridge site from casting depot, including dressing and levelling of surface, providing gravel backing, laying & jointing blocks with cement mortar 1:3 with Contractor's labour and as directed by Engineer-in-charge (All labour and materials including cement by Contractor). Note:	3,300	Cum	-	**6,792.44**	**2,24,15,052.00**

Schedule 'B' Retaining Wall, Bridges & other civil works							
S. No	Item No.	Description of Item	Quantity	Unit	USSOR/ DSR Rate in INR	Estimated Rate including GST@18% in INR	Estimated Amount in INR
		i) Payment for gravel backing will be paid under item no. NS-11of this Schedule. ii) 60% Payment shall be made after casting of pre-cast concrete blocks and bringing at work site. The balance 40% will be made on completion of laying and finishing. iii) Measurement is based on quantity calculation of blocks used only (no of blocks x volume of one block).					
163	**NS-11**	Supplying and laying of 150mm thick well graded stones aggregate/gravel as base layer over the slopes of embankment with manual dressing with water compaction including the cost of supply of all material, labour, lead, lift, tools, plants, crossing of tracks etc. complete as per approved drawings and technical specifications.	2,100	Cum	-	**722.04**	**15,16,284.00**
164	**NS-12**	Providing Boulder Backing behind wing wall, return wall, retaining wall with hand packed boulders & cobbles not less than 15cm in any direction & not less than 15kg (except smaller boulders required for filling voids) including all lead, lift, labour & other incidental charges as complete work in all respect. Cost of boulder/cobbles is included in this item.	28,774	Cum	-	**1,494.09**	**4,29,90,945.66**

Schedule 'B' Retaining Wall, Bridges & other civil works							
S. No	Item No.	Description of Item	Quantity	Unit	USSOR/ DSR Rate in INR	Estimated Rate including GST@18% in INR	Estimated Amount in INR
165	**NS-13**	Providing and fixing of 75mm dia PVC pipe for weep holes in abutments, Wing Wall, Return Wall, Face wall, retaining wall etc. at suitable intervals as directed by the Engineer-in-charge.	8,100	Rmt	-	**244.86**	**19,83,366.00**
166	**NS-14**	Manufacturing, transportation (including loading & unloading) and installation in position (including joining and grouting) M-50 or higher grade precast reinforced cement concrete segmental retaining walls of specified height (height measured from founding level) as per the directions of the Engineer. Precast reinforced retaining walls shall be factory-made and steam cured in a controlled environment with weep holes and in-built inserts for handling/transportation. Dimensional tolerances shall be as per IS: 6408 (part 2) for PC Class 6. Note:- 1. This item includes cost of all the materials, labour, machinery, tools & plant etc. complete required for manufacture of precast segments except Steel Reinforcement which shall be paid separately under relevant item of schedule B1. 2. Boulder Backing and backfilling of filter media behind wall shall be paid separately under NS-12 of this schedule and relevant item of schedule B1.	3,000	Cum	-	**30,126.94**	**9,03,80,820.00**

Schedule 'B' Retaining Wall, Bridges & other civil works							
S. No	Item No.	Description of Item	Quantity	Unit	USSOR/ DSR Rate in INR	Estimated Rate including GST@18% in INR	Estimated Amount in INR
		3. Excavation of soil for foundation shall be paid separately under item (USSOR item No. 022010) of Schedule B1. 4. Before placing of wall segments, 20 mm thick stiff 1:3 cement mortar bedding layer shall be laid over a levelling course of 150 mm thick of M20 concrete. Payment for M20 concrete shall be made under relevant item (USSOR-2019 item 022040) of Schedule B1and for mortar under relevant item (DSR Item no. 3.8) of Schedule- B3. 5. 60% of the rate shall be paid on receipt of the precast retaining wall segments at site and balance 40% will be paid on fixing the same in position in satisfactory condition.					

Schedule 'B' Retaining Wall, Bridges & other civil works							
S. No	Item No.	Description of Item	Quantity	Unit	USSOR/ DSR Rate in INR	Estimated Rate including GST@18% in INR	Estimated Amount in INR
167	**NS-15**	Manufacturing, transportation (including loading & unloading) and installation in position (including joining and grouting) M-50 or higher grade precast reinforced cement concrete U-shaped drain with cover as per the directions of the Engineer. Precast reinforced U-shaped drain shall be factory-made, and steam cured in a controlled environment with inserts for handling/transportation. Dimensional tolerances shall be as per IS: 6408 (part 2) for PC Class 6.Note: -1. This item includes cost of all the materials, labour, machinery, tools & plant etc. complete required for manufacture of precast segments except Steel Reinforcement which shall be paid separately under relevant item of schedule B1.2. Excavation of soil for foundation shall be paid separately under item (USSOR item No. 022010) of Schedule B1. 3. Before placing wall segments, 20 mm thick stiff 1:3 cement mortar bedding layer shall be laid over a levelling course of 150 mm thick of M20 concrete. Payment for M20 concrete shall be made under relevant item (USSOR-2019 item 022040) of Schedule B1and for mortar under relevant item (DSR Item no. 3.8) of Schedule- B3.4. 60% of the rate shall be paid on receipt of the precast drain segments at site and balance 40% will be paid on fixing the same in position in satisfactory condition.	20	Cum	-	**30,126.94**	**6,02,538.80**

