Ref. No: SECI/SD/NIT/2016/PPT/10MW/CLR-01

Clarification — Date: 01/09/2016

SECTION-I: INVITATION FOR BIDS (IFB)

Clause	Page No	Content of Clause	Clarification
4.2.1	5 of 7	Bidder shall submit, in support to the above, the list of projects commissioned along with their work order/ LOI, Commissioning certificates and the letter from Client/Employer /Owner confirming satisfactory performance of the Plant since last one year calculated up to date of publication of NIT.	Joint Meter Reports of projects for one year (till one month prior to issue of NIT) & commissioning certificates from Client can also be considered instead of satisfactory performance certificate.

SECTION-II: INSTRUCTIONS TO BIDDER (ITB)

3.2.1	15 of 31	It is hereby clarified that Joint Ventures/Consortiums are not eligible to participate in this Tender.	
3.4.2	16,17,18 of 31	It is hereby clarified that documents submitted in original must also be submitted online.	

It is hereby clarified that there are No road/rail crossings required placed within the proposed location of Plant and no Right of Way required for transmission line, since the entire land upto sub-station belongs to PPT

SECTION-III: General Conditions of Contract (GCC)

13	17 & 18 of 48	If GST comes in to existence during the course of Project, same shall be treated as New Tax & shall be reimbursed as actual by the employer subject to submission of requisite documentary evidence by the bidder/Contractor, in lieu of existing indirect taxes as applicable. However, in line with treatment of Service Tax & Work Contract Tax for EPC Part, GST in lieu of Service part of the EPC works shall not be reimbursed & has to be absorbed by the Contractor.	

SECTION-IV: Special Conditions of Contract (SCC)

7.2	3 of 14	The minimum acceptable PR of the plant is 0.78 and CUF shall be 16 % against installed rated DC capacity at STC.	It is hereby clarified that minimum acceptable PR & CUF shall be governed by Clause 10 & 11 of the Technical Specification respectively. The contractor must confirm & demonstrate the minimum required CUF for complete O&M period, failing which LD shall be charged as per relevant clause of the Tender document
25.3	12 of 14	The upper capping of such LD shall be complete amount of O&M BG per annum. If O&M BG has already been partially or fully exhausted in lieu any other claims, Contractor has to immediately replenish the O&M BG up to its original value at the beginning of that particular O&M year.	

SECTION-V: Technical Specification (TS)

Auto Cad file of the land is uploaded for reference

It is hereby clarified that, there are no road/rail crossings and also no ROW issues as entire land and route up to existing 132/33 kV sub-station belongs to Port. The evacuation up to this sub-station shall be through 33 kV Underground cables as overhead Transmission line is not allowed.

It is hereby clarified that there will be landfilling by approx. 1.3 meters, carried out by PPT. Contractor will get a soil filled and compacted land, free from tree & bushes. Thereafter, very little levelling/ grading would be required to be done by the Contractor. Geotechnical report of unfilled land is also uploaded for reference & understanding of underneath soil conditions.			
It is hereby clarified that **only Indoor Type 33 kV Breaker** can be used			
3.6	13 of 122	It is hereby, again clarified that obtaining all the statutory approvals /clearances on behalf of the Employer from various Government Departments/STU/DISCOM shall be the responsibility of the Contractor only.	
7.4.3 & 7.4.4	27 OF 122	The Junction Boxes shall have suitable arrangement for the followings ➢ Provide arrangement for disconnection for each of the groups/incomers ➢ Provide a test point for each sub-group for quick fault location and to provide group array isolation	It is hereby clarified that Clause 7.4.4 shall be treated as continuation & part of Clause 7.4.3 only. It is further clarified that, providing disconnection of each groups mean to provide Isolator of suitable Rating in SMU towards Inverter side.
8.18.4	33 of 122	DC cables used from solar modules to array junction box shall be solar grade copper (Cu) with XLPO insulation and rated for 1.1kV only. However, the cables used from array junction box to inverter can be XLPE Aluminium with 1.1kV rating as per relevant standards.	It is hereby clarified that inner Sheathing of such Cables can be of PVC.

Ref. No: SECI/SD/NIT/2016/PPT/10MW/AMD-01			
Amendments			**Date: 01/09/2016**
SECTION-II: INSTRUCTIONS TO BIDDER (ITB)			
Clause	**Page No.**	**Existing Clause**	**Amended Clause.**
1.2.1	5 OF 31	**Bank guarantee against Mobilization Advance, if required by the contractor: Not Applicable**	**Bank guarantee against Mobilization Advance, if required by the contractor**: The Contractor shall furnish within 10 days from the date of issue of Letter of Intent (LOI), an unconditional and irrevocable bank guarantee of 110% of mobilization advance to be drawn, which is interest bearing, the Rate of interest being the SBI base rates prevailing on the 7th day prior to the Date of opening of Techno-commercial Bids, as per Format attached. The mobilization advance amount shall be 10% of the Sum of the Supply Contract, Erection Contract and Civil Work Contracts. However, Mobilization Advance shall be released separately for Supply Contract, Erection Contract and Civil Contract against Submission of requisite BANK Guarantees .The bank guarantee shall be Valid for 7 months from the date of issue of LOI.
1.2.1 PBG & OMBG (ii)	6 OF 31	Performance bank guarantee for EPC: The Contractor shall furnish within 14 days from the date of issue of Letter of Intent (LOI), an unconditional and irrevocable bank guarantee for due Performance as per Format attached and which shall be for 10% of the total Contract Value (i.e., total sum of all the supply contract, erection contract and Civil works contract) and shall be valid up to 90 days beyond defect liability period.	Performance bank guarantee for EPC: The Contractor shall furnish within 14 days from the date of issue of Letter of Intent (LOI), an unconditional and irrevocable bank guarantee for due Performance as per Format attached and which shall be for 10% of the total Contract Value (i.e., total sum of all the supply contract, erection contract and civil works contract) and shall be valid up to 30 days beyond Operational Acceptance. PBG against EPC shall be released after submission & acceptance of following; (i) O&M BG (confirmed by issuing bank), (ii) As built drawings of all components of the Plant, (iii) O&M manuals of the Plant along with Copies of Warranty Certificates for all equipment. (iv) Settlement of any claim by Employer towards EPC part of Project.

			(v) Acceptance of Punch-Points by the Contractor as submitted by the Employer. (vi) Furnishing Copy of Insurance Policy for O&M period in the name of PPT. During O&M Period, till the time of submission of O&M BG, in case of any breakdown/occurrence of fault/ failure in Energy Generation/Liquidated Damage etc., Performance Bank Guarantee for EPC shall also be treated as O&M Bank Guarantee also, and encashment shall take place in line with GCC Clause 50.3/SCC Clause 25 as applicable. In case Contractor fails to submit O&M BG within 30 days before expiry of PBG, the PBG may be encashed to the extent of value of O&M BG, due for submission.
2.10.6	12 of 31	The Employer shall, however, arrange to release the Bid Security in respect of unsuccessful Bidders (except L-2 bidder) within 15 days of Reverse Auction, without any interest, Bid Security of L-2 bidder shall only be released after issue of LOI to the successful bidder and their acknowledgement of the same	The Employer shall, however, arrange to release the Bid Security in respect of unsuccessful Bidders (except L-2 bidder) within 15 days of Reverse Auction, without any interest. Bid Security of L-2 bidder shall only be released after submission of PBG by L-1 bidder & receipt of its acknowledgment from issuing Bank.
SECTION-III: General Conditions of Contract (GCC)			
Clause	**Page No.**	**Existing Clause**	**Amended Clause.**
27.4.1	33 of 48	Final Acceptance shall occur in respect of the Facilities when ➢ The Plant have achieved the Operational acceptance and served the O&M for the period stipulated under the contract agreement; and ➢ All the contractors' liabilities under the O&M contract have been satisfied; and ➢ Contractor has provided the list of recommended spares with detailed specification, source and price for further procurement; and ➢ The Contractor has paid the liquidated damages, if any, as specified in SCC Clause 25 thereto	Final Acceptance shall occur in respect of the Facilities when ➢ The Plant have achieved the Operational acceptance and served the 1 year of successful O&M. ➢ All the contractors' liabilities under EPC part of Contract including DLP have been satisfied; and ➢ Contractor has provided the list of recommended spares with detailed specification, source and price for further procurement; and ➢ The Contractor has paid the liquidated damages till the period of one year of O&M, if any.

27.4.5	33 of 48	The O&M contract period may further be extended for a suitable period as per mutually agreed terms and conditions. The contractor is allowed to submit his intent at the time of Final acceptance	The O&M contract period may further be extended for a suitable period as per mutually agreed terms and conditions. The contractor should submit his intent 30 days before completion of O&M period.
39.1	40 of 48	During the Contract period, i.e., during Construction, all insurance related expenses shall be borne by the Contractor. The goods supplied under the Contract shall be fully insured against the loss or damage incidental to manufacture or acquisition, transportation, storage and delivery in such a manner that Employer shall not incur any financial loss, as long as the plant continues to remain under the custody of the Contractor. During O&M period (after Contract period is over), the insurances shall be arranged by the Owner (at Owner cost).	During the Contract period, i.e., during Construction, all insurance related expenses shall be borne by the Contractor. The goods supplied under the Contract shall be fully insured against the loss or damage incidental to manufacture or acquisition, transportation, storage and delivery in such a manner that Employer shall not incur any financial loss, as long as the plant continues to remain under the custody of the Contractor. During O&M period also, the insurances shall be arranged by the Contractor (at its own cost), duly endorsed in favour of Paradip Port Trust. Contractor shall arrange for immediate replacement of any damaged item, without waiting for settlement of its Insurance Claim. Copy of insurance Policy shall be forwarded to PPT.
SECTION-IV: Special Conditions of Contract (SCC)			
Clause	**Page No.**	**Existing Clause**	**Amended Clause.**
3	3 of 14	Appointing Authority of Adjudicator and Arbitrator shall be Chairman, Paradip Port Trust	Appointing Authority of third Adjudicator shall be Chairman, Paradip Port Trust.
14.1.1	6&7 of 14	For **Supply of Plant & Equipment** including PV Modules, Inverter and BOS up to site (FOR basis) including transportation and insurance along with mandatory spares. (i) 70% of the total price of supplies of Plant and Equipment shall be paid against delivery of supplies on pro-rata basis against receipt of material at site under the Contract. (ii) 20 % of the total price of supplies of Plant and Equipment shall be paid on Operational Acceptance of the Facility pursuant to successful Guarantee Tests and demonstration of PR and submission of all as – built documentation.	For **Supply of Plant & Equipment** including PV Modules, Inverter and BOS up to site (FOR basis) including transportation and insurance along with mandatory spares. (i) 10% of the total price of supplies of Plant and Equipment as advance payment against Bank Guarantee of 110% of the advance Amount to be drawn (with validity as per Amended ITB Clause 1.2.1, Mobilization Advance) which shall be furnished by contractor in addition to Performance Bank Guarantee. (i) 60% of the total price of supplies of Plant and Equipment shall be paid against delivery of supplies on pro-rata basis against receipt of material at site under the Contract.

		(iii) 10 % of the total price of supplies of Plant and Equipment shall be paid after CUF demonstration on completion of first year of O&M of the Facility pursuant to successful Guarantee Tests and demonstration of PR and submission of all requisite documentation. However, this Payment may also be released after demonstration of PR and submission of all requisite documentation on the submission of Bank Guarantee of equivalent amount. The BG shall be valid up to demonstration of CUF for the successful first year of Operation. However, in case of delay, the BG shall be extended suitably.	(ii) 20 % of the total price of supplies of Plant and Equipment shall be paid on Operational Acceptance of the Facility pursuant to successful Guarantee Tests and demonstration of PR and submission of all as – built documentation. (iii) 10 % of the total price of supplies of Plant and Equipment shall be paid after CUF demonstration on completion of first year of O&M of the Facility pursuant to successful Guarantee Tests and demonstration of PR and submission of all requisite documentation. However, this Payment may also be released after demonstration of PR and submission of all requisite documentation on the submission of Bank Guarantee of equivalent amount. The BG shall be valid up to demonstration of CUF for the successful first year of Operation. However, in case of delay, the BG shall be extended suitably
14.1.2	7 of 14	For **Erection, Testing and Commissioning;** (i) 80% of the total price of Erection, Testing and Commissioning shall be paid on pro-rata basis on completion of installation of equipment on certification by the Engineer-In-Charge/ Project Manager for the quantum of work completed after successful clearance of quality check points involved in the quantum of work billed. (ii) 10% of the total price of Erection, Testing and Commissioning shall be paid on Operational Acceptance of the Facility pursuant to successful Guarantee Tests and demonstration of PR. (iii) 10% of the total price of Erection, Testing and Commissioning shall be paid after CUF demonstration after first year of O&M of the Facility pursuant to successful Guarantee Tests and demonstration of PR and submission of all requisite documentation. However, this Payment may also be released after	For **Erection, Testing and Commissioning;** (i) 10% of the total price of Erection, Testing and commissioning as advance payment against Bank Guarantee of 110% of the advance Amount to be drawn (with validity as per Amended ITB Clause 1.2.1, Mobilization Advance) which shall be furnished by contractor in addition to Performance Bank Guarantee. (ii) 70% of the total price of Erection, Testing and Commissioning shall be paid on pro-rata basis on completion of installation of equipment on certification by the Engineer-In-Charge/ Project Manager for the quantum of work completed after successful clearance of quality check points involved in the quantum of work billed. (iii) 10% of the total price of Erection, Testing and Commissioning shall be paid on Operational Acceptance of the Facility pursuant to successful Guarantee Tests and demonstration of PR.

		successful Guarantee Tests and demonstration of PR and submission of all requisite documentation on the submission of Bank Guarantee of equivalent amount. The BG shall be valid up to demonstration of CUF for the successful first year of Operation. However, in case of delay, the BG shall be extended suitably.	(iv) 10% of the total price of Erection, Testing and Commissioning shall be paid after CUF demonstration after first year of O&M of the Facility pursuant to successful Guarantee Tests and demonstration of PR and submission of all requisite documentation. However, this Payment may also be released after successful Guarantee Tests and demonstration of PR and submission of all requisite documentation on the submission of Bank Guarantee of equivalent amount. The BG shall be valid up to demonstration of CUF for the successful first year of Operation. However, in case of delay, the BG shall be extended suitably.
14.1.3	7 & 8 of 14	For **Civil and Allied Works** (i) 80% of the total price of Civil Works shall be paid progressively on certification by the Project Manager/ Engineer In - Charge for the quantum of work completed/ Milestones achieved after successful clearance of quality check points involved in the quantum of work / Milestones billed. (ii) 10% of the total price of Civil Works shall be paid on completion of all the civil works including finishing and debris removal. (iii) 10% of the total price of Civil Works shall be paid shall be paid after CUF demonstration after first year of O&M of the Facility pursuant to completion of all the civil works including finishing and debris removal. However, this Payment may also be released after completion of all the civil works including finishing and debris removal on submission of Bank Guarantee of equivalent amount. The BG shall be valid up to demonstration of CUF for the successful first year of Operation. However, in case of delay, the BG shall be extended suitably.	For **Civil and Allied Works** (i) 10% of the total price of Civil Works as advance payment against Bank Guarantee of 110% of the advance Amount to be drawn (with validity as per Amended ITB Clause 1.2.1, Mobilization Advance) which shall be furnished by contractor in addition to Performance Bank Guarantee. (ii) 70% of the total price of Civil Works shall be paid progressively on certification by the Project Manager/ Engineer In - Charge for the quantum of work completed/ Milestones achieved after successful clearance of quality check points involved in the quantum of work / Milestones billed. (iii) 10% of the total price of Civil Works shall be paid on completion of all the civil works including finishing and debris removal. (iv) 10% of the total price of Civil Works shall be paid shall be paid after CUF demonstration after first year of O&M of the Facility pursuant to completion of all the civil works including finishing and debris removal. However, this Payment may also be released after completion of all the civil works including finishing and debris removal on submission of Bank Guarantee of equivalent amount. The

