OIL INDIA LIMITED
(A Government of India Enterprise)
P.O. Duliajan – 786602, Assam, India
Website: www.oil-india.com
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Corrigendum No. 2 to IFB No. CPI0339P19

Hiring of EPC (Engineering Procurement and construction) Services for construction of New Central Bowser Unloading Station (CBUS) at Duliajan, Dibrugarh District, Assam.

1.   This Corrigendum is issued to notify the following:

a) BEC, SOP, Terms & conditions, specifications and schedules in various sections of the Bidding Document shall stand modified to the extent indicated here below as **Annexure- I.**
b) Reply of Pre-Bid queries raised by bidders is attached herewith as **Annexure- II.**
c) Survey and Geotechnical report as **Annexure –III.**
d) Integrity Pact as **Annexure-IV.**
e) Extension of the Bid Closing/Technical Bid Opening date and date of sale of bid document as under :-

i) Bid Closing Date & Time	**:** 18.03.2019, 11:00 hrs. IST.
ii) Technical Bid Opening Date & Time	**:** 18.03.2019, 14:00 hrs. IST.
iii) Last Date & Registration	**:** 11.03.2019, 15:30 hrs. IST.

2. All other terms and conditions of the tender remain unaltered.

3. All the prospective bidders are requested to regularly visit OIL's website: www.oil-india.com and e-procurement portal https://etender.srm.oilindia.in/irj/portal for further announcements/latest information related to this tender.

4. Bidder to submit this Corrigendum No. 02 along with **Annexure – I, II,III & IV** duly signed & stamped in all pages as token of acceptance and shall upload this document in the un-priced folder of the e- bid**.**

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A. Summary of the modified terms &conditions, specifications and schedules in various sections of the Bidding Document

SL. No	RFQ Section	Reference Clause	Subject	Type	Original	Modified Clause
1	Vol-I, Part-2 Page 1 of 10	Clause 1.1	Bid Evaluation Criteria (BEC)	Clarified and modified	The bidder must be in the business of construction of Road tanker/Bowser Unloading Station (BUS) for Hydrocarbon or Oil Collecting Station (OCS) or Gas Compressor Station (GCS) or Group Gathering Station (GGS) or Oil Tank farms with dehydration facility or Crude Oil Refinery or Petrochemical Processing Plants or Natural Gas Processing Plants in Hydrocarbon sector in EPC/LSTK mode.	The bidder must be in the business of construction of : Bowser (Road tanker) Unloading Station (BUS) for Hydrocarbon Or Oil Collecting Station (OCS) Or Gas Compressor Station (GCS) Or Group Gathering Station (GGS) Or Oil Tank farms with dehydration/pumping facility Or Crude Oil Refinery or Petrochemical Processing Plants or Natural Gas Processing Plants in Hydrocarbon sector in EPC/LSTK mode
2	Vol-I, Part-1 Page 2 of 11	Clause 3.0 (xvii)	Validity of performance security	Modified	3 months beyond successful completion of PGTR plus 12 months defect liability period plus 3 Ys AMC period	3 months beyond successful completion of PGTR plus 12 months defect liability period

SL. No	RFQ Section	Reference Clause	Subject	Type	Original	Modified Clause
3	Vol-I, Part-2 Page 2 of 10	BEC Technical Criteria Clause no. 1.6	BEC(Technical Criteria)	Modified	**Engineering and Design Capability:** The bidder should have in-house design and engineering capability for such EPC/LSTK job. The bidder should provide their in-house set up for design and engineering with the details of their personnel who are on regular pay roll of the bidder. The CV of all such personnel should also be submitted with the bid	**Engineering and Design Capability:** The bidder should have design and engineering capability for such EPC/LSTK job either in-house or through Third Party. The bidder should provide their in-house set up for design and engineering with the details of their personnel who are on regular pay roll of the bidder. The CV of all such personnel should also be submitted with the bid. In case of Design and Engineering by Third party, credential of the Third party is to be submitted along with the bid.
4	Vol-I, Part-3-III Page 28 of 31	Clause 57.0	Customs Duty	Deleted	**NIL Customs Duty & Concessional GST Applicable for Projects in ML/PEL Area** 57.1 Consequent upon implementation of GST w.e.f. 01.07.2017, various Office Ordered/ Circulars and clarifications thereof have been notified by Govt. of India regarding applicability of exemption/ concession on the Customs Duty as well as on GST for procurement of goods & services by OIL & ONGCL in connection with use in PEL/ML Areas for exploration purpose. The items eligible for NIL rates of Customs Duty and Concessional GST @5% are as applicable. 57.2 As per Sl. No. 404 of Customs Notification No. 50/ 2017-Cus dated	Clause stands deleted

SL. No	RFQ Section	Reference Clause	Subject	Type	Original	Modified Clause
					30.06.2017, the goods required for petroleum operation for eligible areas, as mentioned in list 33 of said notification, would attract 5% Customs Duty (BCD Nil & IGST @ 5%) subject to submission of EC to DGH. 57.3 For import of rigs/ equipments/ vessel/tool/spares, consumables and accessories for execution of contract for petroleum operations, the Company will issue Recommendatory Letter to Directorate General of Hydrocarbons (DGH), Ministry of Petroleum & Natural Gas, as per Government guidelines for issuance of Essentiality Certificate (EC) from Directorate General of Hydrocarbons, to enable the Contractor to import goods at concessional Customs Duty so as to provide the services under this Contract.	

SL. No	RFQ Section	Reference Clause	Subject	Type	Original	Modified Clause
5	Vol-I, Part-3-III Page 29 of 31	Clause 58.1	Concessional rate of GST on Indigenous supply of goods is not applicable in works contract.	Modified	**GST :** 58.1.1 Lumpsum prices in the Schedule of Rates/Prices shall be EXCLUSIVE of GST. 58.1.2 GST shall be reimbursed to the Contractor at actual against submission of Invoice issued in accordance with GST Rules. 58.1.3 GST rate shall be subject to Statutory Variation subsequent to submission of last price bid. Concessional rate of GST on Indigenous supply of goods is not applicable in works contract	**GST :** 58.1.1 Lumpsum prices in the Schedule of Rates/Prices shall be EXCLUSIVE of GST. 58.1.2 GST shall be reimbursed to the Contractor at actual against submission of Invoice issued in accordance with GST Rules. 58.1.3 GST rate shall be subject to Statutory Variation subsequent to submission of last price bid.
6	Vol-I, Annexures Page 9 of 21	Annexure II A Sl. No. 10	SOP	modified	Procurement- Completion of erection/construction activities (Hydro test and pre-commissioning) and total plant ready for commissioning	Procurement- Completion of erection/ construction activities (Hydro test and pre-commissioning) and total plant ready for commissioning. **The payment shall be retained till completion of 3 yrs AMC period and will be paid after completion of AMC period.**
7	Vol-I, Annexures Page 10 of 21	Annexure II A Sl. No. 14	SOP	modified	Successful Commissioning of CBUS.	Successful Commissioning of CBUS. **The payment shall be retained till completion of 3 yrs AMC period and will be paid after completion of AMC period.**

SL. No	RFQ Section	Reference Clause	Subject	Type	Original	Modified Clause
8	Vol-I, Annexures Page 10 of 21	Annexure II A Sl. No. 15	SOP	modified	PGTR- as certified by EPMC/OIL on pro-rata basis as per the approved schedule of activities. Wt. 60%	PGTR- as certified by EPMC/OIL on pro-rata basis as per the approved schedule of activities. **Wt. 40%**
9	Vol-I, Annexures Page 10 of 21	Annexure II A Sl. No. 17	SOP	Addition		**Balance payment will be made after completion of 3yrs AMC period.** **Wt. 20%**
10	Vol-I, Annexures Page 11 of 21	Annexure II A Clause A(iv)	Payment summary	Modified	Payment shall be made for Sl. No. 10 upon completion of this activity and acceptance by EPMC/OIL.	Payment shall be made for Sl. Nos. 14 upon completion of these activities and acceptance by EPMC/OIL. **The payment shall be retained till completion of 3years AMC period and will be paid after completion of AMC**
11	Vol-I, Annexures Page 11 of 21	Annexure II A Clause A(vi)	Payment summary	Modified	Payment shall be made for Sl. Nos. 14 upon completion of these activities and acceptance by EPMC/OIL	Payment shall be made for Sl. Nos. 14 upon completion of these activities and acceptance by EPMC/OIL. **The payment shall be retained till completion of 3 years AMC period and will be paid after completion of AMC**
12	Vol-I, Annexures Page 11 of 21	Annexure II A Clause A(ix)	Payment summary	Addition	Addition	**Balance payment under sl. no 17 will be made after completion of 3 years AMC period.**

SL. No	RFQ Section	Reference Clause	Subject	Type	Original	Modified Clause
13	Vol-I, Annexures Page 11 of 21	Annexure II A Clause A(X)	Payment summary	Addition	Addition	**The payment under sl no 10,14 & 17 can be made after commissioning & handing over the project to OIL just before the start of AMC against submission of Advance Bank Guarantee(ABG) of the equivalent amount and the period of ABG will be up to the AMC period.**
14	Vol-II, Section A14: page 2 of 2	1.2.4.1	Vendor selection criteria for Instrument Items.	Modified	Selection criteria of instrument vendor are enclosed in document no. GCS-INS-008 in the section Instrumentation elsewhere in the bid.	Unless otherwise mentioned anywhere in the tender document all instrument engineering item's vendor shall be from EIL's approved vendors list successfully supplying items for project site for at least five year period. The vendor to produce credential for record.
15	Vol-II, Part- B3: page 39 of 112	4.01.00	Field Instrumentation General requirement	Addition		All electronic/electrical instruments and equipment use in hazardous area should fulfil the following: • Item shall be of a type and specification confirming to the relevant standards as specified in the Regulation 107(2) of Oil Mines Regulation-2017 and complying the provisions therein. • Bidder should supply documents specifying the type, details of specification, reference of the particular standard, test criteria as per the standards and status of testing, place of testing, copies of test reports from Indian Government Laboratory or NABL accredited laboratory or IECEx accredited laboratory or ATEX

SL. No	RFQ Section	Reference Clause	Subject	Type	Original	Modified Clause
						notified body which is not a part of manufacture's facilities. • In this regard, Bidder may refer OMR-2017, Notification dated 18th October 2017,
16	Vol-II, Section-A4: Page 4 of 68	Clause 2.02.01	Crude Bowser Unloading System	Modified	Crude oil is received at Central Bowser Unloading Station (CBUS) through road tankers. The tankers are unloaded from the bottom or side. The bottom unloading arms are Connected to the road tankers with the help of quick connecting couplers to ensure zero spillage during the operation. Individual unloading arms are (each) connected to Crude Oil Unloading Pumps (42-P-001 to 010) for onward transfer to Crude Oil Storage Tanks (42-T-001A/B). The Crude Oil Unloading Pumps (42-P-001 to 010) shall be of screw type. All spillages shall be collected by surface drains to drain sump in each unloading pad and collected in Drain Oil Sump (42-T-011A/B/C). All lines and valves excluding loading arms shall be electrically traced for maintaining pumpable characteristics of crude oil.	Crude oil is received at Central Bowser Unloading Station (CBUS) through road tankers. The tankers are unloaded from the bottom or side. The bottom unloading arms are connected to the road tankers with the help of quick connecting couplers to ensure zero spillage during the operation. Individual unloading arms are (each) connected to Crude Oil Unloading Pumps (42-P-001 to 010) for onward transfer to Crude Oil Storage Tanks (42-T-001A/B). The Crude Oil Unloading Pumps (42-P-001 to 010) shall be leak free positive displacement type **(Screw/Seal-less Diaphragm/ reciprocating)**. All spillages shall be collected by surface drains to drain sump in each unloading pad and collected in Drain Oil Sump (42-T-011A/B/C). All lines and valves excluding loading arms shall be electrically traced for maintaining pumpable characteristics of crude oil.
17	Vol-II, Section-A4: Page	Clause 2.02.03	Crude Oil Transfer System	Modified	Crude oil from Crude Oil Storage Tanks (42-T-001A/B) shall be transferred to delivery pipe line (existing) with the help of Crude Oil Transfer Pumps (42 -P-	Crude oil from Crude Oil Storage Tanks (42-T-001A/B) shall be transferred to delivery pipeline (existing) with the help of Crude Oil Transfer Pumps (42-P-012A/B/C/D). Crude Oil Transfer Pumps (42-P-012A/B/C/D)

SL. No	RFQ Section	Reference Clause	Subject	Type	Original	Modified Clause
	5 of 68				012A/B/C/D). Crude Oil Transfer Pumps (42-P-012A/B/C/D) shall be of screw type. All lines shall be electrically traced for maintaining pumpable characteristics of crude oil.	shall be of **Leak Free positive displacement type (Seal-less Diaphragm/ reciprocating).** All lines shall be electrically traced for maintaining pumpable characteristics of crude oil.
18	Vol-II, Section-A4: Page 18 of 68	Clause 3.04.00	Crude Oil Transfer Pump Design Criteria	Modified	Four (4) nos. crude oil transfer pumps shall be of positive displacement type with twin screw/ multiple screw. Bearing shall be antifriction ball or roller type. Bearings shall be adequately sized to absorb radial as well as axial thrust loads, if any. Bearings shall be external and lubricated with oil or grease. Each pump shall have relief valve either built-in with the body or end plate for protection against damage due to accidental closure of discharge valve & pressure build up. The capacity of the relief valve shall be at least that of the pump to ensure the full discharge of liquid through the bypass line to the suction side of the pump during accidental pressure build up. Timing gear shall be provided to transmit torque from one rotor shaft to another and to maintain the proper angular relationship of the rotors. Proper lubricating arrangement for this shall be provided. Pump shall be connected to its drive either directly, or through gear reducer, by means of flexible	Four (4) nos. crude oil transfer pumps shall be of **Leak Free positive displacement type (Seal-less Diaphragm/ reciprocating).** Bearing shall be antifriction ball or roller type. Bearings shall be adequately sized to absorb radial as well as axial thrust loads, if any. Bearings shall be external and lubricated with oil or grease. Each pump shall have relief valve either built-in with the body or end plate for protection against damage due to accidental closure of discharge valve & pressure build up. The capacity of the relief valve shall be at least that of the pump to ensure the full discharge of liquid through the bypass line to the suction side of the pump during accidental pressure build up. Pump shall be connected to its drive either directly, or through gear reducer, by means of flexible coupling. Coupling guard shall be provided.

SL. No	RFQ Section	Reference Clause	Subject	Type	Original	Modified Clause
					coupling. Coupling guard shall be provided.	
19	Vol-II, Section-A4: Page 54 of 68	Clause 7.02.13	Tank Foundation	modified	Pile foundation with RCC cap and ring wall system to be provided to support the water storage steel tank. Sand filling to be done volume enclosed by cap and ring wall and anticorrosive bituminous layer to be provided over the filled sand for resting bottom plate of tank. Necessary earthing protection system to be introduced as per electrical requirement	Pile foundation with RCC cap and ring wall system is recommended however EPC may design the spread foundation with ring wall system based on the recommendation in geotechnical report with necessary ground improvement to support the fire water storage steel tank and crude oil storage tank. Sand filling to be done volume enclosed by cap and ring wall and anticorrosive bituminous layer to be provided over the filled sand for resting bottom plate of tank. Necessary earthing protection system to be introduced as per electrical requirement.
20	Vol-II, B1-2: Page 1 of 7	Section B1-2	Technical specification	Addition		New detail specification for plunger and diaphragm pump with data sheet is annexed as in **Annexure - II**
21	Vol-II, Sec-A5: page 1 of 2	Clause 3.00.00	Planning & Monitoring	Addition		EPC contractor also needs to submit a preliminary WBS along with Engineering, Procurement and construction S curves considering the following weightage of individual activity. 1. Basic & Detail engineering : 5% 2. Procurement : 45% 3. Construction : 45% 4. Commissioning & PGTR : 5% **Total : 100 %**

SL. No	RFQ Section	Reference Clause	Subject	Type	Original	Modified Clause
22	Vol-II, B1-13:Page 2 of 3	Clause 2.01.00 (2)	Internal coating	Addition		The contractor shall have the shear Adhesion test at site to ensure the minimum pull off adhesion of 200 kg/cm2.
23	Vol-II Sec-A3: Page 8 of 11	Clause 1.02.02(n)	Engineering and Project Management	Addition		Supply of Model for New CBUS as detailed in **ANNEXURE II Section B1-2c**

REPLY OF PRE- BID QUERIES FOR Hiring of EPC (Engineering Procurement and construction) Services for construction of New Central Bowser Unloading Station (CBUS) at Duliajan, Dibrugarh District, Assam.

Sr. No	REFERENCE OF BIDDING DOCUMENT				BIDDER'S QUERY	OIL INDIA CLARIFICATION
	Part/ Section	Page No.	Clause No.	SUBJECT		
1	MECHANICAL					
1.1				Crude Unloading and transfer pump	Any other type of unloading/ transfer pump may be considered. Please confirm.	Crude unloading shall be leak free positive displacement type **(Screw/ Seal-less Diaphragm/ reciprocating)**. It will supersede the screw pump mentioned elsewhere in the tender. Crude transfer pump shall be **Leak Free positive displacement type (Seal-less Diaphragm/ reciprocating)**. It will supersede the screw pump mentioned elsewhere in the tender. **Detail specification for Diaphragm pump and plunger pump is annexed in Annexure-II**
1.2				Steam pipe connection	Steam pipe line to be laid from TP-2. Please clarify route and type of support to be considered.	Location of the TP-2 already marked in the layout. However bidder is requested to visit the site and assess the route. Regarding the support structure, the steam pipe will be on pipe rack and RCC trench to be considered in road crossing.

Sr. No	REFERENCE OF BIDDING DOCUMENT				BIDDER'S QUERY	OIL INDIA CLARIFICATION
	Part/ Section	Page No.	Clause No.	SUBJECT		
2	**CIVIL & STRUCTURAL**					
2.1		Page 1 of 19	Section B4-1 Clause no.3.0	Allowable bearing pressure and foundation types for proposed facilities.	As stated in this clause, soil investigation has been carried out and report is attached with this document. Bidder requests to provide the soil report to estimate foundation cost as there is no soil report found as attachment.	Will be uploaded in the portal as corrigendum
2.2					Bidder understands that as per tender requirement, soil investigation will be carried out during detail engineering and foundation design will be performed according to new soil report. Kindly confirm.	Attached soil report is indicative only and for reference purpose. Bidders have to do the test on their own. Foundation Design shall be done based on the report of testing considering only the recommended safe bearing capacity & pile load carrying capacity. However The foundation type recommended in Clause-7.00.00 of Sec-A4: Page 51 of 68 (Volume II) of tender document will remain same and to be followed strictly.
2.3				Finished grade level of plant	Bidder understands that proposed FGL of plant is RL 121.3 m as mentioned in the tender drawings. Please confirm.	Finished Grade Level (FGL) :-RL 121.300 m High Point of Paving (HPP)-RL 121.700 m
2.4				Contour levels of plant	Bidder request to provide Topography Survey Report or Average NGL of plant to estimate volume of grading work.	Attached as Annexure to this corrigendum. However, this report is indicative only and for reference purpose. Bidder shall carry out survey on their own. If required bidder may visit site prior to bid. No extra claim will be entertained thereafter during execution.

Sr. No	REFERENCE OF BIDDING DOCUMENT				BIDDER'S QUERY	OIL INDIA CLARIFICATION
	Part/ Section	Page No.	Clause No.	SUBJECT		
2.5					Whether bidder has to consider the approach road construction while bidding.	Bidder has to consider the construction of approach road aprx. 35 mtr using concrete.
3	C&I					
3.1					No specification details & design criteria available for density meter, level indicator, kindly provide the same	Density meter or Frequency output shall be integral with the Coriolis mass flow meter whose specification is available in the Vol II Part B3, Clause 4.10.08. Specification of Level indicator is available in Vol II Part B, B3, Clause 4.10.04
3.2					Detailed tag description for PUMP MOTOR, MOV & SOV not available, kindly provide	Please follow the numbering system as shown in the legend sheet of the P&IDs
3.3					Please share the operation & control philosophy	Please refer the tender document in Vol II Part A4, Clause 2.03.00, 5.01.07 to 5.01.18 & 5.02.00
3.4					Details of F&G detector not available (location layout, loss & prevention P&ID) Please provide the same.	Specification & guidelines are provided in the tender document in Vol II Part B3, Clause 5.05.00 & 5.06.00, whereas the location layout, loss & prevention P&ID, Gas mapping etc. drawings shall be prepared by the contractor. Area layout, & Equipment layouts are available with the tender document.
4	ANY OTHER					
4.1		Page 11 of 11	Sec-A3: Clause 2.00.00	Terminal point TP1	Battery limit for Crude oil discharge from Tank farm to existing pipeline towards CTF:	OIL will arrange and provide necessary hot tapping at TP-01 with isolation valve and blind flange. Contractor to interconnect his piping at

Sr. No	REFERENCE OF BIDDING DOCUMENT				BIDDER'S QUERY	OIL INDIA CLARIFICATION
	Part/ Section	Page No.	Clause No.	SUBJECT		
					whether hot tapping will in the scope of Bidder. Please confirm.	TP-01
4.2		**Page 11 of 11**	**Sec-A3: Clause 2.00.00**	Terminal points	Whether necessary shutdown will be taken for tie-in at all terminal points. Please confirm.	Shut down for interconnecting tie-in points as required will be arranged by OIL after receipt of mutually agreed shutdown schedule from contractor and following all necessary safety procedure by contractor.

SECTION B1-2a

TECHNICAL SPECIFICATION FOR PLUNGER PUMP

1.00.00   TECHNICAL REQUIREMENTS

1.01.00   The pump model offered shall be from the existing regular manufacturing range of the pump manufacturer. It will be of proven design and in use / operation for the same service for which it is intended to be procured.

1.02.00   The parts of the pump shall be designed to handle the liquid at the pressure and temperature indicated on the attached pump data sheet. The pressure retaining parts shall, as a minimum requirement, meet the requirements of ASME section VIII, Div-1.

1.03.00   Pumps shall be suitable for continuous operation. Castings and forgings shall confirm to their respective material specification and shall be free of flaws and objectionable imperfections and conforming to the highest quality of workmanship.

1.04.00   The pump shall be of leak-proof, plunger type. Horizontal pumps are preferred. Compact design of the pump motor unit is desirable. The pump shall be driven by motor through reducing gear mechanism. Chain or belt drives are not acceptable. Exposed moving parts shall be enclosed by an adequate guard for personnel protection.

1.05.00   Pump design shall be appropriate to give minimum of 30 years of continuous service. The pump shall be designed to facilitate ease of maintenance, inspection and repairs.

1.06.00   The materials of the main pump components shall comply with the requirements of appropriate ASTM Standards. The cylinder block, suction, discharge connections shall be of cast iron as per IS 210 Gr. FG 260 or better. Material for all other parts will be at the discretion of the manufacturer but shall be subject to approval by Purchaser.

1.07.00   The cylinder block shall be provided with replaceable liner or bushings. The liner and plunger material shall be corrosion and wear resistance and the combination shall not gall.

1.08.00   Lubrication of the plunger packing shall be with pumped fluid only. The plunger packing and crankcase sealing arrangements shall be such that there will be no contamination of the pumped fluid or its leakage with oil or grease. The pump shall be provided with a plunger leakage collection arrangement which does not expose the pumped fluid leakage to pump room or crank case atmosphere. Preferred arrangement is triple packing with the interspace between

the adjacent packings and the first (primary) interspace connected to the pump suction while the second (secondary) interspace provided for leak off connection.