Schedule 'B' Retaining Wall, Bridges & other civil works							
S. No	Item No.	Description of Item	Quantity	Unit	USSOR/ DSR Rate in INR	Estimated Rate including GST@18% in INR	Estimated Amount in INR
168	**NS-16**	Linking of track on H- beam sleepers on Open Web Girder (OWG) bridges with 60 Kg running rail and 52 kg guard rail with track fittings/fastenings including leading of Running and guard rails from bridge approach and fixing of running rails & guard rails, bending of guard rails, notching, drilling of holes, cutting of rails etc., as directed and making track structure fit for sectional speed. (Rails will be supplied by Employer)	1,200	RTM	-	**1,388.64**	**16,66,368.00**
169	**NS-17**	Supplying and fixing M.S. Angles 100mmx 100 mmx 10mm size conforming to IS:2062 in expansion joint of Composite girder bridges including provision of 10mm dia dowel bar & 12mm dia anchor bolts at 150 mm centre to centre, and 250mm wide GI plate over the top of angles as per relevant RDSO standard drawing with all material, labour, T&P as a complete job.	275	Each	-	**6,568.82**	**18,06,425.50**
170	**NS-18**	Supply and fixing of Metallic Guided Bearing in position true to line and level as per RDSO drawing No. RDSO/B-11754/3R2 and IRC:83 pt. III-2018 including supply & grouting of anchor bolts with approved non-shrinking epoxy grout with all material, labour, T&P as a complete job.	4	Each	-	**53,000.00**	**2,12,000.00**

Schedule 'B' Retaining Wall, Bridges & other civil works							
S. No	Item No.	Description of Item	Quantity	Unit	USSOR/ DSR Rate in INR	Estimated Rate including GST@18% in INR	Estimated Amount in INR
171	**NS-19**	Supply, fabrication and erection of bed plate of approved sizes as per relevant RDSO drawing No. RDSO/B-11751/4R2, B-11753/5R1, B-11754/3R2 with UpToDate corrections, in exact position over bed block on pier/abutments by giving full and even bearing, setting them on the layer of free flow non-shrinkable grouting compound, scrapping or chipping of bed block, if required, fabrication and fixing of HD bolts of suitable sizes along with nuts, washers etc., drilling holes of required size, grouting of holes by epoxy mortar after fixing HD bolts with all labour, material, T & P as a complete job.					
171a	**NS-19a**	More than 12.2m and upto 18.3m clear span	11,200	Kg	-	**241.43**	**27,04,016.00**
171b	**NS-19b**	More than 18.3m and upto 30.5m clear span	52,800	Kg	-	**252.93**	**1,33,54,704.00**

Schedule 'B' Retaining Wall, Bridges & other civil works							
S. No	Item No.	Description of Item	Quantity	Unit	USSOR/ DSR Rate in INR	Estimated Rate including GST@18% in INR	Estimated Amount in INR
172	**NS-20**	Designing, Providing and erection of specified grade precast RCC Facia Panel of thickness 180 mm made with M-35 Grade Concrete Batching plant, Transit Mixer, Concrete Pump and Vibrator for retaining earth with all element and accessories including reinforcing element complete as per approval drawing and Section 3100 of MORT&H specification including all material labour machinery etc. (Scope of work including designing, getting approval, casting in yad, curing, storing, Transporting, lifting, placing in position, erection with all necessaries fasteners etc complete).The cost of cement & steel are included in this item & no separate payment shall be paid whatsoever. The rate also include cost for excavation, foundation, reinforcing element, fasteners, drainage layer, drain pipe, coping beam and other accessories for which nothing extra shall be paid. Mode of Payment: 1- Casting of RE Panel : 60% 2- Erection & fixing : 35 % 3- Final Bill: 5%	6,000	Sqm	-	**6,229.67**	**3,73,78,020.00**
173	**NS-21**	Providing Placing & Compacting to desired density approved backfill material in layers as per approved methodology including testing of reinforced fill portion in approaches between reinforced soil (RS) wall panels as per approved drawing as per Section	30,000	Cum	-	**381.91**	**1,14,57,300.00**

Schedule 'B' Retaining Wall, Bridges & other civil works							
S. No	Item No.	Description of Item	Quantity	Unit	USSOR/ DSR Rate in INR	Estimated Rate including GST@18% in INR	Estimated Amount in INR
		3103 of MORT&H Specification. The soil should be predominantly coarse grained, Not more than 10 % of particles should pass 75 micron sieve. The item shall be measured and paid for the finished volume of backfill and subgrade placed in position excluding the volume of filter media at base and behind the RS RE Wall					
174	**NS-22**	Providing & constructing of RCC Crash Barrier of M35 at the edge of road , approaches to bridge structures and medians, constructed with specified grade of concrete using batching plant , transit mixer, concrete pump and vibrator with 450 mm long at expansion joint filled with premolded asphalt filler board, keyed to the structure on which it is built and installed as per design and dimension in the approved drawing and at location directed by the engineer, all as specified as per Section 809 of MORT&H Specification including all material labour, scaffolding etc.	500	Cum	-	**7,342.91**	**36,71,455.00**
						Total Estimated Amount of Schedule 'B'	**2,74,48,66,582.33**