			BG shall be valid up to demonstration of CUF for the successful first year of Operation. However, in case of delay, the BG shall be extended suitably.
14.2	8 of 14	Recovery of interest bearing Mobilization advance: **NOT APPLICABLE**	Recovery of interest bearing Mobilization advance: Recovery of the mobilization advance and interest component on the advance amount shall be made from the progressive payments released to the Contractor as per terms below. (i) The amount of interest to be recovered from a particular bill shall be calculated at SBI base rate (per annum) prevailing on the 7th day prior to the date of opening of techno – commercial bid on the value of advance corresponding to the percentage of total progressive payment being released. (ii) The period for which the interest is to be calculated shall be reckoned from the date of release of the advance payment to the actual date of release of the said progressive payment. (iii) The interest on the advance payment shall stand fully recovered on release of all the progressive payments. If the amount payable under any interim bill is not sufficient to cover all deductions to be made for interest on the advance payment and other sums deductible therefrom, the balance outstanding shall be recovered from the next payments immediately falling due. (iv) If the bidder is not taking any mobilization advance from the Employer, then the progressive payments mentioned above shall be modified accordingly (For Supply of Plant & Equipment, the progressive payment shall be 70% in place of 60% and so on)
14.4	9 of 14	Mobilization Advance: **NOT APPLICABLE**	Mobilization Advance, if requested, shall be payable against submission of unconditional and irrevocable Mobilization 110% of the advance payment bank guarantee as per amended format Appendix 20 of Section VI: Forms and

			Formats issued by a bank enlisted at Schedule-1. This bank guarantee shall be valid as per ITB Clause 1.2.1. The recovery of the mobilization advance shall be made in accordance with amended SCC Clause 14.2.
14.5	9 of 14	**NOT USED.**	'OM' indicates the O&M Contract Value quoted by the Successful Bidder for each individual year in its Financial Proposal
18	10 of 14	**Samples**: The Contractor shall within 30 days of issue of Letter of Intent/NTP, provide to the Employer detailed Technical literature &/or test certificates of all major materials it proposes to use irrespective of the fact that specific make/material might have been stipulated. The Employer shall check the compliance of the proposed items and give its comments and/or approval to the same	**Samples**: The Contractor shall, provide to the Employer detailed Technical literature &/or test certificates of all major materials it proposes to use irrespective of the fact that specific make/material might have been stipulated. The Employer shall check the compliance of the proposed items and give its comments and/or approval to the same
SECTION-V: Technical Specifications (TS)			
Clause	**Page No.**	**Existing Clause**	**Amended Clause.**
3.2.7	9 of 122	33kV / 415V auxiliary transformer (s).	33kV / 415V auxiliary transformer (s). However LV of Auxiliary Transformer may also be taken as output Voltage of Inverter, subject to compliance of DISCOM's/STU's requirement & system compatibility.
3.2.11	9 of 122	33 kV indoor/ outdoor panels having incoming and outgoing feeders with VCBs, CTs, PTs, Bus bars, cables terminals kits and Bus coupler having Main and transfer Bus. Each bay shall consist of VCB, CT, Isolators with earth switch, LAs and PT's etc.	33 kV indoor panels having incoming and outgoing feeders with VCBs, CTs, PTs, Bus bars, cables terminals kits and Main Bus. Each bay shall consist of VCB, CT, Isolators with earth switch, LAs and PT's etc.
3.5.8	13 of 122	Construction of Office cum stores cum control room building with Supervisor room, pantry, wash room, conference room etc along with requisite furniture, workstations, air conditioning, Fire detection & protection system, internal and external illumination, other equipment as per the specifications. The minimum floor area of the control room building shall be 500 sqft.	Construction of Office cum stores cum control room building with Supervisor room, pantry, wash room, conference room etc along with requisite furniture, workstations, air conditioning, Fire detection & protection system, internal and external illumination, other equipment as per the specifications. The minimum floor area of the control room building shall be 1500 sqft.
3.9	14 of 122	Complete responsibility of total Operation & Maintenance of Solar Photovoltaic Power Plant including all the	Complete responsibility of total Operation & Maintenance of Solar Photovoltaic Power Plant including all the

		infrastructure developed as a part of EPC Contract for 5 year from Operational Acceptance of the Plant, including deployment of engineering personnel, technicians and security personnel after the commissioning till final acceptance shall be with the Contractor.	infrastructure developed as a part of EPC Contract for 10 year from Operational Acceptance of the Plant, including deployment of engineering personnel, technicians and security personnel after the commissioning till final acceptance shall be with the Contractor.
6.21	24 of 122	……..Module frame thickness/Height should be minimum 40 mm…….	……..Module frame thickness/Height should be minimum 35 mm…….
9.2.4	38 of 122	All the transformers shall be suitable for outdoor installation with 3 phase 50Hz in which the neutral is effectively earthed and they should be suitable for service under fluctuations in supply voltage up to plus 10% to minus 15%.	All the transformers shall be suitable for outdoor installation with 3 phase 50Hz in which the neutral is effectively earthed and they should be suitable for service under fluctuations in supply voltage up to plus 10% to minus 15%. **Though, it is not required to have neutral earthing in Inverter Transformers.**
9.15.4	58 of 122	The earthing for array and LT power system shall be made of 3.0 m long 40 mm diameter perforated GI pipe / chemical compound filled, double walled earthing electrodes including accessories, and providing masonry enclosure with cast iron cover plate having pad-locking arrangement, watering pipe using charcoal or coke and salt as required as per provisions of IS: 3043.	The earthing for array and LT power system shall be made of 3.0 m long 40 mm diameter perforated GI pipe / chemical compound filled, double walled earthing electrodes including accessories, and providing masonry enclosure with cast iron cover plate having pad-locking arrangement, watering pipe using charcoal or coke and salt as required as per provisions of IS: 3043. However, Maintenance Free grounding with Copper bonded rods can also be considered, after establishing its equivalency with above mentioned type of earthing arrangement in terms of performance, safety & life cycle etc, supported by simulated testing. Responsibility of establishing its equivalency lies with Contractor.
Civil, Mechanical & Plumbing Works	91 of 122	All design and construction of civil works shall conform to relevant Indian standards such as BIS, IRC, MORST, NBC etc. Design of steel structures shall conform to IS: 800, 802 or 802 as applicable……..	All design and construction of civil works shall conform to relevant Indian standards such as BIS, IRC, MORST, NBC etc. Design of steel structures shall conform to IS: 800, 801 or 802 as applicable……..
21.15	103 of 122	Modules shall be clamped & bolted with the structure properly. The material of clamps shall be Al / Steel having weather resistant properties. Clamp – bolt shall use EPDM	Modules shall be clamped & bolted with the structure properly. The material of clamps shall be Anodized Al / Stainless Steel. Clamp/bolt shall use EPDM rubber and must

		rubber and shall be designed in such a way so as not to cast any shadow on the active part of a module.	be designed in such a way so as not to cast any shadow on the active part of a module. In case bolts are used, Spring Washers shall be used on bolt head end and EPDM rubber shall be used in between Module & purlin.

SECTION-VI: Forms & Formats

Clause	Page No.	Existing Clause	Amended Clause.
(XXIV)	2 of 59	Appendix-20 :Format of Bank Guarantee for Mobilization Advance: NOT USED	Appendix-20 :Format of Bank Guarantee for Mobilization Advance: Applicable if desired by the Contractor, Contents provided below

Appendix-20: Format of Bank Guarantee for Mobilization Advance

To be on non-judicial stamp paper of Rupees One Hundred Only (INR 100/-) or appropriate value as per Stamp Act relevant to place of execution, duly signed on each page] Reference No. ……. Bank Guarantee No. ……. Dated: …….

To:

WHEREAS PPT has issued LOI No……. for "……." (Hereinafter called "the Contractor"), having its registered office at …….. AND WHEREAS vide Clause 12.2 of Section III: General Conditions of Contract, Mobilization Advance up to 10% (10 percent) of the original contract value of Rs…….. is payable to the Contractor against Bank Guarantees, the Contractor hereby applies for Mobilization Advance of --% (--- percent) amounting to Rs……../- (Rupees……..) of the Contract Price, Now, we the undersigned, Bank of ……., being fully authorized to sign and to incur obligations for and on behalf of and in the name of Bank of ……..hereby declare that the said Bank will guarantee the Employer the full amount of Rs. ……../- (Rupees……..)1.1 times of the amount as stated above. We, ……[Insert Name of Bank], do hereby unconditionally, irrevocably and without demur guarantee and undertake to pay the Employer immediately on demand any or all money payable by the Contractor to the extent of Rs. ……../-(Rupees……..) without any demur, reservation, context, recourse or protest and/or without any reference to the Contractor. Any such demand made by the Employer on the Bank shall be conclusive and binding notwithstanding any difference between the Employer and the Contractor on any dispute pending before any court, Tribunal, Arbitrator or any other authority. We agree that the guarantee herein contained shall be irrevocable and shall continue to be enforceable till the Employer discharges this guarantee. This guarantee is valid till …….. [insert date of validity in accordance with Clause 1.2.1of Section II: ITB] At any time during the period in which this guarantee still valid of the Contractor fails to fulfil its obligation under the Contract, it is understood that the Bank will extend this guarantee under the same condition for the required time on demand by the Employer at the cost of the Contractor. The Guarantee hereinbefore contained shall not be affected by any change in the constitution of the Bank or of the Contractor. The neglect or forbearance of the Employer in enforcement of payment of any money, the payment whereof is intended to be hereby secured or the giving of time by the Employer for the payment hereof shall in no way relieve the Bank of their liability under this Deed. The expressions "the Employer", "the Bank" and "the Contractor" hereinbefore used shall include their respective successors and assigns. Notwithstanding anything contained herein: Our liability under this Bank Guarantee shall not exceed Rs……../- (Rupees……) this bank Guarantee shall be valid up to……..[insert date of validity in

accordance with Clause 1.2.1 of Section II: ITB] We are liable to pay the guaranteed amount or any part thereof under this Bank Guarantee only and only if you serve upon us a written claim or demand on or before ……(date of expiry of Guarantee). In witness whereof we of the Bank have signed and sealed this Guarantee on the ……day of …….. being herewith duly authorized.

For
_____[Insert Name of the Bank]__
Banker's Stamp and Full Address.
Dated this ____ day of ____, 20__
Witness:
1. …….
Signature
Name and Address
2. …….
Signature
Name and Address

INSTRUCTIONS FOR FURNISHING MOBILIZATION ADVANCE BANK GUARANTEE

- The Bank Guarantee by Bidders will be given on non-judicial stamp paper as per stamp duty applicable at the place where the tender has emanated. The non-judicial stamp paper should be in name of the issuing bank.
- The Bank Guarantee by Bidder will be given from bank as per Schedule 1: List of Banks only.
- This bank guarantee/ all further communication relating to the bank guarantee should be forwarded to (_____), Paradip Port Trust.
- The full address along with the Telex/Fax No. and email address of the issuing bank to be mentioned.
- The Bank Guarantee Checklist provided in Appendix 12(d): Bank Guarantee Verification, duly filled in, should be enclosed with The Bank Guarantee.

Creative Studio

(An ISO : 9001 : 2008 Certified Company)

- Engineers
- Architects
- Project Consultant
- Survey
- Material Testing
- Geotechnical Consultant

RITES
THE INFRASTRUCTURE PEOPLE

ISSUE NO.: CS/BBSR/SOIL/RITES/16-17/ DATE.:

GEO-INVESTIGATION WORK FOR PROPOSED SOLAR PLANT AT PARADIP PORT TRUST, PARADIP.

W.O NO:RPO/RITES/BBSR/PPT/SOIL TES/2016-17/994 DATE:21.07.2016

CLIENT:

RITES LIMITED,BHUBANESWAR.

CONSULTANT:

CREATIVE STUDIO
PLOT NO.PP-18(1ST FLOOR),PANDAV NAGAR, ROAD NO-4,
TANKAPANI ROAD,
BHUBANESWAR -751018 ,ODISHA.

Name of Work: Geo-Technical Investigation Work for Proposed Solar Plant at Paradip Port Trust, Paradip.

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1.0 Introduction

Sub-surface exploration plays an important role in the design for the construction of buildings and bridges. Before design, it is essential to study the behavior as well as the engineering properties of the sub-surface strata, which promotes the design more economic and perfect. It also enables to take precaution in the design for the structural safety. **"GEO-TECHNICAL INVESTIGATION WORK FOR PROPOSED SOLAR PLANT AT PARADIP PORT TRUST, PARADIP."** was decided to be designed on the basis of the sub-surface investigation test results. As such, RITES Limited, Bhubaneswar, entrusted the sub-surface investigation work to M/s Creative Studio. The scope of work comprised of boring Five boreholes at site .The fieldwork included making of boreholes by Wash Boring method. The scope also included conducting Standard Penetration Tests at regular intervals and collecting soil samples for identification and logging purposes, and the collected soil samples were tested in the Base Laboratory and the data were analyzed.

Based on the above, this report presents the Bore Logs, Laboratory & Field Test results. On the basis of field & laboratory test results and their analysis, suitable foundations have been suggested.

2.0 Field Operations

2.1 General:

In an attempt for optimization in the design of foundation for the proposed structure to be constructed at this site, Geo-technical Investigation was done. The entire investigation work had been divided mainly into two parts. (i) Field works & (ii) Laboratory tests.

- Field works determine the types of sub-soil deposit and their characteristics.
- Laboratory tests help in determining the relevant geo-technical properties of the sub-surface deposits leading to finalization of foundation depth of the structure basing on Bearing Capacities of the foundation strata as well as the influence zone.

Final depths of boring and observation of water table for each borehole are given below.

2.2 Boring & In-Situ Tests:

Wash boring method was adopted to bore holes to the required depth. UDS & SPT were conducted at regular intervals and the soil samples were brought to the laboratory with proper identification and labeling. Standard split spoon sampler was used for conducting Standard Penetration Test. The number of blows required to drive the sampler for the 1st, 2nd & 3rd 15cm depths were recorded. The total number of blows required to drive the split spoon sampler due to the free fall of a 63.5kg hammer through a distance of 75 cm for the 2nd and 3rd 15cm penetration were taken together as the field 'N' value or the standard penetration test (resistance) of the soil.

After the penetration to full depth, the sampler was carefully pulled out. The cutting shoe and the head were removed. The soil samples were then sealed in polythene bags and labeled properly by indicating the depth of bore hole mark, reference no. etc for visual inspection and identification of soil samples for logging of the bore holes.

The field 'N' values recorded at various depths have been reported in the summarized data sheet. Test results of soil samples & their bore logs were presented separately in the sub-soil report.

Based on the above, this report presents the Bore Logs, Laboratory & Field Test results.

Undisturbed soil samples were carefully extracted in such a manner that the moisture content and structure of soil did not get altered. Standard open tube sampler was used for the collection of undisturbed soil samples. Each end of the sampling tube was carefully sealed with wax, the bore hole number and depth were indicated on the tube for proper identification.

2.3 Sampling:

Representative soil samples were collected from the borehole confirming to IS: 1892-1979. Collected samples were properly sealed in polythene bags and labeled for proper identification during testing. The disturbed samples were used for classification of soils as per IS: 1498-1970.

2.4 Ground Water Table:

Observation of ground water table is important since it influences the bearing capacity of soil in different seasons. When the foundation remains submerged under water the bearing capacity is to be calculated considering the water table correction factor. Therefore while conducting tests during rany season, it is always necessary to enquire about the ground water table level.

Bore Hole No./Location		Termination Depth in m.	Water Table from the G.L. in m.
BH – 1	Paradip Port Trust,Paradip	6.0	1.20
BH – 2		6.0	0.80
BH – 3		6.0	0.65
BH – 4		6.0	0.90
BH – 5		6.0	1.00

3.0 Information about Laboratory Tests

Laboratory test conforming to relevant Indian Standard specifications were conducted on the soil samples collected from both the boreholes as detailed below. All laboratory tests were conducted as per SP: 36 Part-1 1987 of BIS.

3.1 Grain Size Analysis:

To obtain information concerning the type of soil met at various depths and to classify each soil strata, grain size analysis were carried out as per IS: 2720 (Part-IV). The results have been presented in the summarized data sheet.