1.09.00	All valves shall be readily accessible for maintenance and shall have renewable seats designed for easy replacement. To prevent galling, the difference in hardness between valves and seats shall be at least 30 BHN. Sufficient free area through valves shall be kept to restrict liquid velocities below 1.0 m/s. at design capacity.
1.10.00	Inlet and outlet connections shall be flanged conforming to ANSI B 16.5 and rating suitable for design pressure of the pump.
1.11.00	Antifriction bearing life rating shall be computed in accordance with ANSI B 3.11 for a rating life of 60,000 hours.
1.12.00	Each pump-motor unit shall have its own lubrication system. The system shall be such that no dismantling of any part of the unit is necessary to replenish or replace the lubricant. For a unit using a pressure lubrication system, a pressure switch, to the approval of the Purchaser, shall be provided for sensing the lubricating oil pressure. Pressure indication shall also be provided.
1.13.00	Crank-case or packing box vents shall be protected with a mesh filter.
1.14.00	Unless otherwise specified, pulsation suppression devices shall be designed in such a way as to give amplitude of pulsation within the limits of ± 3% of mean. The pulsation suppression devices shall be chosen to suit and perform satisfactorily at the operating pressure of the pump.
1.15.00	**Relief Valve**
1.15.01	Relief valves shall be as per ASME Sec. VIII Div-1 and shall be mounted on pump discharge flange or manifold.
1.15.02	Material of construction of relief valve shall be stainless steel.
1.15.03	End connection of relief valve shall be flanged type and shall be connected to discharge to suction side.
1.15.04	Relief valve shall be selected to pass 100% rated capacity of pump when fully open and to limit accumulation pressure to 110% of rated discharge pressure.
1.16.00	The unit shall be designed to operate with a minimum of vibration. Any vibration isolation equipment required in the pump base assembly shall be indicated. Supplier shall also indicate the guaranteed maximum vibration level for the Unit under normal operating conditions.

1.17.00   Difference between NPSHA (including estimated system acceleration head) and NPSHR of 0.6 meter or less is not acceptable.

2.00.00   PERFORMANCE GUARANTEE

2.01.00   **Performance Requirement**

2.01.01   Performance requirement for the pumps shall be guided by the Data Sheets enclosed as Annexure of this specification.

2.01.02   The Pump shall be subjected to a performance test in accordance with the Standards of the Hydraulic Institute Test code for Power Pumps, Section VIII - PP. For the purpose of this test each pump shall be connected to its own motor. The pump flow, power input to the motor, and the pump efficiency shall be determined over a range of total head from zero to at least maximum rated head. The manufacturer shall submit test curves showing Total Head, efficiency, brake horsepower and volumetric efficiency plotted as ordinates on the same sheet with pump capacity as abscissa.

2.01.03   After the pump performance curves have been determined, the pump shall be run continuously for 24 hours at rated head. A plunger leakage test shall be carried out during this run with the primary seal leakage cavity at atmospheric pressure. The leakage shall not exceed the value stated in the Tender as "the normal leak rate" to be expected. Vibration readings at suitable points shall be recorded during the test.

2.01.04   Manufacturer shall perform the test to verify NPSH required for each pump.

2.02.00   **Guarantees**

2.02.01   The pumps shall be guaranteed to perform as specified herein when tested in accordance with the above codes/standards. Should the equipment fail to meet the specified conditions after fair test run immediately following thorough cleaning, the Bidder shall make such alterations or furnish such additional equipment as may be necessary to meet these specification, free of cost to the purchaser.

2.02.02   The following parameters are to be guaranteed:

a)   Pump rated capacity at rated head

b)   Pump efficiency at rated point

c)   Power consumption at the rated condition.

d)   Vibration level of the pump set

e)   Noise level at 1m from pump and motor.

3.00.00   INSPECTION AND TESTING

3.01.00   Manufacturer shall carry out the physical and chemical tests on the materials used for the construction of Pump in an approved Testing laboratory to ensure the quality of material being used. Test report shall be furnished to Consultant/ Owner for review.

3.02.00   The first and last passes of all pressure containing welds, all external and accessible internal surfaces of the pressure bearing parts, the rotating and reciprocating parts, after final machining and before assembly, shall be inspected by a Liquid Penetration method.

3.03.00   Liquid penetration inspection shall be in conformity with ASTM E 165. Penetrant and developer shall be removed on completion of inspection. The cleaning agent as well as the penetrant and developer shall not contain halogens and sulphur. Any indication of defects on any of the components inspected by dye penetrant inspection will not be acceptable.

3.04.00   Magnetic particle inspection shall be in conformity with ASTM E 109 or ASTM E 13B. Any suitable method specified therein is acceptable. Demagnetization is required.

3.05.00   All pressure containing castings and welds in pressure containing parts shall be fully radiographed in accordance with ASME Pressure Vessel Code Section VIII Div.1 and shall meet the requirements specified therein.

3.06.00   Hydrostatic test shall be carried out on pressure retaining parts at 1.5 times the pump design pressure for 30 mins or duration as specified in relevant standards whichever is higher. The hydrostatic test shall be considered satisfactory when no leaks or structure failures are observed on pumps.

3.07.00   Dimensional and visual checks shall be carried out on the pump assembly and discharge head.

3.08.00   All Pumps shall be performance tested at shop with job motor (at rated speed). The Bidder in the presence of the Purchaser or his representative shall conduct the performance test.

3.09.00   It may be noted that during shop tests no negative tolerance shall be permitted on head (H), Capacity (Q) and the pump efficiency (η).

3.10.00   Check for vibration and noise levels shall also be conducted during performance test.

3.11.00   Strip down examination shall be carried out to check for mechanical damages after shop performance test. The liquid end shall be stripped off, to check for its wear and workmanship. Shafts under packing shall be checked for any abnormal rubbing and wear.

4.00.00   DRAWINGS, DATA, CURVES AND INFORMATION REQUIRED

4.01.00   Following drawings, data and information for the equipment are required to be submitted by the bidder along with his formal proposal.

4.01.01   Drawings

- Outline drawings of the pump showing various dimensions, suction and discharge locations.
- Typical cross section drawing of the pump, showing various components, bearings, seal rings etc. and materials of construction for all items.
- Lubrication arrangement drawings.

4.01.02   Anticipated performance curves.

4.01.03   complete descriptive and illustrative literature on the equipment being offered.

4.01.04   A write-up describing clearly the procedure for installing the pump. A diagram showing the required pump house monorail hook center line above the pump operating floor has also to be furnished.

4.02.00   The drawings/data as asked for in clause no. 4.01.00 above shall also be furnished in a finalized form by the successful bidder (after the contract is awarded to him), for the approval of the Purchaser. In addition, the bidder will also submit the following for Purchaser's approval:

4.02.01   Pump foundation details along with static and dynamic loads.

4.02.02   Test reports, performance curves and other particulars as required by the applicable clauses of this specification.

TECHNICAL DATA SHEET OF PLUNGER PUMP

A. CRUDE OIL UNLOADING PUMPS	
Number	Ten (10) [All working]
Description for each Pump	
Location	Outdoor
Fluid to be handled	Crude Oil
Service	Crude Oil Unloading
Duty	Continuous and to be suitable for parallel operation
Type of Pump	Reciprocating plunger type
Design standard	As per API 674
Service temperature, in ˚C	40
Rated Capacity, in m³/hr [Must Requirement]	30
Permissible tolerance in rated capacity, in %	As per API 674
Suction Condition	Flooded
Head to be developed at rated capacity [Must Requirement]	30 mlc (Bidder to check during detail engineering)

Permissible tolerance in efficiency at rated capacity, in %	As per API 674
Material of construction	
a) Casing	Cast iron as per IS 210 Gr. FG 260
b) Plunger	Bidder to furnish
c) Rod	Bidder to furnish
Type of drive	Electrical Motor
Criteria for selection of drive motor	Minimum 15 % margin over BKW at rated duty point shall be taken and standard motor with next higher KW as available shall be selected. This shall in no way be less than the maximum power required by the Pump.
Rated speed (RPM)	Bidder to furnish
Voltage, Phase & Frequency (± % Variation)	415 V (+10%), 3 Phase, 50 HZ (+3 to –5%).
Noise level (for complete set of Pump & Motor)	Not more than 75 db (At a distance of 1.0 m from the outer surface of Motor)
Tests and Inspection	
a) Material Test required for	As per manufacturer's standard
b) Hydro-test	As per manufacturer's standard
c) Dynamic Balancing Test	As per manufacturer's standard

Performance Test	
a) Test Code	Hydraulic Institute Test code for Power Pumps
b) Tests to be done for determination of	Head-Capacity Curve, BHP-Capacity Curve and Efficiency-Capacity Curve and NPSH Capacity Curve
c) Test to be carried out	Shall be as per Specification / approved QAP
d) Test for satisfactory operation of pump at site	Required
Accessories	
a) Lubrication	Splash lubrication for power end and Mechanical force feed lubrication for plungers (including oil cooler and lube oil pump) / manufacturer's standard
b) Packing	Special Packing Seal against plunger (having no sensitive lips to insure long life under continuous working pressure) Bidder to elaborate packing & type of seal provided.
c) Pressure regulating cum by pass valve	Pressure regulating cum by pass valve for stepless adjustment of Pressure from 0 to Maximum
d) Pressure Safety valve	Spring loaded, vertical mounted
e) Coupling	Flexible Pin bush type coupling in between engine & gear box & in between gear box & pump along with guard
f) Suction stabilizer	Bladderless volume bottle type suction stabilizer
g) Pressure Switch	Suction pressure switch for lube oil
h) Temperature Switch	Discharge temperature switch for crude oil

i) Suction Filter	Basket Strainer of SS (Body & Internals)
j) Special tools & tackles (if Required)	Special tools for valve, valve seat replacement, Plunger packing replacement etc.
k) Lifting arrangement	Lifting eye bolts / lugs will be provided for pump, motor, gear box etc. Skid shall have lifting arrangement
l) Piping	Associated piping, flanges, gaskets, nuts & bolts for mounting of all the above accessories on the pump

B. CRUDE OIL TRANSFER PUMPS	
Number	Four (4) [Two working, one operating standby and one maintenance stand by]
Description for each Pump	
Location	Outdoor
Fluid to be handled	Crude Oil
Service	Crude Oil Transfer
Duty	Continuous and to be suitable for parallel operation
Type of Pump	Reciprocating plunger type
Design standard	As per API 674
Service temperature, in ℃	40
Rated Capacity, in m³/hr [Must Requirement]	35

Permissible tolerance in rated capacity, in %	As per API 674
Suction Condition	Flooded
Head to be developed at rated capacity [Must Requirement]	500 mlc (Bidder to check during detail engineering)
Permissible tolerance in efficiency at rated capacity, in %	As per API 674
Material of construction	
d) Casing	Cast iron as per IS 210 Gr. FG 260
e) Plunger	Bidder to furnish
f) Rod	Bidder to furnish
Type of drive	Electrical Motor
Criteria for selection of drive motor	Minimum 15 % margin over BKW at rated duty point shall be taken and standard motor with next higher KW as available shall be selected. This shall in no way be less than the maximum power required by the Pump.
Rated speed (RPM)	Bidder to furnish
Voltage, Phase & Frequency (± % Variation)	415 V (+10%), 3 Phase, 50 HZ (+3 to –5%).
Noise level (for complete set of Pump & Motor)	Not more than 75 db (At a distance of 1.0 m from the outer surface of Motor)
Tests and Inspection	

d) Material Test required for	As per manufacturer's standard
e) Hydro-test	As per manufacturer's standard
f) Dynamic Balancing Test	As per manufacturer's standard
Performance Test	
e) Test Code	Hydraulic Institute Test code for Power Pumps
f) Tests to be done for determination of	Head-Capacity Curve, BHP-Capacity Curve and Efficiency-Capacity Curve and NPSH Capacity Curve
g) Test to be carried out	Shall be as per Specification / approved QAP
h) Test for satisfactory operation of pump at site	Required
Accessories	
m) Lubrication	Splash lubrication for power end and Mechanical force feed lubrication for plungers (including oil cooler and lube oil pump) / manufacturer's standard
n) Packing	Special Packing Seal against plunger (having no sensitive lips to insure long life under continuous working pressure) Bidder to elaborate packing & type of seal provided.
o) Pressure regulating cum by pass valve	Pressure regulating cum by pass valve for stepless adjustment of Pressure from 0 to Maximum
p) Pressure Safety valve	Spring loaded, vertical mounted
q) Coupling	Flexible Pin bush type coupling in between engine & gear box & in between gear box & pump along with guard

r)	Suction stabilizer	Bladderless volume bottle type suction stabilizer
s)	Pressure Switch	Suction pressure switch for lube oil
t)	Temperature Switch	Discharge temperature switch for crude oil
u)	Suction Filter	Basket Strainer of SS (Body & Internals)
v)	Special tools & tackles (if Required)	Special tools for valve, valve seat replacement, Plunger packing replacement etc.
w)	Lifting arrangement	Lifting eye bolts / lugs will be provided for pump, motor, gear box etc. Skid shall have lifting arrangement
x)	Piping	Associated piping, flanges, gaskets, nuts & bolts for mounting of all the above accessories on the pump

SUPPLY OF ACCESSORIES AND SERVICES FOR EACH PUMP- MOTOR SET

Lifting lugs/eye bolts on pump motor set for handling.	:	Yes
Necessary tools & tackles	:	Yes
Recommended Spare parts for 3 years operation	:	Yes
Painting & protective coating on pump	:	Yes
Mandatory Spare Parts as per List	:	Yes
Erection & Commissioning Spares	:	Yes

SECTION B1-2b

TECHNICAL SPECIFICATION FOR DIAPHRAGM PUMP

1.00.00   **TECHNICAL REQUIREMENTS**

1.01.00   The pump model offered shall be from the existing regular manufacturing range of the pump manufacturer. It will be of proven design and in use / operation for the same service for which it is intended to be procured.

1.02.00   The parts of the pump shall be designed to handle the liquid at the pressure and temperature indicated on the attached pump data sheet. The pressure retaining parts shall, as a minimum requirement, meet the requirements of ASME Section VIII, Div-1.

1.03.00   Pumps shall be suitable for continuous operation. Castings and forgings shall confirm to their respective material specification and shall be free of flaws and objectionable imperfections and conforming to the highest quality of workmanship.

1.04.00   The pump shall be of sealless positive displacement type conforming to API 674, with smooth low-pulse output. Compact design of the pump-motor unit is desirable.

1.05.00   Chain or belt drives are not acceptable. Exposed moving parts shall be enclosed by an adequate guard for personnel protection.

1.06.00   Pump design shall be appropriate to give minimum of 30 years of continuous service. The pump shall be designed to facilitate ease of maintenance, inspection and repairs.

1.07.00   The materials of the main pump components shall comply with the requirements of appropriate ASTM Standards. Material for pump parts shall be as per manufacturer's standard but shall be subject to approval by Purchaser.

1.08.00   Inlet and outlet connections shall be flanged conforming to ANSI B 16.5 and rating suitable for design pressure of the pump.

1.09.00   Antifriction bearing life rating shall be computed in accordance with ANSI B 3.11 for a rating life of 60,000 hours.

1.10.00	Each pump-motor unit shall have its own lubrication system. The system shall be such that no dismantling of any part of the unit is necessary to replenish or replace the lubricant.
1.11.00	Unless otherwise specified, pulsation suppression devices shall be designed in such a way as to give amplitude of pulsation within the limits of ± 3% of mean. The pulsation suppression devices shall be chosen to suit and perform satisfactorily at the operating pressure of the pump.
1.12.00	**Relief Valve**
1.12.01	Relief valves shall be as per ASME Sec. VIII Div-1 and shall be mounted on pump discharge flange or manifold.
1.12.02	Material of construction of relief valve shall be stainless steel.
1.12.03	End connection of relief valve shall be flanged type and shall be connected to discharge to suction side.
1.12.04	Relief valve shall be selected to pass 100% rated capacity of pump when fully open and to limit accumulation pressure to 110% of rated discharge pressure.
1.12.05	The unit shall be designed to operate with a minimum of vibration. Any vibration isolation equipment required in the pump base assembly shall be indicated. Supplier shall also indicate the guaranteed maximum vibration level for the Unit under normal operating conditions.
1.12.06	Difference between NPSHA (including estimated system acceleration head) and NPSHR of 0.6 meter or less is not acceptable.
2.00.00	**PERFORMANCE GUARANTEE**
2.01.00	**Performance Requirement**
2.01.01	Performance requirement for the pumps shall be guided by the Data Sheets enclosed as Annexure of this specification.
2.01.02	The Pump shall be subjected to a performance test in accordance with the API 675. For the purpose of this test each pump shall be connected to its own motor. The pump flow, power input to the motor, and the pump efficiency shall be determined over a range of total head from zero to at least maximum rated head. The manufacturer shall submit

test curves showing Total Head, efficiency, brake horsepower and volumetric efficiency plotted as ordinates on the same sheet with pump capacity as abscissa.

2.01.03   After the pump performance curves have been determined, the pump shall be run continuously for 24 hours at rated head. A leakage test shall be carried out as per relevant standard. Vibration readings at suitable points shall be recorded during the test.

2.01.04   Manufacturer shall perform the test to verify NPSH required for each pump.

2.02.00   **Guarantees**

2.02.01   The pumps shall be guaranteed to perform as specified herein when tested in accordance with the above codes/standards. Should the equipment fail to meet the specified conditions after fair test run immediately following thorough cleaning, the Bidder shall make such alterations or furnish such additional equipment as may be necessary to meet these specification, free of cost to the purchaser.

2.02.02   The following parameters are to be guaranteed:

a) Pump rated capacity at rated head

b) Pump efficiency at rated point

c) Power consumption at the rated condition.

d) Vibration level of the pump set

e) Noise level at 1m from pump and motor.

3.00.00   INSPECTION AND TESTING

3.01.00   Manufacturer shall carry out the physical and chemical tests on the materials used for the construction of Pump in an approved Testing laboratory to ensure the quality of material being used. Test report shall be furnished to Consultant/ Owner for review.

3.02.00	The first and last passes of all pressure containing welds, all external and accessible internal surfaces of the pressure bearing parts, the rotating and reciprocating parts, after final machining and before assembly, shall be inspected by a Liquid Penetration method.
3.03.00	Liquid penetration inspection shall be in conformity with ASTM E 165. Penetrant and developer shall be removed on completion of inspection. The cleaning agent as well as the penetrant and developer shall not contain halogens and sulphur. Any indication of defects on any of the components inspected by dye penetrant inspection will not be acceptable.
3.04.00	Magnetic particle inspection shall be in conformity with ASTM E 109 or ASTM E 13B. Any suitable method specified therein is acceptable. Demagnetization is required.
3.05.00	All pressure containing castings and welds in pressure containing parts shall be fully radiographed in accordance with ASME Pressure Vessel Code Section VIII Div.1 and shall meet the requirements specified therein.
3.06.00	Hydrostatic test shall be carried out on pressure retaining parts at 1.5 times the pump design pressure for 30 mins or duration as specified in relevant standards whichever is higher. The hydrostatic test shall be considered satisfactory when no leaks or structure failures are observed on pumps.
3.07.00	Dimensional and visual checks shall be carried out on the pump assembly and discharge head.
3.08.00	All Pumps shall be performance tested at shop with job motor (at rated speed). The Bidder in the presence of the Purchaser or his representative shall conduct the performance test.
3.09.00	It may be noted that during shop tests no negative tolerance shall be permitted on head (H), Capacity (Q) and the pump efficiency (η).
3.10.00	Check for vibration and noise levels shall also be conducted during performance test.
3.11.00	Strip down examination shall be carried out to check for mechanical damages after shop performance test. The liquid end shall be stripped off, to check for its wear and workmanship. Shafts under packing shall be checked for any abnormal rubbing and wear.

4.00.00   DRAWINGS, DATA, CURVES AND INFORMATION REQUIRED

4.01.00   Following drawings, data and information for the equipment are required to be submitted by the bidder along with his formal proposal.

4.01.01   Drawings

- Outline drawings of the pump showing various dimensions, suction and discharge locations.
- Typical cross section drawing of the pump, showing various components, bearings, seal rings etc. and materials of construction for all items.
- Lubrication arrangement drawings.

4.01.02   Anticipated performance curves.

4.01.03   Complete descriptive and illustrative literature on the equipment being offered.

4.01.04   A write-up describing clearly the procedure for installing the pump. A diagram showing the required pump house monorail hook center line above the pump operating floor has also to be furnished.

4.02.00   The drawings/data as asked for in clause no. 4.01.00 above shall also be furnished in a finalized form by the successful bidder (after the contract is awarded to him), for the approval of the Purchaser. In addition, the bidder will also submit the following for Purchaser's approval:

4.02.01   Pump foundation details along with static and dynamic loads.

4.02.02   Test reports, performance curves and other particulars as required by the applicable clauses of this specification.

ANNEXURE-B1-2b/1

TECHNICAL DATA SHEET OF DIAPHRAGM PUMP

A. CRUDE OIL UNLOADING PUMPS	
Number	Ten (10) [All working]
Description for each Pump	
Location	Outdoor
Fluid to be handled	Crude Oil
Service	Crude Oil Unloading
Duty	Continuous and to be suitable for parallel operation
Type of Pump	Diaphragm type
Design standard	As per API 674
Service temperature, in ˚C	40
Rated Capacity, in m³/hr [Must Requirement]	30
Permissible tolerance in rated capacity, in %	As per API 674

Suction Condition	Flooded
Head to be developed at rated capacity [Must Requirement]	30 mlc (Bidder to check during detail engineering)
Permissible tolerance in efficiency at rated capacity, in %	As per API 674
Material of construction	
g) Casing	Cast iron as per IS 210 Gr. FG 260
h) Plunger	Bidder to furnish
i) Rod	Bidder to furnish
Type of drive	Electrical Motor
Criteria for selection of drive motor	Minimum 15 % margin over BKW at rated duty point shall be taken and standard motor with next higher KW as available shall be selected. This shall in no way be less than the maximum power required by the Pump.
Rated speed (RPM)	Bidder to furnish
Voltage, Phase & Frequency (± % Variation)	415 V (+10%), 3 Phase, 50 HZ (+3 to −5%).
Noise level (for complete set of Pump & Motor)	Not more than 75 db (At a distance of 1.0 m from the outer surface of Motor)

Tests and Inspection	
g) Material Test required for	As per manufacturer's standard
h) Hydro-test	As per manufacturer's standard
i) Dynamic Balancing Test	As per manufacturer's standard
Performance Test	
i) Test Code	API 675
j) Tests to be done for determination of	Head-Capacity Curve, BHP-Capacity Curve and Efficiency-Capacity Curve and NPSH Capacity Curve
k) Test to be carried out	Shall be as per Specification / approved QAP
l) Test for satisfactory operation of pump at site	Required
Accessories	
y) Lubrication	As per manufacturer's standard
z) Pressure Safety valve	Spring loaded, vertical mounted
aa) Coupling	Flexible Pin bush type coupling in between engine & gear box & in between gear box & pump along with guard
bb) Suction Filter	Basket Strainer of SS (Body & Internals)

cc)	Special tools & tackles (if Required)	Special tools for valve, valve seat replacement, etc.
dd)	Lifting arrangement	Lifting eye bolts / lugs will be provided for pump, motor, gear box etc. Skid shall have lifting arrangement
ee)	Piping	Associated piping, flanges, gaskets, nuts & bolts for mounting of all the above accessories on the pump

B. CRUDE OIL TRANSFER PUMPS

Number	Four (4) [Two working, one operating standby and one maintenance stand by]
Description for each Pump	
Location	Outdoor
Fluid to be handled	Crude Oil
Service	Crude Oil Transfer
Duty	Continuous and to be suitable for parallel operation
Type of Pump	Diaphragm type
Design standard	As per API 674
Service temperature, in °C	40
Rated Capacity, in m³/hr [Must Requirement]	35
Permissible tolerance in rated capacity, in %	As per API 674
Suction Condition	Flooded
Head to be developed at rated capacity [Must Requirement]	500 mlc (Bidder to check during detail engineering)
Permissible tolerance in efficiency at rated capacity, in %	As per API 674
Material of construction	

j) Casing	Cast iron as per IS 210 Gr. FG 260
k) Plunger	Bidder to furnish
l) Rod	Bidder to furnish
Type of drive	Electrical Motor
Criteria for selection of drive motor	Minimum 15 % margin over BKW at rated duty point shall be taken and standard motor with next higher KW as available shall be selected. This shall in no way be less than the maximum power required by the Pump.
Rated speed (RPM)	Bidder to furnish
Voltage, Phase & Frequency (± % Variation)	415 V (+10%), 3 Phase, 50 HZ (+3 to –5%).
Noise level (for complete set of Pump & Motor)	Not more than 75 db (At a distance of 1.0 m from the outer surface of Motor)
Tests and Inspection	
j) Material Test required for	As per manufacturer's standard
k) Hydro-test	As per manufacturer's standard
l) Dynamic Balancing Test	As per manufacturer's standard
Performance Test	

m) Test Code	API 675
n) Tests to be done for determination of	Head-Capacity Curve, BHP-Capacity Curve and Efficiency-Capacity Curve and NPSH Capacity Curve
o) Test to be carried out	Shall be as per Specification / approved QAP
p) Test for satisfactory operation of pump at site	Required
Accessories	
ff) Lubrication	As per manufacturer's standard
gg) Pressure Safety valve	Spring loaded, vertical mounted
hh)Coupling	Flexible Pin bush type coupling in between engine & gear box & in between gear box & pump along with guard
ii) Suction Filter	Basket Strainer of SS (Body & Internals)
jj) Special tools & tackles (if Required)	Special tools for valve, valve seat replacement, etc.
kk) Lifting arrangement	Lifting eye bolts / lugs will be provided for pump, motor, gear box etc. Skid shall have lifting arrangement
ll) Piping	Associated piping, flanges, gaskets, nuts & bolts for mounting of all the above accessories on the pump

SUPPLY OF ACCESSORIES AND SERVICES FOR EACH PUMP- MOTOR SET

Lifting lugs/eye bolts on pump motor set for handling.	:	Yes
Necessary tools & tackles	:	Yes
Recommended Spare parts for 3 years operation	:	Yes
Painting & protective coating on pump	:	Yes
Mandatory Spare Parts as per List	:	Yes
Erection & Commissioning Spares	:	Yes

Section -B1-2c

Bidder shall prepare and supply one project model for the CBUS installation. Each and every component of the project shall be displayed in appropriate scale. Minimum size shall be 1.5 m x 1.5 m.