7 Schedule 'C': General Electrical Services

Schedule 'C' General Electrical Services					
S. No.	**ITEM Description**	**Item Qty**	**Unit**	**Unit Rate including GST @18% (INR)**	**Estimated Amount in INR**
1	Concealed/Surface conduit wiring system- Supply of material and wiring of LP/TP/FP/Ex. Fan point with 1.5sqmm PVC single core multistranded copper wire insulated concealed in stone/brick masonry wall in19/20 mm conduit with 1.5sqmm PVC wire insulated copper for earth wire 1-way/2-way switch 5/6A as required and good quality ceiling rose including connection(with modular switch, socket & ceiling rose) as per specification.	880	Numbers	289.94	255147.20
2	Supply and fixing 5/6A plug, modular 5-pin 230V including modular switch and with modular board and wiring with 2.5sqmm PVC CU cable as per specification.	480	Numbers	173.84	83443.20
3	Supply and fixing 15/16A plug, modular 5-pin 230V including modular switch and with modular board and wiring with 4 sqmm PVC CU cable as per specifications.	200	Numbers	192.3	38460.00
4	Supply and fixing 2 module modular switch board plate for fixing of modular switches -plug with sheet metal box of good quality and standard size, concealed fixing of GI /PVC as per specifications.	360	Numbers	74.73	26902.80
5	Supply and fixing 4 module modular switch board plate for fixing of modular switches -plug with sheet metal box of good quality and standard size, concealed fixing of *GI /PVC* as per specifications.	440	Numbers	103.29	45447.60

Schedule 'C' General Electrical Services					
S. No.	**ITEM Description**	**Item Qty**	**Unit**	**Unit Rate including GST @18% (INR)**	**Estimated Amount in INR**
6	Supply and fixing 8 module modular switch board plate for fixing of modular switches -plug with sheet metal box of good quality and standard size, concealed fixing of *GI /PVC* as per specification.	250	Numbers	178.02	44505.00
7	Supply and fixing 12 module modular switch board plate for fixing of modular switches -plug with sheet metal box of good quality and standard size, concealed fixing of *GI /PVC* as per specification.	180	Numbers	191.5	34462.80
8	Supply, laying, connection and commissioning of sub- main 2x2.5 Sqmm with PVC insulated single core copper conductor cable and same size PVC insulated copper conductor for earthing wire in 19/20 mm conduit as per site requirement etc. as per specifications.	11000	Metre	58.14	639540.00
9	Supply, laying, connection and commissioning of sub- main 2x4 Sqmm with PVC insulated single core copper conductor cable and same size (4 sqmm) PVC insulated copper conductor for earthing wire in 19/20 mm conduit as per site requirement and as per specification.	6000	Metre	97.16	582960.00
10	Supply, laying, connection and commissioning of sub- main 2x6 Sqmm with PVC insulated single core copper conductor cable and same size PVC insulated copper conductor for earthing wire in 19/20 mm conduit as per site requirement and as per specification	3000	Metre	98.40	295200.00
11	Supply, Installation, testing and commissioning of 1200/1400mm ceiling fans ISI marked, 5 star rated reputed make and as per specification.	250	Numbers	1042.98	260745.00

Schedule 'C' General Electrical Services					
S. No.	**ITEM Description**	**Item Qty**	**Unit**	**Unit Rate including GST @18% (INR)**	**Estimated Amount in INR**
12	Supply and fixing of ceiling fan regulator electronic type 5-step (modular type) as per specifications.	250	Numbers	282.16	70540.00
13	Supply of 4 Core 16 Sqmm XLPE Armoured Cable with Aluminium Conductor 650/1100 V grade confirming to IS 7098 (Part-1) 1988, 1.1 KV grade LT XLPE insulated armoured, aluminium conductor cable as per specification	12000	Meters	171.59	2059080.00
14	Supply of 4 Core, 35 Sqmm XLPE, Armoured Cable with Aluminium Conductor 650/1100 V grade confirming to IS 7098 (Part-1) 1988, 1.1 KV grade LT XLPE insulated armoured, aluminium conductor cable as per specification.	5000	Meters	295.2	1476000.00
15	Supply of 4 Core 50 Sqmm XLPE Armoured Cable with Aluminium Conductor 650/1100 V grade confirming to IS 7098 (Part-1)1988, 1.1 KV grade LT XLPE insulated armoured, aluminium conductor cable as per specification.	9500	Meters	393.60	3739200.00
16	Supply of 4 Core 70 Sqmm XLPE Armoured Cable with Aluminium Conductor 650/1100 V grade confirming to IS 7098 (Part-1) 1988, 1.1 KV grade LT XLPE insulated armoured, aluminium conductor cable as per specification.	1500	Meters	527.3	790890.00

Schedule 'C' General Electrical Services					
S. No.	**ITEM Description**	**Item Qty**	**Unit**	**Unit Rate including GST @18% (INR)**	**Estimated Amount in INR**
17	Supply of 4 Core 95 Sqmm XLPE Armoured Cable with Aluminium Conductor 650/1100 V grade confirming to IS 7098 (Part-1) 1988, 1.1 KV grade LT XLPE insulated armoured, aluminium conductor cable as per specification.	1500	Meters	664.2	996300.00
18	Supply of 4 Core 120 Sqmm XLPE Armoured Cable with Aluminium Conductor 650/1100 V grade confirming to IS 7098 (Part-1) 1988, 1.1 KV grade LT XLPE insulated armoured, aluminium conductor cable.	3000	Meters	818.0	2453850.00
19	Supply of 4 Core 185 Sqmm XLPE Armoured Cable with Aluminium Conductor 650/1100 V grade confirming to IS 7098 (Part-1) 1988, 1.1 KV grade LT XLPE insulated armoured, aluminium conductor cable as per specification.	1200	Meters	1243.53	1492236.00
20	Supply, fixing, installation and commissioning of 25 ltrs. fully automatic with auto cut off RO (Reverse osmosis) portable water purification system with inbuild storage tank similar to Aquaguard model no - AG 25 LPH RO S 8421 and as per specification.	5	Nos	22360.58	111802.90
21	Supply and laying of HDPE pipe conforming to IS 4984:1995, 75/80 mm dia wall thickness 3 mm PN-4 under the road/air, as per specification.	5500	Meters	71.26	391930.00