3.2 Index Properties:

Soil consistency refers to the resistance of the soil offered against forces that tend to deform or rupture the soil aggregate. Consistency limits indicate the soil moisture content limits for various states of consistency. The consistency limits include Liquid Limit (L.L) and Plastic Limit (P.L). The difference between the numerical values of liquid limit and plastic limit of the soil is called the Plasticity Index (P.I). It indicates the range of moisture content over which the soil exhibits plasticity. It is determined as per the procedure laid down in IS: 2720 (Part-IV). Plasticity index was computed. Results of liquid limit and plasticity index have been reported in the summarized data sheets.

3.3 Specific Gravity:

The specific gravity of the soil sample is the ratio of the mass of a given volume of soil sample in air to the mass of an equal volume of water at 27^0C. Specific gravity of soil sample was determined as per the provisions of IS: 2720 (Part –III). Specific gravity of soil sample obtained during the test has been reported in the summarized data sheet.

3.4 Void Ratio:

Void ratio of different soil samples were determined in through appropriate formula.

3.5 DFS:

Differential free swell index of different soil samples were determined in the laboratory and are mentioned in the laboratory test result sheet.

3.6 TRIAXIAL SHEAR STRENGTH (As per IS: 2720(Part-11)-1993)
(Unconsolidated Undrained)

This standard describes the test for the determination of the compressive strength of a specimen of saturated cohesive soil in the tri-axial compression apparatus under condition in which the cell pressure is maintained constant and there is no change in the total water content of the specimen.

3.7 Final Logging:

The logging of the boreholes as obtained during field work were checked with the disturbed and undisturbed soil samples and scrutinized with the findings of laboratory tests to avoid discrepancies, if any. The bore logs have been reported in the summarized data sheets.

3.8 Results of Test:

The findings of various in-situ and laboratory tests conducted on disturbed /SPT samples have been reported in the summarized data sheet. The soil has been classified into different categories base on their Engineering properties. A careful study of the sub soil strata was made in accordance with the provisions of IS: 1498-1970 to find out their suitability as foundation materials.

4.0 BORELOG

Name of the Consultant:- M/s. Creative studio .
Name of The client :- Rites Limited,Bhubaneswar.
Name of The project :-Proposed Solar Plant at Paradip Port Trust Paradip.
BH No:-01
Test Site Location:-Paradip.
Type of boring:- wash boring
Diameter of boring :-150mm
Inclination:- Vertical
Ground Water Table:- 1.2m Below EGL

Date of starting:18.07.2016
Date of completion:18.07.2016

Sl. No	Thickness of soil strata in m.	R.L. in mt. RL= 98.50 m	Graphical representation of soil strata	Depth from ground level in m.	Type of soil strata	Type of sample collected	No. of blows for 1st 15 cm penetration (1)	No. of blows for 2nd 15 cm penetration (2)	No. of blows for 3rd 15 cm penetration (3)	S.P.T. value = 2+3 =N	Penetration of soil strata in cm.	Remarks
01	1.0	98.0m		0.5	Poorly Graded Sand	DS	---	---	---	---	---	DS Collected
02												
03	3.5	97.0m		1.5	Clay With intermediate compressibility	UDS	---	---	---	---	45	UDS Collected
04		95.5m		3.0		UDS	---	---	---	---	45	UDS Collected
05		94.0m		4.5		SPT	3	4	6	10	45	SPT Sample Collected
06	1.5	92.5m		6.0	Poorly Graded Sand	SPT	4	5	7	12	45	SPT Sample Collected

4.1. BORELOG

Name of the Consultant:- M/s. Creative studio .
Name of The client :- Rites Limited,Bhubaneswar.
Name of The project :-Proposed Solar Plant at Paradip Port Trust Paradip.
BH No:-02
Test Site Location:-Paradip.
Type of boring:- wash boring
Diameter of boring :-150mm
Inclination:- Vertical
Ground Water Table:- 0.80 m Below EGL
Date of starting:18.07.2016
Date of completion:18.07.2016

Sl. No	Thickness of soil strata in m.	R.L. in mt. RL= 97.70m	Graphical representation of soil strata	Depth from ground level in m.	Type of soil strata	Type of sample collected	No. of blows for 1st 15 cm penetration (1)	No. of blows for 2nd 15 cm penetration (2)	No. of blows for 3rd 15 cm penetration (3)	S.P.T. value = 2+3 =N	Penetration of soil strata in cm.	Remarks
01		97.2m		0.5		DS	---	---	---	---	---	DS Collected
02		96.2m		1.5	Clay With intermediate compressibility	UDS	---	---	---	---	45	UDS Collected
03	4.5	94.7m		3.0		UDS	---	---	---	---	45	UDS Collected
04		93.2m		4.5		SPT	3	4	5	9	45	UDS Collected
05	1.5				Silty Sand							
06		91.7m		6.0		SPT	4	5	6	11	45	SPT Sample Collected

4.2. BORELOG

Name of the Consultant:- M/s. Creative studio .
Name of The client :- Rites Limited,Bhubaneswar.
Name of The project :-Proposed Solar Plant at Paradip Port Trust Paradip.
BH No:-03
Test Site Location:-Paradip.
Type of boring:- wash boring
Diameter of boring :-150mm
Inclination:- Vertical
Ground Water Table:-0.65m Below EGL.
Date of starting:19.07.2016
Date of completion:19.07.2016

Sl. No	Thickness of soil strata in m.	R.L. in mt. RL= 97.52m	Graphical representation of soil strata	Depth from ground level in m.	Type of soil strata	Type of sample collected	No. of blows for 1st 15 cm penetration (1)	No. of blows for 2nd 15 cm penetration (2)	No. of blows for 3rd 15 cm penetration (3)	S.P.T. value = 2+3 =N	Penetration of soil strata in cm.	Remarks
01		97.02m		0.5		DS	---	---	---	---	---	DS Collected
02	3.0	96.02m		1.5	Clay With Intermediate compressibility	UDS	---	---	---	---	45	UDS Collected
03		94.52m		3.0		SPT	3	3	5	8	45	SPT Sample Collected
04		93.02m		4.5	Silty Sand	SPT	4	4	5	9	45	SPT Sample Collected
05	3.0											
06		91.52m		6.0		SPT	4	5	7	12	45	SPT Sample Collected

4.3. BORELOG

Name of the Consultant:- M/s. Creative studio .
Name of The client :- Rites Limited,Bhubaneswar.
Name of The project :-Proposed Solar Plant at Paradip Port Trust Paradip.
BH No:-04
Test Site Location:-Paradip.
Type of boring:- wash boring
Diameter of boring :-150mm
Inclination:- Vertical
Ground Water Table:-0.90m Below EGL.
Date of starting:19.07.2016
Date of completion:19.07.2016

Sl. No	Thickness of soil strata in m.	R.L. in mt. RL= 98.02 m	Graphical representation of soil strata	Depth from ground level in m.	Type of soil strata	Type of sample collected	No. of blows for 1st 15 cm penetration (1)	No. of blows for 2nd 15 cm penetration (2)	No. of blows for 3rd 15 cm penetration (3)	S.P.T. value = 2+3 =N	Penetration of soil strata in cm.	Remarks
01	3.0	97.52m		0.5	Clay With intermediate compressibility	DS	---	---	---	---	---	DS Collected
02		96.52m		1.5		UDS	---	---	---	---	45	UDS Collected
03		95.02m		3.0		SPT	2	2	4	6	45	SPT Sample Collected
04	3.0	93.52m		4.5	Silty Sand	SPT	4	7	7	12	45	SPT Sample Collected
05												
06		92.02m		6.0		SPT	5	6	9	14	45	SPT Sample Collected

4.4. BORELOG

Name of the Consultant:- M/s. Creative studio .
Name of The client :- Rites Limited,Bhubaneswar.
Name of The project :-Proposed Solar Plant at Paradip Port Trust Paradip.
BH No:-05
Test Site Location:-Paradip.
Type of boring:- wash boring
Diameter of boring :-150mm
Inclination:- Vertical
Ground Water Table:-1.00m Below EGL.
Date of starting:19.07.2016
Date of completion:19.07.2016

Sl. No	Thickness of soil strata in m.	R.L. in mt. RL= 97.94 m	Graphical representation of soil strata	Depth from ground level in m.	Type of soil strata	Type of sample collected	No. of blows for 1st 15 cm penetration (1)	No. of blows for 2nd 15 cm penetration (2)	No. of blows for 3rd 15 cm penetration (3)	S.P.T. value = 2+3 =N	Penetration of soil strata in cm.	Remarks
01	4.5	97.44m		0.5	Clay With intermediate compressibility	DS	---	---	---	---	---	DS Collected
02		96.44m		1.5		UDS	---	---	---	---	45	UDS Collected
03		94.94m		3.0		UDS	---	---	---	---	45	UDS Collected
04		93.44m		4.5		SPT	3	4	7	11	45	SPT Sample Collected
05	1.5				Silty Sand							
06		91.94m		6.0		SPT	5	5	8	13	45	SPT Sample Collected

5.0 LAB. TEST RESULT

5.1 SUB SOIL INVESTIGATION TEST RESULT

BORE HOLE NO-1

Requisitioner:- RITES LIMITED,BHUBANESWAR
Name of work: - PROPOSED SOLAR PLANT AT PARADIP PORT TRUST,PARADIP.
Bed Level R.L.= 98.50 Mtr
Date of Completion:- 26.07.2016

(TEST CONDUCTED AS PER IS: 2720 (Pt. I, Pt. II, Pt. III , Pt. IV , Pt. V, Pt. XI / Pt. XIII , Pt. XXXX) AND IS: 1498 – 1970)

Sl No.	Soil Sample Collected at depth (m)	Type of Collection	Grain size analysis					Atterberg's Limits			Bulk Density in g/cc	DryDensity in g/cc	Specific Gravity	Natural Moisture Content (%)	Void Ratio (e)	Cohesion (C) (Kg/Cm^2) [UU Test]	Free swelling index in %	SPT (N) Value	Group of soil
			Fine Gravel In % (20mm to 4.75mm)	Coarse Sand In % (4.75mm to 2.00mm)	Medium Sand In % (2.00 mm to 0.425 mm)	Fine Sand in % (0.425mm to 0.075mm)	Silt & Clay in % (0.075mm to 0.001mm)	Liquid Limit in %	Plastic Limit in %	Plasticity Index in %									
1	0.50	DS	0.00	1.34	30.56	64.20	3.90	18.0	Nil	NP	---	---	2.65	---	---	---	0	---	SP
2	1.50	UDS	0.00	0.00	0.12	5.62	94.26	44.0	20.0	24.0	1.795	1.44	2.70	24.62	0.88	0.18	40	---	CI
3	3.00	UDS	0.00	0.00	0.22	6.15	93.63	41.0	18.0	23.0	1.768	1.39	2.70	27.32	0.94	0.22	40	---	CI
4	4.50	SPT	2.12	0.50	31.18	62.76	3.44	18.0	Nil	NP	---	---	2.65	---	---	---	0	10	SP
5	6.00	SPT	1.92	0.26	34.62	60.12	3.08	18.0	Nil	NP	---	---	2.65	---	---	---	0	12	SP

Test report relates only to the above tests & the samples received by this organization.

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5.2 SUB SOIL INVESTIGATION TEST RESULT

BORE HOLE NO-2

Requisitioner:- RITES LIMITED,BHUBANESWAR
Name of work: - PROPOSED SOLAR PLANT AT PARADIP PORT TRUST,PARADIP.
Bed Level R.L.= 97.70 Mtr
Date of Completion:- 26.07.2016

(TEST CONDUCTED AS PER IS: 2720 (Pt. I, Pt. II, Pt. III , Pt. IV , Pt. V, Pt. XI / Pt. XIII , Pt. XXXX) AND IS: 1498 – 1970)

Sl No.	Soil Sample Collected at depth (m)	Type of Collection	Grain size analysis					Atterberg's Limits			Bulk Density in g/cc	DryDensity in g/cc	Specific Gravity	Natural Moisture Content (%)	Void Ratio (e)	Cohesion (C) (Kg/Cm^2) [UU Test]	Free swelling index in %	SPT (N) Value	Group of soil
			Fine Gravel In % (20mm to 4.75mm)	Coarse Sand In % (4.75mm to 2.00mm)	Medium Sand In % (2.00 mm to 0.425 mm)	Fine Sand in % (0.425mm to 0.075mm)	Silt & Clay in % (0.075mm to 0.001mm)	Liquid Limit in %	Plastic Limit in %	Plasticity Index in %									
1	0.50	DS	0.00	0.00	0.00	3.34	96.66	41.0	19.0	22.0	---	---	2.70	---	---	---	36	---	CI
2	1.50	UDS	0.00	0.00	0.24	6.15	93.61	42.0	20.0	22.0	1.762	1.44	2.70	22.18	0.88	0.20	40	---	CI
3	3.00	UDS	0.00	0.00	0.00	7.36	92.64	42.0	20.0	22.0	1.758	1.38	2.70	27.32	0.96	0.23	40	---	CI
4	4.50	SPT	0.00	0.00	1.14	76.15	22.71	22.0	Nil	NP	---	---	2.65	---	---	---	0	9	SM
5	6.00	SPT	0.00	0.00	1.22	74.86	23.92	22.0	Nil	NP	---	---	2.65	---	---	---	0	11	SM

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5.3 SUB SOIL INVESTIGATION TEST RESULT

BORE HOLE NO-3

Requisitioner:- RITES LIMITED,BHUBANESWAR
Name of work: - PROPOSED SOLAR PLANT AT PARADIP PORT TRUST,PARADIP.
Bed Level R.L.= 97.52 Mtr
Date of Completion:- 26.07.2016

(TEST CONDUCTED AS PER IS: 2720 (Pt. I, Pt. II, Pt. III , Pt. IV , Pt. V, Pt. XI / Pt. XIII , Pt. XXXX) AND IS: 1498 – 1970)

Sl No.	Soil Sample Collected at depth (m)	Type of Collection	Grain size analysis					Atterberg's Limits			Bulk Density in g/cc	DryDensity in g/cc	Specific Gravity	Natural Moisture Content (%)	Void Ratio (e)	Cohesion (C) (Kg/Cm^2) [UU Test]	Free swelling index in %	SPT (N) Value	Group of soil
			Fine Gravel In % (20mm to 4.75mm)	Coarse Sand In % (4.75mm to 2.00mm)	Medium Sand In % (2.00 mm to 0.425 mm)	Fine Sand in % (0.425mm to 0.075mm)	Silt & Clay in % (0.075mm to 0.001mm)	Liquid Limit in %	Plastic Limit in %	Plasticity Index in %									
1	0.50	DS	0.00	0.00	0.00	4.32	95.68	40.0	18.0	22.0	---	---	2.70	---	---	---	36	---	CI
2	1.50	UDS	0.00	0.00	0.33	5.85	93.82	42.0	20.0	22.0	1.784	1.47	2.70	21.14	0.84	0.17	42	---	CI
3	3.00	SPT	0.00	0.00	2.22	68.35	29.43	24.0	Nil	NP	---	---	2.65	---	---	---	0	8	SM
4	4.50	SPT	0.00	0.00	1.14	75.32	23.54	22.0	Nil	NP	---	---	2.65	---	---	---	0	9	SM
5	6.00	SPT	0.00	0.00	1.02	70.98	28.00	22.0	Nil	NP	---	---	2.65	---	---	---	0	12	SM

Test report relates only to the above tests & the samples received by this organization.