Model shall be made of acrylic , copper wire, pvc wire etc. The model shall be covered by using transparent toughened glass. Model shall be displaced permanently in the control room/office room as decided by OIL.

Annexure-III: Survey and Geotechnical report.
Annexure-IV: Integrity Pact

O Oil India Limited
Duliajan, Dibrugarh, Assam
EPMC Services for CBUS

FEED & Basic Engineering Package
(Phase-I)
Appendix

APPENDIX

APPENDIX - I

SURVEY AND GEOTECHNICAL

INVESTIGATION REPORT

CONTENTS

ATTACHMENT	DESCRIPTION
1.0	Geotechnical Investigation Report by Reliant Foundations Pvt. Ltd
2.0	Earth Resistivity Test Report by Reliant Foundations Pvt. Ltd.
3.0	Survey Drawings by Reliant Foundations Pvt. Ltd.

1.0
SURVEY AND GEOTECHNICAL

INVESTIGATION REPORT

A
REPORT ON

GEO-TECHNICAL INVESTIGATION

FOR

CONSTRUCTION OF NEW CENTRAL BOWSER UNLOADING STATION (CBUS) AT DULIAJAN, DIBRUGARH, ASSAM
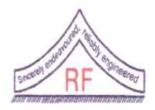

OWNER: OIL INDIA LTD

REPORT SUBMITTED TO

M/S RICHARD DESIGN SERVICES INDIA PVT LTD
KOLKATA-700091

REPORT PREPARED BY

RELIANT FOUNDATIONS PVT LTD

H-7, BYE LANE NO: 1(A, NORTH), PANJABARI ROAD
SIXMILE, GUWAHATI - 22

PHONE NO: 094351-92896, 07086020945
Email: rel_engrs@yahoo.com

REPORT ON SOIL INVESTIGATION WORK FOR CONSTRUCTION OF NEW CENTRAL BOWSER UNLOADING STATION (CBUS) AT DULIAJAN, DIBRUGARH, ASSAM

1. INTRODUCTION: The work of soil Investigation was awarded to RELIANT FOUNDATIONS PVT LTD, H-7, BYE LANE NO.1 (A.NORTH), PANJABARI ROAD, SIXMILE, GUWAHATI-22

2. Soil investigation work by making boreholes :

2.1 The field and laboratory investigations carried out by us to access the nature of sub-strata and to evaluate the soil parameters required for design of foundations proposed to be constructed for proposed construction.

2.2 Client's help is gratefully acknowledged in providing bore hole locations, close supervision and checking during boring, sampling, various testing operations and cooperation and guidance during finalization of report.

2.3 This report is based upon the results of field, laboratory tests conducted on selected soil samples collected from borehole locations.

3. SCOPE OF WORK:

The scope of work provided to us for this project was limited to the following:-

3.1 Mobilizing necessary plant, equipments and personnel to the project site, setting up the equipment, carrying out the field investigations on land and demobilization on completion of work.

3.2 Making 150 mm nominal diameter bore holes at the site in all types of soil using suitable approved method of boring to be given at site by the Engineer-in-Charge. Refusal shall mean when SPT field 'N' value reaches 100 for 30 cm or less penetration of SPT sampler.

3.2.1 Conducting standard penetration tests in the bore holes at 1.50 m interval in depth as per specifications / instructions of Engineer-in-Charge.

3.2.2 Collecting undisturbed soil samples from bore holes at 3.0m interval or every change of strata, whichever is earlier as per specifications.

3.2.3 Collecting disturbed soil samples from bore hole at regular interval and at every identifiable change of strata to supplement the boring records.

3.2.4 Recording the depth of ground water table in all the bore hole if observed up to the depth of exploration during boring work as per specifications & withdrawing the casing pipe.

3.3 Conducting the following laboratory tests on selected disturbed / undisturbed soil samples collected from bore hole / test locations :-

(a) Bulk density and Moisture content

(b) Sieve analysis

(c) Hydrometer analysis

(d) Liquid limit & Plastic limits

(e) Specific gravity

(f) Shear test on undisturbed and remoulded saturated disturbed soil samples

(g) Determination of void ratio.

3.4 Preparation and submission of report in three copies.

4.0 FIELD INVESTIGATIONS:

4.1 Necessary plant, equipment and personnel for conducting the requisite field work were mobilized to the site.

4.2 Bore hole was bored at this site using Auger and wash boring method as per IS: 1892-1979. Casing or Bentonite has been used as required to retain the bore hole. Depth of Bore hole was 15.0M.

4.3.1 Standard penetration tests were conducted in the above bore hole at every 1.50 m interval & at change of strata as per specifications / instructions of Engineer-in-Charge. The bore was cleaned up to the desired depths. Standard split spoon sampler attached to lower end of 'A' drill rods was driven in the bore holes by means of standard hammer of 63.5 Kg. falling freely from a height of 75 cm. The sampler was driven 45 cm as per specifications & the numbers of blows required for each 15 cm penetration were recorded. The numbers of blows for the first 15 cm penetration were not taken into account. This was considered as seating drive. The numbers of blows for next 30 cm penetration were designated as SPT 'N' value. Wherever the total penetration was less than 45 cm, the number of blows & the depth penetrated is incorporated in respective bore logs. Disturbed soil samples obtained from standard split spoon sampler for all the above standard penetration tests were collected in polythene bags of suitable size. These samples were properly sealed, labeled, recorded and carefully transported to the laboratory for testing.

4.3.2 Undisturbed soil samples were collected from the bore hole at every 3.00 m interval in depth & at change of strata as per sampling specifications. These sampling tubes after retrieval from the bore hole was properly waxed and sealed at both ends. These were carefully labeled and transported to the laboratory for testing. Undisturbed soil samples wherever slipped during lifting, were duly marked in the field bore logs as well as in the soil profile.

4.3.3 Disturbed soil samples were also collected from the bore hole at suitable depths/intervals to supplement the boring records. These samples were collected in polythene bags of suitable size. These samples were properly sealed, labeled, recorded & carefully transported to the laboratory for testing.

4.3.4 The depth of ground water table was checked / measured in all bore holes.

4.3.5 Summary of bore holes:

Sl. No	Borehole number	Coordinates			Depth of borehole (M)	Depth of water table below EGL(M)
		Easting	Northing	Z		
1	BH1	731050.810	3025548.29	120.180	20.0	2.20
2	BH2	7310.21.110	3025641.50	120.383	20.0	2.60
3	BH3	730995.874	3025596.75	120.600	20.0	2.90

5.0 LABORATORY INVESTIGATIONS:

5.1 The following laboratory tests were conducted on selected soil samples recovered from bore hole / test locations: -

(a) Bulk density and Moisture content

(b) Sieve analysis

(c) Hydrometer analysis

(d) Liquid limit & Plastic limits

(e) Specific gravity

(f) Shear test on remolded and saturated disturbed soil samples

(g) Determination of void ratio..

All the above laboratory tests were carried out as per relevant Indian Standards. All the soil samples were identified and classified as per IS: 1498-1970.

6.0 FINDING OF GEOTECHNICAL INVESTIGATION:

The study of bore logs/results of laboratory and other field tests are tabulated through different tables as annexure.

7.0 CALCULATION OF BEARING CAPACITY

Calculation of Net Safe Bearing Capacity based on shear Criteria

IS: 6403-1981 recommends the following equation to calculate the net Safe Bearing Capacity ' q_s ' based on Hansen's Bearing Capacity analysis:

$$q_s = 1/F \{CN_c\, S_c\, d_c\, I_c + q\, (N_q - 1)\, S_q\, d_q\, i_q + 0.5\, \gamma\, B\, N_\gamma\, S_\gamma\, d_\gamma\, i_\gamma \times R_w\}$$

Where, C = Cohesion of soil.

γ	= Saturated Density of soil
B	= Width of footing = 2.0 m (assumed)
R_w	= Water table correction factor depending upon position of water table with respect to founding level
Q	= Effective surcharge at footing level = γD (D = depth of footing)
N_c, N_q, N_γ	= Bearing capacity factor
S_c, S_q, S_γ	= Shape factor
d_c, d_q, d_γ	= depth factor
i_c, i_q, i_γ	= inclination factors
F	= Factor of safety =3.0

B) <u>Calculation of safe bearing pressure based on tolerable settlement.</u>

The safe bearing pressure is to be found out from the elastic settlement consideration and is found from the following equation given I.S. 8009 (part-1) 1976

$$S_f = S_{oed} = (H_t / 1+e_o) \, C_c \log_{10} (p_o + \Delta p)/ p_o$$

S_f = Final settlement in mm

S_{oed} = Settlement computed from one dimensional test

H_t = Thickness of soil layer in m

e_o = Initial void ratio at mid height of of layer

C_c = Compression Index

p_o = Initial effective pressure at mid height of layer

Δp = pressure increment

For the computation of settlement of foundation founded at certain depth, a correction should be applied to the calculated S_f in the form of a depth factor to be read from

Fig: 12 of I.S. 8009 (part-1) 1976.

Corrected settlement $S_{fd} = S_f \times$ depth factor

Depth factor is dependent on the following

i. D= Depth of footing   ii. L= Length of footing   iii. B= Width of footing

For granular soil settlement is calculated from the *method Based on Dynamic PetutrationTest as per IS 8009-Part-I, 1976, reaffirmed 1998*

— Settlement of a footing of width *B* under unit **intensity** of pressure resting on dry cohesion less deposit with known standard **penetration** resistance value N, (determined according to IS: 2131- 1963t), may be

read from Fig. 9 (*IS 8009-Part-I*) . The settlement under any other pressure may be **computed by** assuming that the settlement is proportional to the intensity of pressure.

8.0 Pile load capacity in compression

Ultimate bearing capacity in compression in sand, Q_U from IS: 2911(Part-I)-1981

$Q_u = Q_P + Q_f$
= End bearing resistance + Frictional resistance of pile in sand and clay.

$Q_u = Ap \, (1/2 \, D \, \gamma \, N\gamma + P_D \, Nq) + \Sigma \, K \, P_{Di} \, \tan \delta \, A_{Si} + \alpha \, Ca \, As + Ap \, Nc \, Cp$

$Q_{Ps} = Ap \, (1/2 \, D \, \gamma \, N\gamma + P_D \, Nq)$

$Q_{fs} = \Sigma \, K \, P_{Di} \, \tan \delta \, A_{Si}$

$Q_{fc} = \alpha \, Ca \, As$

$Q_{pc} = Ap \, Nc \, Cp$

Qsafe = Q_U/FOS = Q_U/3

where

Ap	= Cross sectional area of pile toe in cm^2.
Nγ, Nq	= bearing capacity factors depending upon the angle of internal friction
K	= earth pressure coefficient (usually taken as 1.5 for sandy soils)
δ	= Angle of wall friction between pile and soil.
As	= Circumferential area of pile stem = Πx l x d
l	= Length of embedment.
d	= Diameter of the pile.

8.2 Pile load capacity in uplift

Ultimate uplift capacity Q $_{Uf}$ = Skin friction in sand + Self weight of pile
= $Q_{fs} + Q_{self \, wt}$

8.3 Lateral load capacity is considered as 5% of the safe load compression. (Ref: Foundation design Manual , by Narayan V Nayak, Dhanpat Rai Publication , Ch 3.13.2.1)

9. RECOMMENDATION OF FOUNDATION

After obtaining the laboratory test results of the samples collected from the field and analyzing the subsoil parameters in a very careful manner, the net safe bearing capacities of isolated footing foundation at different depths are calculated and shown in table 1.

Table 1: Safe Bearing Capacities of Footing Foundations

Depth (m)	Size (m²)	Net ultimate bearing capacity (Metric Ton /Sqm)		FOS	Safe bearing capacity (Metric Ton /Sqm)	
		Square	Circular		Square	Circular
1.5m	2x2	19.20	19.20	3	6.4	6.4
2.0m	2x2	20.31	20.31	3	6.8	6.8
2.5m	2x2	21.43	21.43	3	7.1	7.1
3.0m	2x2	22.54	22.54	3	7.5	7.5
Depth (m)	**Size (m)**	**Strip**			**Strip**	
	2	2.8		3	0.95	
1.5m	3	3.0		3	1.01	
	4	3.2		3	1.07	
	2	3.1		3	1.02	
2.0m	3	3.3		3	1.08	
	4	3.4		3	1.14	
	2	3.3		3	1.10	
2.5m	3	3.5		3	1.16	
	4	3.7		3	1.22	
	2	3.5		3	1.17	
3.0m	3	3.7		3	1.23	
	4	3.9		3	1.29	
Depth (m)	**Size (m²)**	**Rectangle**			**Rectangle**	
	1x2	18.39		3	6.1	
1.5m	2x4	16.33		3	5.4	
	3x6	15.69		3	5.2	
	1x2	20.06		3	6.7	
2.0m	2x4	17.29		3	5.8	
	3x6	16.41		3	5.5	
	1x2	21.74		3	7.2	
2.5m	2x4	18.25		3	6.1	
	3x6	17.14		3	5.7	
	1x2	23.41		3	7.8	
3.0m	2x4	19.21		3	6.4	
	3x6	17.86		3	6.0	

RCC Pile Foundation : The load carrying capacities of bored cast in situ uniform diameter piles of 10.0M to 20.0M length with pile diameters 45 cm, 50 cm and 60cm. respectively are calculated and shown in Table2.

Table2: Safe Load carrying capacity of bored cast in situ uniform diameter pile

Length of Pile from E.G.L. (m)	Pile Stem Dia. (mm)	Depth of fixity of pile (m)	Pile Cutoff Length (m)	Safe load on pile in compression (ton)	Safe load on pile in uplift (ton)	Lateral Load capacity on pile (ton)
10	450	3.01	1	18.01	11.42	11.05
12			1	22.92	15.98	11.05
15			1	32.15	24.40	11.05
20			1	52.55	42.59	11.05
10	500	3.28	1	21.84	12.95	13.08
12			1	27.29	18.08	13.08
15			1	34.55	27.52	13.08
20			1	60.22	47.88	13.08
10	600	3.79	1	31.28	16.18	17.51
12			1	37.82	22.48	17.51
15			1	50.13	34.01	17.51
20			1	77.34	58.80	17.51

10.0 CONCLUSION:

Soil at this site is of silty clay type upto a depth of 3.10M after that it is predominantly of fine to medium sand. For design calculation average weakest soil parameters from the boreholes are considered.

Safe bearing capacities for open foundation are shown in table 1.

As an alternative, for improving bearing capacity of soil, Bored cast in situ pile foundation may be provided. Safe load on pile in both compression and uplift including lateral load capacities are shown in Table 2. Since the fixity of pile doesn't vary with the length of the Pile Hence lateral load capacity on Pile remains same where as it changes with diameter of the pile

BORE LOG CUM LABORATORY TEST RESULT

Name of Project: Soil investigation work for construction of new central bowser unloading station (CBUS) at Duliajan, Dibrugarh, Assam

Boring method: Shell& Auger & Wash   Boring dia: 150mm   Date Commenced: 12-10-2018   Date completed: 12-10-2018

DEPTH OF WATER TABLE= 2.20M from EGL

BH: 1

Depth in meters below reference	Types of Sample	Observed N-Value	Group Symbol	Visual description of soil	% Gravel >.75mm	% Sand 4.75-0.075 mm	Silt 0.075-0.002	% Clay < 0.002 mm	Field density, gms/cm³	Specific Gravity	Void Ratio	Natural moisture content	Unconfined compressive Strength Kg/cm² (U D)	Cohesion 'c' Kg/cm²	Angle of shearing resistance (Φ')	Compression Index Cc	LL%	PL%	Passing 75 micron (%)
1.5-1.95	P	5	CL	Brownish Silty CLAY. 3.10M															
2.0	U																		
3.0-3.45	P	5					25	75	1.72	2.65	0.77	28.9		0.29	7	0.15	37.82	24.81	
3.5	U			Brownish grey fine to medium SAND															
4.5-4.95	P	8				100			1.76	2.65					29				
5.0	U																		
6.0-6.45	P	28				100			1.80	2.65					29				
6.5	U																		
7.5-7.95	P	44	SP			100													
8.0	D																		
9.0-9.45	P	70				100			1.91	2.65					38				
9.5	D																		
10.5-10.95	P	R				100			2.01	2.65					40				
11.0	D																		
12.0-12.45	P	R				100													
12.5	D																		
13.5-13.95	P	R				100			2.10	2.65					42				
14.0	D																		
15.0-15.45	P	R				100													
15.5	D																		
16.5-16.95	P	R				100			2.23	2.65					42				
17.0	D																		
18.0-18.45	P	R				100													
18.5	D																		
19.5-19.95	P	R			20.0M		100			2.28	2.65					44				
20.0	D																		

U: Undisturbed Sample::   D: Disturbed Sample::   P: Standard Penetration test::   DS: Direct shear test::   R=Refusal, N-value>100

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BORE LOG CUM LABORATORY TEST RESULT

Name of Project: Soil investigation work for construction of new central bowser unloading station (CBUS) at Duliajan, Dibrugarh, Assam

Boring method: Shell & Auger & Wash   Boring dia: 150mm   Date Commenced: 13-10-2018   Date completed: 13-10-2018

BH: 2   DEPTH OF WATER TABLE= 2.60M from EGL

Depth in meters below reference	Types of Sample	Observed N-Value	Group Symbol	Visual description of soil	% Gravel >.75mm	% Sand 4.75-0.075 mm	Silt 0.075-0.002	% Clay < 0.002 mm	Field density, gms/cm³	Specific Gravity	Void Ratio	Natural moisture content	Unconfined compressive Strength Kg/cm² (U D)	Cohesion 'c' Kg/cm²	Angle of shearing resistance (Φ°)	Compression Index Cc	LL%	PL%	Passing 75 micron (%)
0.0-0.60				Brownish silty clay															
1.5-1.95	P	12				100													
2.0	U								1.78	2.65					30				
3.0-3.45	P	16		Brownish fine to medium SAND		100													
3.5	U																		
4.5-4.95	P	32				100													
5.0	U								1.93	2.65					36				
6.0-6.45	P	55				100													
6.5	U																		
7.5-7.95	P	86				100													
8.0	D		SP			100			2.01	2.65					40				
9.0-9.45	P	R				100													
9.5	D																		
10.5-10.95	P	R				100													
11.0	D								2.10	2.65					42				
12.0-12.45	P	R				100													
12.5	D																		
13.5-13.95	P	R				100													
14.0	D								2.17	2.65					42				
15.0-15.45	P	R				100													
15.5	D																		
16.5-16.95	P	R				100													
17.0	D								2.22	2.65					44				
18.0-18.45	P	R				100													
18.5	D																		
19.5-19.95	P	R				100													
20.0	D			20.0M		100			2.27	2.65					44				

U: Undisturbed Sample::   D: Disturbed Sample::   P: Standard Penetration test::   DS: Direct shear test::   R=Refusal, N-value>100

BORE LOG CUM LABORATORY TEST RESULT

Name of Project: Soil investigation work for construction of new central bowser unloading station (CBUS) at Duliajan, Dibrugarh, Assam

Boring method: Shell& Auger & Wash Boring dia: 150mm Date Commenced: 13-10-2018 Date completed: 13-10-2018

BH: 3

DEPTH OF WATER TABLE= 2.90M from EGL

Depth in meters below reference	Types of Sample	Observed N-Value	Group Symbol	Visual description of soil	% Gravel >.75mm	% Sand 4.75-0.075 mm	Silt 0.075-0.002	% Clay < 0.002 mm	Field density, gms/cm³	Specific Gravity	Void Ratio	Natural moisture content	Unconfined compressive Strength Kg/cm² (U D)	Cohesion 'c' Kg/cm²	Angle of shearing resistance (Φ')	Compression Index Cc	LL%	PL%	Passing 75 micron (%)
0.0-1.30				Little fine sand															
1.5-1.95	P	6		Brownish fine to medium SAND		100													
2.0	U					100			1.72	2.65					29				
3.0-3.45	P	11				100													
3.5	U					100													
4.5-4.95	P	22				100													
5.0	U					100			1.88	2.65					34				
6.0-6.45	P	37				100													
6.5	U					100													
7.5-7.95	P	69	SP			100													
8.0	D	R				100			1.97	2.65					40				
9.0-9.45	P	R				100													
9.5	D					100													
10.5-10.95	P	R				100													
11.0	D	R				100			2.02	2.65					42				
12.0-12.45	P	R				100													
12.5	D					100													
13.5-13.95	P	R				100													
14.0	D	R				100			2.15	2.65					42				
15.0-15.45	P	R				100													
15.5	D					100													
16.5-16.95	P	R				100													
17.0	D	R				100			2.17	2.65					44				
18.0-18.45	P	R				100													
18.5	D					100													
19.5-19.95	P	R			20.0M		100													
20.0	D	R				100			2.27	2.65					44				

U: Undisturbed Sample:: D: Disturbed Sample:: P: Standard Penetration test:: DS: Direct shear test:: R=Refusal, N-value>100

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RELIANT ENGINEERS

Name of Project : Construction of new central bowser unloading station (CBUS) at Duliajan, Dibrugarh, Assam

BORE LOG CHART

BORE HOLE NO:1		DATE OF STARTING:-12-10-2018	GROUND WATER LEVEL
		DATE OF COMPLETION: 12-10-2018	2.20 M from EGL.