Schedule 'C' General Electrical Services					
S. No.	**ITEM Description**	**Item Qty**	**Unit**	**Unit Rate including GST @18% (INR)**	**Estimated Amount in INR**
22	Supply and laying of HDPE pipe conforming to IS 4984:1995, 50 mm dia wall thickness 3 mm PN-4 under the road/air, as per specification.	24000	Meters	72.89	1749360.00
23	Supply and laying of HDPE pipe dia 160mm (OD) under road/ground/ floor/railway track or as per site requirement already excavated trench. the material grade PE-80 and class of pipe should be PN-4 IS-4984/1995 wall thickness between 6.2mm to 7.1 mm as per specification.	2000	Meters	369	738780.00
24	Supply and fixing of 50mm dia G.I. pipe medium B class for cable laying as per specification	200	Meters	178.57	35714.00
25	Laying of LT/HT cables in Air/pipe/cable tray/trench etc. as per specification.	33700	Meters	16.24	547288.00
26	Excavation & Refilling of trench of size 0.5 mtr wide x 1.2 mtr deep as per specification. Trench work may be on kuchha/pacca land and all type of soil as per site requirement and without protective layer of brick. Surface of trench shall be made good in all respect and satisfaction of site engineer includes suitable protection of loop cable and as per specification.	28000	Meters	96.51	2702280.00
27	Supply, fixing & commissioning of 300 mm sweep ISI marked exhaust fan with louvre shutter as per specification.	80	Numbers	956.87	76549.60

Schedule 'C' General Electrical Services					
S. No.	**ITEM Description**	**Item Qty**	**Unit**	**Unit Rate including GST @18% (INR)**	**Estimated Amount in INR**
28	Supply and fixing of Double Door MCB, TPN DB 8 modules 4 row, neutral and earth link, with one no four pole MCB 40 amp, one no FP RCCB 40 amp 30 mA and twenty four no SP MCB 40/32/25/16/10/6amp. 'C' series. Breaking capacity not less than 10 kA. MCB, RCCB and DB should be as per technical specifications and of same make.	15	Numbers	13403.41	201051.15
29	Supply and fixing of Double Door MCB, DB SP 12 way (10+ 2 module),neutral and earth link, with one no DP MCB 40amp, one no DP RCCB 40 amp 30 mA and eight no SP MCB 32/25/16/10/6 amp. 'C'series. Breaking capacity not less than 10 kA. MCB, RCCB and DB should be as per technical specifications and of same make.	20	Numbers	6099.17	121983.40
30	Supply, fixing, testing and commissioning of 22 W Energy efficient LED tubular lamp four feet with its driver and Luminaire of CRCA steel sheet enclosure, IP-20 for indoor application, operating voltage (140-270)V, minimum 2000 Lumens, color temperature 6500ºK, CRI>65 as per specification.	580	Numbers	501.13	290655.40
31	Supply, Transportation, erection, testing, Installation & commissioning of self-contained drinking water cooler (150 litre) with all connected standard fitting, accessories etc and 5 kVA wall mounted IC controlled electronic auto voltage corrector with time delay relay. Supply and erection of earth electrode and connection to earthing system etc as required.	10	Numbers	66260.70	662607.00

Schedule 'C' General Electrical Services					
S. No.	**ITEM Description**	**Item Qty**	**Unit**	**Unit Rate including GST @18% (INR)**	**Estimated Amount in INR**
32	Supply & erection of 5 m high with single/ double arm model, hot dip galvanized steel octagonal pole with galvanized base plate of 200x200x12 mm, junction box with 6 Amp. MCB and GI stud terminals (for mounting inside the base compartment of pole), GI foundation bolt size 4x16mm dia. 600 mm in length including excavation and making foundation as per specification and drawing. It shall be galvanized internally and externally by single dipping methods. The pole and foundation shall be made as per specification.	250	Numbers	8081.77	2020442.50
33	Supply, fixing and commissioning of street light fitting accessories i.e GI pipe of suitable size.	50	Numbers	117.14	5857.00
34	Supply, Erection, testing & commissioning of 40 Watt LED Energy efficient LED based street light fitting with pressure die cast aluminium housing with driver & suitable fixing arrangement, IP-65 for outdoor application, operating voltage (140-270) V, System efficacy more than 100 lm/W, color temperature 6500K, CRI>65, and as per technical specification.	300	Numbers	3313.66	994098.00
35	Supply, fixing testing and commissioning of (OFF delay) modular digital timers for operation of platforms and circulating area street light, as per specification.	12	Numbers	4148.88	49786.56

