

CONSTRUCTION OF INTERNATIONAL AND DOMESTIC CRUISE TERMINAL AND OTHER ALLIED FACILITIES AT MORMUGAO PORT TRUST, GOA, THROUGH ENGINEERING, PROCUREMENT AND CONSTRUCTION (EPC) CONTRACT” (TENDER NO. T15/T-1946/2021-C)

ADDENDUM /CORRIGENDUM No.7

The following clauses in the Bid Document stand amended / replaced as below:

Sl. No.	Section / Clause No. / Page No.	Modified as / Replace with
Volume I- Notice Inviting Request for Proposal		
1	Clause 3.7 (Page 13)	Following para.is added to Clause 3.7 as the last para.: In case of Joint Venture, all the partners of the joint venture should sign the Integrity Pact. In the case of sub-contracting, the Principal Contractor shall take the responsibility of the adoption of IP by the subcontractor <u>and</u> ensure that all subcontractors also sign the IP.
2	Clause 4.7.2 (Page -25)	Item (xxv) is modified as below; (xxv) An undertaking to furnish Professional Indemnity Insurance Policy (PI) for minimum amount equal to the estimated Project Cost, in case of successful bidder. The policy shall be effective till the completion of five (5) years after issue of Taking Over Certificate by the Employer Item (xxvi) is added at the end of the this Clause as below: (xxvi) Format for Power Attorney for Authorised signatory to sign Joint Venture Agreement (Form -19) FORM - 19 is attached.
3	New clause as Clause 4.7.3 (Page -25)	A new clause is added as Clause 4.7.3: 4.7.3 In the Bid Submission Letter, the Bidder shall compulsorily indicate 2 nos. of current active e-mail IDs to which further Bid related communication can be sent by CoPT. All communication from CoPT shall be deemed to have been delivered when the e-mail is sent to the specified e-mail ID and the date of sending the e-mail by CoPT shall be considered as the receipt by the Bidder. CoPT shall no way be responsible for the non-receipt of any such communication by the Bidder whatever be the reason due to which this has occurred.
4	Clause 4.15 Performance Security (Page –29)	In the third line of clause 4.15, the words, “ or any reputed foreign bank “stands deleted. A new sentence at the end of this clause is added as below: IntheeventtheContractorfailstoprovidethePerformanceSecuritywithin 21(twenty one)days of the date of Letter of Award, it may seek extension of time for a period not exceeding a further period of 15(fifteen)days, on payment of damages for such extended period in a sum calculated at the rate of 0.05% (zero point zero five per cent) of the Contract Price for each day until the Performance Security is

		provided.
5	Clause 4.16 Signing of Agreement (Page – 29)	Following sentences are added at the end of the Clause 4.16 as below: The prescribed format for Agreement to be signed by the Bidder is attached as “ Form A ”. The Contractor shall also make available 15(Fifteen) hard bound copies of the Agreement to the Employer, at his cost. Unless and until a formal Contract Agreement is prepared and executed, the Employer’s Letter of Award shall constitute a binding Contract between the Employer and the Contractor.
6	FORM 1 FORMAT FOR BID SUBMISSION LETTER (Page – 32)	Para.9 of FORM 1 is replaced as below: 9. We have not made any tampering or changes in the Bid Documents on which the Bid is being submitted and if any tampering or changes are detected at any stage, we understand the Bid will invite summary rejection and suspending / debarring as stated in EMD Declaration / the Contract will be liable to be terminated along with forfeiture of Contract Performance Security, even if LOA has been issued.
7	FORM 5C (Page-39)	Modified and attached as FORM 5C(Amended):DETAILS OF SIMILAR WORKS EXECUTED ON EPC BASIS (Page – 39)
8	FORM 6B (Page-42)	At the end of the Table at Page 43, add the following as foot note to the Table “NOTE: A. List all current contracts in progress which have started before the closing of the latest submitted Audited Balance Sheet. B. List all current contracts in progress which have started or to be started after the closing of the latest submitted Audited Balance Sheet.”
9	FORM 13 PROFORMA OF PRE-CONTRACT INTEGRITY PACT (PAGE – 55)	Modified and attached as FORM 13 (Amended) .
Volume II -General Conditions of Contract		
10	Definitions	Following definition shall be included as 2. xii xii. “ Employer ” means The Cochin Port Trust, represented by the Chief Engineer, Cochin Port Trust, Willingdon Island, Kochi - 682009.