AUGER & WASH BORING

GRAPHICAL REPRESENTATION OF N-Value

DEPTH (M)	TYPE OF SAMPLE	SPT 15 CM	SPT 15 CM	SPT 15 CM	N-Value	VISUAL DESCRIPTION OF SOIL	LOG
1.5-1.95	P	2	2	3	5	Brownish Gray Silty CLAY. 3.10M	
2	U				5		
3.0-3.45	P	2	2	3	5		
3.5	U						
4.5-4.95	P	3	3	5	8		
5	U						
6.0-6.45	P	7	10	18	28	Brownish grey Fine to Medium SAND.	
6.5	U						
7.5-7.95	P	13	19	25	44		
8	D						
9.0-9.45	P	22	31	39	70		
9.5	D						
10.5-10.95	P	33	48	57	R		
11	D						
12.0-12.45	P	47	58	R	R		
12.5	D						
13.5-13.95	P	52	R	R	R		
14	D						
15.0-15.45	P	58	R	R	R		
15.5	D						
16.5-16.95	P	59	R	R	R		
17	D						
18.0-18.45	P	61	R	R	R		
18.5	D						
19.5-19.95	P	63	R	R	R	20.0M	
20	D						

U: UNDISTURBED SAMPLE::   D: DISTURBED SAMPLE::

EGL: EXISTING GROUND LEVEL

P: STANDARD PENETRATION TEST::

R:REFUSAL;N>100::

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RELIANT ENGINEERS

Name of Project : Construction of new central bowser unloading station (CBUS) at Duliajan, Dibrugarh, Assam

BORE LOG CHART

BORE HOLE NO:2

DATE OF STARTING:-13-10-2018
DATE OF COMPLETION: 13-10-2018

GROUND WATER LEVEL: 2.60 M from EGL.

AUGER & WASH BORING

GRAPHICAL REPRESENTATION OF N-Value

DEPTH (M)	TYPE OF SAMPLE	SPT 15 CM	SPT 15 CM	SPT 15 CM	N-Value	VISUAL DESCRIPTION OF SOIL	LOG
0.00-0.60						BrownishSilty CLAY 0.60M	
1.5-1.95	P	3	5	7	12		
2	U						
3.0-3.45	P	6	7	9	16	Brownish Fine to Medium SAND.	
3.5	U						
4.5-4.95	P	10	14	18	32		
5	U						
6.0-6.45	P	16	22	33	55		
6.5	U						
7.5-7.95	P	29	38	48	86		
8	D						
9.0-9.45	P	46	53	R	R		
9.5	D						
10.5-10.95	P	56	R	R	R		
11	D						
12.0-12.45	P	59	R	R	R		
12.5	D						
13.5-13.95	P	60	R	R	R		
14	D						
15.0-15.45	P	58	R	R	R		
15.5	D						
16.5-16.95	P	57	R	R	R		
17	D						
18.0-18.45	P	55	R	R	R		
18.5	D						
19.5-19.95	P	62	R	R	R	20.0M	
20	D						

U: UNDISTURBED SAMPLE::   **D: DISTURBED SAMPLE::**   **P: STANDARD PENETRATION TEST::**

EGL: EXISTING GROUND LEVEL   **R:REFUSAL;N>100::**

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RELIANT ENGINEERS

Name of Project : Construction of new central bowser unloading station (CBUS) at Duliajan, Dibrugarh, Assam

BORE LOG CHART

BORE HOLE NO:3		DATE OF STARTING:-13-10-2018	GROUND WATER LEVEL
		DATE OF COMPLETION: 13-10-2018	2.90 M from EGL.

AUGER & WASH BORING

GRAPHICAL REPRESENTATION OF N-Value

DEPTH (M)	TYPE OF SAMPLE	SPT 15 CM	SPT 15 CM	SPT 15 CM	N-Value	VISUAL DESCRIPTION OF SOIL	LOG
0.00-1.30						Fine sand 1.30M	
1.5-1.95	P	3	3	3	6	Brownish Fine to Medium SAND.	
2	U						
3.0-3.45	P	4	5	6	11		
3.5	U						
4.5-4.95	P	7	9	13	22		
5	U						
6.0-6.45	P	14	16	21	37		
6.5	U						
7.5-7.95	P	21	30	39	69		
8	D						
9.0-9.45	P	37	49	52	R		
9.5	D						
10.5-10.95	P	48	53	R	R		
11	D						
12.0-12.45	P	57	R	R	R		
12.5	D						
13.5-13.95	P	61	R	R	R		
14	D						
15.0-15.45	P	60	R	R	R		
15.5	D						
16.5-16.95	P	62	R	R	R		
17	D						
18.0-18.45	P	57	R	R	R		
18.5	D						
19.5-19.95	P	60	R	R	R	20.0M	
20	D						

P: STANDARD PENETRATION TEST::
R:REFUSAL;N>100::
D: DISTURBED SAMPLE::
U: UNDISTURBED SAMPLE::
EGL: EXISTING GROUND LEVEL

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Annex- IV
SBC calculation for Square and circular
Depth of foundn(M)Df = 1.5

Soil parameter						
C=	0.29 kg/scm=		2.9 t/sqm	γsub (ton/m3) =	1.01	
Ø=	7 , shear condition		Local			

Angle of shearing resistance for local failure $= Ø_m = \tan^{-1} 2/3 \tan Ø$

		Bearing capacity factor		
		Nc	Nq	Nγ
Ø	7	6.22	1.45	0.36
Ø m	4			

Width(B)M=	2	Length L =	2

Shape Factor						
Sc=	1.3	Sq=	1.2	Sγ=	(square)	0.8
(square and circular)		(square and circular)		Sγ=	(circular)	0.6
Sc = 1+ 0.2x B/L = (Rectangle)	1.2	Sq = 1+ 0.2x B/L = (Rectangle)	1.20	Sγ = 1- 0.4x B/L = (Rectangle)		0.6
Sc (to be adopted)=	1.3	Sq (to be adopted)=	1.2	Sγ (to be adopted)=		0.8

Depth Factor			
dc=(1+0.2(Df/B)tan(45+Ø/2)		dq=dγ=1+0.1(Df/B) tan(45+Ø/2) for Ø>10	
.=	1.16		1.08
		dq=dγ=	1 for Ø<10
		dq=dγ=(to be adopted)	1

Inclinination factor
ic=iq=iγ= (1 - α/90)
.= 1

Water table correction factor Rw =	0.5

F=Factor of safety =3

qd = {2/3x sc dc ic c Nc + sq dq iq γ D (Nq – 1) + 0.5sγ dγ iγ γ B Nγ Rw}

qs = 1/F {2/3x sc dc ic c Nc + sq dq iq γ D (Nq – 1) + sγ dγ iγ γ B Nγ Rw}

qd =   19.20

qsafe =	6.40 t/sqm say	6.4 t/sqm

Annex- IV
SBC calculation for Square and circular
Depth of foundn(M)Df = 2

Soil parameter						
C=	0.29 kg/scm=		2.9 t/sqm	γsub (ton/m3) =	1.01	
$\emptyset$=	7 , shear condition		Local			

Angle of shearing resistance for local failure = $\emptyset_m = \tan^{-1} 2/3 \tan\emptyset$

		Bearing capacity factor		
$\emptyset$	7	Nc	Nq	Nγ
$\emptyset$ m	4	6.22	1.45	0.36

Width(B)M=	2	Length L =	2

Shape Factor

Sc=	1.3	Sq=	1.2	Sγ= (square)	0.8
(square and circular)		(square and circular)		Sγ= (circular)	0.6
Sc = 1+ 0.2x B/L = (Rectangle)	1.2	Sq = 1+ 0.2x B/L = (Rectangle)	1.20	Sγ = 1- 0.4x B/L = (Rectangle)	0.6
Sc (to be adopted)=	1.3	Sq (to be adopted)=	1.2	Sγ (to be adopted)=	0.8

Depth Factor

dc=(1+0.2(Df/B)tan(45+$\emptyset$/2) dq=dγ=1+0.1(Df/B) tan(45+$\emptyset$/2) for $\emptyset$>10
.= 1.21 1.11

dq=dγ= 1 for $\emptyset$<10

dq=dγ=(to be adopted) 1

Inclinination factor
ic=iq=iγ= (1 - α/90)
.= 1

Water table correction factor Rw =	0.5

F=Factor of safety =3

qd = {2/3x sc dc ic c Nc + sq dq iq γ D (Nq – 1) + 0.5sγ dγ iγ γ B Nγ Rw}
qs = 1/F {2/3x sc dc ic c Nc + sq dq iq γ D (Nq – 1) + sγ dγ iγ γ B Nγ Rw}

qd = 20.31

qsafe =	6.77 t/sqm say	6.8 t/sqm

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Annex- IV
SBC calculation for Square and circular
Depth of foundn(M)Df = 2.5

Soil parameter						
C=	0.29 kg/scm=		2.9 t/sqm	γsub (ton/m3) =	**1.01**	
$\emptyset$=	7 , shear condition		Local			

Angle of shearing resistance for local failure = $\emptyset_m$ = $\tan^{-1} 2/3 \tan\emptyset$

		Bearing capacity factor		
		Nc	Nq	Nγ
$\emptyset$	7	6.22	1.45	0.36
$\emptyset$ m	4			

Width(B)M=	2	Length L =	2

Shape Factor

Sc=	1.3	Sq=	1.2	Sγ=	(square)	0.8
(square and circular)		(square and circular)		Sγ=	(circular)	0.6
Sc = 1+ 0.2x B/L = (Rectangle)	1.2	Sq = 1+ 0.2x B/L = (Rectangle)	1.20	Sγ = 1- 0.4x B/L = (Rectangle)		0.6
Sc (to be adopted)=	1.3	Sq (to be adopted)=	1.2	Sγ (to be adopted)=		0.8

Depth Factor

dc=(1+0.2(Df/B)tan(45+$\emptyset$/2)   dq=dγ=1+0.1(Df/B) tan(45+$\emptyset$/2) for $\emptyset$>10
.=   **1.27**   1.13

dq=dγ=   1   for $\emptyset$<10

dq=dγ=(to be adopted)   1

Inclinination factor

ic=iq=iγ= (1 - α/90)
.= 1

Water table correction factor Rw =	0.5

F=Factor of safety =3

qd = {2/3x sc dc ic c Nc + sq dq iq γ D (Nq – 1) + 0.5sγ dγ iγ γ B Nγ Rw}
qs = 1/F {2/3x sc dc ic c Nc + sq dq iq γ D (Nq – 1) + sγ dγ iγ γ B Nγ Rw}

qd =   21.43

qsafe =	7.14 t/sqm say	7.1 t/sqm

Annex- IV
SBC calculation for Square and circular
Depth of foundn(M)Df = 3

Soil parameter					
C=	0.29 kg/scm=		2.9 t/sqm	γsub (ton/m3) =	1.01
Ø=	7 , shear condition		Local		

Angle of shearing resistance for local failure $= Ø_m = \tan^{-1} 2/3 \tan Ø$

		Bearing capacity factor		
		Nc	Nq	Nγ
Ø	7			
Ø m	4	6.22	1.45	0.36

Width(B)M=	2	Length L =	2

Shape Factor					
Sc=	1.3	Sq=	1.2	Sγ= (square)	0.8
(square and circular)		(square and circular)		Sγ= (circular)	0.6
Sc = 1+ 0.2x B/L = (Rectangle)	1.2	Sq = 1+ 0.2x B/L = (Rectangle)	1.20	Sγ = 1- 0.4x B/L = (Rectangle)	0.6
Sc (to be adopted)=	1.3	Sq (to be adopted)=	1.2	Sγ (to be adopted)=	0.8

Depth Factor

$dc=(1+0.2(Df/B)\tan(45+Ø/2))$ $dq=dγ=1+0.1(Df/B) \tan(45+Ø/2)$ for Ø>10

.=   1.32   1.16

$dq=dγ=$ 1   for Ø<10

dq=dγ=(to be adopted)   1

Inclinination factor

$ic=iq=iγ= (1 - α/90)$

.= 1

Water table correction factor Rw =	0.5

F=Factor of safety =3

qd = {2/3x sc dc ic c Nc + sq dq iq γ D (Nq – 1) + 0.5sγ dγ iγ γ B Nγ Rw}
qs = 1/F {2/3x sc dc ic c Nc + sq dq iq γ D (Nq – 1) + sγ dγ iγ γ B Nγ Rw}

qd =   22.54

qsafe =	7.51 t/sqm say	7.5 t/sqm

Annex-IV

SBC calculation for Strip

For depth 1.5m,

 2m long strip,

 $Q_{net} = CN_C + \gamma D(N_q - 1) + 0.5\gamma BN\gamma$

 $= 2.8$

 $Q_{safe} = Q_{net}/F.O.S$

 $= 0.95$

 3m long strip,

 $Q_{net} = CN_C + \gamma D(N_q - 1) + 0.5\gamma BN\gamma$

 $= 3.0$

 $Q_{safe} = Q_{net}/F.O.S$

 $= 1.01$

 4m long strip,

 $Q_{net} = CN_C + \gamma D(N_q - 1) + 0.5\gamma BN\gamma$

 $= 3.2$

 $Q_{safe} = Q_{net}/F.O.S$

 $= 1.07$

For depth 2.0m,

2m long strip,

$Q_{net} = CN_C + \gamma D(N_q - 1) + 0.5\gamma B N\gamma$

$= 3.1$

$Q_{safe} = Q_{net}/F.O.S$

$= 1.02$

3m long strip,

$Q_{net} = CN_C + \gamma D(N_q - 1) + 0.5\gamma B N\gamma$

$= 3.3$

$Q_{safe} = Q_{net}/F.O.S$

$= 1.08$

4m long strip,

$Q_{net} = CN_C + \gamma D(N_q - 1) + 0.5\gamma B N\gamma$

$= 3.4$

$Q_{safe} = Q_{net}/F.O.S$

$= 1.14$

For depth 2.5m,

2m long strip,

$$Q_{net}=CN_C+\gamma D(N_q-1)+ 0.5\gamma BN\gamma$$

$$=3.3$$

$$Q_{safe}=Q_{net}/F.O.S$$

$$=1.10$$

3m long strip,

$$Q_{net}=CN_C+\gamma D(N_q-1)+ 0.5\gamma BN\gamma$$

$$=3.5$$

$$Q_{safe}=Q_{net}/F.O.S$$

$$=1.16$$

4m long strip,

$$Q_{net}=CN_C+\gamma D(N_q-1)+ 0.5\gamma BN\gamma$$

$$=3.7$$

$$Q_{safe}=Q_{net}/F.O.S$$

$$=1.22$$

For depth 3.0m,

2m long strip,

$Q_{net} = CN_C + \gamma D(N_q - 1) + 0.5\gamma BN\gamma$

=3.5

$Q_{safe} = Q_{net}/F.O.S$

=1.17

3m long strip,

$Q_{net} = CN_C + \gamma D(N_q - 1) + 0.5\gamma BN\gamma$

=3.7

$Q_{safe} = Q_{net}/F.O.S$

=1.23

4m long strip,

$Q_{net} = CN_C + \gamma D(N_q - 1) + 0.5\gamma BN\gamma$

=3.9

$Q_{safe} = Q_{net}/F.O.S$

=1.29

Annex- IV
SBC calculation for Rectangle
Depth of foundn(M)Df = 1.5

Soil parameter				
C=	0.29 kg/scm=	2.9 t/sqm	γsub (ton/m3) =	1.01
$\emptyset$=	7 , shear condition	Local		

Angle of shearing resistance for local failure = $\emptyset_m$ = $\tan^{-1} 2/3 \tan\emptyset$

		Bearing capacity factor		
		Nc	Nq	Nγ
$\emptyset$	7			
$\emptyset$ m	4	6.22	1.45	0.36

Width(B)M=	1	**Length L =**	2

Shape Factor

Sc=	1.3	Sq=	1.1	Sγ=	(square)	0.8
(square and circular)		(square and circular)		Sγ=	(circular)	0.6
Sc = 1+ 0.2x B/L = (Rectangle)	1.1	Sq = 1+ 0.2x B/L = (Rectangle)	1.10	Sγ = 1- 0.4x B/L = (Rectangle)		0.8
Sc (to be adopted)=	1.1	Sq (to be adopted)=	1.1	Sγ (to be adopted)=		0.8

Depth Factor

dc=(1+0.2(Df/B)tan(45+$\emptyset$/2)   dq=dγ=1+0.1(Df/B) tan(45+$\emptyset$/2) for $\emptyset$>10
          .=   1.32   1.16

dq=dγ=   1   for $\emptyset$<10

dq=dγ=(to be adopted)   1

Inclinination factor
ic=iq=iγ= (1 - α/90)
          .= 1

Water table correction factor Rw =	0.5

F=Factor of safety =3

qd = {2/3x sc dc ic c Nc + sq dq iq γ D (Nq – 1) + 0.5sγ dγ iγ γ B Nγ Rw}
qs = 1/F {2/3x sc dc iq c Nc + sq dq iq γ D (Nq – 1) + sγ dγ iγ γ B Nγ Rw}

qd =   18.39

qsafe =	6.13 t/sqm say	6.1 t/sqm

Annex- IV
SBC calculation for Rectangle
Depth of foundn(M)Df = 1.5

Soil parameter						
C=	0.29 kg/scm=		2.9 t/sqm	ysub (ton/m3) =	1.01
Ø=	7 , shear condition		Local		

Angle of shearing resistance for local failure = $\emptyset_m$ = $\tan^{-1}$2/3 tanØ

		Bearing capacity factor		
Ø	7	Nc	Nq	Nɣ
Ø m	4	6.22	1.45	0.36

Width(B)M=	2	Length L =	4

Shape Factor						
Sc=	1.3	Sq=	1.1	Sɣ=	(square)	0.8
(square and circular)		(square and circular)		Sɣ=	(circular)	0.6
Sc = 1+ 0.2x B/L = (Rectangle)	1.1	Sq = 1+ 0.2x B/L = (Rectangle)	1.10	Sɣ = 1- 0.4x B/L = (Rectangle)		0.8
Sc (to be adopted)=	1.1	Sq (to be adopted)=	1.1	Sɣ (to be adopted)=		0.8

Depth Factor
dc=(1+0.2(Df/B)tan(45+Ø/2)   dq=dɣ=1+0.1(Df/B) tan(45+Ø/2) for Ø>10
.=   1.16   1.08

                                         dq=dɣ=   1   for Ø<10

                                         dq=dɣ=(to be adopted)   1

Inclinination factor
ic=iq=iɣ= (1 - α/90)
.= 1

Water table correction factor Rw =	0.5

F=Factor of safety =3

qd = {2/3x sc dc ic c Nc + sq dq iq ɣ D (Nq – 1) + 0.5sɣ dɣ iɣ ɣ B Nɣ Rw}
qs = 1/F {2/3x sc dc ic c Nc + sq dq iq ɣ D (Nq – 1) + sɣ dɣ iɣ ɣ B Nɣ Rw}

qd =   16.33

qsafe =	5.44 t/sqm say	5.4 t/sqm

Annex- IV
SBC calculation for Rectangle
Depth of foundn(M)Df = 1.5

Soil parameter						
C=	0.29 kg/scm=		2.9 t/sqm	γsub (ton/m3) =	1.01	
$\emptyset$=	7 , shear condition		Local			

Angle of shearing resistance for local failure $= \emptyset_m = \tan^{-1} 2/3 \tan\emptyset$

		Bearing capacity factor		
$\emptyset$	7	Nc	Nq	Nγ
$\emptyset$ m	4	6.22	1.45	0.36

Width(B)M=	3	Length L =	6

Shape Factor

Sc=	1.3	Sq=	1.1	Sγ=	(square)	0.8
(square and circular)		(square and circular)		Sγ=	(circular)	0.6
Sc = 1+ 0.2x B/L = (Rectangle)	1.1	Sq = 1+ 0.2x B/L = (Rectangle)	1.10	Sγ = 1- 0.4x B/L = (Rectangle)		0.8
Sc (to be adopted)=	1.1	Sq (to be adopted)=	1.1	Sγ (to be adopted)=		0.8

Depth Factor

dc=(1+0.2(Df/B)tan(45+$\emptyset$/2)   dq=dγ=1+0.1(Df/B) tan(45+$\emptyset$/2) for $\emptyset$>10
          .=   1.11   1.05

                                    dq=dγ=   1   for $\emptyset$<10

                                    dq=dγ=(to be adopted)   1

Inclinination factor

ic=iq=iγ= (1 - α/90)
          .= 1

Water table correction factor Rw =	0.5

F=Factor of safety =3

qd = {2/3x sc dc ic c Nc + sq dq iq γ D (Nq – 1) + 0.5sγ dγ iγ γ B Nγ Rw}
qs = 1/F {2/3x sc dc ic c Nc + sq dq iq γ D (Nq – 1) + sγ dγ iγ γ B Nγ Rw}

qd =   15.69

qsafe =	5.23 t/sqm say	5.2 t/sqm

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Annex- IV
SBC calculation for Rectangle
Depth of foundn(M)Df = 2

Soil parameter						
C=	0.29 kg/scm=		2.9 t/sqm	γsub (ton/m3) =	1.01	
$\emptyset$=	7 , shear condition		Local			

Angle of shearing resistance for local failure $= \emptyset_m = \tan^{-1} 2/3 \tan\emptyset$

		Bearing capacity factor		
		Nc	Nq	Nγ
$\emptyset$	7			
$\emptyset$ m	4	6.22	1.45	0.36

Width(B)M=	1	Length L =	2

Shape Factor

Sc=	1.3	Sq=	1.1	Sγ=	(square)	0.8
(square and circular)		(square and circular)		Sγ=	(circular)	0.6
Sc = 1+ 0.2x B/L = (Rectangle)	1.1	Sq = 1+ 0.2x B/L = (Rectangle)	1.10	Sγ = 1- 0.4x B/L = (Rectangle)		0.8
Sc (to be adopted)=	1.1	Sq (to be adopted)=	1.1	Sγ (to be adopted)=		0.8

Depth Factor

dc=(1+0.2(Df/B)tan(45+$\emptyset$/2)   dq=dγ=1+0.1(Df/B) tan(45+$\emptyset$/2) for $\emptyset$>10

.=   **1.43**   1.21

                              dq=dγ=   1   for $\emptyset$<10

                              dq=dγ=(to be adopted)   1

Inclinination factor

ic=iq=iγ= (1 - α/90)

.= 1

Water table correction factor Rw =	0.5

F=Factor of safety =3

qd = {2/3x sc dc ic c Nc + sq dq iq γ D (Nq – 1) + 0.5sγ dγ iγ γ B Nγ Rw}

qs = 1/F {2/3x sc dc ic c Nc + sq dq iq γ D (Nq – 1) + sγ dγ iγ γ B Nγ Rw}

qd =   20.06

qsafe =	6.69 t/sqm say	6.7 t/sqm

Annex- IV
SBC calculation for Rectangle
Depth of foundn(M)Df = 2

Soil parameter					
C=	0.29 kg/scm=		2.9 t/sqm	γsub (ton/m3) =	1.01
$\emptyset$=	7 , shear condition		Local		

Angle of shearing resistance for local failure $= \emptyset_m = \tan^{-1} 2/3 \tan\emptyset$

		Bearing capacity factor		
		Nc	Nq	Nγ
$\emptyset$	7			
$\emptyset$ m	4	6.22	1.45	0.36