Schedule 'C' General Electrical Services					
S. No.	**ITEM Description**	**Item Qty**	**Unit**	**Unit Rate including GST @18% (INR)**	**Estimated Amount in INR**
36	Supply, Fixing, testing and commissioning of *feeder pillar CRCA material powder coated with 7 tank process* of size 900x600x300 mm and bus bar capacity 200 Amp 3 phase and neutral with box as per specification.	15	Numbers	2940.55	44108.25
37	Supply, installation, Testing & Commissioning of rechargeable batten type Emergency light 60 LED 4 watt or higher with one hour minimum backup.	50	Numbers	2230.63	111531.50
38	Supply and preparation of all drawings in AutoCAD (Original + *5* copies) showing electrical installation being done through this contract for station as per specification.	5	Numbers	2802.78	14013.90
39	Supply, installation, testing and commissioning of Single sided LED signage board with pictogram/symbol (if any) as per specification.	*48*	*Square Mtr*	*16549.9*	794395.20
40	Supply, installation, testing and commissioning of double sided LED signage board with symbol as per specification.	*28*	*Square Mtr*	*20526.3*	574736.40
41	Supply and fixing of Rubber mat (ISI marked) nonstick type suitable for 11 kv AC size 2000x1000x25mm & as per specification.	30	Numbers	738.00	22140.00

Schedule 'C' General Electrical Services					
S. No.	**ITEM Description**	**Item Qty**	**Unit**	**Unit Rate including GST @18% (INR)**	**Estimated Amount in INR**
42	Supply, installation, testing and commissioning of LT heat shrinkable straight through joint with required accessories complete in all respect suitable for LT ,XLPE, 4 core cable as per site requirement and as per specification.	30	Numbers	1597.35	47920.50
43	Supply and erection of GI cable route marker of size not less than 200x150x3mm thick GI Plate. for HT / LT Electric underground cable as per Drawing and specification.	250	Numbers	329.64	82410.00
44	Dismantling of Rail/cable tray Pole & Over head line, EFT's, cable tray complete, as per specification.	30	Numbers	410.43	12312.90
45	Supply, installation, testing and commissioning earth electrode complete in all respect with perforated GI pipe medium "B" class (Blue) confirming to IS 1239 part-I length of 3 mtr, bore 50mm with all accessories like nut, bolt, reducer nipple, wire meshed funnel and CC finished chamber covered by CI/RCC frame etc. Digging pit and refilling it with charcoal and salt in successive layers and connection with 8 SWG GI wire and as per IS:3043 and drawing and testing of earth resistance as required.	220	Numbers	924.29	203343.80

Schedule 'C' General Electrical Services					
S. No.	**ITEM Description**	**Item Qty**	**Unit**	**Unit Rate including GST @18% (INR)**	**Estimated Amount in INR**
46	Design, manufacture, Supply, testing, erection and commissioning of indoor type LT PANEL, Medium voltage switch board front operated type will have digital ammeter, voltmeter, multifunction energy meter of reputed make on all the main and 3 phase. LED type indication lamps on all the mains, digital ammeter & 3 phase flush type mounted electronic energy meter counter display in every outgoing MCCB's copper bus bar and accessories as per specification with following features: (A) incoming 2x250 amp 4 pole MCCB's with change over provision with microprocessor release having integral overload, short circuit, earth fault and neutral protection and breaking capacity 60 KA (Ics=100%Icu). (B)outgoing 2x125 amps, 2x100 amps and 2x63 amp, 4 poles MCCB's with adjustable overload and adjustable short trip unit and breaking capacity 36KA (Ics=100%Icu). the panel is to be provided with over voltage protection with suitable relay. work includes formation for panel foundation and other civil work with suitable trench up to the satisfaction of the site engineer (as per technical specification). panel shall be manufactured from CPRI tested firm. All the material should be of reputed make and as per tech specification. General arrangement, single line diagram and technical detail (make & model no) of the equipment and electrical accessories.	5	Numbers	129429.62	647148.10

Schedule 'C' General Electrical Services					
S. No.	**ITEM Description**	**Item Qty**	**Unit**	**Unit Rate including GST @18% (INR)**	**Estimated Amount in INR**
47	Supply, erection, testing and commissioning of phase change over distribution board (phase selector box) size 610x450x190 mm fabricated from 1.6mm thick CRCA sheet with 7 tank process power coated with 01 no, 100 Amp FP MCCB at the incomer and 01 no, 100 amp SPN MCCB as outgoing and 01 no 63 amp phase selector switch with multi LED indication lamps & by pass arrangement as per specification.	5	Numbers	7944.16	39720.80
48	Supply and fixing of GI cable duct 40 x 60 mm (Approx.) slot greenish as per specification.	1000	Meters	73.82	73820.00
49	Supply and fixing of 4 pole MCCB 200 amp. 36 kA with enclosure and adjustable thermal, fix magnetic release complete. MCCB should be of reputed make and as per specification.	10	Numbers	12778.00	127780.00

Schedule 'C' General Electrical Services					
S. No.	**ITEM Description**	**Item Qty**	**Unit**	**Unit Rate including GST @18% (INR)**	**Estimated Amount in INR**
50	Laying of cable under the road/Railway track, recessing in platform /wall along with Railway Track. in laid HDPE /GI pipe as required 1.1 KV grade LT XLPE insulated armored, aluminium conductor cable including making chase & plastering after laying of cable/digging of cable trench, sand cushioning, protective covering with bricks of compressive strength 7.5/sqmm (minimum). Provision of cable route marker as per technical specification. including end terminations with Aluminium Crimping socket/lugs testing and commissioning of Various sizes. NOTE:- i) All cable connection shall be made with proper size of crimping socket /Glands by the contractor at his own cost and labour ii) Road/floor where cable is to be laid shall be made good as original by the firm at his own cost and to the satisfaction of Engineer.	800	Meters	39.80	31840.00
51	Supply and fixing of GI jali 1"x1" welded on GI angle as per specification.	1200	Kg	46.70	56040.00
52	Supply of submersible energy efficient pump set of 10 HP (3 star & above rated), 20 Stages, Head :120-160 Mtr, 415 V, AC complete with accessories at sight as per specification.	10	Numbers	50457.00	504570.00
53	Supply fixing, testing and commissioning of automatic control panel with star delta starter for 10 HP three- phase pump including connections and providing cable from main board to control panel and connection for water level controller (WLC) in bore well as per specification.	10	Numbers	14118.00	141180.00