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5.4 SUB SOIL INVESTIGATION TEST RESULT

BORE HOLE NO-4

Requisitioner:- RITES LIMITED,BHUBANESWAR
Name of work: - PROPOSED SOLAR PLANT AT PARADIP PORT TRUST,PARADIP.
Bed Level R.L.= 98.02 Mtr
Date of Completion:- 26.07.2016

(TEST CONDUCTED AS PER IS: 2720 (Pt. I, Pt. II, Pt. III , Pt. IV , Pt. V, Pt. XI / Pt. XIII , Pt. XXXX) AND IS: 1498 – 1970)

Sl No.	Soil Sample Collected at depth (m)	Type of Collection	Grain size analysis					Atterberg's Limits			Bulk Density in g/cc	DryDensity in g/cc	Specific Gravity	Natural Moisture Content (%)	Void Ratio (e)	Cohesion (C) (Kg/Cm^2) [UU Test]	Free swelling index in %	SPT (N) Value	Group of soil
			Fine Gravel In % (20mm to 4.75mm)	Coarse Sand In % (4.75mm to 2.00mm)	Medium Sand In % (2.00 mm to 0.425 mm)	Fine Sand in % (0.425mm to 0.075mm)	Silt & Clay in % (0.075mm to 0.001mm)	Liquid Limit in %	Plastic Limit in %	Plasticity Index in %									
1	0.50	DS	0.00	0.00	0.35	5.36	94.29	40.0	19.0	21.0	---	---	2.70	---	---	---	40	---	CI
2	1.50	UDS	0.00	0.00	0.28	6.22	93.50	42.0	20.0	22.0	1.768	1.46	2.70	21.05	0.85	0.19	40	---	CI
3	3.00	SPT	0.00	0.00	1.32	74.25	24.43	22.0	Nil	NP	---	---	2.65	---	---	---	0	6	SM
4	4.50	SPT	0.00	0.00	1.42	71.14	27.44	22.0	Nil	NP	---	---	2.65	---	---	---	0	12	SM
5	6.00	SPT	0.00	0.00	1.35	72.65	26.00	22.0	Nil	NP	---	---	2.65	---	---	---	0	14	SM

Test report relates only to the above tests & the samples received by this organization.

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5.5 SUB SOIL INVESTIGATION TEST RESULT

BORE HOLE NO-5

Requisitioner:- RITES LIMITED,BHUBANESWAR
Name of work: - PROPOSED SOLAR PLANT AT PARADIP PORT TRUST,PARADIP.
Bed Level R.L.= 97.94 Mtr
Date of Completion:- 26.07.2016

(TEST CONDUCTED AS PER IS: 2720 (Pt. I, Pt. II, Pt. III , Pt. IV , Pt. V, Pt. XI / Pt. XIII , Pt. XXXX) AND IS: 1498 – 1970)

Sl No.	Soil Sample Collected at depth (m)	Type of Collection	Grain size analysis					Atterberg's Limits			Bulk Density in g/cc	DryDensity in g/cc	Specific Gravity	Natural Moisture Content (%)	Void Ratio (e)	Cohesion (C) (Kg/Cm^2) [UU Test]	Free swelling index in %	SPT (N) Value	Group of soil
			Fine Gravel In % (20mm to 4.75mm)	Coarse Sand In % (4.75mm to 2.00mm)	Medium Sand In % (2.00 mm to 0.425 mm)	Fine Sand in % (0.425mm to 0.075mm)	Silt & Clay in % (0.075mm to 0.001mm)	Liquid Limit in %	Plastic Limit in %	Plasticity Index in %									
1	0.50	DS	0.00	0.00	0.12	7.32	92.56	42.0	20.0	22.0	---	---	2.70	---	---	---	36	---	CI
2	1.50	UDS	0.00	0.00	0.44	5.15	94.41	44.0	21.0	23.0	1.8	1.45	2.70	24.32	0.86	0.22	40	---	CI
3	3.00	UDS	0.00	0.00	0.24	4.85	94.91	44.0	21.0	23.0	1.82	1.43	2.70	26.89	0.89	0.24	40	---	CI
4	4.50	SPT	0.00	0.00	1.25	68.85	29.90	22.0	Nil	NP	---	---	2.65	---	---	---	0	11	SM
5	6.00	SPT	0.00	0.00	1.04	75.36	23.60	22.0	Nil	NP	---	---	2.65	---	---	---	0	13	SM

Test report relates only to the above tests & the samples received by this organization.

6.0 Calculation of Net Safe Bearing Capacity

6.1 NET SAFE BEARING CAPACITY FROM SHEAR FAILURE CRITERIA

B.H No.	:	1
Depth (D_t)	:	1.5 m
Width of Foundation (B)	:	2.0 m
Length of foundation (L)	:	2.0 m
Depth of water table (D_f)	:	1.20 m

As per the Lab. report

Cohesion (C)	:	0.18 kgf/cm^2
Specific Gravity (Gs)	:	2.7
Void ratio (e)	:	0.88

Bearing Capacity Factors

Based on φ value	:	N_c = 5.14
Type of footing	:	Square
Shape Factors	:	S_c = 1.3
Depth Factors	:	d_c = 1.15
Inclination of load to the vertical	:	0 Degree
Inclination Factors	:	ic = 1

Since Ø = 0,The net ultiate bearing capacity calculated as per Cl No. 5.3 of IS 6403:1981

qd = cNcscdcic	=	13.83 **T/m^2**
Factor of Saftey for Soil	:	2.5
Net Safe Bearing Capacity (NSBC)	:	5.53 **T/m^2**

6.2 NET SAFE BEARING CAPACITY FROM SHEAR FAILURE CRITERIA

B.H No.	:		1	
Depth (D_t)	:		3.0	m
Width of Foundation (B)	:		2.0	m
Length of foundation (L)	:		2.0	m
Depth of water table (D_f)	:		1.20	m
As per the Lab. report				
Cohesion (C)	:		0.22	kgf/cm^2
Specific Gravity (Gs)	:		2.7	
Void ratio (e)	:		0.94	
Bearing Capacity Factors				
Based on φ value	:	N_c =		5.14
Type of footing	:	Square		
Shape Factors	:	S_c =		1.3
Depth Factors	:	d_c =		1.301
Inclination of load to the vertical	:		0	Degree
Inclination Factors	:	ic =		1

Since Ø = 0,The net ultiate bearing capacity calculated as per Cl No. 5.3 of IS 6403:1981

qd = cNcscdcic	=	19.13	**T/m^2**
Factor of Saftey for Soil	:	2.5	
Net Safe Bearing Capacity (NSBC)	:	7.65	**T/m^2**

6.3 SAFE BEARING CAPACITY FOR COHESSIONLESS SOIL BY SHEAR FAILURE CRITERIA FROM SPT N-VALUE.

1.As per the Field report :

Bore Hole No.	:	1				
Field SPT (N) Value	:	10				
Depth (Df)	:	6.0	m			
Depth of water table	:	1.2	m			

2.As per the Lab report :

Specific gravity		2.65				
Submeged unit weight (γ_{sub})		10.00	KN/m^3			
Correction factor for cohessionless soil		1	Strata below water table			
Correction for overburden (N')		10	contains fine sands and			**YES**
Due to Dilatancy (N'')		10	silts			
Angle of shearing resistance (ϕ)		30.0	Degree			
ϕ'		21.1	Degree			

3. Assumptions

Width of Foundation (B)		2	m			
Length of foundation (L)		2	m			
Type of footing	:	Square				

4. Calculation

Since ϕ Between 30 to 36 , Interpolate is considered. The ultimate bearing capacity is calculated As per IS: 6403 Clause-5.2.2.1

Over burdern pressure (q)		60	KN/m^2			
Bearing Capacity Factors (Based on φ value)	:	N_q =	18.4			
		N_y =	22.40			
Bearing Capacity Factors (Based on φ' value)	:	N'_q =	7.34			
	:	N'_y =	6.6			
Shape Factors	:	S_q =	1.2			
	:	S_y =	0.8			
Depth Factors	:	d_q =	1.52			
	:	d_y =	1.52			
Inclination of load to the vertical	:	0	Degree			
Inclination Factors	:	iq=	1.0			
		iy=	1.0			
Effect of Water Table = **W'**	:	0.5				
Difference in Nq	:	11.06				
Difference in Ny	:	15.80				
From interpolation Nq	:	7.34				
From interpolation Ny	:	6.60				
$qd = q(Nq -1)\, sq\, dq\, iq + 1/2\, B\gamma\, N_y\, s\gamma\, d\gamma\, i\gamma\, W'$	:	693.85	+	40.13	=	733.98 KN/m^2
Considering factor of safety	:	3				
Net Safe Bearing Capacity (NSBC)	:	244.66	KN/m^2	=	24.94	**T/m^2**

Name of Work: Geo-Technical Investigation Work for Proposed Solar Plant at Paradip Port Trust, Paradip.

6.4 SAFE BEARING CAPACITY FOR COHESSIONLESS SOIL BY SHEAR FAILURE CRITERIA FROM SPT N-VALUE.

1.As per the Field report :

Bore Hole No.	:	1				
Field SPT (N) Value	:	12				
Depth (Df)	:	6.0	m			
Depth of water table	:	1.2	m			

2.As per the Lab report :

Specific gravity	2.65			
Submeged unit weight (γ_{sub})	10.00	KN/m^3		
Correction factor for cohessionless soil	1	Strata below water table		
Correction for overburden (N')	12	contains fine sands and	**YES**	
Due to Dilatancy (N'')	12	silts		
Angle of shearing resistance (ϕ)	30.6	Degree		
ϕ'	21.6	Degree		

3. Assumptions

Width of Foundation (B)		2	m			
Length of foundation (L)		2	m			
Type of footing	:	Square				

4. Calculation

Since ϕ Between 30 to 36 , Interpolate is considered. The ultimate bearing capacity is calculated As per IS: 6403 Clause-5.2.2.1

Over burdern pressure (q)		60	KN/m^2				
Bearing Capacity Factors (Based on ϕ value)	:	$N_{q=}$	20.19				
		$N_{y=}$	25.48				
Bearing Capacity Factors (Based on ϕ' value)	:	$N'_{q=}$	7.76				
	:	$N'_{y=}$	7.15				
Shape Factors	:	$S_{q=}$	1.2				
	:	$S_{y=}$	0.8				
Depth Factors	:	$d_{q=}$	1.53				
	:	$d_{y=}$	1.53				
Inclination of load to the vertical	:	0	Degree				
Inclination Factors	:	iq=	1.0				
		iy=	1.0				
Effect of Water Table = **W'**	:	0.5					
Difference in Nq	:	12.43					
Difference in Ny	:	18.33					
From interpolation Nq	:	9					
From interpolation Ny	:	8.98					
$qd = q(Nq - 1)\, sq\, dq\, iq + 1/2\, B\gamma\, N_y\, s\gamma\, d\gamma\, i\gamma\, W'$	:	881.28	+	54.96	=	936.24	KN/m^2
Considering factor of safety	:	3					
Net Safe Bearing Capacity (NSBC)	:	312.08	KN/m^2	=	31.81	**T/m^2**	

Name of Work: Geo-Technical Investigation Work for Proposed Solar Plant at Paradip Port Trust, Paradip.

6.5 NET SAFE BEARING CAPACITY FROM SHEAR FAILURE CRITERIA

B.H No.	:	2
Depth (D_t)	:	1.5 m
Width of Foundation (B)	:	2.0 m
Length of foundation (L)	:	2.0 m
Depth of water table (D_f)	:	0.80 m

As per the Lab. report

Cohesion (C)	:	0.20 kgf/cm^2
Specific Gravity (Gs)	:	2.7
Void ratio (e)	:	0.88

Bearing Capacity Factors

Based on φ value	:	N_c = 5.14
Type of footing	:	Square
Shape Factors	:	S_c = 1.3
Depth Factors	:	d_c = 1.151
Inclination of load to the vertical	:	0 Degree
Inclination Factors	:	ic = 1

Since Ø = 0,The net ultiate bearing capacity calculated as per Cl No. 5.3 of IS 6403:1981

qd = cNcscdcic	=	15.38 **T/m^2**
Factor of Saftey for Soil	:	2.5
Net Safe Bearing Capacity (NSBC)	:	6.15 **T/m^2**

6.6 NET SAFE BEARING CAPACITY FROM SHEAR FAILURE CRITERIA

B.H No.	:	2
Depth (D_t)	:	3.0 m
Width of Foundation (B)	:	2.0 m
Length of foundation (L)	:	2.0 m
Depth of water table (D_f)	:	0.80 m
As per the Lab. report		
Cohesion (C)	:	0.23 kgf/cm^2
Specific Gravity (Gs)	:	2.7
Void ratio (e)	:	0.96
Bearing Capacity Factors		
Based on φ value	:	N_c = 5.14
Type of footing	:	Square
Shape Factors	:	S_c = 1.3
Depth Factors	:	d_c = 1.301
Inclination of load to the vertical	:	0 Degree
Inclination Factors	:	ic = 1

Since Ø = 0,The net ultiate bearing capacity calculated as per Cl No. 5.3 of IS 6403:1981

qd = cNcscdcic	=	19.99 **T/m^2**
Factor of Saftey for Soil	:	2.5
Net Safe Bearing Capacity (NSBC)	:	8.00 **T/m^2**

6.7 SAFE BEARING CAPACITY FOR COHESSIONLESS SOIL BY SHEAR FAILURE CRITERIA FROM SPT N-VALUE.

1.As per the Field report :

Bore Hole No.	:	2		
Field SPT (N) Value	:	9		
Depth (Df)	:	4.5	m	
Depth of water table	:	0.8	m	

2.As per the Lab report :

Specific gravity	2.65		
Submeged unit weight (γ_{sub})	10.00	KN/m^3	
Correction factor for cohessionless soil	1	Strata below water table	
Correction for overburden (N')	9	contains fine sands and	**YES**
Due to Dilatancy (N'')	9	silts	
Angle of shearing resistance (ϕ)	29.6	Degree	
ϕ'	20.8	Degree	

3. Assumptions

Width of Foundation (B)	2	m	
Length of foundation (L)	2	m	
Type of footing	: Square		

4. Calculation

Since ϕ <30 , Local shear is considered. The ultimate bearing capacity is calculated
As per IS: 6403 Clause-5.2.2.1

Over burdern pressure (q)		45	KN/m^2			
Bearing Capacity Factors (Based on φ' value)	:	$N'_{q=}$	7.08			
	:	$N'_{y=}$	6.27			
Shape Factors	:	$S_{q=}$	1.2			
	:	$S_{y=}$	0.8			
Depth Factors	:	$d_{q=}$	1.39			
	:	$d_{y=}$	1.39			
Inclination of load to the vertical	:	0	Degree			
Inclination Factors	:	iq=	1.0			
		iy=	1.0			
Z_w	:	0	m			
Effect of Water Table = **W'**	:	0.5				
$q'd = q(N'q -1)\, sq\, dq\, iq + 1/2\, B\gamma\, N'_y\, s\gamma\, d\gamma\, i\gamma\, W'$	:	456.36	+	34.86	=	491.22 KN/m^2
Considering factor of safety	:	3				
Net Safe Bearing Capacity (NSBC)	:	163.74	KN/m^2	=	16.69	**T/m^2**

Name of Work: Geo-Technical Investigation Work for Proposed Solar Plant at Paradip Port Trust, Paradip.

6.8 SAFE BEARING CAPACITY FOR COHESSIONLESS SOIL BY SHEAR FAILURE CRITERIA FROM SPT N-VALUE.

1.As per the Field report :

Bore Hole No.	:	2				
Field SPT (N) Value	:	11				
Depth (Df)	:	6.0	m			
Depth of water table	:	0.8	m			

2.As per the Lab report :

Specific gravity	2.65			
Submeged unit weight (γ_{sub})	10.00	KN/m^3		
Correction factor for cohessionless soil	1	Strata below water table		
Correction for overburden (N')	11	contains fine sands and	**YES**	
Due to Dilatancy (N'')	11	silts		
Angle of shearing resistance (ϕ)	30.3	Degree		
ϕ'	21.4	Degree		

3. Assumptions

Width of Foundation (B)	2	m	
Length of foundation (L)	2	m	
Type of footing	: Square		

4. Calculation

Since ϕ Between 30 to 36 , Interpolate is considered. The ultimate bearing capacity is calculated As per IS: 6403 Clause-5.2.2.1

Over burdern pressure (q)		60	KN/m^2			
Bearing Capacity Factors (Based on φ value)	:	N_q =	19.29			
		N_y =	23.94			
Bearing Capacity Factors (Based on φ' value)	:	N'_q =	7.59			
	:	N'_y =	6.93			
Shape Factors	:	S_q =	1.2			
	:	S_y =	0.8			
Depth Factors	:	d_q =	1.52			
	:	d_y =	1.52			
Inclination of load to the vertical	:	0	Degree			
Inclination Factors	:	iq=	1.0			
		iy=	1.0			
Effect of Water Table = **W'**	:	0.5				
Difference in Nq	:	11.7				
Difference in Ny	:	17.01				
From interpolation Nq	:	8.18				
From interpolation Ny	:	7.78				
$qd = q(Nq -1)\, sq\, dq\, iq + 1/2\, B\gamma\, N_y\, s\gamma\, d\gamma\, i\gamma\, W'$	:	785.78	+	47.30	=	833.08 KN/m^2
Considering factor of safety	:	3				
Net Safe Bearing Capacity (NSBC)	:	277.69	KN/m^2	=	28.31	**T/m^2**

Name of Work: Geo-Technical Investigation Work for Proposed Solar Plant at Paradip Port Trust, Paradip.