Width(B)M=	2	Length L =	4

Shape Factor

Sc=	1.3	Sq=	1.1	Sγ= (square)	0.8
(square and circular)		(square and circular)		Sγ= (circular)	0.6
Sc = 1+ 0.2x B/L = (Rectangle)	1.1	Sq = 1+ 0.2x B/L = (Rectangle)	1.10	Sγ = 1- 0.4x B/L = (Rectangle)	0.8
Sc (to be adopted)=	1.1	Sq (to be adopted)=	1.1	Sγ (to be adopted)=	0.8

Depth Factor

dc=(1+0.2(Df/B)tan(45+$\emptyset$/2)   dq=dγ=1+0.1(Df/B) tan(45+$\emptyset$/2) for $\emptyset$>10
.=   **1.21**   1.11

dq=dγ=   1   for $\emptyset$<10

dq=dγ=(to be adopted)   1

Inclinination factor

ic=iq=iγ= (1 - α/90)
.= 1

Water table correction factor Rw =	0.5

F=Factor of safety =3

qd = {2/3x sc dc ic c Nc + sq dq iq γ D (Nq – 1) + 0.5sγ dγ iγ γ B Nγ Rw}
qs = 1/F {2/3x sc dc ic c Nc + sq dq iq γ D (Nq – 1) + sγ dγ iγ γ B Nγ Rw}

qd =   17.29

qsafe =	5.76 t/sqm say	5.8 t/sqm

Annex- IV
SBC calculation for Rectangle
Depth of foundn(M)Df = 2

Soil parameter						
C=	0.29 kg/scm=		2.9 t/sqm	γsub (ton/m3) =	1.01
Ø=	7 , shear condition		Local		

Angle of shearing resistance for local failure $= \emptyset_m = \tan^{-1} 2/3 \tan\emptyset$

		Bearing capacity factor		
		Nc	Nq	Nγ
Ø	7	6.22	1.45	0.36
Ø m	4			

Width(B)M=	3	**Length L =**	6

Shape Factor

Sc=	1.3	Sq=	1.1	Sγ=	(square)	0.8
(square and circular)		(square and circular)		Sγ=	(circular)	0.6
Sc = 1+ 0.2x B/L = (Rectangle)	1.1	Sq = 1+ 0.2x B/L = (Rectangle)	1.10	Sγ = 1- 0.4x B/L = (Rectangle)		0.8
Sc (to be adopted)=	1.1	Sq (to be adopted)=	1.1	Sγ (to be adopted)=		0.8

Depth Factor

dc=(1+0.2(Df/B)tan(45+Ø/2)   dq=dγ=1+0.1(Df/B) tan(45+Ø/2) for Ø>10
.=   1.14   1.07

dq=dγ=   1   for Ø<10

dq=dγ=(to be adopted)   1

Inclinination factor
ic=iq=iγ= (1 - α/90)
.= 1

Water table correction factor Rw =	0.5

F=Factor of safety =3

qd = {2/3x sc dc ic c Nc + sq dq iq γ D (Nq – 1) + 0.5sγ dγ iγ γ B Nγ Rw}
qs = 1/F {2/3x sc dc ic c Nc + sq dq iq γ D (Nq – 1) + sγ dγ iγ γ B Nγ Rw}

qd =   16.41

qsafe =	5.47 t/sqm say	5.5 t/sqm

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Annex- IV
SBC calculation for Rectangle
Depth of foundn(M)Df = 2.5

Soil parameter						
C=	0.29 kg/scm=		2.9 t/sqm	ysub (ton/m3) =	1.01	
Ø=	7 , shear condition		Local			

Angle of shearing resistance for local failure = $Ø_m = \tan^{-1} 2/3 \tan Ø$

Ø	7	Bearing capacity factor		
		Nc	Nq	Nγ
Ø m	4	6.22	1.45	0.36

Width(B)M=	1	**Length L =**	2

Shape Factor						
Sc=	1.3	Sq=	1.1	Sγ= (square)	0.8	
(square and circular)		(square and circular)		Sγ= (circular)	0.6	
Sc = 1+ 0.2x B/L = (Rectangle)	1.1	Sq = 1+ 0.2x B/L = (Rectangle)	1.10	Sγ = 1- 0.4x B/L = (Rectangle)	0.8	
Sc (to be adopted)=	1.1	Sq (to be adopted)=	1.1	Sγ (to be adopted)=	0.8	

Depth Factor

dc=(1+0.2(Df/B)tan(45+Ø/2)   dq=dγ=1+0.1(Df/B) tan(45+Ø/2) for Ø>10
.=   **1.54**   1.27

dq=dγ=   1   for Ø<10

dq=dγ=(to be adopted)   1

Inclinination factor

ic=iq=iγ= (1 - α/90)
.= 1

Water table correction factor Rw =	0.5

F=Factor of safety =3

qd = {2/3x sc dc ic c Nc + sq dq iq γ D (Nq – 1) + 0.5sγ dγ iγ γ B Nγ Rw}
qs = 1/F {2/3x sc dc ic c Nc + sq dq iq γ D (Nq – 1) + sγ dγ iγ γ B Nγ Rw}

qd =   21.74

qsafe =	7.25 t/sqm say	7.2 t/sqm

Annex- IV
SBC calculation for Rectangle
Depth of foundn(M)Df = 2.5

Soil parameter						
C=	0.29 kg/scm=		2.9 t/sqm	γsub (ton/m3) =	1.01	
Ø=	7 , shear condition		Local			

Angle of shearing resistance for local failure = $Ø_m = \tan^{-1} 2/3 \tan Ø$

		Bearing capacity factor		
		Nc	Nq	Nγ
Ø	7	6.22	1.45	0.36
Ø m	4			

Width(B)M=	2	**Length L =**	4

Shape Factor						
Sc=	1.3	Sq=	1.1	Sγ=	(square)	0.8
(square and circular)		(square and circular)		Sγ=	(circular)	0.6
Sc = 1+ 0.2x B/L = (Rectangle)	1.1	Sq = 1+ 0.2x B/L = (Rectangle)	1.10	Sγ = 1- 0.4x B/L = (Rectangle)		0.8
Sc (to be adopted)=	1.1	Sq (to be adopted)=	1.1	Sγ (to be adopted)=	0.8	

Depth Factor				
dc=(1+0.2(Df/B)tan(45+Ø/2)		dq=dγ=1+0.1(Df/B) tan(45+Ø/2)	for Ø>10	
.=	1.27		1.13	
		dq=dγ=	1	for Ø<10
		dq=dγ=(to be adopted)	1	

Inclinination factor
ic=iq=iγ= (1 - α/90)
.= 1

Water table correction factor Rw =	0.5

F=Factor of safety =3

qd = {2/3x sc dc ic c Nc + sq dq iq γ D (Nq – 1) + 0.5sγ dγ iγ γ B Nγ Rw}
qs = 1/F {2/3x sc dc ic c Nc + sq dq iq γ D (Nq – 1) + sγ dγ iγ γ B Nγ Rw}

qd =   18.25

qsafe =	6.08 t/sqm say	6.1 t/sqm

Annex- IV
SBC calculation for Rectangle
Depth of foundn(M)Df = 2.5

Soil parameter						
C=	0.29 kg/scm=		2.9 t/sqm		γsub (ton/m3) =	1.01
$\emptyset$=	7 , shear condition		Local			

Angle of shearing resistance for local failure = $\emptyset_m$ = $\tan^{-1}$ 2/3 tan$\emptyset$

		Bearing capacity factor		
$\emptyset$	7	Nc	Nq	Nγ
$\emptyset$ m	4	6.22	1.45	0.36

Width(B)M=	3	Length L =	6

Shape Factor

Sc=	1.3	Sq=	1.1	Sγ=	(square)	0.8
(square and circular)		(square and circular)		Sγ=	(circular)	0.6
Sc = 1+ 0.2x B/L = (Rectangle)	1.1	Sq = 1+ 0.2x B/L = (Rectangle)	1.10	Sγ = 1- 0.4x B/L = (Rectangle)		0.8
Sc (to be adopted)=	1.1	Sq (to be adopted)=	1.1	Sγ (to be adopted)=		0.8

Depth Factor

dc=(1+0.2(Df/B)tan(45+$\emptyset$/2)   dq=dγ=1+0.1(Df/B) tan(45+$\emptyset$/2) for $\emptyset$>10
.=   **1.18**   1.09

dq=dγ=   1   for $\emptyset$<10

dq=dγ=(to be adopted)   **1**

Inclinination factor

ic=iq=iγ= (1 - α/90)
.= 1

Water table correction factor Rw =	0.5

F=Factor of safety =3

qd = {2/3x sc dc ic c Nc + sq dq iq γ D (Nq – 1) + 0.5sγ dγ iγ γ B Nγ Rw}
qs = 1/F {2/3x sc dc ic c Nc + sq dq iq γ D (Nq – 1) + sγ dγ iγ γ B Nγ Rw}

qd =   17.14

qsafe =	5.71 t/sqm say	5.7 t/sqm

Annex- IV
SBC calculation for Rectangle
Depth of foundn(M)Df = 3

Soil parameter					
C=	0.29 kg/scm=		2.9 t/sqm	γsub (ton/m3) =	1.01
Ø=	7 , shear condition		Local		

Angle of shearing resistance for local failure = $Ø_m$ = $\tan^{-1} 2/3 \tan Ø$

		Bearing capacity factor		
		Nc	Nq	Nγ
Ø	7	6.22	1.45	0.36
Ø m	4			

Width(B)M=	1	Length L =	2

Shape Factor

Sc=	1.3	Sq=	1.1	Sγ=	(square)	0.8
(square and circular)		(square and circular)		Sγ=	(circular)	0.6
Sc = 1+ 0.2x B/L = (Rectangle)	1.1	Sq = 1+ 0.2x B/L = (Rectangle)	1.10	Sγ = 1- 0.4x B/L = (Rectangle)		0.8
Sc (to be adopted)=	1.1	Sq (to be adopted)=	1.1	Sγ (to be adopted)=		0.8

Depth Factor

dc=(1+0.2(Df/B)tan(45+Ø/2)   dq=dγ=1+0.1(Df/B) tan(45+Ø/2) for Ø>10
.=   1.64   1.32

dq=dγ=   1   for Ø<10

dq=dγ=(to be adopted)   1

Inclinination factor

ic=iq=iγ= (1 - α/90)
.= 1

Water table correction factor Rw =	0.5

F=Factor of safety =3

qd = {2/3x sc dc ic c Nc + sq dq iq γ D (Nq – 1) + 0.5sγ dγ iγ γ B Nγ Rw}
qs = 1/F {2/3x sc dc ic c Nc + sq dq iq γ D (Nq – 1) + sγ dγ iγ γ B Nγ Rw}

qd =   23.41

qsafe =	7.80 t/sqm say	7.8 t/sqm

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Annex- IV
SBC calculation for Rectangle
Depth of foundn(M)Df = 3

Soil parameter					
C=	0.29 kg/scm=		2.9 t/sqm	γsub (ton/m3) =	1.01
Ø=	7 , shear condition		Local		

Angle of shearing resistance for local failure $= \emptyset_m = \tan^{-1} 2/3 \tan\emptyset$

		Bearing capacity factor		
		Nc	Nq	Nγ
Ø	7			
Ø m	4	6.22	1.45	0.36

Width(B)M=	2	Length L =	4

Shape Factor

Sc=	1.3	Sq=	1.1	Sγ=	(square)	0.8
(square and circular)		(square and circular)		Sγ=	(circular)	0.6
Sc = 1+ 0.2x B/L = (Rectangle)	1.1	Sq = 1+ 0.2x B/L = (Rectangle)	1.10	Sγ = 1- 0.4x B/L = (Rectangle)		0.8
Sc (to be adopted)=	1.1	Sq (to be adopted)=	1.1	Sγ (to be adopted)=		0.8

Depth Factor

dc=(1+0.2(Df/B)tan(45+Ø/2)   dq=dγ=1+0.1(Df/B) tan(45+Ø/2) for Ø>10
.=   1.32   1.16

dq=dγ=   1   for Ø<10

dq=dγ=(to be adopted)   1

Inclinination factor
ic=iq=iγ= (1 - α/90)
.= 1

Water table correction factor Rw =	0.5

F=Factor of safety =3

qd = {2/3x sc dc ic c Nc + sq dq iq γ D (Nq – 1) + 0.5sγ dγ iγ γ B Nγ Rw}
qs = 1/F {2/3x sc dc ic c Nc + sq dq iq γ D (Nq – 1) + sγ dγ iγ γ B Nγ Rw}

qd =   19.21

qsafe =	6.40 t/sqm say	6.4 t/sqm

Annex- IV
SBC calculation for Rectangle
Depth of foundn(M)Df = 3

Soil parameter						
C=	0.29 kg/scm=		2.9 t/sqm		ysub (ton/m3) =	1.01
Ø=	7 , shear condition		Local			

Angle of shearing resistance for local failure = $\emptyset_m$ = $\tan^{-1} 2/3 \tan\emptyset$

		Bearing capacity factor		
Ø	7	Nc	Nq	Nγ
Ø m	4	6.22	1.45	0.36

Width(B)M=	3	Length L =	6

Shape Factor					
Sc=	1.3	Sq=	1.1	Sγ= (square)	0.8
(square and circular)		(square and circular)		Sγ= (circular)	0.6
Sc = 1+ 0.2x B/L = (Rectangle)	1.1	Sq = 1+ 0.2x B/L = (Rectangle)	1.10	Sγ = 1- 0.4x B/L = (Rectangle)	0.8
Sc (to be adopted)=	1.1	Sq (to be adopted)=	1.1	Sγ (to be adopted)=	0.8

Depth Factor		
dc=(1+0.2(Df/B)tan(45+Ø/2)	dq=dγ=1+0.1(Df/B) tan(45+Ø/2) for Ø>10	
.= 1.21	1.11	
	dq=dγ=	1 for Ø<10
	dq=dγ=(to be adopted)	1

Inclinination factor
ic=iq=iγ= (1 - α/90)
.= 1

Water table correction factor Rw =	0.5

F=Factor of safety =3

qd = {2/3x sc dc ic c Nc + sq dq iq γ D (Nq – 1) + 0.5sγ dγ iγ γ B Nγ Rw}
qs = 1/F {2/3x sc dc ic c Nc + sq dq iq γ D (Nq – 1) + sγ dγ iγ γ B Nγ Rw}

qd =	17.86

qsafe =	5.95 t/sqm say	6.0 t/sqm

34

Annex- V

Calculation of settlements of foundations as IS 8009:(part 1)1976

IMMEDIATE SETTLEMENT

FOR SQUARE FOOTING

Depth of foundation(m)	1.5
LENGTH(m)=	2
BREATH(m)=	2

L/B=	1
INFLUNCE FACTOR (If)=	1.12
S.B.C (t/m^2)=	6.4

For stiff clay

E (t/m^2)=	5000
μ=	0.5

Settlement (m)=	0.00215
Settlement (mm)=	2.1504

for rigid footing

Settlement (mm)	1.72032

Depth correction factor

D.C.F=	0.73	ref IS 8009:(part 1)1976
S_D=	1.256	fig 12

CONSOLIDATION SETTLEMENT

C_c=	0.15
e_o=	0.77
H (m)=	3
field density (t/m^3)=	1.72

P=	5.16
ΔP =	1.6

Settlement Si (m)=	0.02982
Settlement Si (mm)=	29.821

Correction for 3D Consolidation settlement

λ=	0.8
Settlement for 3D	23.857
Total settlement(mm)=	26.007 <40mm , Hence safe

35

Annex-V

Calculation of settlements of foundations as IS 8009:(part 1)1976

IMMEDIATE SETTLEMENT

FOR SQUARE FOOTING

Depth of foundation(m)	2
LENGTH(m)=	2
BREATH(m)=	2

L/B=	1
INFLUNCE FACTOR (If)=	1.12
S.B.C (t/m^2)=	6.8

For stiff clay

E (t/m^2)=	5000
μ=	0.5

Settlement (m)=	0.002285
Settlement (mm)=	2.2848

for rigid footing

Settlement (mm)	1.82784

Depth correction factor

D.C.F=	0.73	ref IS 8009:(part 1)1976
S_D=	1.334	fig 12

CONSOLIDATION SETTLEMENT

C_c=	0.15
e_o=	0.77
H (m)=	3
field density (t/m^3)=	1.72

P=	5.16
ΔP =	1.7

Settlement Si (m)=	0.03144
Settlement Si (mm)=	31.443

Correction for 3D Consolidation settlement

λ=	0.8
Settlement for 3D	25.154

Total settlement(mm)=   27.439 <40mm , Hence safe

36

Annex-V

Calculation of settlements of foundations as IS 8009:(part 1)1976

IMMEDIATE SETTLEMENT

FOR SQUARE FOOTING

Depth of foundation(m)	2.5
LENGTH(m)=	2
BREATH(m)=	2

L/B=	1
INFLUNCE FACTOR (I$_f$)=	1.12
S.B.C (t/m^2)=	7.1

For stiff clay

E (t/m^2)=	5000
μ=	0.5

Settlement (m)=	0.002386
Settlement (mm)=	2.3856

for rigid footing

Settlement (mm)	1.90848

Depth correction factor

D.C.F=	0.73	ref IS 8009:(part 1)1976
S$_D$=	1.393	fig 12

CONSOLIDATION SETTLEMENT

Cc=	0.15
e$_o$=	0.77
H (m)=	3
field density (t/m^3)=	1.72

P=	5.16
ΔP =	1.775

Settlement Si (m)=	0.03264
Settlement Si (mm)=	32.643

Correction for 3D Consolidation settlement

λ=	0.8
Settlement for 3D	26.115

Total settlement(mm)=   28.500 <40mm , Hence safe

Annex-V

Calculation of settlements of foundations as IS 8009:(part 1)1976

IMMEDIATE SETTLEMENT

FOR SQUARE FOOTING

Depth of foundation(m)	3
LENGTH(m)=	2
BREATH(m)=	2

L/B=	1
INFLUNCE FACTOR (If)=	1.12
S.B.C (t/m^2)=	7.5

For stiff clay

E (t/m^2)=	5000
μ=	0.5

Settlement (m)=	0.00252
Settlement (mm)=	2.52

for rigid footing

Settlement (mm)	2.016

Depth correction factor

D.C.F=	0.73	ref IS 8009:(part 1)1976
S_D=	1.472	fig 12

CONSOLIDATION SETTLEMENT

C_c=	0.15
e_o=	0.77
H (m)=	3
field density (t/m^3)=	1.72

P=	5.16
ΔP =	1.875

Settlement Si (m)=	0.03422
Settlement Si (mm)=	34.224

Correction for 3D Consolidation settlement

λ=	0.8
Settlement for 3D	27.379

Total settlement(mm)=   29.899 <40mm , Hence safe

38

Annex- VI

$\gamma\ (\text{ton/m}^3)$ in clay = **1.72**

Pile is designed as Pile resting in Sand

$\gamma\ (\text{ton/m}^3)$ in sand = **1.80**

Here, cp(t/sqm)= 0 ca(t/sqm)= 1.6 $\emptyset^0$ = 29

Nc= 28.25 Nq= 20 Ng= 20.09

Diameter of pile D (cm)= 45 **Length of Pile below EGL(M)** 10

Pile cutoff length (m)+ soft layer 1

Area of pile tip(sqm) = 0.1589625

Circumferential area of pile stem in sand(sqm) = 9.7497

Circumferential area of pile stem in Clay(sqm) = 2.9673

Qp Ton)= 17.21 ton

Qfs (Sand) = 23.07 ton

Qfc (Clay) = 4.74768 ton

Qf=Qf (Sand)+Qf (Clay) = 27.82 ton

Qu=Qp+Qf = 45.03

Safe load in compression(Ton) **Qcs =** **18.01** ton
(FOS=2.5)

Safe load in uplift (ton) **Qus =** 9.3 ton + self weight of pile
(FOS=3.0)

Final safe load in uplift (ton) **Qus =** **11.42**

Diameter of pile D (cm)= 50 **Length of Pile below EGL(M)** 10

$\gamma(\text{ton/m}^3)$ = 1.8

Here, cp(t/sqm)= 0 ca(t/sqm)= 1.6 $\emptyset^0$ = 29

Nc= 28.25 Nq= 19.6 Ng= 20.09

Area of pile tip(sqm) = 0.19625

Circumferential area of pile stem in sand(sqm) = 10.833

Circumferential area of pile stem in Clay(sqm) = 3.297

Qp Ton)= 23.68

Qf (Sand) = 25.64

Qf (Clay) = 5.28

Qf=Qf (Sand)+Qf (Clay) = 30.91

Qu=Qp+Qf = 54.59

Safe load in compression(Ton) **Qs =** **21.84**

Safe load in uplift (ton) **Qsu =** 10.3 + self weight of pile
(FOS=3.0)

Final safe load in uplift (ton) **Qus =** **12.95**

39

Diameter of pile D (cm)=   60   **Length of Pile below EGL(M)**   10

$\gamma(ton/m^3) =$ 1.8

Here ,   cp(t/sqm)=   0 ca(t/sqm)=   1.6 $\emptyset^0 =$ 29

Nc=   28.25   Nq=   19.6   Ng=   20.09

Area of pile tip(sqm) =   0.2826
Circumferential area of pile stem in sand(sqm) =   12.9996
Circumferential area of pile stem in Clay(sqm) =   3.9564

Qp Ton)=   41.11
Qf (Sand) =   30.76

Qf (Clay) =   6.33024

Qf=Qf (Sand)+Qf (Clay) =   37.09

Qu=Qp+Qf =   78.20

Safe load in compression(Ton) **Qs =**   **31.28**

Safe load in uplift (ton)   **Qsu =**   12.4   + self weight of pile
(FOS=3.0)
Final safe load in uplift (ton)   **Qus =**   **16.18**

40

Annex- VI

γ (ton/m³) in clay =	1.72
γ (ton/m³) in sand =	1.80

Pile is designed as Pile resting in Sand

Here , cp(t/sqm)= 0 ca(t/sqm)= 1.6 $\emptyset^0$ = 29

Nc= 28.25 Nq= 20 Ng= 20.09

Diameter of pile D (cm)= 45 **Length of Pile below EGL(M)** 12

Pile cutoff length (m)+ soft layer 1

Area of pile tip(sqm) = 0.1589625
Circumferential area of pile stem in sand(sqm) = 12.5757
Circumferential area of pile stem in Clay(sqm) = 2.9673

Qp Ton)= 17.21 ton
Qfs (Sand) = 35.33 ton

Qfc (Clay) = 4.74768 ton

Qf=Qf (Sand)+Qf (Clay) = 40.08 ton

Qu=Qp+Qf = 57.29

Safe load in compression(Ton) **Qcs =** 22.92 ton
(FOS=2.5)

Safe load in uplift (ton) **Qus =** 13.4 ton + self weight of pile
(FOS=3.0)

Final safe load in uplift (ton) **Qus =** 15.98

Diameter of pile D (cm)= 50 **Length of Pile below EGL(M)** 12

γ(ton/m³) = 1.8

Here , cp(t/sqm)= 0 ca(t/sqm)= 1.6 $\emptyset^0$ = 29

Nc= 28.25 Nq= 19.6 Ng= 20.09

Area of pile tip(sqm) = 0.19625
Circumferential area of pile stem in sand(sqm) = 13.973
Circumferential area of pile stem in Clay(sqm) = 3.297

Qp Ton)= 23.68
Qf (Sand) = 39.26

Qf (Clay) = 5.28

Qf=Qf (Sand)+Qf (Clay) = 44.54

Qu=Qp+Qf = 68.22

Safe load in compression(Ton) **Qs =** 27.29

Safe load in uplift (ton) **Qsu =** 14.8 + self weight of pile
(FOS=3.0)