Schedule 'C' General Electrical Services					
S. No.	**ITEM Description**	**Item Qty**	**Unit**	**Unit Rate including GST @18% (INR)**	**Estimated Amount in INR**
54	Lowering, testing and commissioning of submersible pump set of 10 HP with G.I. pipe, nuts, bolts, washer & rubber packing and copper flat cable & as per specification. Interface shall be made with Civil agency who will be making the bore hole.	10	Numbers	3435.00	34350.00
55	Supply, Installation, Testing and commissioning of mono-block submersible pump 2.0 HP complete in all respect as per specification.	6	Numbers	10901.79	65410.74
56	Supply & fixing of G.I. pipe 50 MM dia B class with flanges, sockets and welding as per IS 1239 as per specification.	800	Meters	167.38	133904.00
57	Supply and fixing pipe fitting bends, sockets, flanges, delivery valve, Non Return valve and supporting clamps (2 set). As per specification.	10	set	2996.86	29968.60
58	Supply, fixing, testing, commissioning of 3 core 6 Sq.mm. size PVC insulated PVC sheathed multi strand flat copper cable conductor. As per specification.	2000	Metre	57.80	115600.00
59	SITC of Submersible mono block pump (150 mm dia) 5 HP, 3.75KW (dia 150 mm), 20-25 mtrs. Head, discharge 700 LPM complete with all accessories and as per specification.	4	Numbers	16290.69	65162.76

Schedule 'C' General Electrical Services					
S. No.	**ITEM Description**	**Item Qty**	**Unit**	**Unit Rate including GST @18% (INR)**	**Estimated Amount in INR**
60	Supply, fixing, testing and commissioning of automatic control panel with DOL starter for 5 HP three-phase pump including connections and providing cable from main board to control & as per specification. Interface shall be made with Civil agency who will be making the bore hole.	4	Numbers	8287.09	33148.36
61	Lowering, testing and commissioning of horizontal monoblock submersible pump set. as per specification.	4	Numbers	1207.25	4829.00
62	Supply, installation, testing and commissioning of 32 Amp. DP MCB, 10 kA, 'C' curve with metal enclosure as per specification.	30	Numbers	1206.07	36182.10
63	Supply of material and wiring of shed with 1.5 sqmm single core multi-stranded copper wire PVC insulated in conduit 1.5mm thick 19mm size white colour shall be fixed with junction box TEE and 1.5mmsq PVC CU cable insulated multi stranded for earth wire and 5/6A, ceiling rose. The conduit shall be fixed with rawl plugs/ tied with 14 S.W.G. GI wire including connection. As per specification and satisfaction of Engineer.	450	Numbers	106.28	47826.00

Schedule 'C' General Electrical Services					
S. No.	**ITEM Description**	**Item Qty**	**Unit**	**Unit Rate including GST @18% (INR)**	**Estimated Amount in INR**
64	*Supply, installation, testing and commissioning of 125 KVA Capacity radiator cooled Silent DG Set with AMF panel and Complete with all accessories like- exhaust fan system, diesel engine with alternator capable of delivering continuous power output at 3 phase 4 wire 415 Volts AC Supply with control panel, electronic energy meter, digital Ammeter, Voltmeter, Power factor meter, Digital frequency meter, clustered LED Type indication light, cable glands, earthing terminal maintenance free battery set mounted on wooden frame and plank, Anti-Vibration pad and all other accessories equipment, protective device, Exhaust fan shall be installed as per latest CPCB norms as per specification.*	*1*	*Numbers*	*885000.00*	*885000.00*
65	Supply, installation, testing and commissioning of Cu Earthing with 600mmx600mmx3mm thick copper earth plate, as per IS 3043(latest version) to achieve earth resistance less than one ohm and salt, providing concrete enclosure and cast Iron(CI) cover plate with lifting arrangement, watering pipe etc. as required and as per specification.	10	Numbers	7424.0	74240.00
66	Supply and fixing 40mm x 5mm copper strip on surface or in recess or in 50mm dia G.I. pipe as required and as per specification.	50	Meters	1102.0	55100.00

Schedule 'C' General Electrical Services					
S. No.	**ITEM Description**	**Item Qty**	**Unit**	**Unit Rate including GST @18% (INR)**	**Estimated Amount in INR**
67	Supply, fixing, testing and commissioning of passenger Lift, gearless machine room less, single landing (GF & FF) Minimum load 13 persons, speed - 1 m/s to 1.5 m/s, Automatic doors with two sides opening, Microprocess based variable frequency, variable voltage drive controller with ARD etc. and all safety devices as required. (The cost excludes Civil and Electrical work) as per specification, with warranty period of 24 months from the date of commissioning of lift and 30 months from the date of supply, whichever is earlier.	3	Numbers	2580137.0	7740411.00
68	Supply, Fixing, testing & commissioning of 1.5 Ton heavy duty Split inverter type Air conditioner with including petty hardwares, gas charging along with the cost of refrigerant with LCD display cordless remote ,5 star rating suitable for 1 phase, 230 Volts & IC controlled electronic auto voltage corrector.	30	Numbers	46731.80	1401954.00
69	Supply and fixing of Metal Clad Plug Socket 20A single phase with 32A MCB including fixing and sheet metal enclosure box with one 20A plug top (Ray roll type) to be supplied with board as per spec as per specification,	30	Numbers	750.75	22522.50