6.9 NET SAFE BEARING CAPACITY FROM SHEAR FAILURE CRITERIA

B.H No.	:		3	
Depth (D_t)	:		1.5	m
Width of Foundation (B)	:		2.0	m
Length of foundation (L)	:		2.0	m
Depth of water table (D_f)	:		0.65	m
As per the Lab. report				
Cohesion (C)	:		0.17	kgf/cm^2
Specific Gravity (Gs)	:		2.7	
Void ratio (e)	:		0.84	
Bearing Capacity Factors				
Based on φ value	:	N_c =		5.14
Type of footing	:	Square		
Shape Factors	:	S_c =		1.3
Depth Factors	:	d_c =		1.15
Inclination of load to the vertical	:		0	Degree
Inclination Factors	:	ic =		1

Since Ø = 0,The net ultiate bearing capacity calculated as per Cl No. 5.3 of IS 6403:1981

qd = cNcscdcic	=	13.06	**T/m^2**
Factor of Saftey for Soil	:	2.5	
Net Safe Bearing Capacity (NSBC)	:	5.22	**T/m^2**

6.10 SAFE BEARING CAPACITY FOR COHESSIONLESS SOIL BY SHEAR FAILURE CRITERIA FROM SPT N-VALUE.

1.As per the Field report :

Bore Hole No.	:	3		
Field SPT (N) Value	:	8		
Depth (Df)	:	3.0	m	
Depth of water table	:	0.65	m	

2.As per the Lab report :

Specific gravity		2.65		
Submeged unit weight (γ_{sub})		10.00	KN/m^3	
Correction factor for cohessionless soil		1	Strata below water table	
Correction for overburden (N')		8	contains fine sands and	**YES**
Due to Dilatancy (N'')		8	silts	
Angle of shearing resistance (ϕ)		29.2	Degree	
ϕ'		20.5	Degree	

3. Assumptions

Width of Foundation (B)		2	m
Length of foundation (L)		2	m
Type of footing	:	Square	

4. Calculation

Since ϕ <30 , Local shear is considered. The ultimate bearing capacity is calculated
As per IS: 6403 Clause-5.2.2.1

Over burdern pressure (q)			30	KN/m^2		
Bearing Capacity Factors (Based on φ' value)	:	$N'_{q=}$	6.83			
	:	$N'_{y=}$	5.94			
Shape Factors	:	$S_{q=}$	1.2			
	:	$S_{y=}$	0.8			
Depth Factors	:	$d_{q=}$	1.26			
	:	$d_{y=}$	1.26			
Inclination of load to the vertical	:		0	Degree		
Inclination Factors	:	iq=	1.0			
		iy=	1.0			
Z_w	:		0	m		
Effect of Water Table = **W'**	:		0.5			
$q'd = q(N'q -1)\, sq\, dq\, iq + 1/2\, B\gamma\, N'_y\, s\gamma\, d\gamma\, i\gamma\, W'$	:		264.45	+ 29.94	=	294.39 KN/m^2
Considering factor of safety	:		3			
Net Safe Bearing Capacity (NSBC)	:		98.13	KN/m^2 =		10.0 **T/m^2**

6.11 SAFE BEARING CAPACITY FOR COHESSIONLESS SOIL BY SHEAR FAILURE CRITERIA FROM SPT N-VALUE.

1.As per the Field report :

Bore Hole No.	:	3	
Field SPT (N) Value	:	9	
Depth (Df)	:	4.5	m
Depth of water table	:	0.65	m

2.As per the Lab report :

Specific gravity		2.65	
Submeged unit weight (γ_{sub})		10.00	KN/m^3
Correction factor for cohessionless soil		1	Strata below water table
Correction for overburden (N')		9	contains fine sands and **YES**
Due to Dilatancy (N'')		9	silts
Angle of shearing resistance (ϕ)		29.6	Degree
ϕ'		20.8	Degree

3. Assumptions

Width of Foundation (B)		2	m
Length of foundation (L)		2	m
Type of footing	:	Square	

4. Calculation

Since ϕ <30 , Local shear is considered. The ultimate bearing capacity is calculated
As per IS: 6403 Clause-5.2.2.1

Over burdern pressure (q)		45	KN/m^2
Bearing Capacity Factors (Based on φ' value)	:	$N'_{q=}$	7.08
	:	$N'_{y=}$	6.27
Shape Factors	:	$S_{q=}$	1.2
	:	$S_{y=}$	0.8
Depth Factors	:	$d_{q=}$	1.39
	:	$d_{y=}$	1.39
Inclination of load to the vertical	:	0	Degree
Inclination Factors	:	iq=	1.0
		iy=	1.0
Z_w	:	0	m
Effect of Water Table = **W'**	:	0.5	

$q'd = q(N'q -1) sq\ dq\ iq + 1/2\ B\gamma\ N'_y\ s\gamma\ d\gamma\ i\gamma\ W'$	:	456.36	+	34.86	=	491.22	KN/m^2
Considering factor of safety	:	3					
Net Safe Bearing Capacity (NSBC)	:	163.74	KN/m^2	=	16.69	**T/m^2**	

6.12 SAFE BEARING CAPACITY FOR COHESSIONLESS SOIL BY SHEAR FAILURE CRITERIA FROM SPT N-VALUE.

1.As per the Field report :						
Bore Hole No.	:	3				
Field SPT (N) Value	:	12				
Depth (Df)	:	6.0	m			
Depth of water table	:	0.65	m			
2.As per the Lab report :						
Specific gravity		2.65				
Submeged unit weight (γ_{sub})		10.00	KN/m^3			
Correction factor for cohessionless soil		1	Strata below water table			
Correction for overburden (N')		12	contains fine sands and			**YES**
Due to Dilatancy (N'')		12	silts			
Angle of shearing resistance (ϕ)		30.6	Degree			
ϕ'		21.6	Degree			
3. Assumptions						
Width of Foundation (B)		2	m			
Length of foundation (L)		2	m			
Type of footing	:	Square				
4. Calculation						
Since ϕ Between 30 to 36 , Interpolate is considered. The ultimate bearing capacity is calculated As per IS: 6403 Clause-5.2.2.1						
Over burdern pressure (q)		60	KN/m^2			
Bearing Capacity Factors (Based on φ value)	:	N_q =	20.19			
		N_y =	25.48			
Bearing Capacity Factors (Based on φ' value)	:	N'_q =	7.76			
	:	N'_y =	7.15			
Shape Factors	:	S_q =	1.2			
	:	S_y =	0.8			
Depth Factors	:	d_q =	1.53			
	:	d_y =	1.53			
Inclination of load to the vertical	:	0	Degree			
Inclination Factors	:	iq=	1.0			
		iy=	1.0			
Effect of Water Table = **W'**	:	0.5				
Difference in Nq	:	12.43				
Difference in Ny	:	18.33				
From interpolation Nq	:	9				
From interpolation Ny	:	8.98				
$qd = q(Nq -1)\, sq\, dq\, iq + 1/2\, B\gamma\, N_y\, s\gamma\, d\gamma\, i\gamma\, W'$	:	881.28	+	54.96	=	936.24 KN/m^2
Considering factor of safety	:	3				
Net Safe Bearing Capacity (NSBC)	:	312.08	KN/m^2	=	31.81	**T/m^2**

6.13 NET SAFE BEARING CAPACITY FROM SHEAR FAILURE CRITERIA

B.H No.	:		4	
Depth (D_t)	:		1.5	m
Width of Foundation (B)	:		2.0	m
Length of foundation (L)	:		2.0	m
Depth of water table (D_f)	:		0.90	m
As per the Lab. report				
Cohesion (C)	:		0.19	kgf/cm^2
Specific Gravity (Gs)	:		2.7	
Void ratio (e)	:		0.85	
Bearing Capacity Factors				
Based on φ value	:	N_c =		5.14
Type of footing	:	Square		
Shape Factors	:	S_c =		1.3
Depth Factors	:	d_c =		1.15
Inclination of load to the vertical	:		0	Degree
Inclination Factors	:	ic =		1

Since Ø = 0,The net ultiate bearing capacity calculated as per Cl No. 5.3 of IS 6403:1981

qd = cNcscdcic	=		14.60	**T/m^2**
Factor of Saftey for Soil	:	2.5		
Net Safe Bearing Capacity (NSBC)	:		5.84	**T/m^2**

6.14 SAFE BEARING CAPACITY FOR COHESSIONLESS SOIL BY SHEAR FAILURE CRITERIA FROM SPT N-VALUE.

1.As per the Field report :

Bore Hole No.	:	4	
Field SPT (N) Value	:	6	
Depth (Df)	:	3.0	m
Depth of water table	:	0.9	m

2.As per the Lab report :

Specific gravity		2.65	
Submeged unit weight (γ_{sub})		10.00	KN/m^3
Correction factor for cohessionless soil		1	Strata below water table
Correction for overburden (N')		6	contains fine sands and **YES**
Due to Dilatancy (N'')		6	silts
Angle of shearing resistance (ϕ)		28.4	Degree
ϕ'		19.9	Degree

3. Assumptions

Width of Foundation (B)		2	m
Length of foundation (L)		2	m
Type of footing	:	Square	

4. Calculation

Since ϕ <30 , Local shear is considered. The ultimate bearing capacity is calculated
As per IS: 6403 Clause-5.2.2.1

Over burdern pressure (q)		30	KN/m^2
Bearing Capacity Factors (Based on φ' value)	:	$N'_{q=}$	6.35
	:	$N'_{y=}$	5.34
Shape Factors	:	$S_{q=}$	1.2
	:	$S_{y=}$	0.8
Depth Factors	:	$d_{q=}$	1.25
	:	$d_{y=}$	1.25
Inclination of load to the vertical	:	0	Degree
Inclination Factors	:	iq=	1.0
		iy=	1.0
Z_w	:	0	m
Effect of Water Table = **W'**	:	0.5	

$q'd = q(N'q -1)\, sq\, dq\, iq + 1/2\, B\gamma\, N'_y\, s\gamma\, d\gamma\, i\gamma\, W'$	:	240.75	+	26.7	=	267.45 KN/m^2
Considering factor of safety	:	3				
Net Safe Bearing Capacity (NSBC)	:	89.15	KN/m^2	=	9.09	**T/m^2**

6.15 SAFE BEARING CAPACITY FOR COHESSIONLESS SOIL BY SHEAR FAILURE CRITERIA FROM SPT N-VALUE.

1.As per the Field report :

Bore Hole No.	:	4				
Field SPT (N) Value	:	12				
Depth (Df)	:	4.5	m			
Depth of water table	:	0.9	m			

2.As per the Lab report :

Specific gravity	2.65			
Submeged unit weight (γ_{sub})	10.00	KN/m^3		
Correction factor for cohessionless soil	1	Strata below water table		
Correction for overburden (N')	12	contains fine sands and	**YES**	
Due to Dilatancy (N'')	12	silts		
Angle of shearing resistance (ϕ)	30.6	Degree		
ϕ'	21.6	Degree		

3. Assumptions

Width of Foundation (B)	2	m	
Length of foundation (L)	2	m	
Type of footing	: Square		

4. Calculation

Since ϕ Between 30 to 36 , Interpolate is considered. The ultimate bearing capacity is calculated As per IS: 6403 Clause-5.2.2.1

Over burdern pressure (q)		45	KN/m^2			
Bearing Capacity Factors (Based on φ value)	:	$N_{q=}$	20.19			
		$N_{y=}$	25.48			
Bearing Capacity Factors (Based on φ' value)	:	$N'_{q=}$	7.76			
	:	$N'_{y=}$	7.15			
Shape Factors	:	$S_{q=}$	1.2			
	:	$S_{y=}$	0.8			
Depth Factors	:	$d_{q=}$	1.39			
	:	$d_{y=}$	1.39			
Inclination of load to the vertical	:	0	Degree			
Inclination Factors	:	iq=	1.0			
		iy=	1.0			
Effect of Water Table = **W'**	:	0.5				
Difference in Nq	:	12.43				
Difference in Ny	:	18.33				
From interpolation Nq	:	9				
From interpolation Ny	:	8.98				
$qd = q(Nq -1) sq dq iq + 1/2 B\gamma N_y s\gamma d\gamma i\gamma W'$	:	600.48	+	49.93	=	650.41 KN/m^2
Considering factor of safety	:	3				
Net Safe Bearing Capacity (NSBC)	:	216.8	KN/m^2	=	22.10	**T/m^2**

Name of Work: Geo-Technical Investigation Work for Proposed Solar Plant at Paradip Port Trust, Paradip.

6.16 SAFE BEARING CAPACITY FOR COHESSIONLESS SOIL BY SHEAR FAILURE CRITERIA FROM SPT N-VALUE.

1.As per the Field report :

Bore Hole No.	:	4				
Field SPT (N) Value	:	14				
Depth (Df)	:	6.0	m			
Depth of water table	:	0.9	m			

2.As per the Lab report :

Specific gravity		2.65			
Submeged unit weight (γ_{sub})		10.00	KN/m^3		
Correction factor for cohessionless soil		1	Strata below water table		
Correction for overburden (N')		14	contains fine sands and		**YES**
Due to Dilatancy (N'')		14	silts		
Angle of shearing resistance (ϕ)		31.2	Degree		
ϕ'		22.1	Degree		

3. Assumptions

Width of Foundation (B)		2	m
Length of foundation (L)		2	m
Type of footing	:	Square	

4. Calculation

Since ϕ Between 30 to 36 , Interpolate is considered. The ultimate bearing capacity is calculated As per IS: 6403 Clause-5.2.2.1

Over burdern pressure (q)			60	KN/m^2		
Bearing Capacity Factors (Based on φ value)	:	$N_{q=}$	21.98			
		$N_{y=}$	28.55			
Bearing Capacity Factors (Based on φ' value)	:	$N'_{q=}$	8.19			
	:	$N'_{y=}$	7.7			
Shape Factors	:	$S_{q=}$	1.2			
	:	$S_{y=}$	0.8			
Depth Factors	:	$d_{q=}$	1.53			
	:	$d_{y=}$	1.53			
Inclination of load to the vertical	:		0	Degree		
Inclination Factors	:	iq=	1.0			
		iy=	1.0			
Effect of Water Table = **W'**	:		0.5			
Difference in Nq	:		13.79			
Difference in Ny	:		20.85			
From interpolation Nq	:		10.95			
From interpolation Ny	:		11.87			
$qd = q(Nq - 1)\, sq\, dq\, iq + 1/2\, B\gamma\, N_y\, s\gamma\, d\gamma\, i\gamma\, W'$	:		1096.09	+ 72.64	=	1168.73 KN/m^2
Considering factor of safety	:		3			
Net Safe Bearing Capacity (NSBC)	:		389.58	KN/m^2 =		39.71 **T/m^2**

Name of Work: Geo-Technical Investigation Work for Proposed Solar Plant at Paradip Port Trust, Paradip.