Final safe load in uplift (ton) **Qus =** 18.08

41

Diameter of pile D (cm)=   60   **Length of Pile below EGL(M)**   12

$\gamma(\text{ton/m}^3) =$ 1.8

Here ,   cp(t/sqm)=   0 ca(t/sqm)=   1.6 $\emptyset^0 =$ 29

Nc=   28.25   Nq=   19.6   Ng=   20.09

Area of pile tip(sqm) =   0.2826
Circumferential area of pile stem in sand(sqm) =   16.7676
Circumferential area of pile stem in Clay(sqm) =   3.9564

Qp Ton)=   41.11
Qf (Sand) =   47.11

Qf (Clay) =   6.33024

Qf=Qf (Sand)+Qf (Clay) =   53.44

Qu=Qp+Qf =   94.55

Safe load in compression(Ton) **Qs =**   **37.82**

Safe load in uplift (ton)   **Qsu =**   17.8   + self weight of pile
(FOS=3.0)
Final safe load in uplift (ton)   **Qus =**   **22.48**

42

Annex- VI

		γ (ton/m^3) in clay =	1.72
Pile is designed as Pile resting in Sand		γ (ton/m^3) in sand =	1.80

Here , cp(t/sqm)= 0 ca(t/sqm)= 1.6 $\emptyset^0$ = 29

Nc= 28.25 Nq= 20 Ng= 20.09

Diameter of pile D (cm)= 45 **Length of Pile below EGL(M)** 15

Pile cutoff length (m)+ soft layer 1

Area of pile tip(sqm) = 0.1589625
Circumferential area of pile stem in sand(sqm) = 16.8147
Circumferential area of pile stem in Clay(sqm) = 2.9673

Qp Ton)= 17.21 ton
Qfs (Sand) = 58.42 ton

Qfc (Clay) = 4.74768 ton

Qf=Qf (Sand)+Qf (Clay) = 63.17 ton

Qu=Qp+Qf = 80.38

Safe load in compression(Ton) **Qcs =** **32.15** ton
(FOS=2.5)

Safe load in uplift (ton) **Qus =** 21.1 ton + self weight of pile
(FOS=3.0)

Final safe load in uplift (ton) **Qus =** **24.40**

Diameter of pile D (cm)= 50 **Length of Pile below EGL(M)** 15

γ(ton/m^3) = 1.8

Here , cp(t/sqm)= 0 ca(t/sqm)= 1.6 $\emptyset^0$ = 29

Nc= 28.25 Nq= 19.6 Ng= 20.09

Area of pile tip(sqm) = 0.19625
Circumferential area of pile stem in sand(sqm) = 18.683
Circumferential area of pile stem in Clay(sqm) = 3.297

Qp Ton)= 23.68
Qf (Sand) = 64.91

Qf (Clay) = 5.28

Qf=Qf (Sand)+Qf (Clay) = 70.19

Qu=Qp+Qf = 93.87

Safe load in compression(Ton) **Qs =** **37.55**

Safe load in uplift (ton) **Qsu =** 23.4 + self weight of pile
(FOS=3.0)

Final safe load in uplift (ton) **Qus =** **27.52**

43

Diameter of pile D (cm)=   60   **Length of Pile below EGL(M)**   **15**

$\gamma(\text{ton/m}^3) =$ 1.8

Here ,   cp(t/sqm)=   0 ca(t/sqm)=   1.6 $\emptyset^0 =$ 29

    Nc=   28.25   Nq=   19.6   Ng=   20.09

Area of pile tip(sqm) =   0.2826

Circumferential area of pile stem in sand(sqm) =   22.4196

Circumferential area of pile stem in Clay(sqm) =   3.9564

Qp Ton)=   41.11

Qf (Sand) =   77.90

Qf (Clay) =   6.33024

Qf=Qf (Sand)+Qf (Clay) =   84.23

Qu=Qp+Qf =   125.34

Safe load in compression(Ton) **Qs =**   **50.13**

Safe load in uplift (ton)   **Qsu =**   28.1   + self weight of pile

(FOS=3.0)

Final safe load in uplift (ton)   **Qus =**   **34.01**

Annex- VI

		γ (ton/m³) in clay =	1.72

Pile is designed as Pile resting in Sand γ (ton/m³) in sand =   1.80

Here ,   cp(t/sqm)=   0 ca(t/sqm)=   1.6 $\emptyset^0$ =   29

Nc=   28.25   Nq=   20   Ng=   20.09

Diameter of pile D (cm)=   45   **Length of Pile below EGL(M)**   20

Pile cutoff length (m)+ soft layer   1

Area of pile tip(sqm) =   0.1589625

Circumferential area of pile stem in sand(sqm) =   23.8797

Circumferential area of pile stem in Clay(sqm) =   2.9673

Qp Ton)=   17.21 ton

Qfs (Sand) =   109.43 ton

Qfc (Clay) =   4.74768 ton

Qf=Qf (Sand)+Qf (Clay) =   114.18 ton

Qu=Qp+Qf =   131.38

Safe load in compression(Ton)   **Qcs =**   **52.55** ton
(FOS=2.5)

Safe load in uplift (ton)   **Qus =**   38.1 ton   + self weight of pile
(FOS=3.0)

Final safe load in uplift (ton)   **Qus =**   **42.59**

Diameter of pile D (cm)=   50   **Length of Pile below EGL(M)**   20

γ(ton/m³) =   1.8

Here ,   cp(t/sqm)=   0 ca(t/sqm)=   1.6 $\emptyset^0$ =   29

Nc=   28.25   Nq=   19.6   Ng=   20.09

Area of pile tip(sqm) =   0.19625

Circumferential area of pile stem in sand(sqm) =   26.533

Circumferential area of pile stem in Clay(sqm) =   3.297

Qp Ton)=   23.68

Qf (Sand) =   121.59

Qf (Clay) =   5.28

Qf=Qf (Sand)+Qf (Clay) =   126.86

Qu=Qp+Qf =   150.54

Safe load in compression(Ton) **Qs =**   **60.22**

Safe load in uplift (ton)   **Qsu =**   42.3   + self weight of pile
(FOS=3.0)

Final safe load in uplift (ton)   **Qus =**   **47.88**

Diameter of pile D (cm)=   **60**   **Length of Pile below EGL(M)**   **20**

$\gamma(\text{ton/m}^3) =$ 1.8

Here ,   cp(t/sqm)=   0 ca(t/sqm)=   1.6 $\emptyset^0 =$ 29

Nc=   28.25   Nq=   19.6   Ng=   20.09

Area of pile tip(sqm) =   0.2826

Circumferential area of pile stem in sand(sqm) =   31.8396

Circumferential area of pile stem in Clay(sqm) =   3.9564

Qp Ton)=   41.11

Qf (Sand) =   145.90

Qf (Clay) =   6.33024

Qf=Qf (Sand)+Qf (Clay) =   152.23

Qu=Qp+Qf =   193.34

Safe load in compression(Ton) **Qs =**   **77.34**

Safe load in uplift (ton)   **Qsu =**   50.7   + self weight of pile

(FOS=3.0)

Final safe load in uplift (ton)   **Qus =**   **58.80**

46
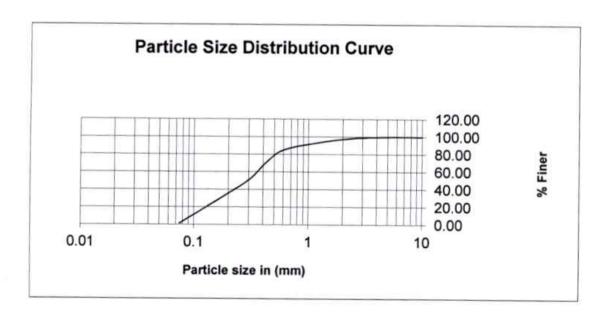
Location : BH 1   ,Depth=8.0m

Dry sieve analysis of sand sample

IS Sieve Size(MM)	Wt. Retained gm (f)	Percentage Wt. Ret. (fi)	Cum. % material Retained	% Passing
10			0	100.00
4.75	0.00	0.00	0.00	100.00
2.36	6.39	1.64	1.64	98.36
1.18	20.00	5.13	6.77	93.23
0.6	32.00	8.21	14.97	85.03
0.425	55.80	14.31	29.28	70.72
0.3	77.20	19.80	49.08	50.92
0.15	98.60	25.28	74.36	25.64
0.075	95.00	24.36	98.72	1.28
Pan	5.00	84.41		
	390.0			

Particle Size Distribution Curve
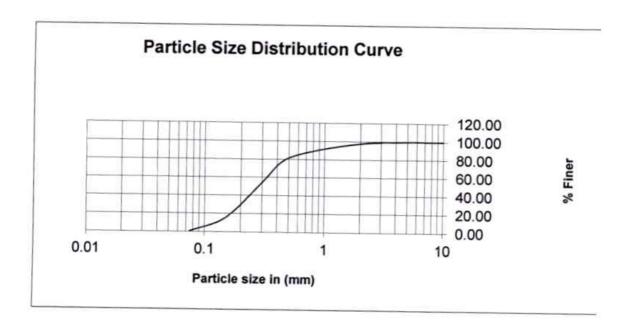
Location : BH2, Depth=9.50m

Dry sieve analysis of sand sample

IS Sieve Size(MM)	Wt. Retained gm (f)	Percentage Wt. Ret. (fi)	Cum. % material Retained	% Passing
10			0	100.00
4.75	0.00	0.00	0.00	100.00
2.36	5.09	1.27	1.27	98.73
1.18	20.12	5.03	6.30	93.70
0.6	33.55	8.39	14.69	85.31
0.425	36.71	9.18	23.87	76.13
0.3	87.66	21.92	45.79	54.21
0.15	154.23	38.56	84.35	15.65
0.075	60.11	15.03	99.37	0.63
Pan	2.50	90.20		
	400.0			

Particle Size Distribution Curve

% Finer

Particle size in (mm)

48
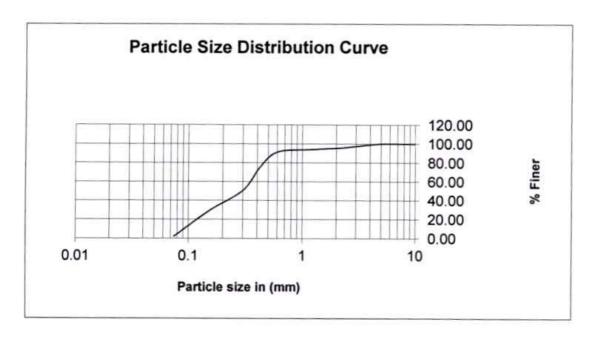
Location : BH3,Depth=8.00 m

Dry sieve analysis of sand sample

IS Sieve Size(MM)	Wt. Retained gm (f)	Percentage Wt. Ret. (fi)	Cum. % material Retained	% Passing
10			0	100.00
4.75	0.00	0.00	0.00	100.00
2.36	15.23	3.81	3.81	96.19
1.18	8.40	2.10	5.91	94.09
0.6	10.57	2.64	8.55	91.45
0.425	63.32	15.83	24.38	75.62
0.3	99.47	24.87	49.25	50.75
0.15	88.56	22.14	71.40	28.60
0.075	105.50	26.38	97.77	2.23
Pan	8.90	81.94		
	400.0			

Particle Size Distribution Curve

49
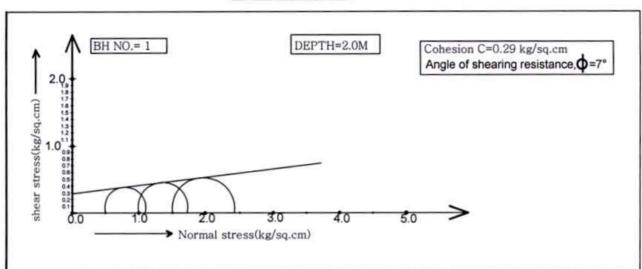
Annex-VIII

Consolidated Undrained Test (Mohr Circle attached)

BH NO.	Depth(m)	C	Ø
1	2.00	0.29	7

Shear test curve

BH NO.= 1

DEPTH=2.0M

Cohesion C=0.29 kg/sq.cm
Angle of shearing resistance, ϕ =7°

shear stress(kg/sq.cm)

Normal stress(kg/sq.cm)
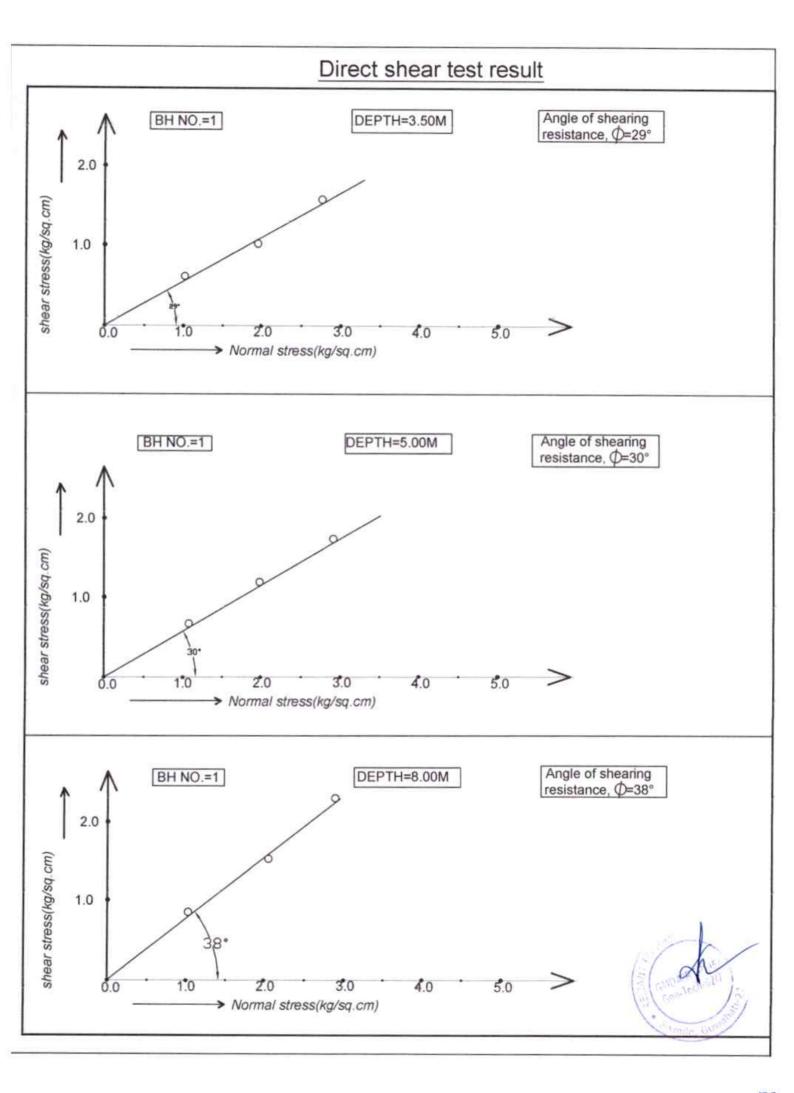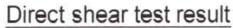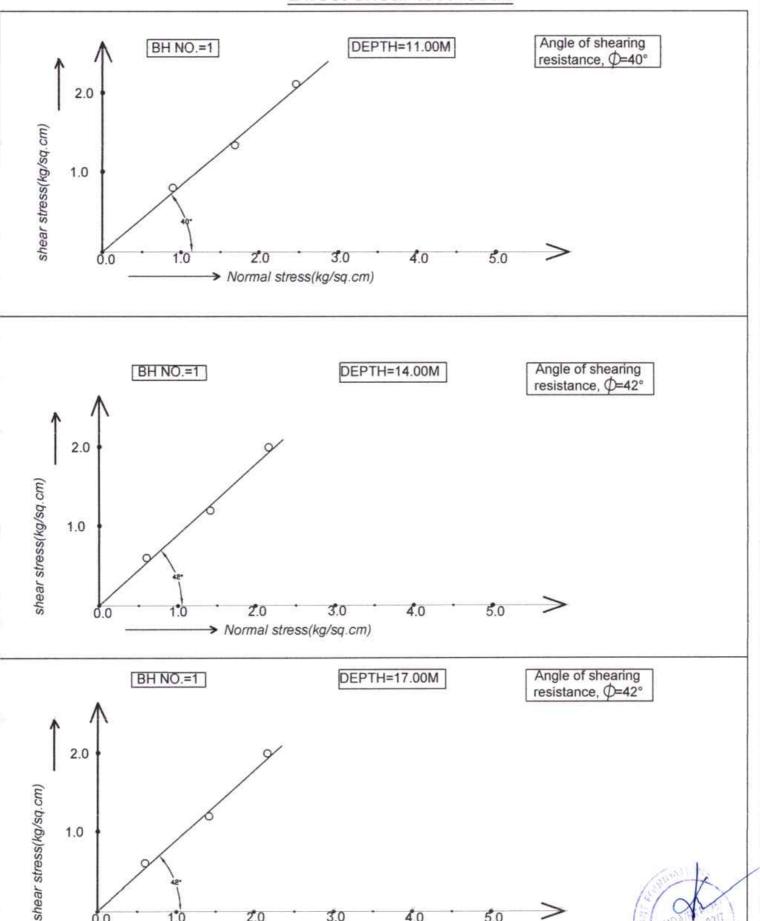
Annex- IX

Direct Shear Test

BH NO.	Depth(m)	Ø
1	3.5	29
	5.0	30
	8.0	38
	11.0	40
	14.00	42
	17.00	42
	20.00	44
2	2.0	30
	5.0	36
	8.0	40
	11.0	42
	14.0	42
	17.00	44
	20.00	44
3	2.0	29
	5.0	34
	8.0	40
	11.0	42
	14.0	42
	17.0	44
	20.0	44

Direct shear test result

BH NO.=1   DEPTH=3.50M   Angle of shearing resistance, ϕ=29°

BH NO.=1   DEPTH=5.00M   Angle of shearing resistance, ϕ=30°

BH NO.=1   DEPTH=8.00M   Angle of shearing resistance, ϕ=38°

53

Direct shear test result

BH NO.=1 DEPTH=11.00M Angle of shearing resistance, Φ=40°

shear stress(kg/sq.cm) vs Normal stress(kg/sq.cm), 40°

BH NO.=1 DEPTH=14.00M Angle of shearing resistance, Φ=42°

shear stress(kg/sq.cm) vs Normal stress(kg/sq.cm), 42°

BH NO.=1 DEPTH=17.00M Angle of shearing resistance, Φ=42°

shear stress(kg/sq.cm) vs Normal stress(kg/sq.cm), 42°

54

Direct shear test result

BH NO.=1   DEPTH=20.00M   Angle of shearing resistance, ϕ=44°

BH NO.=2   DEPTH=2.00M   Angle of shearing resistance, ϕ=30°

BH NO.=2   DEPTH=5.00M   Angle of shearing resistance, ϕ=36°

55

Direct shear test result

BH NO.=2   DEPTH=8.00M   Angle of shearing resistance, $\Phi=40°$

shear stress(kg/sq.cm) vs Normal stress(kg/sq.cm), $40°$

BH NO.=2   DEPTH=11.00M   Angle of shearing resistance, $\Phi=42°$

shear stress(kg/sq.cm) vs Normal stress(kg/sq.cm), $42°$

BH NO.=2   DEPTH=14.00M   Angle of shearing resistance, $\Phi=42°$

shear stress(kg/sq.cm) vs Normal stress(kg/sq.cm), $42°$

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Annex- X

PERMEABILITY TEST RESULT

BH No.	Depth(m)	K(cm/sec)
1	3.50	1×10^{-31}
	8.00	1×10^{-28}
2	5.00	1×10^{-36}
	9.50	1×10^{-30}
3	3.50	1×10^{-32}
	8.00	1×10^{-25}

Annex-XI

Proctor test result (IS:2720-VII)

sample 1 (near BH1)

1 Size of mould	=	10 cm dia x 12.73 cm height
2 Capacity of mould	=	1000 cc
3 Rammer	=	2.6 Kg x 310mm
4 No of layer	=	3
5 Blows per layer	=	25
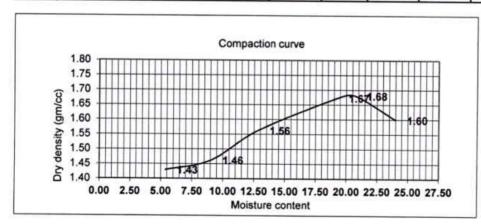
Density determination

		Test No	1	2	3	4	6	7
1	Mass of mould + soil	(gm)	3513	3601	3769	4001	4035	3989
2	Mass of empty mould	(gm)	2006	2006	2006	2006	2006	2006
3	Mass of compacted soil	(gm)	1507	1595	1763	1995	2029	1983
4	Bulk density	(gm/cc)	1.51	1.60	1.76	2.00	2.03	1.98
5	Dry density	(gm/cc)	1.43	1.46	1.56	1.67	1.68	1.60

Moisture content determination

1	Container No		100	115	113	1	102	7
2	Mass of cont + wet soil	gm	81.89	78.01	57.67	69.07	66.98	72.53
3	Mass of cont + dry soil	gm	78.51	73.06	52.81	61.94	57.91	61.14
4	Mass of water present	gm	3.38	4.95	4.86	8.12	9.07	11.39
5	Mass of empty container	gm	15.69	18.35	14.92	19.77	14.13	13.69
6	Mass of dry soil	gm	62.82	54.71	37.89	42.17	43.78	47.45
7	Moisture content	%	5.38	9.05	12.83	19.26	20.72	24.00

Compaction curve

Maximum dry density (MDD) =1.68 gm/cc
Optimum moisture content (OMC) = 20.72%

Proctor test result (IS:2720-VII)   sample 2 (near BH2)

1 Size of mould   10 cm dia x 12.73 cm height
2 Capacity of mould   1000 cc
3 Rammer   2.6 Kg x 310mm
4 No of layer   3
5 Blows per layer   25

(a) *Density determination*
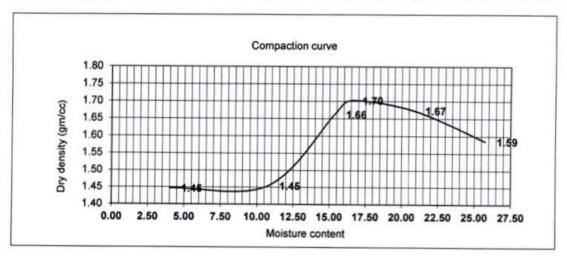
		Test No	1	2	3	4	5	6
1	Mass of mould + soil		3511	3617	3923	3989	4028	4000
2	Mass of en	(gm)	2006	2006	2006	2006	2006	2006
3	Mass of co	(gm)	1505	1611	1917	1983	2022	1994
4	Bulk densit	(gm/cc)	1.51	1.61	1.92	1.98	2.02	1.99
5	Dry density	(gm/cc)	1.45	1.45	1.66	1.70	1.67	1.59

(b *Moisture content determination*

1	Container No		1	2	7	8	9	10
2	Mass of co	gm	81.77	80	60	68.89	67.01	73.05
3	Mass of co	gm	79.22	74.01	54	61.94	57.91	61.14
4	Mass of wa	gm	2.55	5.99	6	6.95	9.1	11.91
5	Mass of er	gm	15.69	18.35	14.92	19.77	14.23	14.9
6	Mass of dr	gm	63.53	55.66	39.08	42.17	43.68	46.24
7	Moisture co	%	4.01	10.76	15.35	16.48	20.83	25.76

Compaction curve

Maximum dry density (MDD)   =1.70 gm/cc
Optimum moisture content (OMC)   = 16.48%