Schedule 'C' General Electrical Services					
S. No.	**ITEM Description**	**Item Qty**	**Unit**	**Unit Rate including GST @18% (INR)**	**Estimated Amount in INR**
70	Supply and fixing of junction box size 390x305x170mm comprising of SMP/FRP material with rubber gasket, padlock arrangement, zinc passivated earth bolt, etc. similar to Sintex model no. GSJB 3525 or similar with 4 no. aluminium busbar cap 200 Amp., suitable for 415 volt supply requirement.	100	Numbers	1972.92	197292.00
71	Supply, Installation, testing and commissioning of 2 kVA, 240 volt AC, pure sine wave, online UPS cum inverter consisting of intelligent battery charging mechanism with adaptive battery charging and 150 AH , 24 Volt tubular battery (2 batteries of 12 V each connected in series) suitable for heavy duty application. with UPS cum inverter warranty of 24 months and for Battery - 36 months, as per specification.	10	Numbers	32864.78	328647.80
72	Supply, installation and commissioning and of Perforated Cable Tray of size 150x50 mm made out of GI sheet hot dip galvanized (85 microns) 1.6 mm thick with suitable fixing arrangement.	500	Meters	535.46	267730.00
73	Supply, Installation, testing & commissioning of control and distribution panel for colour light signalling for 10/25 kVA AT supply in 25 kV AC traction system as per RSDO technical specifications No. TI/SPC/PSI/CLS/ 0020 (12/02) With A&C slips No. 1 to 4 or latest, connections as required.	10	Numbers	77563.80	775638.0

Schedule 'C' General Electrical Services					
S. No.	**ITEM Description**	**Item Qty**	**Unit**	**Unit Rate including GST @18% (INR)**	**Estimated Amount in INR**
74	*New Connection/Load Augmentation complete in all respect for bringing Power supply HT/LT from DISCOM terminal to HORC HT/LT Panel and payment of all fees/charges to DISCOM as per specification.*	*300*	*KW*	*6000.0*	*1800000.0*
75	Supply, Installation, testing and commissioning of 16 M high mast shaft totally hot dip galvanized and suitable for wind velocity as per IS 875 part-3. The mast shaft shall be in two finished sections, it shall also include all accessories for 16M high mast including head frame, steel wire rope 6mm dia (7/19 construction) double drum winch galvanized lantern carriage arrangement suitable for 8 luminaries and its control gear boxes and lightning finial. The mast shall have integral power tool installed at its base compartment. The high-powered single- phase non-reversible power tool for electrical operation of raising and lowering of lantern carriage with its supporting stand, torque limiter and fixing chain. The mast shall have only one longitudinal seam weld per section along with Earthing with *GI flat.* As per specification.	4	Numbers	174988.3	699953.0
76	Design and casting of suitable foundation with M-20 concrete for the 16 mtr High Mast having the safe soil bearing capacity at site as *10T/sqm at 2 meter depth* including supply of foundation bolts manufactured from special steel along with *GI nuts, washers and anchor plates and templates.* As per specification.	4	Numbers	18811.0	75244.0

Schedule 'C' General Electrical Services					
S. No.	**ITEM Description**	**Item Qty**	**Unit**	**Unit Rate including GST @18% (INR)**	**Estimated Amount in INR**
77	Supply, fixing, testing and commissioning of LED type flood light luminaries wattage 200 Watt made up of pressure die cast housing and heat sink in aluminium extrusion with IP- 66 protection as per CEE/NR/121-Elect/PS/2018 (Rev-03) dt 28/06/18 & CEE/NR/121- Elect/PS/2019(Rev-04) dt 04 /11/19 or latest specification and as per site requirement. Guarantee five years from date of commissioning and as per specification.	32	Numbers	9220.0	295040.0
78	Supply, installation, testing and commissioning of LED Aviation light luminaries Model no. BGAV 302 LED of Bajaj or similar as per specification.	4	Numbers	8215.0	32860.0
79	Supply, installation, testing and commissioning of control panel housing suitable timer contactor circuit for automatic ON & OFF of the mast lights at a pre-set time, (16M) as per specification.	4	Numbers	8431.0	33724.0
80	*Supply, installation, testing and commissioning of 11/0.433kV ,250 kVA outdoor type CSS consisting of 2 LBS (Load break Switch) and 1 VCB at HT side (630 Amps., 20 kA), 250 kVA Dry type transformer and 400 Amps ACB at LT side including RMU and other associated items as per requirement & as per specification.*	*2*	*Numbers*	*1857800.0*	*3715600.0*
81	Supply, installation, testing and commissioning of automatic power factor correction control panel (APFC panel) with 100 KVAR shunt capacitors complete in all respect and as per specification.	1	Numbers	73731.4	73731.4
				Total Estimated Amount of Schedule 'C'	**4,86,55,175.76**