6.17 NET SAFE BEARING CAPACITY FROM SHEAR FAILURE CRITERIA

B.H No.	:		5	
Depth (D_t)	:		1.5	m
Width of Foundation (B)	:		2.0	m
Length of foundation (L)	:		2.0	m
Depth of water table (D_f)	:		1.00	m
As per the Lab. report				
Cohesion (C)	:		0.22	kgf/cm^2
Specific Gravity (Gs)	:		2.7	
Void ratio (e)	:		0.86	
Bearing Capacity Factors				
Based on φ value	:	N_c =		5.14
Type of footing	:	Square		
Shape Factors	:	S_c =		1.3
Depth Factors	:	d_c =		1.151
Inclination of load to the vertical	:		0	Degree
Inclination Factors	:	ic =		1

Since Ø = 0,The net ultiate bearing capacity calculated as per Cl No. 5.3 of IS 6403:1981

qd = cNcscdcic	=		16.92	**T/m^2**
Factor of Saftey for Soil	:	2.5		
Net Safe Bearing Capacity (NSBC)	:		6.77	**T/m^2**

6.18 NET SAFE BEARING CAPACITY FROM SHEAR FAILURE CRITERIA

B.H No.	:		5	
Depth (D_t)	:		3.0	m
Width of Foundation (B)	:		2.0	m
Length of foundation (L)	:		2.0	m
Depth of water table (D_f)	:		1.00	m
As per the Lab. report				
Cohesion (C)	:		0.24	kgf/cm^2
Specific Gravity (Gs)	:		2.7	
Void ratio (e)	:		0.89	
Bearing Capacity Factors				
Based on φ value	:	N_c =		5.14
Type of footing	:	Square		
Shape Factors	:	S_c =		1.3
Depth Factors	:	d_c =		1.301
Inclination of load to the vertical	:		0	Degree
Inclination Factors	:	ic =		1

Since Ø = 0,The net ultiate bearing capacity calculated as per Cl No. 5.3 of IS 6403:1981

qd = cNcscdcic	=		20.86	**T/m^2**
Factor of Saftey for Soil	:	2.5		
Net Safe Bearing Capacity (NSBC)	:		8.34	**T/m^2**

6.19 SAFE BEARING CAPACITY FOR COHESSIONLESS SOIL BY SHEAR FAILURE CRITERIA FROM SPT N-VALUE.

1.As per the Field report :

Bore Hole No.	:	5				
Field SPT (N) Value	:	11				
Depth (Df)	:	4.5	m			
Depth of water table	:	1.0	m			

2.As per the Lab report :

Specific gravity	2.65			
Submeged unit weight (γ_{sub})	10.00	KN/m^3		
Correction factor for cohessionless soil	1	Strata below water table		
Correction for overburden (N')	11	contains fine sands and	**YES**	
Due to Dilatancy (N'')	11	silts		
Angle of shearing resistance (ϕ)	30.3	Degree		
ϕ'	21.4	Degree		

3. Assumptions

Width of Foundation (B)	2	m	
Length of foundation (L)	2	m	
Type of footing	: Square		

4. Calculation

Since ϕ Between 30 to 36 , Interpolate is considered. The ultimate bearing capacity is calculated As per IS: 6403 Clause-5.2.2.1

Over burdern pressure (q)		45	KN/m^2			
Bearing Capacity Factors (Based on ϕ value)	:	$N_{q=}$	19.29			
		$N_{y=}$	23.94			
Bearing Capacity Factors (Based on ϕ' value)	:	$N'_{q=}$	7.59			
	:	$N'_{y=}$	6.93			
Shape Factors	:	$S_{q=}$	1.2			
	:	$S_{y=}$	0.8			
Depth Factors	:	$d_{q=}$	1.39			
	:	$d_{y=}$	1.39			
Inclination of load to the vertical	:	0	Degree			
Inclination Factors	:	iq=	1.0			
		iy=	1.0			
Effect of Water Table = **W'**	:	0.5				
Difference in Nq	:	11.7				
Difference in Ny	:	17.01				
From interpolation Nq	:	8.18				
From interpolation Ny	:	7.78				
$qd = q(Nq -1)\ sq\ dq\ iq + 1/2\ B\gamma\ N_y\ s\gamma\ d\gamma\ i\gamma\ W'$	:	538.93	+	43.26	=	582.19 KN/m^2
Considering factor of safety	:	3				
Net Safe Bearing Capacity (NSBC)	:	194.06	KN/m^2	=	19.78	**T/m^2**

Name of Work: Geo-Technical Investigation Work for Proposed Solar Plant at Paradip Port Trust, Paradip.

6.20 SAFE BEARING CAPACITY FOR COHESSIONLESS SOIL BY SHEAR FAILURE CRITERIA FROM SPT N-VALUE.

1.As per the Field report :

Bore Hole No.	:	5				
Field SPT (N) Value	:	13				
Depth (Df)	:	6.0	m			
Depth of water table	:	1.0	m			

2.As per the Lab report :

Specific gravity		2.65			
Submeged unit weight (γ_{sub})		10.00	KN/m^3		
Correction factor for cohessionless soil		1	Strata below water table		
Correction for overburden (N')		13	contains fine sands and		**YES**
Due to Dilatancy (N'')		13	silts		
Angle of shearing resistance (ϕ)		30.9	Degree		
ϕ'		21.9	Degree		

3. Assumptions

Width of Foundation (B)		2	m
Length of foundation (L)		2	m
Type of footing	:	Square	

4. Calculation

Since ϕ Between 30 to 36 , Interpolate is considered. The ultimate bearing capacity is calculated As per IS: 6403 Clause-5.2.2.1

Over burdern pressure (q)		60	KN/m^2			
Bearing Capacity Factors (Based on φ value)	:	N_q =	21.08			
		N_y =	27.01			
Bearing Capacity Factors (Based on φ' value)	:	N'_q =	8.02			
	:	N'_y =	7.48			
Shape Factors	:	S_q =	1.2			
	:	S_y =	0.8			
Depth Factors	:	d_q =	1.53			
	:	d_y =	1.53			
Inclination of load to the vertical	:	0	Degree			
Inclination Factors	:	iq=	1.0			
		iy=	1.0			
Effect of Water Table = **W'**	:	0.5				
Difference in Nq	:	13.06				
Difference in Ny	:	19.53				
From interpolation Nq	:	9.98				
From interpolation Ny	:	10.41				
qd = q(Nq -1) sq dq iq + 1/2 Bγ N_y sγ dγ iγ W'	:	989.24	+	63.71	=	1052.95 KN/m^2
Considering factor of safety	:	3				
Net Safe Bearing Capacity (NSBC)	:	350.98	KN/m^2	=	35.78	**T/m^2**

7.0 CALCULATION OF SETTLEMENT OF FOOTING

7.1 CALCULATION OF SETTLEMENT OF FOOTING

AS PER IS:8009 (PART -I)-1976

Bore Hole No.:-1

Defth of footing (Df)	:	1.50 m
Width of footing (B)	:	2.00 m
Length of footing (L)	:	2.00 m
Height of Compressible layer (Ht)	=	3.00 m
Consider,Estimate Load (q_o)	:	5.53 t/m^2
Compression Index (Cc)	:	0.306
Void ratio e_0	:	0.88
Specificgravity(G)	:	2.7
Using the 2:1 method, z	=	1.50 m
Submerged density (ysub)	:	1.0 g/cc

CLCULATION OF PRIMARY CONSOLIDATION SETTLEMENT OF CLAY

The clay is normally consolidated.

Thus Sc $= \frac{H_t}{(1+e_0)} X\ C_c\ [\log_{10} (P_0 + D_P)/P_0]$

Initial Pressure P_0 = 3.00 t/m^2

Using the 2:1 method, $\Delta_p = \frac{q_o \times B \times L}{(B+z) \times (L+z)} = \frac{22.12}{12.25}$ = 1.81 t/m^2

Sc = 100.11 mm

Avg. value of λ, for normally consolidated clay as per table 1 of IS:8009 Pt 1 = 0.85

Corrected settlement (S_c) = 85.09 mm

Depth factor = 0.78

Correceted total settlement (S) = 66.37 mm

7.2 CALCULATION OF SETTLEMENT OF FOOTING

AS PER IS:8009 (PART -I)-1976

Bore Hole No.:-1

Defth of footing (Df)	:	3.00 m
Width of footing (B)	:	2.00 m
Length of footing (L)	:	2.00 m
Height of Compressible layer (Ht)	=	1.50 m
Consider,Estimate Load (q_o)	:	7.65 t/m^2
Compression Index (Cc)	:	0.279
Void ratio e_0	:	0.94
Specificgravity(G)	:	2.7
Using the 2:1 method, z	=	0.75 m
Submerged density (ysub)	:	1.0 g/cc

CLCULATION OF PRIMARY CONSOLIDATION SETTLEMENT OF CLAY

The clay is normally consolidated.

Thus Sc $= \frac{H_t}{(1+e_0)} X\ C_c\ [\log_{10} (P_0 + D_P)/P_0]$

Initial Pressure P_0 = 3.75 t/m^2

Using the 2:1 method, $\Delta_p = \frac{q_o \times B \times L}{(B+z) \times (L+z)} = \frac{30.6}{7.56}$ = 4.05 t/m^2

Sc = 68.61 mm

Avg. value of λ, for normally consolidated clay as per table 1 of IS:8009 Pt 1 = 0.85

Corrected settlement (S_c) = 58.32 mm

Depth factor = 0.66

Correceted total settlement (S) = 38.49 mm

7.3 CALCULATION OF SETTLEMENT OF FOOTING

AS PER IS:8009 (PART -I)-1976

Bore Hole No:-1

Depth of footing (Df)	:	4.5	m
Width of footing (B)	:	2.0	m
Length of footing (L)	:	2.0	m
Estimate Load (q_o) (NSBC)	:	24.94	t/m^2
Ground water table	:	1.20	m

IMMEDIATE SETTLEMENT FROM SPT (N) VALUE

Field SPT N Value	=	10	
Corrected N value	=	10	
As per IS: 8009-1976 of Fig.9 Settlement in mm per unit pressure ($1kg/cm^2$)	=	32	mm
Effect of water table	=	0.5	
Settlement after water table correction	=	64	mm
So, Settlement (S_i)		159.62	mm
Depth factor	=	0.61	
Correceted total settlement (S)	=	97.37	mm

7.4 CALCULATION OF SETTLEMENT OF FOOTING

AS PER IS:8009 (PART -I)-1976

Bore Hole No:-1

Depth of footing (Df)	:	6.0	m
Width of footing (B)	:	2.0	m
Length of footing (L)	:	2.0	m
Estimate Load (q_o) (NSBC)	:	31.81	t/m^2
Ground water table	:	1.20	m

IMMEDIATE SETTLEMENT FROM SPT (N) VALUE

Field SPT N Value	=	12	
Corrected N value	=	12	
As per IS: 8009-1976 of Fig.9 Settlement in mm per unit pressure (1kg/cm^2)	=	25.5	mm
Effect of water table	=	0.5	
Settlement after water table correction	=	51	mm
So, Settlement (S_i)		162.23	mm
Depth factor	=	0.58	
Correceted total settlement (S)	=	94.09	mm

7.5 CALCULATION OF SETTLEMENT OF FOOTING

AS PER IS:8009 (PART -I)-1976

Bore Hole No.:-2

Defth of footing (Df)	:	1.50 m
Width of footing (B)	:	2.00 m
Length of footing (L)	:	2.00 m
Height of Compressible layer (Ht)	=	3.00 m
Consider,Estimate Load (q_o)	:	6.15 t/m^2
Compression Index (Cc)	:	0.288
Void ratio e_0	:	0.88
Specificgravity(G)	:	2.7
Using the 2:1 method, z	=	1.50 m
Submerged density (ysub)	:	1.0 g/cc

CLCULATION OF PRIMARY CONSOLIDATION SETTLEMENT OF CLAY

The clay is normally consolidated.

Thus Sc $= \frac{H_t}{(1+e_0)} X\ C_c\ [\log_{10} (P_0 + D_P)/P_0]$

Initial Pressure P_0 = 3.00 t/m^2

Using the 2:1 method, $\Delta_p = \frac{q_o \times B \times L}{(B+z) \times (L+z)} = \frac{24.6}{12.25}$ = 2.01 t/m^2

Sc = 102.35 mm

Avg. value of λ, for normally consolidated clay as per table 1 of IS:8009 Pt 1 = 0.85

Corrected settlement (S_c) = 87 mm

Depth factor = 0.78

Correceted total settlement (S) = 67.86 mm

7.6 CALCULATION OF SETTLEMENT OF FOOTING

AS PER IS:8009 (PART -I)-1976

Bore Hole No.:-2

Defth of footing (Df)	:	3.00 m
Width of footing (B)	:	2.00 m
Length of footing (L)	:	2.00 m
Height of Compressible layer (Ht)	=	1.50 m
Consider,Estimate Load (q_o)	:	8.00 t/m^2
Compression Index (Cc)	:	0.288
Void ratio e_0	:	0.96
Specificgravity(G)	:	2.7
Using the 2:1 method, z	=	0.75 m
Submerged density (ysub)	:	1.0 g/cc

CLCULATION OF PRIMARY CONSOLIDATION SETTLEMENT OF CLAY

The clay is normally consolidated.

Thus Sc $= \frac{H_t}{(1+e_0)} X\ C_c\ [\log_{10} (P_0 + D_P)/P_0]$

Initial Pressure P_0 = 3.75 t/m^2

Using the 2:1 method, $\Delta_p = \frac{q_o \times B \times L}{(B+z) \times (L+z)} = \frac{32}{7.56}$ = 4.23 t/m^2

Sc = 72.29 mm

Avg. value of λ, for normally consolidated clay as per table 1 of IS:8009 Pt 1 = 0.85

Corrected settlement (S_c) = 61.45 mm

Depth factor = 0.66

Correceted total settlement (S) = 40.56 mm

7.7 CALCULATION OF SETTLEMENT OF FOOTING

AS PER IS:8009 (PART -I)-1976

Bore Hole No:-2

Depth of footing (Df)	:	4.5	m
Width of footing (B)	:	2.0	m
Length of footing (L)	:	2.0	m
Estimate Load (q_o) (NSBC)	:	16.69	t/m^2
Ground water table	:	0.80	m

IMMEDIATE SETTLEMENT FROM SPT (N) VALUE

Field SPT N Value	=	9	
Corrected N value	=	9	
As per IS: 8009-1976 of Fig.9 Settlement in mm per unit pressure ($1kg/cm^2$)	=	40	mm
Effect of water table	=	0.5	
Settlement after water table correction	=	80	mm
So, Settlement (S_i)		133.52	mm
Depth factor	=	0.61	
Correceted total settlement (S)	=	81.45	mm

7.8 CALCULATION OF SETTLEMENT OF FOOTING

AS PER IS:8009 (PART -I)-1976

Bore Hole No:-2

Depth of footing (Df)	:	6.0	m
Width of footing (B)	:	2.0	m
Length of footing (L)	:	2.0	m
Estimate Load (q_o) (NSBC)	:	28.31	t/m^2
Ground water table	:	0.80	m

IMMEDIATE SETTLEMENT FROM SPT (N) VALUE

Field SPT N Value	=	11	
Corrected N value	=	11	
As per IS: 8009-1976 of Fig.9 Settlement in mm per unit pressure ($1kg/cm^2$)	=	28	mm
Effect of water table	=	0.5	
Settlement after water table correction	=	56	mm
So, Settlement (S_i)		158.54	mm
Depth factor	=	0.58	
Correceted total settlement (S)	=	91.95	mm

7.9 CALCULATION OF SETTLEMENT OF FOOTING

AS PER IS:8009 (PART -I)-1976

Bore Hole No.:-3

Defth of footing (Df)	:	1.50 m
Width of footing (B)	:	2.00 m
Length of footing (L)	:	2.00 m
Height of Compressible layer (Ht)	=	1.50 m
Consider,Estimate Load (q_o)	:	5.22 t/m^2
Compression Index (Cc)	:	0.288
Void ratio e_0	:	0.84
Specificgravity(G)	:	2.7
Using the 2:1 method, z	=	0.75 m
Submerged density (ysub)	:	1.0 g/cc

CLCULATION OF PRIMARY CONSOLIDATION SETTLEMENT OF CLAY

The clay is normally consolidated.