Proctor test result (IS:2720-VII)   sample 3(near BH3)
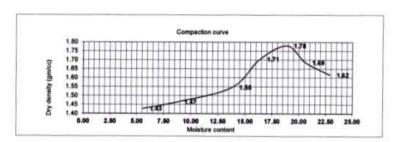
1 Size of mould   =   10 cm dia x 12.73 cm height
2 Capacity of mould   =   1000 cc
3 Rammer   = 2.6 Kg x 310mm
4 No of layer   =   3
5 Blows per layer   =   25

(a) Density determination

		Test No	1	2	3	4	5	6	7
1	Mass of mould + soil		3514	3600	3767	3991	4122	4040	3993
2	Mass of em	(gm)	2006	2006	2006	2006	2006	2006	2006
3	Mass of cor	(gm)	1508	1594	1761	1985	2116	2034	1987
4	Bulk density	(gm/cc)	1.51	1.59	1.76	1.99	2.12	2.03	1.99
5	Dry density	(gm/cc)	1.43	1.47	1.55	1.71	1.78	1.69	1.62

(b Moisture content determination

1	Container No		1	2	7	8	9	10	13
2	Mass of cor	gm	82.00	79.1	58.22	68.89	67.05	67.01	73.05
3	Mass of cor	gm	78.52	74.26	53	62.01	58.8	58.03	62.00
4	Mass of wa	gm	3.48	4.84	5.22	6.88	8.25	8.98	11.05
5	Mass of em	gm	16.00	19	15.23	20.01	15.10	14.44	13.7
6	Mass of dry	gm	62.52	55.26	37.77	42	43.7	43.59	48.3
7	Moisture co	%	5.57	8.76	13.82	16.38	18.88	20.60	22.88

Compaction curve

Maximum dry density (MDD)   =1.78 gm/cc
Optimum moisture content (OMC)   = 18.88%

Annex- XII

LABORATORY C.B.R. TEST DATA SHEET (As per IS : 2720 part XVI)

Location
Sample 1

Test condition: Soaked

Nature of Sample: Compacted in 3 layers with 55 blows of 2.6 kg rammer
having 31 cm drop at OMC and 100% Proctor Density (approx)

Size of Mould = 15cm dia x 12.73 cm height   Sample Taken = 6 kg

Penetration Data   **Proving Ring Used: 1000kg**
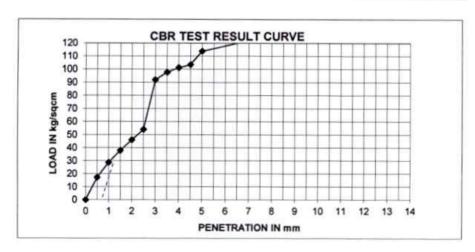
Penetration (mm)	TEST LOAD (kg)		Corrected load (kg)	Standard Load (kg)	% standard load (%)	C.B.R.
	Proving ring Reading	Load				
0	0	0				
0.5	15	17.3				
1.0	25	28.8				
1.5	33	38.0				
2.0	40	46.0				
2.5	47	54.1	92	1370	6.7	
3.0	80	92.0				6.7
3.5	85	97.8				
4.0	88	101.2				
4.5	90	103.5				
5.0	99	113.9	124	2055	6.0	
7.5	108	124.2				
10.0	109	125.4				
12.5	110	126.5				

CBR TEST RESULT CURVE

Annex- XII

LABORATORY C.B.R. TEST DATA SHEET (As per IS : 2720 part XVI)

Location
Sample 2

Test condition: Soaked

Nature of Sample: Compacted in 3 layers with 55 blows of 2.6 kg rammer
having 31 cm drop at OMC and 100% Proctor Density (approx)

Size of Mould = 15cm dia x 12.73 cm height   Sample Taken = 6 kg

Penetration Data   **Proving Ring Used: 1000kg**
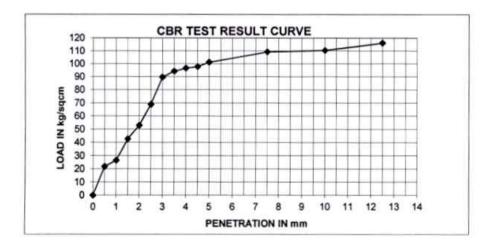
Penetration (mm)	TEST LOAD (kg)		Corrected load (kg)	Standard Load (kg)	% standard load (%)	C.B.R.
	Proving ring Reading	Load				
0	0	0				
0.5	19	21.9				
1.0	23	26.5				
1.5	37	42.6				
2.0	46	52.9				
2.5	60	69.0	89	1370	6.5	
3.0	78	89.7				6.5
3.5	82	94.3				
4.0	84	96.6				
4.5	85	97.8				
5.0	88	101.2	109	2055	5.3	
7.5	95	109.3				
10.0	96	110.4				
12.5	101	116.2				

CBR TEST RESULT CURVE

65
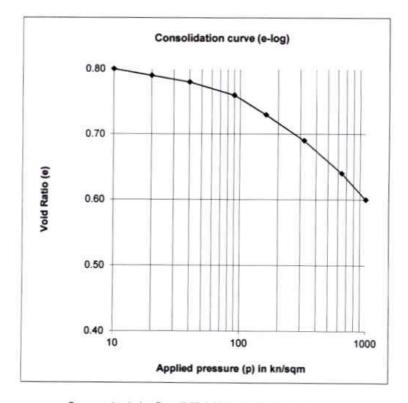
Annex- XIII

Consolidation Test Result

BH 1   **Depth: 2.00M**

Sl No	Applied Pressure (kn/sqm)	Void Ratio
1	10	0.80
2	20	0.79
3	40	0.78
4	90	0.76
5	160	0.73
6	320	0.69
7	640	0.64
8	1000	0.60

Consolidation curve (e-log)

Compression Index Cc = (0.76-0.60)/log(1000/90) = 0.15

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Annex-XIV

Name of test   : Chemical analysis of Water sample

Source: Ground water

Sl No	Details of test	Results obtained
1	Chlorides (as Cl)	238mg/lit
2	Sulphates (as SO_4)	188mg/lit
3	PH	6.9

Name of test   : Chemical analysis of soil sample

Depth of sample : 3.5m from existing ground level

Sl No	Details of test	Results obtained % by weight
1	Sulphate content	0.12
2	Chloride content	0.15
3	Carbonate	Practically Nil
4	Organic matter	Practically Nil

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Annex- XV

Swell pressure and Free swell index:

BH No.	Swell pressure (KN/m^2)	Free swell Index (%)
1	5.2	9.3
2	4.9	8.9
3	4.9	9.2

Dynamic properties of soil layers (1.0m – 6.0m from NGL)

1. Coefficient of uniform elastic compression , C_u = 18000 KN/m^3
2. Coefficient of uniform elastic shear , C_τ = ½ C_u = 9000 KN/m^3
3. Coefficient of elastic non uniform compression C_ϕ = 3.46 C_τ = 31140 KN/m^3
4. Modulus of subgrade reaction, K_s = 11000 KN/m^3

Annex- XVII

CALCULATION OF LATERAL LOAD CAPACITY OF PILE
Ref : Appendix-C (cl 6.5.2) of IS 2911 (Part 1/Sec. 2) – 2010

Stiffness factor $\quad R = \quad \sqrt[4]{\dfrac{EI}{KB}} \quad$ for clay soil

$\qquad\qquad\qquad T = \quad \sqrt[5]{\dfrac{EI}{\eta h}} \quad$ for sandy soil

E = Modulus of Elasticity of pile material= $5000\sqrt{f_{ck}}$

E = 25×10^6 KN/m^2 for concrete for f_{ck} = 25 N/mm^2

I = Moment of Inertia = $\qquad \pi D^4 /64$

B= D = diameter of pile

Deflection of pile

$$y= \frac{H(e+Zf)\times 1000}{12\ EI}$$

H= lateral load in KN

y = deflection of pile head in mm

e = cantilever length above ground/ bed

E= Modulus of elasticity in KN/m^2

I = Moment of Inertia in m^4

Z_f= Depth of point of fixity in m

Calculation details (For Sand)

	fck=	25 N/mm2	
	E=	25000000 KN/m2	

1	Pile dia	B=D(m)	0.45
2	Pile Length	L(m)	NA (Doesn't affect)
3	Pile Length (soft soil)	L1(m)	0.00
4	ηh =Modulus of subgrade reaction		10000.00 KN/m3 for Cohesionless soil
5	I= Moment of inertia		0.00 m4
6	E = Modulus of elasticity		25000000 KN/m2
7	T		1.38
8	L1/T		0.00
9	Lf/T		2.18 (From graph)
10	Lf	(Length of fixity)	3.01
11	e (m)	eccentricity	0.00
12	zf (m)		0.00
13	y=(Permissible deflection mm)		5.00
14	**H = lateral load capacity**		**110.51 KN** = 11.05 Ton

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CALCULATION OF LATERAL LOAD CAPACITY OF PILE

Ref : Appendix-C (cl 6.5.2) of IS 2911 (Part 1/Sec. 2) – 2010

Stiffness factor $\qquad R = \sqrt[4]{\dfrac{EI}{KB}}$ $\qquad$ for clay soil

$\qquad\qquad\qquad T = \sqrt[5]{\dfrac{EI}{\eta h}}$ $\qquad$ for sandy soil

E = Modulus of Elasticity of pile material= $5000\sqrt{f_{ck}}$

E = 25×10^6 KN/m^2 for concrete for f_{ck} = 25 N/mm^2

I = Moment of Inertia = $\qquad\qquad \pi D^4 /64$

B= D = diameter of pile

Deflection of pile

$$y= \frac{H(e+Zf)\times 1000}{12\ EI}$$

H= lateral load in KN

y = deflection of pile head in mm

e = cantilever length above ground/ bed

E= Modulus of elasticity in KN/m^2

I = Moment of Inertia in m^4

Z_f= Depth of point of fixity in m

Calculation details $\qquad$ **(For Sand)**

$\qquad\qquad\qquad\qquad\qquad\qquad$ fck= $\qquad\qquad$ 25 N/mm2

$\qquad\qquad\qquad\qquad\qquad\qquad$ E= $\qquad$ 25000000 KN/m2

1	Pile dia	B=D(m)	0.50
2	Pile Length	L(m)	NA (Doesn't affect)
3	Pile Length (soft soil)	L1(m)	0.00
4	ηh =Modulus of subgrade reaction		10000.00 KN/m3 for Cohesionless soil
5	I= Moment of inertia		0.00 m4
6	E = Modulus of elasticity		25000000 KN/m2
7	T		1.50
8	L1/T		0.00
9	Lf/T		2.18 (From graph)
10	Lf	(Length of fixity)	3.28
11	e (m)	eccentricity	0.00
12	zf (m)		0.00
13	y=(Permissible deflection mm)		5.00
14	H = lateral load capacity		130.80 KN = 13.08 Ton

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CALCULATION OF LATERAL LOAD CAPACITY OF PILE

Ref : Appendix-C (cl 6.5.2) of IS 2911 (Part 1/Sec. 2) – 2010

Stiffness factor $\quad R = \quad \sqrt[4]{\dfrac{EI}{KB}} \qquad$ for clay soil

$$T = \quad \sqrt[5]{\dfrac{EI}{\eta h}} \qquad$$ for sandy soil

E = Modulus of Elasticity of pile material= $5000\sqrt{f_{ck}}$

$E = 25 \times 10^6$ KN/m^2 for concrete for $f_{ck} = 25$ N/mm^2

I = Moment of Inertia = $\qquad \pi D^4/64$

B= D = diameter of pile

Deflection of pile

$$y = \dfrac{H(e+Zf) \times 1000}{12\ EI}$$

H= lateral load in KN

y = deflection of pile head in mm

e = cantilever length above ground/ bed

E= Modulus of elasticity in KN/m^2

I = Moment of Inertia in m^4

Z_f = Depth of point of fixity in m

Calculation details $\qquad$ **(For Sand)**

fck=	25 N/mm2	
E=	25000000 KN/m2	

1	Pile dia	B=D(m)	0.60
2	Pile Length	L(m)	NA (Doesn't affect)
	Pile Length (		
3	soft soil)	L1(m)	0.00
4	ηh =Modulus of subgrade reaction		10000.00 KN/m3 $\qquad$ for Cohesionless soil
5	I= Moment of inertia		0.01 m4
6	E = Modulus of elasticity		25000000 KN/m2
7	T		1.74
8	L1/T		0.00
9	Lf/T		2.18 (From graph)
10	Lf	(Length of fixity)	3.79
11	e (m)	eccentricity	0.00
12	zf (m)		0.00
13	y=(Permissible deflection mm)		5.00
14	H = lateral load capacity		175.11 KN = $\qquad$ 17.51 $\qquad$ Ton
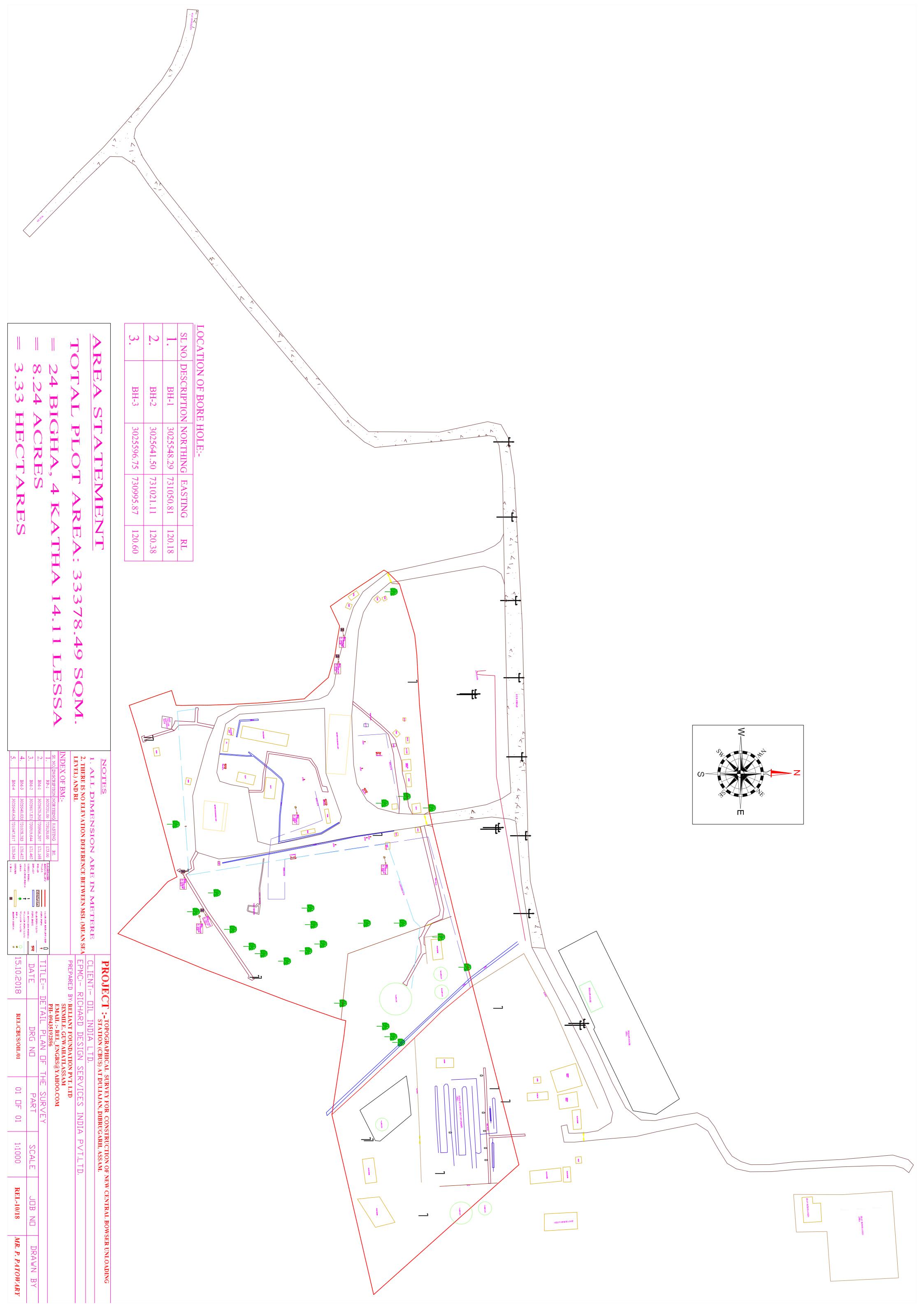
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AREA STATEMENT

TOTAL PLOT AREA: 33378.49 SQM.

= 24 BIGHA, 4 KATHA 14.11 LESSA
= 8.24 ACRES
= 3.33 HECTARES

LOCATION OF BORE HOLE:-

SL. NO.	DESCRIPTION	NORTHING	EASTING	RL
1.	BH-1	3025548.29	731050.81	120.18
2.	BH-2	3025641.50	731021.11	120.38
3.	BH-3	3025596.75	730995.87	120.60

NOTES:-

1. ALL DIMENSION ARE IN METRE
2. THERE IS NO ELEVATION DIFFERENCE BETWEEN MSL (MEAN SEA LEVEL) AND RL

INDEX OF BM:-

SL. NO.	DESCRIPTION	NORTHING	EASTING	RL
1.	BP-1	3025721.00	730723.09	123.90
2.	BM-1	3025630.30	730906.207	121.145
3.	BM-2	3025617.833	730893.644	121.402
4.	BM-3	3025540.033	731058.383	120.852
5.	BM-4	3025496.626	731047.817	120.545

PROJECT :- TOPOGRAPHICAL SURVEY FOR CONSTRUCTION OF NEW CENTRAL BOWSER UNLOADING STATION (CBUS) AT DULIAJAN, DIBRUGARH, ASSAM.

CLIENT- OIL INDIA LTD.					
EPMC- RICHARD DESIGN SERVICES INDIA PVT.LTD.					

PREPARED BY RELIANT FOUNDATION PVT.LTD.
SIXMILE, GUWAHATI,ASSAM
EMAIL:- REL_ENGIS@YAHOO.COM
PH: 09435192896

TITLE:- DETAIL PLAN OF THE SURVEY					
DATE	DRG NO	PART	SCALE	JOB NO	DRAWN BY
15.10.2018	REL/CBUS/OIL/01	01 OF 01	1:1000	REL-10/18	MR. P. PATOWARY

2.0
EARTH RESISTIVITY

TEST REPORT

A

REPORT ON

ELECTRICAL EARTH RESISTIVITY TEST

FOR

CONSTRUCTION OF NEW CENTRAL BOWSER UNLOADING STATION (CBUS) AT DULIAJAN, DIBRUGARH, ASSAM

OWNER: OIL INDIA LTD

REPORT SUBMITTED TO

M/S RICHARD DESIGN SERVICES INDIA PVT LTD KOLKATA-700091

REPORT PREPARED BY

RELIANT FOUNDATIONS PVT LTD

H-7, BYE LANE NO: 1(A, NORTH), PANJABARI ROAD SIXMILE, GUWAHATI - 22

PHONE NO: 094351-92896, 07086020945
Email: rel_engrs@yahoo.com

REPORT ON ERT FOR CONSTRUCTION OF NEW CENTRAL BOWSER UNLOADING STATION (CBUS) AT DULIAJAN, DIBRUGARH, ASSAM

INTRODUCTION:

It is well known that the resistance of an earth electrode is heavily influenced by the resistivity of the soil in which it is driven and as such, soil resistivity measurements are an important parameter when designing earthing installations.

One of the main objectives of earthing electrical systems is to establish a common reference potential for the power supply system, building structure, plant steelwork, electrical conduits, cable ladders & trays and the instrumentation system. To achieve this objective, a suitable low resistance connection to earth is desirable. However, this is often difficult to achieve and depends on a number of factors:

• Soil resistivity
• Stratification
• Size and type of electrode used
• Depth to which the electrode is buried
• Moisture and chemical content of the soil

The resistivity test was conducted during dry weather.

THEORY OF SOIL RESISTIVITY:

Resistance is that property of a conductor which opposes electric current flow when a voltage is applied across the two ends. Its unit of measure is the Ohm (Ω) and the commonly used symbol is R. Resistance is the ratio of the applied voltage (V) to the resulting current flow (I) as defined by the well known linear equation from Ohm's Law:

$$V = I \times R$$

Where:
V - Potential Difference across the conductor (Volts)
I - current flowing through the conductor in (Amperes)
R - Resistance of the conductor in (Ohm)

"Good conductors" are those with a low resistance. "Bad conductors" are those with a high resistance. "Very bad conductors" are usually called insulators.

The Resistance of a conductor depends on the atomic structure of the material or its Resistivity (measured in Ohm-m or Ω-m), which is that property of a material that measures its ability to conduct electricity. A material with a low resistivity will behave as a "good conductor" and one with a high resistivity will behave as a "bad conductor". The commonly used symbol for resistivity is ρ (Greek symbol rho).

The resistance (R) of a conductor can be derived from the resistivity as:

$$R = \rho \times L/A$$

Where ρ: Resistivity (Ω-m) of the conductor material

L: Length of the conductor (m)

A: Cross sectional Area (m^2)

L-Length of the conductor (m), A-Cross sectional Area (m2), here ρ-Resistivity (Ω-m) of the conductor material between the opposite faces of a cube of material with a side dimension of 1 meter.

PRINCIPLE OF OPERATION:

Every substance has physical property of Electrical receptivity. Depending upon this property all the substances can be thus classified in terms of their Characteristics resistivity. On the other hand if resistivity values are known, then the corresponding material can be predicted.

Electrical current is introduced into earth mass, through Electrodes. This current produces the potential drop in Earth mass which is proportional to the resistivity of the volume unto which current is penetrated.

Horizontal distances of the electrodes spacing on soil surface has fixed relationship with the depth of earth mass which is effective n determining the Apparent resistivity.

The resistivity of rock is very high, while that of water is comparatively very low. Other types of strata have varying resistivity depending upon their moisture and mineral content.

SOME TYPICAL VALUES OF APPARENT RESISTIVITY OF SOIL ARE AS FOLLOWS:

Type of Soil or Water	Typical Resistivity Ωm	Usual Limit Ωm
Sea water	2	0.1 to 10
Clay	40	8 to 70
Ground well & spring water	50	10 to 150
Clay & sand mixtures	100	4 to 300
Shale, slates, sandstone etc.	120	10 to 100
Peat, loam & mud	150	5 to 250
Lake & brook water	250	100 to 400
Sand	2000	200 to 3000
Moraine gravel	3000	40 to 10000
Ridge gravel	15000	3000 to 30000
Solid granite	25000	10000 to 50000
Ice	100000	10000

APPARENT RESISTIVITY CALCULATION:

In homogeneous isotropic earth the resistivity will be constant. However, if the earth is non homogeneous and the electrode spacing varied, a different value of resistivity (ρa) will be found for each measurement. This measured value of resistivity is known as the apparent resistivity. The apparent resistivity is a function of the array geometry, measured voltage (Δv), and injected current (I).

For the arrays described in the previous section the apparent resistivity is found from the field measurements using the following formulae.

Wernner array
$\rho aw = (2\pi a \Delta v)/I$
$\rho aw = 2\pi aR$
Where ρaw = apparent resistivity (Ω)
a = probe spacing (m)
Δv = voltage measured (volts)
I = injected current (Amps)
R = measured resistance (Ω)

METHOD OF RESISTIVITY MEASUREMENT:

1. Wenner Four Electrode Method
2. Two Pin Method

The present test series were conducted by applying Werner Four Electrode Method. The instrument used was four point Earth testers (Megger). The instrument can read resistance from 0-1000 ohm.

Wenner Four Electrode Method is carried out as per the guidelines of IS: 3043-1987.