8 Schedule D: Item Rate for Miscellaneous Works

Schedule 'D' Item Rate for Miscellaneous Works					
S. No	**Item Reference DSR-21/USSOR-2019 (NWR)**	**Description of Item**	**Unit**	**DSR/USSOR Rate in INR**	**Estimated Rate including GST@18% in INR**
DSR-21 Items (From S. No. 1 to 2)					
1	19.35	Providing and laying Non Pressure NP-3 class (Medium duty) R.C.C. pipes including collars/spigot jointed with stiff mixture of cement mortar in the proportion of 1:2 (1 cement : 2 fine sand) including testing of joints etc. complete.			
I	19.35.1	450mm dia. RCC pipes	Metre	2385.5	2,612.84
II	19.35.2	600 mm dia RCC pipes.	Metre	3051.55	3,342.36
2	19.6	Providing and laying non-pressure NP2 class (light duty) R.C.C. pipes with collars jointed with stiff mixture of cement mortar in the proportion of 1:2 (1 cement : 2 fine sand) including testing of joints etc. complete :			
I	19.6.1	100 mm dia. R.C.C. pipe	Metre	447.25	489.87
II	19.6.2	150 mm dia. R.C.C. pipe	Metre	493.1	540.09
III	19.6.3	250 mm dia. R.C.C. pipe	Metre	811	888.29

Schedule 'D' Item Rate for Miscellaneous Works					
S. No	**Item Reference DSR-21/USSOR-2019 (NWR)**	**Description of Item**	**Unit**	**DSR/USSOR Rate in INR**	**Estimated Rate including GST@18% in INR**
USSOR-2019 (NWR) Items - (From S. No. 3 to 6)					
3	031110	Load testing of one or more spans of bridge as selected by the Engineer as per approved load test procedure following relevant IS/IRC/Railway codes with contractor's labour, deflection measuring instruments, loading materials, recoding and analyzing the load testing results including all lead & lift, etc. complete as required. The rates are all inclusive and will be paid after load test is finished and girder is cleared of the kentledges/loading material etc. The load shall be 1.25 times the stipulated design load.			
I	031111	For Span design load upto 100 MT	Each	85662.09	96,815.29
II	031112	Extra for every increase 1 MT or part thereof in the span design load capacity upto 800 MT	MT	845.81	955.93
4	021010	Exploratory drilling of boreholes down to required depth, drilling of 150mm dia. boreholes in all type of soils except hard rock & large boulders (boulder core more than 30cm) including refilling, reinstating surface and disposing off surplus material including use of mechanical rigs with power operated winches as well as percussion/chiselling tool for advancing through occasional seams of hard strata to be employed, where necessary in Dry area.			
I	021011	0m to 10m	Metre	1,213.51	1,371.48
II	021012	10m to 20m	Metre	1,296.46	1,465.22
III	021013	20m to 30m	Metre	1,431.59	1,617.94
IV	021014	30m to 40m	Metre	1,554.68	1,757.06

Schedule 'D' Item Rate for Miscellaneous Works					
S. No	**Item Reference DSR-21/USSOR-2019 (NWR)**	**Description of Item**	**Unit**	**DSR/USSOR Rate in INR**	**Estimated Rate including GST@18% in INR**
5	021050	Drilling of NX size borehole (75mm dia.) in all types of hard rock and collection of rock core samples from boreholes and preserving in boxes			
I	021051	0m to 10m	Metre	3,189.64	3,604.84
II	021052	10m to 20m	Metre	3,418.43	3,863.41
III	021053	20m to 30m	Metre	3,775.66	4,267.15
6	021060	Conducting in-situ full size Plate Load Test (PLT) at selected location as per IS:1888 including making loading arrangements & casting of RCC/cast in-situ concrete footing as per codal provisions including excavation and refilling of trial pit			
I	021062	Plate size 45cm x 45cm	Each	27,754.18	31,367.00
II	021063	Plate size 60cm x 60cm	Each	31,000.02	35,035.35
7	021080	Conducting SCPT for soil as per IS:4968	Each	47,313.49	53,472.38
8	021090	Conducting DCPT for soil as per IS:4968	Each	37,394.02	42,261.67
9	021110	Taking out 100mm dia. & 450mm long undisturbed samples of soil from bore holes, including provision of air tight containers for packing and, labelling incl. transporting the samples to laboratory. Piston sampler shall be used for extracting undisturbed samples where necessary. Samples shall be collected as per IS:2720.	Each	152.52	172.37

Schedule 'D' Item Rate for Miscellaneous Works					
S. No	**Item Reference DSR-21/USSOR-2019 (NWR)**	**Description of Item**	**Unit**	**DSR/USSOR Rate in INR**	**Estimated Rate including GST@18% in INR**
10	021120	Taking out 100mm dia. & 450mm long disturbed samples of soil from bore holes, including provision of air tight containers for packing, labelling and transporting the samples to laboratory. Samples shall be collected as per IS:2720.	Each	164.57	185.99
11	021130	Conducting standard penetration test as per IS:2131 at approximate1.5m intervals in bore holes, as directed by the Engineer in charge	Each	852.27	963.21
12	021150	Conducting laboratory Tests on collected soil samples as per relevant IS code			
I	021151	Moisture Content/Dry Density	Each	287.66	325.11
II	021152	Atterberg Limits	Each	586.02	662.30
III	021153	Specific Gravity	Each	631.51	713.71
IV	021154	Grain size analysis including Hydrometer analysis	Each	731.85	827.12
V	021155	Direct Shear Test	Each	2,140.70	2,419.36
VI	021156	Natural Density	Each	709.11	801.42
VII	021157	Consolidation Test	Each	6,886.37	7,782.78
VIII	021158	Unconfined Compression Test	Each	2,006.91	2,268.15
IX	021159	Tri-axial Test	Each	2,408.29	2,721.78

Total Estimated cost of Schedule 'D'- INR 2.00 Crore (INR 20 million).