11	Scope and Performance:(Page – 5)	Para 5 stands deleted
12	Performance Guarantee	The prescribed format for furnishing Performance Guarantee is modified and attached as FORMAT 1(Amended) .
13	Clause 24 - Life Cycle Cost: (Page – 41)	A sentence is added to the end of this clause: The Contractor shall have the obligation for the structural design and stability of structures minimum upto 5 years from the date of completion of the work.
14	Clause 36: Theoretical Conception of Material (Page – 50)	The Heading of Clause 36 shall be read as Theoretical Consumption of Material .
15	Attachment – 2 – Model Rules for the Protection of Health and Sanitary arrangements for workers ... 8. CRECHES (Page- 62)	In the last sentence of para 8.(i), the clause mentioned may be read as 19G (ii) a, b & c instead of 19H (ii) a, b & c.
Volume III - Special Conditions of Contract		
16	Clause 1.3 Definitions	Volume-I mentioned in this clause shall be read as Volume II.
17	Clause 6.1.2 (Page- 22)	The number of the last para. in page No. 22 shall be deleted. In the first sentence of the last para., the words ‘Section VI’ is replaced with ‘Volume IV’.
18	Clause 6.1.3(Page- 23)	Para d) under Sub clause 6.1.3 is replaced with the following: d) An integrated schedule of staged / segmented sequential design, construction and supporting activities that result in the earliest possible completion and Employer’s Taking Over of the complete Works.
19	Clause 12.1 V3 Contractor’s site Establishment Plan Page 57 & 58	In the Sub clause b), the words “ <i>GoPT’s and IN’s offices</i> ”are replaced with “ <i>Employer’s office</i> “ In page 58, the first paragraph is modified as below: <i>Labour camp and stone crushing plant are not allowed inside the Project Site.</i>
20	Clause 12.2 V3 Temporary Utilities (Page – 58)	The third paragraph is replaced with the following: MoPT may provide power supply and drinking water provision (for running offices), at one location near the Project Site, which are chargeable as per MoPT’s prevailing rates. The Contractor shall arrange to have suitable metering devices towards quantifying consumption.

<p align="center">21</p>	<p>Clause 13: V3 Construction Facilities 13.1 V3 Contractor’s site compound (Page – 58)</p>	<p>In the third line of sub clause 13.1, the words ‘<i>and IN’s</i>’ are deleted.</p>
<p align="center">22</p>	<p>Clause 14.8 V3 Labour timing (Page – 67)</p>	<p>This clause shall be replaced with the following:</p> <p>Clause 14.8 V3 Customs, Security & Safety Requirements at Project Site</p> <p>The Contractor shall prepare the Site Access Management Plan with a view to minimizing interference with existing traffic (both landside road traffic and marine traffic and shipping) to and from the existing facilities in the vicinity of the site. All vehicles or marine craft using the existing public roads/ waters external to the site shall comply with the prevailing local and port rules and regulations as well as the requirements of any other relevant authorities.</p> <p>The Site Access Management Plan shall identify such facilities as are necessary to ensure that construction dust and debris is not carried onto the existing port roads, thorough fares or adjoining properties by vehicles leaving the site. Any damage or disturbance caused by vehicles leaving the site shall be rectified immediately by the Contractor to the satisfaction of the Employer.</p> <p>The approval of the Site Access Management Plan by the Employer shall constitute a Hold Point on the commencement of site establishment, temporary or any other Site Works under the Contract as well as mobilization of plant and delivery of any materials or equipment to the site.</p> <p>Any request by the Contractor to change the agreed proposals shall be subject to the consent of the Employer.</p> <p>The Contractor shall provide;</p> <p>(a) Proposed internal construction traffic controls (signage, line-marking, signals etc.) both for internal site roads and at interfaces with existing external roads;</p> <p>(b) Any proposed temporary traffic controls for existing external roads that may be necessary from time to time to facilitate delivery of materials or equipment to site or any other Works on such roads</p> <p>The Contractor shall be responsible for safety of his stores / items / works. The Employer will not be responsible for the Contractor’s stores / items / works.</p> <p>The Contractor shall also be responsible for safe keeping of Employer’s goods, if any, related to the Project.</p> <p>The Contractor shall comply with all regulations imposed by the Authorities with regard to Customs, Security and Safety</p>