Thus Sc $= \frac{H_t}{(1+e_0)} X\ C_c\ [\log_{10} (P_0 + D_P)/P_0]$

Initial Pressure P_0 = 2.25 t/m^2

Using the 2:1 method, $\Delta_p = \frac{q_o \times B \times L}{(B+z) \times (L+z)} = \frac{20.88}{7.56}$ = 2.76 t/m^2

Sc = 81.62 mm

Avg. value of λ, for normally consolidated clay as per table 1 of IS:8009 Pt 1 = 0.85

Corrected settlement (S_c) = 69.38 mm

Depth factor = 0.78

Correceted total settlement (S) = 54.12 mm

7.10 CALCULATION OF SETTLEMENT OF FOOTING

AS PER IS:8009 (PART -I)-1976

Bore Hole No:-3

Depth of footing (Df)	:	3.0	m
Width of footing (B)	:	2.0	m
Length of footing (L)	:	2.0	m
Estimate Load (q_o) (NSBC)	:	10.00	t/m^2
Ground water table	:	0.65	m

IMMEDIATE SETTLEMENT FROM SPT (N) VALUE

Field SPT N Value	=	8	
Corrected N value	=	8	
As per IS: 8009-1976 of Fig.9 Settlement in mm per unit pressure ($1kg/cm^2$)	=	45	mm
Effect of water table	=	0.5	
Settlement after water table correction	=	90	mm
So, Settlement (S_i)		90	mm
Depth factor	=	0.66	
Correceted total settlement (S)	=	59.40	mm

7.11 CALCULATION OF SETTLEMENT OF FOOTING

AS PER IS:8009 (PART -I)-1976

Bore Hole No:-3

Depth of footing (Df)	:	4.5	m
Width of footing (B)	:	2.0	m
Length of footing (L)	:	2.0	m
Estimate Load (q_o) (NSBC)	:	16.69	t/m^2
Ground water table	:	0.65	m

IMMEDIATE SETTLEMENT FROM SPT (N) VALUE

Field SPT N Value	=	9	
Corrected N value	=	9	
As per IS: 8009-1976 of Fig.9 Settlement in mm per unit pressure (1kg/cm^2)	=	40	mm
Effect of water table	=	0.5	
Settlement after water table correction	=	80	mm
So, Settlement (S_i)		133.52	mm
Depth factor	=	0.61	
Correceted total settlement (S)	=	81.45	mm

7.12 CALCULATION OF SETTLEMENT OF FOOTING

AS PER IS:8009 (PART -I)-1976

Bore Hole No:-3

Depth of footing (Df)	:	6.0	m
Width of footing (B)	:	2.0	m
Length of footing (L)	:	2.0	m
Estimate Load (q_o) (NSBC)	:	31.81	t/m^2
Ground water table	:	0.65	m

IMMEDIATE SETTLEMENT FROM SPT (N) VALUE

Field SPT N Value	=	12	
Corrected N value	=	12	
As per IS: 8009-1976 of Fig.9 Settlement in mm per unit pressure ($1kg/cm^2$)	=	25.5	mm
Effect of water table	=	0.5	
Settlement after water table correction	=	51	mm
So, Settlement (S_i)		162.23	mm
Depth factor	=	0.58	
Correceted total settlement (S)	=	94.09	mm

7.13 CALCULATION OF SETTLEMENT OF FOOTING

AS PER IS:8009 (PART -I)-1976

Bore Hole No.:-4

Defth of footing (Df)	:	1.50 m
Width of footing (B)	:	2.00 m
Length of footing (L)	:	2.00 m
Height of Compressible layer (Ht)	=	1.50 m
Consider,Estimate Load (q_o)	:	5.84 t/m^2
Compression Index (Cc)	:	0.288
Void ratio e_0	:	0.85
Specificgravity(G)	:	2.7
Using the 2:1 method, z	=	0.75 m
Submerged density (ysub)	:	1.0 g/cc

CLCULATION OF PRIMARY CONSOLIDATION SETTLEMENT OF CLAY

The clay is normally consolidated.

Thus Sc $= \frac{H_t}{(1+e_0)} X\ C_c\ [\log_{10} (P_0 + D_P)/P_0]$

Initial Pressure P_0 = 2.25 t/m^2

Using the 2:1 method, $\Delta_p = \frac{q_o \times B \times L}{(B+z) \times (L+z)} = \frac{23.36}{7.56}$ = 3.09 t/m^2

Sc = 87.65 mm

Avg. value of λ, for normally consolidated clay as per table 1 of IS:8009 Pt 1 = 0.85

Corrected settlement (S_c) = 74.5 mm

Depth factor = 0.78

Correceted total settlement (S) = 58.11 mm

7.14 CALCULATION OF SETTLEMENT OF FOOTING

AS PER IS:8009 (PART -I)-1976

Bore Hole No:-4

Depth of footing (Df)	:	3.0	m
Width of footing (B)	:	2.0	m
Length of footing (L)	:	2.0	m
Estimate Load (q_o) (NSBC)	:	9.09	t/m^2
Ground water table	:	0.90	m

IMMEDIATE SETTLEMENT FROM SPT (N) VALUE

Field SPT N Value	=	6	
Corrected N value	=	6	
As per IS: 8009-1976 of Fig.9 Settlement in mm per unit pressure ($1kg/cm^2$)	=	78.5	mm
Effect of water table	=	0.5	
Settlement after water table correction	=	157	mm
So, Settlement (S_i)		142.71	mm
Depth factor	=	0.66	
Correceted total settlement (S)	=	94.19	mm

7.15 CALCULATION OF SETTLEMENT OF FOOTING

AS PER IS:8009 (PART -I)-1976

Bore Hole No:-4

Depth of footing (Df)	:	4.5	m
Width of footing (B)	:	2.0	m
Length of footing (L)	:	2.0	m
Estimate Load (q_o) (NSBC)	:	22.10	t/m^2
Ground water table	:	0.90	m

IMMEDIATE SETTLEMENT FROM SPT (N) VALUE

Field SPT N Value	=	12	
Corrected N value	=	12	
As per IS: 8009-1976 of Fig.9 Settlement in mm per unit pressure ($1kg/cm^2$)	=	25.5	mm
Effect of water table	=	0.5	
Settlement after water table correction	=	51	mm
So, Settlement (S_i)		112.71	mm
Depth factor	=	0.61	
Correceted total settlement (S)	=	68.75	mm

7.16 CALCULATION OF SETTLEMENT OF FOOTING

AS PER IS:8009 (PART -I)-1976

Bore Hole No:-4

Depth of footing (Df)	:	6.0	m
Width of footing (B)	:	2.0	m
Length of footing (L)	:	2.0	m
Estimate Load (q_o) (NSBC)	:	39.71	t/m^2
Ground water table	:	0.90	m

IMMEDIATE SETTLEMENT FROM SPT (N) VALUE

Field SPT N Value	=	14	
Corrected N value	=	14	
As per IS: 8009-1976 of Fig.9 Settlement in mm per unit pressure (1kg/cm^2)	=	20	mm
Effect of water table	=	0.5	
Settlement after water table correction	=	40	mm
So, Settlement (S_i)		158.84	mm
Depth factor	=	0.58	
Correceted total settlement (S)	=	92.13	mm

7.17 CALCULATION OF SETTLEMENT OF FOOTING

AS PER IS:8009 (PART -I)-1976

Bore Hole No.:-5

Defth of footing (Df)	:	1.50 m
Width of footing (B)	:	2.00 m
Length of footing (L)	:	2.00 m
Height of Compressible layer (Ht)	=	3.00 m
Consider,Estimate Load (q_o)	:	6.77 t/m^2
Compression Index (Cc)	:	0.306
Void ratio e_0	:	0.86
Specificgravity(G)	:	2.7
Using the 2:1 method, z	=	1.50 m
Submerged density (ysub)	:	1.0 g/cc

CLCULATION OF PRIMARY CONSOLIDATION SETTLEMENT OF CLAY

The clay is normally consolidated.

Thus Sc $= \frac{H_t}{(1+e_0)} X\ C_c\ [\log_{10} (P_0 + D_P)/P_0]$

Initial Pressure P_0 = 3.00 t/m^2

Using the 2:1 method, $\Delta_p = \frac{q_o \times B \times L}{(B+z) \times (L+z)} = \frac{27.08}{12.25}$ = 2.21 t/m^2

Sc = 118.31 mm

Avg. value of λ, for normally consolidated clay as per table 1 of IS:8009 Pt 1 = 0.85

Corrected settlement (S_c) = 100.56 mm

Depth factor = 0.78

Correceted total settlement (S) = 78.44 mm

7.18 CALCULATION OF SETTLEMENT OF FOOTING

AS PER IS:8009 (PART -I)-1976

Bore Hole No.:-5

Defth of footing (Df)	:	3.00 m
Width of footing (B)	:	2.00 m
Length of footing (L)	:	2.00 m
Height of Compressible layer (Ht)	=	1.50 m
Consider,Estimate Load (q_o)	:	8.34 t/m^2
Compression Index (Cc)	:	0.306
Void ratio e_0	:	0.89
Specificgravity(G)	:	2.7
Using the 2:1 method, z	=	0.75 m
Submerged density (ysub)	:	1.0 g/cc

CLCULATION OF PRIMARY CONSOLIDATION SETTLEMENT OF CLAY

The clay is normally consolidated.

Thus Sc $= \frac{H_t}{(1+e_0)} X\ C_c\ [\log_{10} (P_0 + D_P)/P_0]$

Initial Pressure P_0 = 3.75 t/m^2

Using the 2:1 method, $\Delta_p = \frac{q_o \times B \times L}{(B+z) \times (L+z)} = \frac{33.36}{7.56}$ = 4.41 t/m^2

Sc = 82 mm

Avg. value of λ, for normally consolidated clay as per table 1 of IS:8009 Pt 1 = 0.85

Corrected settlement (S_c) = 69.7 mm

Depth factor = 0.66

Correceted total settlement (S) = 46.0 mm

7.19 CALCULATION OF SETTLEMENT OF FOOTING

AS PER IS:8009 (PART -I)-1976

Bore Hole No:-5

Depth of footing (Df)	:	4.5	m
Width of footing (B)	:	2.0	m
Length of footing (L)	:	2.0	m
Estimate Load (q_o) (NSBC)	:	19.78	t/m^2
Ground water table	:	1.00	m

IMMEDIATE SETTLEMENT FROM SPT (N) VALUE

Field SPT N Value	=	11	
Corrected N value	=	11	
As per IS: 8009-1976 of Fig.9 Settlement in mm per unit pressure (1kg/cm^2)	=	28	mm
Effect of water table	=	0.5	
Settlement after water table correction	=	56	mm
So, Settlement (S_i)		110.77	mm
Depth factor	=	0.61	
Correceted total settlement (S)	=	67.57	mm

7.20 CALCULATION OF SETTLEMENT OF FOOTING

AS PER IS:8009 (PART -I)-1976

Bore Hole No:-5

Depth of footing (Df)	:	6.0	m
Width of footing (B)	:	2.0	m
Length of footing (L)	:	2.0	m
Estimate Load (q_o) (NSBC)	:	35.78	t/m^2
Ground water table	:	1.00	m

IMMEDIATE SETTLEMENT FROM SPT (N) VALUE

Field SPT N Value	=	13	
Corrected N value	=	13	
As per IS: 8009-1976 of Fig.9 Settlement in mm per unit pressure ($1kg/cm^2$)	=	24.8	mm
Effect of water table	=	0.5	
Settlement after water table correction	=	49.6	mm
So, Settlement (S_i)		177.47	mm
Depth factor	=	0.58	
Correceted total settlement (S)	=	102.93	mm

8.0 Analysis of the Sub Surface Investigation

BH: 1

1. It is seen that, non plastic, non expansive poorly graded sand strata is existing up to 1.0m depth from the OGL, where in one DS was collected at 0.5m depth.
2. From 1.0m to 4.5m depth It is seen that, high plastic, high expansive clays with intermediate compressibility strata is existing. where in two UDS were collected at 1.5m & 3.0m depth.
3. From 4.5m to 6.0m depth, it is seen that, non plastic, non expansive poorly graded sand strata is existing. Wherein two SPTs were conducted at 4.5m & 6.0m depth. The field N values from SPT are found to be 10 & 12 at respectively depth.

BH: 2

1. It is seen that, high plastic, high expansive clays with intermediate compressibility strata is existing up to 4.5m depth from the OGL, where in one DS was collected at 0.5m depth and two UDS were collected at 1.5m & 3.0m depth.
2. From 4.5m to 6.0m depth, it is seen that, non plastic, non expansive poorly graded sand strata is existing. Wherein two SPTs were conducted at 4.5m & 6.0m depth. The field N values from SPT are found to be 9 & 11 at respectively depth.

BH: 3

1. It is seen that, high plastic, high expansive clays with intermediate compressibility strata is existing up to 3.0m depth from the OGL, where in one DS was collected at 0.5m depth and one UDS was collected at 1.5m depth.
2. From 3.0m to 6.0m depth, it is seen that, non plastic, non expansive silt sand strata is existing. Wherein three SPTs were conducted at 3.0m, 4.5m & 6.0m depth. The field N values from SPT are found to be varying from 8 to 12 respectively.

BH: 4

1. It is seen that, high plastic, high expansive clays with intermediate compressibility strata is existing up to 3.0m depth from the OGL, where in one DS was collected at 0.5m depth and one UDS was collected at 1.5m depth.
2. From 3.0m to 6.0m depth, it is seen that, non plastic, non expansive silt sand strata is existing. Wherein three SPTs were conducted at 3.0m, 4.5m & 6.0m depth. The field N values from SPT are found to be varying from 6 to 14 respectively.

BH: 5

- It is seen that, high plastic, high expansive clays with intermediate compressibility strata is existing up to 4.5m depth from the OGL, where in one DS was collected at 0.5m depth and two UDS were collected at 1.5m & 3.0m depth.
- From 4.5m to 6.0m depth, it is seen that, non plastic, non expansive silt sand strata is existing. Wherein two SPTs were conducted at 4.5m & 6.0m depth. The field N values from SPT are found to be 11 & 13 at respectively depth.

9.0 Abstract of Safe Bearing Pressure

1	2	3	4	5	6	7	
Location	Depth in mt.	Type of sample collected	Group of soil	NSBC in T/m^2	Settlement in mm	Safe Bearing Pressure (SBP) in T/m^2	
						for 25mm	for 40 mm
BH-1	1.5	UDS	CI	5.53	66.37	2.08	3.33
	3.0	UDS	CI	7.65	38.49	4.97	7.95
	4.5	SPT (N -10)	SP	24.94	97.37	6.40	10.25
	6.0	SPT (N -12)	SP	31.81	94.09	8.45	13.52
BH-2	1.5	UDS	CI	6.15	67.86	2.27	3.63
	3.0	UDS	CI	8.00	40.56	4.93	7.89
	4.5	SPT (N -9)	SM	16.69	81.45	5.12	8.20
	6.0	SPT (N -11)	SM	28.31	91.95	7.70	12.32
BH-3	1.5	UDS	CI	5.22	54.12	2.41	3.86
	3.0	SPT (N -8)	SM	10.00	59.40	4.21	6.73
	4.5	SPT (N -9)	SM	16.69	81.45	5.12	8.20
	6.0	SPT (N -12)	SM	31.81	94.09	8.45	13.52
BH-4	1.5	UDS	CI	5.84	58.11	2.51	4.02
	3.0	SPT (N -6)	SM	9.09	94.19	2.41	3.86
	4.5	SPT (N -12)	SM	22.10	68.75	8.04	12.86
	6.0	SPT (N -14)	SM	39.71	92.13	10.78	17.24
BH-5	1.5	UDS	CI	6.77	78.44	2.16	3.45
	3.0	UDS	CI	8.34	46.00	4.53	7.25
	4.5	SPT (N -11)	SM	19.78	67.57	7.32	11.71
	6.0	SPT (N -13)	SM	35.78	102.93	8.69	13.90

Name of Work: Geo-Technical Investigation Work for Proposed Solar Plant at Paradip Port Trust, Paradip.