PURPOSE OF INVESTIGATION :

The purpose of this investigation is to determine an average value of electrical resistivity of subsurface for design of safe earthing system with the help of Microprocessor based electrical resistivity meter model DET-Auto.

SURVEY PROCEDURE :

Resistivity sounding is used to make investigations along the depth. In this method, the center of configuration is kept fixed and measurements are made by successively increasing electrode spacing .The apparent resistivity values obtained with increasing values of electrode separations are used to estimate the thickness and resistivity of the subsurface formations . In Wenner's configuration all the four electrodes are arranged in a line at a equal distance 'a' between the consecutive electrodes. Measurements were taken at 0.5m, 1.0m, 2.0m, 3.0m, 4.0m and 5.0m. Current is sent through the outer electrodes and the potential difference is measured between the inner electrodes. The resistance (R=V/I) is measured for each electrode separation and apparent resistivity is calculated by multiplying value of 'R' with Wenner configuration factor (2pa), where 'a' is the uniform distance between the electrodes.

COMPUTATION OF EARTH RESISTIVITY :

When the earth resistivity readings for different electrode spacing in a direction are within 20% to 30%,the soil is considered to be uniform. When the spacing is increased gradually from low values, at a stage , it may be found that the resistivity readings are more or less constant irrespective of the increase in the electrode spacing. The resistivity for this spacing is noted and taken as the resistivity for that direction. In a similar way, resistivity for at least one equally spaced direction from the center of the site is measured.This resistivity for is plotted in a graph sheets joining all the resistivity points plotted to get the polar resistivity curve. The area inside the polar resistivity curve is measured and equivalent circle of the same area is found out. The radius of this equivalent circle is the average resistivity of the site under considerations. The average resistivity thus obtained may be used for the design of the earthing gid at that particular depth.

NOTE: FOR EARTH MAT DESIGN:

Following criteria are to be considered -

1. Average of all the resistivity values should be considered, if difference between all the average resistivity values are minimum.
2. If all the average resistivity values differ by a large margin, then highest of all average resistivity values is to be considered to be on the safer side.

Conclusion:

Resistivity at North direction is found to be the highest, to be on safer side this higher value is recommended to consider for further consideration. Resistivity at the site is to be considered as 19.13 Ohm-m.
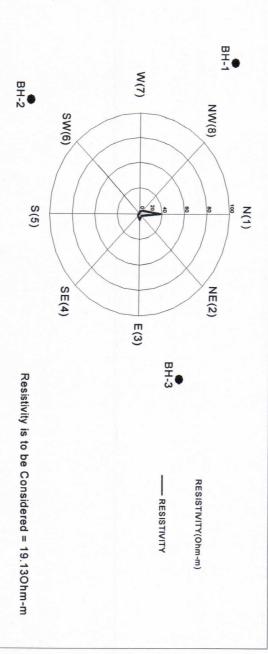
Project : soil investigation work for construction of new central bowser unloading station (CBUS) at Duliajan, Dibrugarh, Assam
Location : Duliajan, Dibrugarh, Assam
Date of Testing : 25-10-2018
Coordinate: N-3025609.19, E-731029.61, Z-120.69

SOIL RESISTIVITY TEST

RESULT

DIRECTION		NORTH (1)		NORTH - EAST (2)		EAST (3)		SOUTH-EAST (4)		SOUTH (5)		SOUTH-WEST (6)		WEST(7)		NORTH-WEST (8)	
PROBE DISTANCE "S" (m)		Megger reading "R" (Ohm)	Resistivity (ohm-m) "ρ = 2x3.14xSxR"	Megger reading "R" (Ohm)	Resistivity (ohm-m) "ρ = 2x3.14xSxR"	Megger reading "R" (Ohm)	Resistivity (ohm-m) "ρ = 2x3.14xSxR"	Megger reading "R" (Ohm)	Resistivity (ohm-m) "ρ = 2x3.14xSxR"	Megger reading "R" (Ohm)	Resistivity (ohm-m) "ρ = 2x3.14xSxR"	Megger reading "R" (Ohm)	Resistivity (ohm-m) "ρ = 2x3.14xSxR"	Megger reading "R" (Ohm)	Resistivity (ohm-m) "ρ = 2x3.14xSxR"	Megger reading "R" (Ohm)	Resistivity (ohm-m) "ρ = 2x3.14xSxR"
2		0.14	1.76	0.00	0.00	0.1	1.26	0.00	0.00	0.03	0.38	0.01	0.13	0.06	0.75	0.1	1.26
5		0.58	18.21	0.00	0.00	0.11	3.45	0.01	0.314	0.05	1.57	0.02	0.63	0.08	2.51	0.11	3.45
10		0.6	37.68	0.01	0.63	0.04	2.512	0.04	2.512	0.02	1.26	0.01	0.628	0.02	1.256	0.05	3.14
15		0.19	17.898	0.04	3.768	0.09	8.478	0.05	4.71	0.03	2.826	0.03	2.826	0.03	2.826	0.06	5.652
20		0.16	20.096	0.05	6.28	0.05	6.28	0.03	3.768	0.01	1.256	0.01	1.256	0.06	5.652	0.03	3.768

DIRECTION	AVERAGE RESISTIVITY (Ohm-m)
NORTH (1)	19.13
NORTH EAST (2)	2.14
EAST (3)	4.40
SOUTH EAST (4)	2.26
SOUTH (5)	1.51
SOUTH WEST (6)	1.09
WEST (7)	1.84
NORTH WEST (8)	3.45

BH-1 BH-2 BH-3

Polar chart directions: N(1), NE(2), E(3), SE(4), S(5), SW(6), W(7), NW(8) — scale 0, 20, 40, 60, 80, 100

—— RESISTIVITY(Ohm-m)

—— RESISTIVITY

Resistivity is to be Considered = 19.13 Ohm-m

3.0
SURVEY

DRAWINGS

LOCATION OF BORE HOLE:-

SL. NO.	DESCRIPTION	NORTHING	EASTING	RL
1.	BH-1	3025548.29	731050.81	120.18
2.	BH-2	3025641.50	731021.11	120.38
3.	BH-3	3025596.75	730995.87	120.60

NOTES

1. ALL DIMENSION ARE IN METERE
2. THERE IS NO ELEVATION DEFFRENCE BETWEEN MSL (MEAN SEA LEVEL) AND RL

INDEX OF BM:-

SL. NO.	DESCRIPTION	NORTHING	EASTING	RL
1.	BP-1	3025751.00	730726.09	123.90
2.	BM-1	3025650.302	730906.207	121.145
3.	BM-2	3025601.832	730938.644	121.402
4.	BM-3	3025584.033	731035.383	120.822
5.	BM-4	3025494.628	731047.817	120.343

LOCATION OF BORE HOLE:-

SL. NO.	DESCRIPTION	NORTHING	EASTING	RL
1.	BH-1	3025548.29	731050.81	120.18
2.	BH-2	3025641.50	731021.11	120.38
3.	BH-3	3025596.75	730995.87	120.60

NOTES

1. ALL DIMENSION ARE IN METERE

2. THERE IS NO ELEVATION DIFFERENCE BETWEEN MSL (MEAN SEA LEVEL) AND RL

INDEX OF BM:-

SL. NO.	DESCRIPTION	NORTHING	EASTING	RL
1.	BP-1	3025725.100	730530.09	123.99
2.	BM-1	3025650.305	730906.207	123.140
3.	BM-2	3025617.303	730916.044	123.407
4.	BM-3	3025564.005	731008.383	125.427
5.	BM-4	3025540.626	731047.517	120.343

PROJECT :- TOPOGRAPHICAL SURVEY FOR CONSTRUCTION OF NEW CENTRAL BOWSER UNLOADING "B" STATION (CBUS), AT DULIAJAN, DIBRUGARH, ASSAM.

CLIENT:- OIL INDIA LTD.

EPMC:- RICHARD DESIGN SERVICES INDIA PVT.LTD.

PREPARED BY RELIANT FOUNDATION PVT LTD
SIX MILE , GUWAHATI, ASSAM
EMAIL: REL_ENGRS@YAHOO.COM
PH: 09435193396

TITLE:- DETAIL PLAN OF THE SURVEY			
DATE	DRG NO	PART	SCALE	JOB NO
15.10.2018	REL/CBUS/SOIL/02	01 OF 01	1:1000	REL-10/18

DRAWN BY: MR. P. PATOWARY

N

AREA STATEMENT

TOTAL PLOT AREA: 33378.49 SQM.

= 24 BIGHA, 4 KATHA 14.11 LESSA
= 24 BIGHA, 4 KATHA 14.11 LESSA
= 8.24 ACRES
= 3.33 HECTARES

LOCATION OF BORE HOLE:-

SL. NO	DESCRIPTION	NORTHING	EASTING	RL
1.	BH-1	3025548.29	731050.81	120.18
2.	BH-2	3025641.50	731021.11	120.38
3.	BH-3	3025596.75	730995.87	120.60

NOTES

1. ALL DIMENSION ARE IN METERE
2. THERE IS NO ELEVATION DIFFERENCE BETWEEN MSL (MEAN SEA LEVEL) AND RL

INDEX OF BM:-

SL. NO	DESCRIPTION	NORTHING	EASTING	RL
1.	BP-1	3025035.60	728250.00	125.00
2.	BM-1	3025930.13	730906.397	121.168
3.	BM-2	3025617.821	730919.644	121.462
4.	BM-3	3025560.028	731028.281	120.342
5.	BM-4	3025268.076	731047.037	120.543

PROJECT :- TOPOGRAPHICAL SURVEY FOR CONSTRUCTION OF NEW CENTRAL BOWSER UNLOADING STATION (CBUS) AT DULIAJAN,DIBRUGARH, ASSAM.

CLIENT:- OIL INDIA LTD.

EPMC:- RICHARD DESIGN SERVICES INDIA PVT.LTD.

PREPARED BY RELIANT FOUNDATION PVT. LTD
SIXMILE, GUWAHATI,ASSAM
EMAIL:- REL_ENGRS@YAHOO.COM
PH. 09435192806

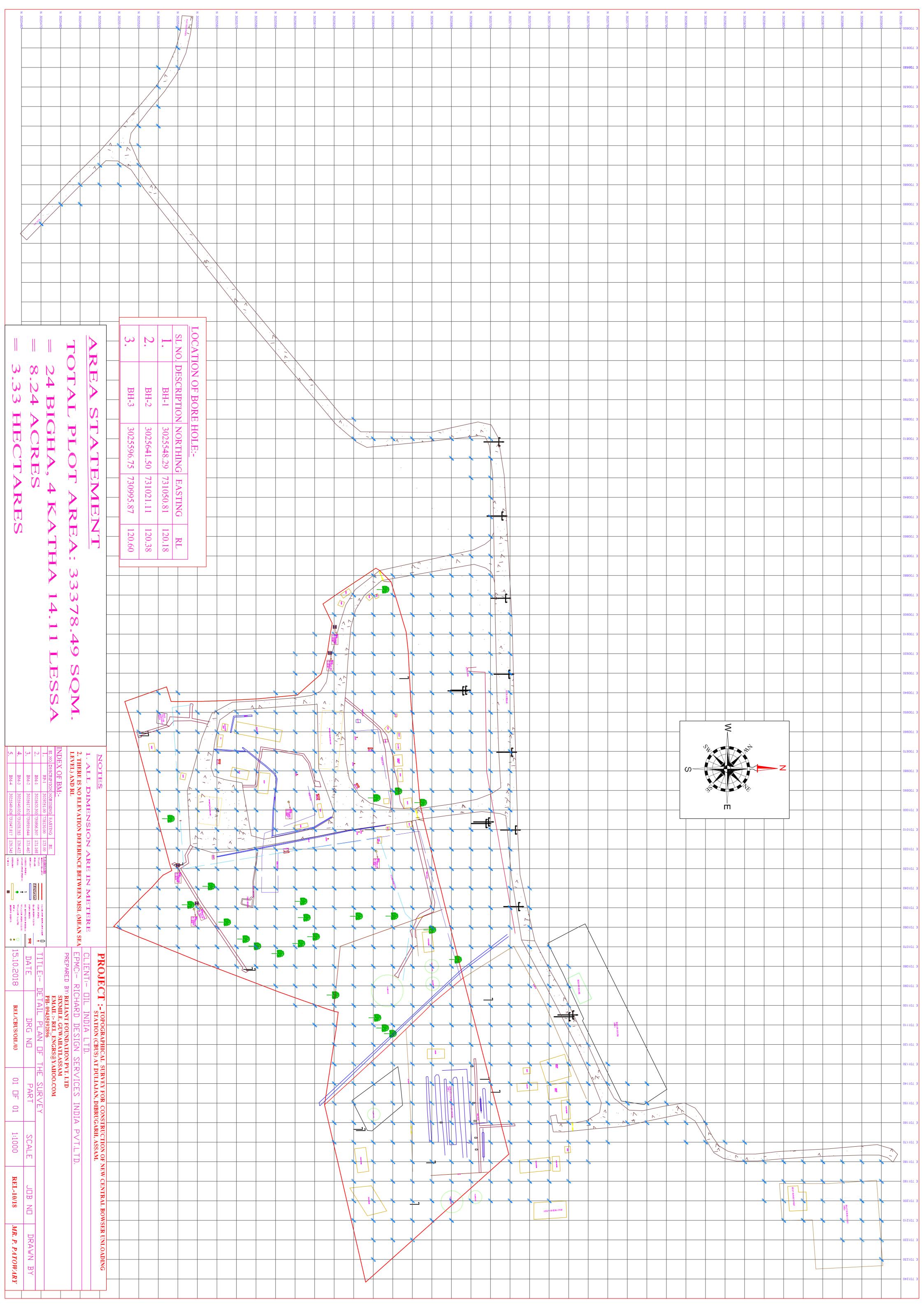| TITLE:- DETAIL PLAN OF THE SURVEY				
DATE	DRG. NO	PART	SCALE	JOB NO	DRAWN BY
15.10.2018	REL/CBUS/OIL/03	01 OF 01	1:1000	REL-10/18	MR. P. PATOWARY

N

INTEGRITY PACT

Between

Oil India Limited (OIL) hereinafter referred to as "The Principal"

And

(Name of the bidder)..hereinafter referred to as "The Bidder/Contractor"

Preamble:

The Principal intends to award, under laid down organizational procedures, contract/s for **.....................................** The Principal values full compliance with all relevant laws and regulations, and the principles of economic use of resources, and of fairness and transparency in its relations with its Bidder/s and Contractor/s.

In order to achieve these goals, the Principal cooperates with the renowned international Non-Governmental Organization "Transparency International" (TI). Following TI's national and international experience, the Principal will appoint an external independent Monitor who will monitor the tender process and the execution of the contract for compliance with the principles mentioned above.

Section: 1 -Commitments of the Principal

(1) The Principal commits itself to take all measures necessary to prevent corruption and to observe the following principles:

1. No employee of the Principal, personally or through family members, will in connection with the tender for, or the execution of a contract, demand, take a promise for or accept, for him/herself or third person, any material or immaterial benefit which he/she is not legally entitled to.

2. The Principal will, during the tender process treat all Bidders with equity and reason. The Principal will in particular, before and during the tender process, provide to all Bidders the same information and will not provide to any Bidder confidential/additional information through which the Bidder could obtain an advantage in relation to the tender process or the contract execution.

3. The Principal will exclude from the process all known prejudiced persons.

(2) If the Principal obtains information on the conduct of any of its employees which is a criminal offence under the relevant Anti-Corruption Laws of India, or if there be a Page 2 of 6 substantive suspicion in this regard, the Principal will inform its Vigilance Office and in addition can initiate disciplinary actions.

Section: 2 -Commitments of the Bidder/Contractor

(1) The Bidder/Contractor commits itself to take all measures necessary to prevent corruption. He commits himself to observe the following principles during his participation in the tender process and during the contract execution.

> 1. The Bidder/Contractor will not, directly or through any other person or firm, offer, promise or give to any of the Principal's employees involved in the tender process or the execution of the contract or to any third person any material or immaterial benefit which h e/she is not legally entitled to, in order to obtain in exchange any advantage of any kind whatsoever during the tender process or during the execution of the contract.

> 2. The Bidder/Contractor will not enter with other Bidders into any undisclosed agreement or understanding, whether formal or informal. This applies in particular to prices, specifications, certifications, Subsidiary contracts, submission or non-submission of bids or any other actions to restrict competitiveness or to introduce cartelization in the bidding process.

> 3. The Bidder/Contractor will not commit any offence under the relevant Anticorruption Laws of India; further the Bidder/Contractor will not use improperly, for purposes of competition or personal gain, or pass on to others, any information or document provided by the Principal as part of the business relationship, regarding plans, technical proposals and business details, including information contained or transmitted electronically.

> 4. The Bidder/Contractor will, when presenting his bid, disclose any and all payments he has made, is committed to or intends to make to agents, brokers or any other intermediaries in connection with the award of the contract.

(2) The Bidder/Contractor will not instigate third persons to commit offences outlined above or be an accessory to such offences.

(3) The Bidder/Contractor signing Integrity Pact shall not approach the Courts while representing the matters to IEMs and he/she will await their decision in the matter.

Section 3 -Disqualification from tender process and exclusion from future Contracts

If the Bidder, before contract award has committed a transgression through a violation of Section 2 or in any other form such as to put his reliability or risibility as Bidder into question, the Principal is entitled to disqualify the Bidder from the tender process or to terminate the contract, if already signed, for such reason.

1. If the Bidder/Contractor has committed a transgression through a violation of Section 2 such as to put his reliability or credibility into question, the Principal is entitled also to exclude the Bidder/Contractor from future contract award processes. The imposition and duration of the exclusion will be determined by the severity of the transgression. The severity will be determined by the circumstances of the case, in particular the number of transgressions, the position of the transgressions within the company hierarchy of the Bidder and the amount of the damage. The exclusion will be imposed for a minimum of 6 months and maximum of 3 years.

2. The Bidder accepts and undertakes to respect and uphold the Principal's Absolute right to resort to and impose such exclusion and further accepts and undertakes not to challenge or question such exclusion on any ground, including the lack of any hearing before the decision to resort to such exclusion is taken. This undertaking is given freely and after obtaining independent legal advice.

3. If the Bidder/Contractor can prove that he has restored/recouped the Damage caused by him and has installed a suitable corruption prevention system, the Principal may revoke the exclusion prematurely.

4. A transgression is considered to have occurred if in light of available evidence no reasonable doubt is possible.

5. Integrity Pact, in respect of a particular contract, shall be operative from the date Integrity Pact is signed by both the parties till the final completion of the contract **or as mentioned in Section 9- Pact Duration whichever is later**. Any violation of the same would entail disqualification of the bidders and exclusion from future business dealings

Section 4 -Compensation for Damages

1. If the Principal has disqualified the Bidder from the tender process prior to the award according to Section 3, the Principal is entitled to demand and

recover from the Bidder liquidated damages equivalent to Earnest Money Deposit / Bid Security.

(2) If the Principal has terminated the contract according to Section 3, or if the Principal is entitled to terminate the contract according to Section 3, the principal shall be entitled to demand and recover from the Contractor liquidated damages equivalent to Security Deposit / Performance Bank Guarantee.

3. The bidder agrees and undertakes to pay the said amounts without protest or demur subject only to condition that if the Bidder/Contractor can prove and establish that the exclusion of the Bidder from the tender process or the termination of the contract after the contract award has caused no damage or less damage than the amount or the liquidated damages, the Bidder/Contractor shall compensate the Principal only to the extent of the damage in the amount proved.

Section 5 -Previous transgression

1. The Bidder declares that no previous transgression occurred in the last 3 years with any other Company in any country conforming to the TI approach or with any other Public Sector Enterprise in India that could justify his exclusion from the tender process.

2. If the Bidder makes incorrect statement on this subject, he can be disqualified from the tender process or the contract, if already awarded, can be terminated for such reason.

Section: 6 -Equal treatment of all Bidders/Contractor/Subcontractors

1. The Principal will enter into Pacts on identical terms with all bidders and contractors.

2. The Bidder/Contractor undertake(s) to procure from all subcontractors a commitment in conformity with this Integrity Pact. The Bidder/Contractor shall be responsible for any violation(s) of the provisions laid down in this agreement/Pact by any of its sub-contractors/sub-vendors.

3. The Principal will disqualify from the tender process all bidders who do not sign this Pact or violate its provisions.

Section: 7 -Criminal charges against violating Bidders/Contractors/ Subcontractors

If the Principal obtains knowledge of conduct of a Bidder, Contractor or Subcontractor, or of an employee or a representative or an associate of a Bidder, Contractor or Subcontractor, which constitutes corruption, or if the Principal has substantive suspicion in this regard, the Principal will inform the Vigilance Office.

Section: 8 -External Independent Monitor/Monitors

1. The Principal appoints competent and credible external independent Monitor for this Pact. The task of the Monitor is to review independently and objectively, whether and to what extent the parties comply with the obligations under this agreement.

2. The Monitor is not subject to instructions by the representatives of the parties and performs his functions neutrally and independently. He reports to the Chairperson of the Board of the Principal.

3. The Contractor accepts that the Monitor has the right to access without restriction to all Project documentation of the Principal including that provided by the Contractor. The Contractor will also grant the Monitor, upon his request and demonstration of a valid interest, unrestricted and unconditional access to his project documentation. The same is applicable to Subcontractors. The Monitor is under contractual obligation to treat the information and documents of the Bidder/Contractor/Subcontractor with confidentiality.

4. The Principal will provide to the Monitor sufficient information about all meetings among the parties related to the Project provided such meetings could have an impact on the contractual relations between the Principal and the Contractor. The parties offer to the Monitor the option to participate in such meetings.

5. As soon as the Monitor notices, or believes to notice, a violation of this agreement, he will so inform the Management of the Principal and request the Management to discontinue or heal the violation, or to take other relevant action. The monitor can in this regard submit non-binding recommendations. Beyond this, the Monitor has no right to demand from the parties that they act in a specific manner, refrain from action or tolerate action. However, the Independent External Monitor shall give an opportunity to the bidder/contractor to present its case before making its recommendations to the Principal.

6. The Monitor will submit a written report to the Chairperson of the Board of the Principal within 8 to 10 weeks from the date of reference or intimation to him by the 'Principal' and, should the occasion arise, submit proposals for correcting problematic situations.

7. If the Monitor has reported to the Chairperson of the Board a Substantiated suspicion of an offence under relevant Anti-Corruption Laws of India, and the Chairperson has not, within reasonable time, taken visible action to proceed against such offence or reported it to the Vigilance Office, the Monitor may also transmit this information directly to the Central Vigilance Commissioner, Government of India.

8. The word 'Monitor' would include both singular and plural.

Section:9 -Pact Duration

This Pact begins when both parties have legally signed it. It expires for the Contractor 12 months after the last payment under the respective contract, and for all other Bidders 6 months after the contract has been awarded.

If any claim is made/ lodged during this time, the same shall be binding and continue to be valid despite the lapse of this pact as specified above, unless it is discharged/determined by Chairperson of the Principal.

Section:10 -Other provisions

1. This agreement is subject to Indian Law. Place of performance and jurisdiction is the Registered Office of the Principal, i.e. New Delhi. The Arbitration clause provided in the main tender document/contract shall not be applicable for any issue/dispute arising under Integrity Pact.

2. Changes and supplements as well as termination notices need to be made in writing. Side agreements have not been made.

3. If the Contractor is a partnership or a consortium, this agreement must be, signed by all partners or consortium members.

4. Should one or several provisions of this agreement turn out to be invalid, the remainder of this agreement remains valid. In this case, the parties will strive to come to an agreement to their original intensions.

....
For the Principal

....
For the Bidder/Contractor

Witness 1: ....

Witness 2: ....

Place.
Date.