		Requirement in respect of the passage of plant, materials and personnel. The Contractor shall execute his Works in such a way that existing Terminal works / operation are not disturbed. The Contractor shall not be entitled to any extension of time or additional payment in this regard
23	Clause 14.9 V3 Temporary Barriers and Enclosures Page – 67)	The words “ <i>Clause 4.22 of Conditions of Contract</i> ” ,appearing at the end of the first paragraph shall be replaced with “ <i>Clause 14.8</i> ”. [Please see Sl. No.18 above.]
24	General	The words ‘ <i>IN, Naval offices</i> ’, ‘ <i>Naval</i> ’, wherever they occur in the Bid document stand deleted. Wherever temporary fencing height is mentioned as ‘8m’, the same may be considered as ‘ 5m ’
25	Contractor’s responsibility	A new clause is added as Clause 24, which is attached at Annexure I
26	Insurance	A new clause is added as Clause 25 which is attached at Annexure I
27	Force Majeure	A new clause is added as Clause 26 which is attached at Annexure I
28	Change in Law	A new clause is added as Clause 27which is attached at Annexure I
29	Priority of Documents	A new clause is added as Clause 28 28. Priority of Documents The documents forming the contract are to be taken as mutually explanatory of one another. For the purpose of interpretation, the priority of the documents shall be in accordance with following sequence. (a) The Integrity Pact (b) The Contract Agreement; (i) Milestones for Payments (ii) The Special Conditions; (iii) The General Conditions of Contract; (iv) The Employer’s Requirements; (v) Contractor’s Technical Proposal; (vi) Site Data, Reports and Plans; and (vii) Contractor’s Proposal and any other documents forming part of the Contract (c) The Letter of Award; Subject to the above, in case of ambiguities or discrepancies within this Contract, the following shall apply:

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		<p>(i) between two or more Clauses of this Contract, the provisions of a specific Clause relevant to the issue under consideration shall prevail over those in other Clauses;</p> <p>(ii) between the written description on the Drawings and the Specifications, the latter shall prevail;</p> <p>(iii) between the dimension scaled from the Drawing and its specific written dimension, the latter shall prevail; and</p> <p>(iv) between any value written in numerals and that in words, the latter shall prevail</p> <p>In case of any other discrepancies, decision of the EMPLOYER shall be final and binding.</p>
GENERAL		
30	Soil Investigation Report	Report on Geo-Technical Investigation done for development of berth No.7 at Mormugao Port Trust in 2008 shared by MoPT is enclosed for reference.

Sd/-

CHIEF ENGINEER

24. Contractor's responsibility

All materials for use on the works shall be supplied and provided by the contractor at his own cost and shall conform to relevant BIS Specification and of the best quality unless otherwise specified.

- 24.1 Samples of all materials including fixtures, if any, to be incorporated in the work shall be got approved by the Engineer-in-Charge before procurement.
- 24.2 The contractor shall thoroughly study the specifications and drawings and errors/omissions/modifications, if any, shall be brought to the notice of the Engineer-in-Charge well in advance so that a final decision in the matter could be given in time.
- 24.3 All labour, skilled or unskilled shall be provided by the contractor. Settling any dispute with the labour will be contractor's responsibility.
- 24.4 The contractor shall take all care to observe no / least disturbance to the functioning of the offices at the working places.
- 24.5 The contractor shall be solely responsible for any damage or injury to the persons or things caused or suffered during the execution of the work and these shall be made good or compensated at his risk & cost. The contractor shall ensure that valid Insurance Policy as per contract document is available at all times.
- 24.6 The contractor shall take all care and precautionary measures for avoiding any kind of damage/accident in the work site on any account. The department shall not entertain any claim from the contractor whatsoever towards compensation for any damage/accidents at the site due to negligence from his part, during the execution of work.
- 24.7 The contractor shall prior to commencement of the work insure in the joint names of the Employer and the contractor against all loss or damage from whatever cause arising for which he is responsible under the terms of contract.
- 24.8 The work shall be arranged by the contractor without causing any damage to Port's/ any other structures. Any damage caused by the contractor's operation shall be compensated/ made good at contractor's risk and cost to the satisfaction of the Engineer-in-Charge of the works, failing which department will do the rectification work and the cost incurred will be recovered from any sum due to him from the Port.
- 24.9 All plants and equipments and consumables required for the whole work shall be provided by the contractor at his own cost.
- 24.10 The contractor shall not construct any structure, even of temporary nature, for any purpose at site, except with the written permission of the Engineer-in-Charge of the work and any construction so put up shall be removed by the contractor whenever the Engineer-in-Charge calls upon the contractor to do so.
- 24.11 The Contractor shall be responsible for the true and proper setting out of the works in relation to original points, lines and levels of reference given by the Engineer-in-charge and for the correctness of the position, levels, dimensions and alignment of all parts of the works and for the provision of all necessary instruments, appliances and labour in connection therewith. If at any time during the progress of work any error shall appear or arrive in the position, levels, dimensions or alignment of any part of the works, the contractor on being required to do so by the Engineer-in-Charge shall, at his own cost, rectify such error to the satisfaction of the Engineer-in-Charge, unless such error is based on incorrect data supplied by the Engineer-in-Charge, in which case the expense of rectifying the same shall be borne by the department. The checking of any setting out or of any line or level by the Engineer-in-charge shall not in any way relieve the contractor of his responsibility for the correctness thereof and the contractor shall carefully protect and