10.0 LOAD -CARRYING CAPACITY OF PILES-STATIC ANALYSIS

AS PER IS : 2911 PART I / SEC 2 - 1979 (APPENDIX B)

From Lab test report:

B.H. No-1

Pile Dia : 0.45 m Pile Length: 6.00 m

Layer	Depth in Mtr.	SPT Value N	Corrected SPT Value N	Effective unit weight γ_{sub}	Angle of shearing resistance (f)	C	Overburden pressure	Maximum effective overburden pressure	Skinfriction of individual layer (Cohesive Soil)=α C' As	Skinfriction of individual layer (Granular Soil)=Σ K Pdi	Total Skinfriction (Ultimate)
				Kn/m^2	(degrees)	kN/m^2	kN/m^2	kN/m^2	KN	KN	KN
1	1.50	-	-	9.81	0.0	17.66	14.72	88.29	37.45	0	225.74
2	3.00	-	-	9.81	0.0	21.58	29.43		45.77	0	
3	4.50	10	10	9.81	30.0	0.00	44.15		0	58.55	
4	6.00	12	12	9.81	30.6	0.00	58.86		0	83.97	

Ultimate Load Carrying Capacity (Qu) :

Q_u = **225.74** KN = 23.011 TON

Safe Load Carrying Capacity (Qs):

Qs = **8.0** Ton

Where;
- A_p = cross- sectional area of pile tip,in m^2
- D = diameter of pile shaft,in m.
- γ = effective unit weight of the soil at pile tip,in kN/m^3
- P_D = effective overburden pressure at pile tip,in kN/m^2
- $\Sigma^n_{i=1}$ = Summation of layers 1 to n in which pile is installed and which contribute to positive skin friction
- K_i = coefficient of Earth pressure applicable for the ith layer
- P_{Di} = effective overburden pressure for the " i^{th} " layer ,in Kn/m^2
- δ_i = angle of wall friction between pile and soil for the ith layer
- A_{si} = surface area of pile shaft in the ith layer,in m^2

Note: End bearing has not been taken in to account being not presence of hard starta(rock).

10.1 LOAD -CARRYING CAPACITY OF PILES-STATIC ANALYSIS

AS PER IS : 2911 PART I / SEC 2 - 1979 (APPENDIX B)

From Lab test report:

B.H. No-2

Pile Dia : 0.45 m Pile Length: 6.00 m

Layer	Depth in Mtr.	SPT Value N	Corrected SPT Value N	Effective unit weight γ_{sub}	Angle of shearing resistance (f)	C	Overburden pressure	Maximum effective overburden pressure	Skinfriction of individual layer (Cohesive Soil)=α C' As	Skinfriction of individual layer (Granular Soil)=Σ K Pdi	Total Skinfriction (Ultimate)
				Kn/m^2	(degrees)	kN/m^2	kN/m^2	kN/m^2	KN	KN	KN
1	1.50	-	-	9.81	0.0	19.62	14.72	88.29	41.61	0	230.04
2	3.00	-	-	9.81	0.0	22.56	29.43		47.85	0	
3	4.50	9	9	9.81	29.6	0.00	44.15		0	57.61	
4	6.00	11	11	9.81	30.3	0.00	58.86		0	82.97	

Ultimate Load Carrying Capacity (Qu) :

Q_u = **230.04** KN = 23.45 TON

Safe Load Carrying Capacity (Qs):

Qs = **8.0** Ton

Where;

A_p	=	cross- sectional area of pile tip,in m^2
D	=	diameter of pile shaft,in m.
γ	=	effective unit weight of the soil at pile tip,in kN/m^3
P_D	=	effective overburden pressure at pile tip,in kN/m^2
$\Sigma^n_{i=1}$	=	Summation of layers 1 to n in which pile is installed and which contribute to positive skin friction
K_i	=	coefficient of Earth pressure applicable for the ith layer
P_{Di}	=	effective overburden pressure for the " i^{th} " layer ,in Kn/m^2
δ_i	=	angle of wall friction between pile and soil for the ith layer
A_{si}	=	surface area of pile shaft in the ith layer,in m^2

Note: End bearing has not been taken in to account being not presence of hard starta(rock).

10.2 LOAD -CARRYING CAPACITY OF PILES-STATIC ANALYSIS

AS PER IS : 2911 PART I / SEC 2 - 1979 (APPENDIX B)

From Lab test report:

B.H. No-3

Pile Dia : 0.45 m Pile Length: 6.00 m

Layer	Depth in Mtr.	SPT Value N	Corrected SPT Value N	Effective unit weight γ_{sub}	Angle of shearing resistance (f)	C	Overburden pressure	Maximum effective overburden pressure	Skinfriction of individual layer (Cohessive Soil)=α C' As	Skinfriction of individual layer (Granular Soil)=Σ K Pdi	Total Skinfriction (Ultimate)
				Kn/m^2	(degrees)	kN/m^2	kN/m^2	kN/m^2	KN	KN	KN
1	1.50	-	-	9.81	0.0	16.68	14.72	88.29	35.36	0	210.95
2	3.00	8	8	9.81	29.2	0.00	29.43		0	34.01	
3	4.50	9	9	9.81	29.6	0.00	44.15		0	57.61	
4	6.00	11	11	9.81	30.6	0.00	58.86		0	83.97	

Ultimate Load Carrying Capacity (Qu) :

Q_u = **210.95** KN = 21.504 TON

Safe Load Carrying Capacity (Qs):

Qs = **7.0** Ton

Where;
- A_p = cross- sectional area of pile tip,in m^2
- D = diameter of pile shaft,in m.
- γ = effective unit weight of the soil at pile tip,in kN/m^3
- P_D = effective overburden pressure at pile tip,in kN/m^2
- $\Sigma^n_{i=1}$ = Summation of layers 1 to n in which pile is installed and which contribute to positive skin friction
- K_i = coefficient of Earth pressure applicable for the ith layer
- P_{Di} = effective overburden pressure for the " i^{th} " layer ,in Kn/m^2
- δ_i = angle of wall friction between pile and soil for the ith layer
- A_{si} = surface area of pile shaft in the ith layer,in m^2

Note: End bearing has not been taken in to account being not presence of hard starta(rock).

10.3 LOAD -CARRYING CAPACITY OF PILES-STATIC ANALYSIS

AS PER IS : 2911 PART I / SEC 2 - 1979 (APPENDIX B)

From Lab test report:

B.H. No-4

Pile Dia : 0.45 m Pile Length: 6.00 m

Layer	Depth in Mtr.	SPT Value N	Corrected SPT Value N	Effective unit weight γ_{sub}	Angle of shearing resistance (f)	C	Overburden pressure	Maximum effective overburden pressure	Skinfriction of individual layer (Cohessive Soil)=α C' As	Skinfriction of individual layer (Granular Soil)=Σ K Pdi	Total Skinfriction (Ultimate)
				Kn/m^2	(degrees)	kN/m^2	kN/m^2	kN/m^2	KN	KN	KN
1	1.50	-	-	9.81	0.0	18.64	14.72	88.29	39.53	0	218.4
2	3.00	6	6	9.81	28.4	0.00	29.43		0	32.9	
3	4.50	12	12	9.81	30.6	0.00	44.15		0	59.98	
4	6.00	14	14	9.81	31.2	0.00	58.86		0	85.99	

Ultimate Load Carrying Capacity (Qu) :

Q_u = **218.4** KN = 22.263 TON

Safe Load Carrying Capacity (Qs):

Qs = **7.0** Ton

Where;

A_p = cross- sectional area of pile tip,in m^2

D = diameter of pile shaft,in m.

γ = effective unit weight of the soil at pile tip,in kN/m^3

P_D = effective overburden pressure at pile tip,in kN/m^2

$\Sigma^n_{i=1}$ = Summation of layers 1 to n in which pile is installed and which contribute to positive skin friction

K_i = coefficient of Earth pressure applicable for the ith layer

P_{Di} = effective overburden pressure for the " i^{th} " layer ,in Kn/m^2

δ_i = angle of wall friction between pile and soil for the ith layer

A_{si} = surface area of pile shaft in the ith layer,in m^2

Note: End bearing has not been taken in to account being not presence of hard starta(rock).

10.4 LOAD -CARRYING CAPACITY OF PILES-STATIC ANALYSIS

AS PER IS : 2911 PART I / SEC 2 - 1979 (APPENDIX B)

From Lab test report:

B.H. No-5

Pile Dia : 0.45 m Pile Length: 6.00 m

Layer	Depth in Mtr.	SPT Value N	Corrected SPT Value N	Effective unit weight γ_{sub}	Angle of shearing resistance (f)	C	Overburden pressure	Maximum effective overburden pressure	Skinfriction of individual layer (Cohessive Soil)=α C' As	Skinfriction of individual layer (Granular Soil)=Σ K Pdi	Total Skinfriction (Ultimate)
				Kn/m^2	(degrees)	kN/m^2	kN/m^2	kN/m^2	KN	KN	KN
1	1.50	-	-	9.81	0.0	21.58	14.72	88.29	45.77	0	239.93
2	3.00	-	-	9.81	0.0	23.54	29.43		49.93	0	
3	4.50	11	11	9.81	30.3	0.00	44.15		0	59.26	
4	6.00	13	13	9.81	30.9	0.00	58.86		0	84.97	

Ultimate Load Carrying Capacity (Qu) :

Q_u = **239.93** KN = 24.458 TON

Safe Load Carrying Capacity (Qs):

Qs = **8.0** Ton

Where;

A_p = cross- sectional area of pile tip,in m^2

D = diameter of pile shaft,in m.

γ = effective unit weight of the soil at pile tip,in kN/m^3

P_D = effective overburden pressure at pile tip,in kN/m^2

$\Sigma^n_{i=1}$ = Summation of layers 1 to n in which pile is installed and which contribute to positive skin friction

K_i = coefficient of Earth pressure applicable for the ith layer

P_{Di} = effective overburden pressure for the " i^{th} " layer ,in Kn/m^2

δ_i = angle of wall friction between pile and soil for the ith layer

A_{si} = surface area of pile shaft in the ith layer,in m^2

Note: End bearing has not been taken in to account being not presence of hard starta(rock).

11.0 SUMMARY OF CHEMICAL TEST RESULTS

Sl No.	B.H No.	Depth	Chemical Test on Soil Samples			Chemical Test on Water Samples			
			Chloride in mg/kg	Sulphate as SO3 in %	Ph Value	B.H No.	Sulphate content in mg/L	Chloride Content in mg/L	Ph Value
1	1	0.00-0.50	58.33	0.0182	6.6	1	16.5	54.35	7.4
2	2	1.50-1.95	57.18	0.0258	6.8	2	15.02	61.15	7.1
3	3	3.0-3.45	62.14	0.0241	7.0	3	17.11	58.65	7.2
4	4	4.5-4.95	63.24	0.0188	7.3	4	16.48	60.25	7.6
5	5	6.0-6.45	63.75	0.01820	7.3	5	16.32	54.25	7.5

12.0 CONCLUSION AND RECOMMENDATION

This report describes the information obtained through geotechnical investigation carried out for the proposed solar plant at Paradip Port Trust, Paradip. The data incorporated have been obtained and processed using procedures specified in various codes of practices, good engineering norms and conventions. The field / laboratory results and records reported here are relevant for the test locations and time at which the tests have been conducted. We are thankful to the management and staff of RITES Limited whose wholehearted cooperation and help enabled us to overcome the extremely difficult site conditions and complete the project satisfactorily.

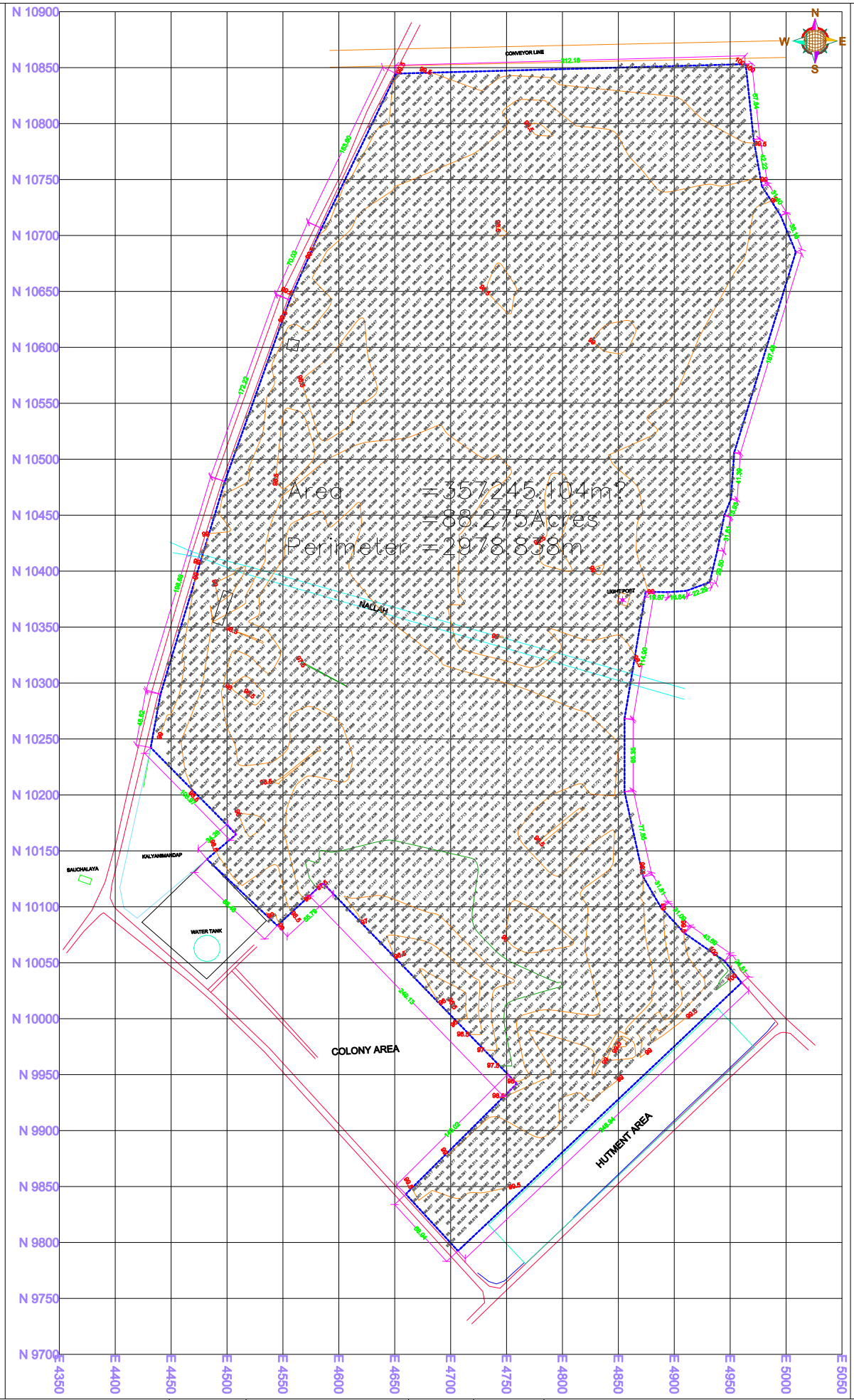
- At this site, for geotechnical investigation 5 nos.(6.0m depth each) of boreholes were conducted.

- Water table was found at 0.65m to 1.2m depth in all bore holes during the exploration. Exploration was done during monsoon period.

- After analyzing all the engineering properties of 5 bore holes, Pile foundation is recommended for all types of structures. The dia and depth of pile shall be decided by the structural designer as per the type of structure and as per actual load carrying on that. The maximum pile length should be 6.0m from OGL as the investigation was done up to 6.0m.

- In case of heavy load carrying structure, Geo investigation should be carried out up to higher depth at site.

Quality Control Division
Creative Studio, Bhubaneswar.



FOOT NOTES :-
ALL DIMENSIONS ARE IN METERS ONLY.

LEGEND :
BT ROAD
CONVEYOR LINE
BUILDING, HUT
CULVERT
BOUNDARY WALL
CANAL
CONTOUR WITH VALUE

CLIENT :-	PARADIP PORT TRUST
CONSULTANT :-	RITES LIMITED.BHUBANESWAR
PROJECT:	RECLAMATION OF LOW LAYING AREA NEAR BRUNDABAN COLONY FOR SOLAR POWER STATION
DRG.NO	RITES/BBS/PPT/2016/
SH.NO	
DATE	JUNE-2016
REV	

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