- preserve all bench marks, pegs, other things used in setting out the work and measurement purpose.
- 24.12 Qualified Engineers with sufficient experience in works of similar nature as indicated in “Schedule - F” shall be available at site throughout the contract period during working hours in order to receive instructions from department and to implement them properly and in time.
- 24.13 The contractor shall take all care and precautionary measures for avoiding damage or accidents to the work from other operations in the area. The department will not entertain any claim from the contractor whatsoever, towards compensation for any such damage or accident occurring during the execution of the contract.
- 24.14 The contractor shall observe all safety regulations during the execution of the work. Safety measures, precautions, warning signals etc. shall be done at the contractor’s cost as directed by the Engineer-in-charge of the work. **The contractor shall provide all necessary personnel protection equipments such as helmet, lifeguard, goggles, boots etc. to the workmen at his own cost. It shall be the contractor’s responsibility to ensure that the workmen make use of the personnel protection equipments during the execution of work**
- 24.15 The work shall be arranged by the contractor without causing any hindrance to the ship and other water craft operating in the area. No damage shall be caused to the structures in the area, water crafts operating in the area or otherwise by the contractor’s operations. Any damage or accident caused by the contractor’s operations shall be compensated / made good at the contractor’s risk and cost.
- 24.16 The contractor shall supply at his own cost monthly or at intervals as directed by the Engineer-in-charge, well executed photographs in standard size (approximately 24x18 cm) with soft copy showing the progress of the work and also such other particular item of the work.
- 24.17 No information or photograph concerning the works shall be published without the prior permission of the Chief Engineer and drafts of all such proposal/ publication shall be submitted for approval.
- 24.18 The information and data shown in the drawing and detailed elsewhere in the tender document are furnished for general information and guidance only and the Port Trust in no case will be held responsible for the strict accuracy thereof or any deduction, interpretation or conclusion drawn by the tenderer.
- 24.19 The contractor shall observe the conservancy rules relating to the Port and shall always take necessary steps to keep the Port water free of noxious or unhygienic matter due to the work, as are required by the Engineer-in-Charge. Under no circumstances, inflammable materials are allowed to spill into Port waters.
- 24.20 The Mormugao Port is an International Ship & Port Facility Security (ISPS) code compliant Port and the contractor is obliged to comply with the provisions of the code in force and as amended from time to time, if applicable
- 24.21 The contractor shall provide necessary arrangements as desired by the Engineer-in-Charge for inspection of work without any extra cost from commencement till completion of work.
- 24.22 The Contractor shall ensure that no labourers with criminal background are engaged for the work.
- 24.23 All fossils, coins, Clauses of value or antiques and structures and other remains or things of geological or archaeological interest discovered in the site of work shall be deemed to be the absolute property of the Port Trust and the contractor shall take responsible precautions to prevent his workmen or any other persons from removing or damaging any such Clause or thing and shall immediately upon discovery thereof and before removal, acquaint the

departmental officers of such recovery and carry out at the expense of the department, the Engineer-in-Charge's orders as to the disposal of the same.

- 24.24 The contractor shall take all precautions for not to damage any cables/pipes etc. passing through the area of work. Damages, if any, caused to electrical cables/ water lines/ telephone lines shall be rectified by the Contractor at his cost and risk.
- 24.25 The contractor shall remove all materials brought to work site / stacked at the work site or anywhere else within the Port area and clear the site at his cost to the full satisfaction of the Engineer-in-Charge before the site is returned to the Port Trust. All such materials including debris, tools & plants etc. shall be disposed off to any place as pointed out by the Engineer-in-Charge or be taken away from the location and shall be cleared in every respect and to reinstate to its original condition at no extra cost to the Port Trust immediately after completion of the work. In case, any such material is found left in the work site or anywhere in the Port area, rent for the storage space occupied by the contractor, either for stacking the materials /debris or for areas used for such purpose but not cleared thereafter, will be recovered as per the prevailing Scale of Rate of Cochin Port Trust, for the rent applicable for open storage space for commercial purpose, for the period for which the area had been occupied by the contractor. In addition to the above, in case the Port requires the area immediately for its use, Port will repossess the land after restoring it to its original condition, material will be confiscated and disposed off at the risk and cost of the contractor, after issuing two notices giving 15 days' time each for removing the material. All expenses incurred on this shall be recovered by disposing off the material if any confiscated. any balance amount still remains to be realized that will be recovered from the contractor by appropriate means.
- 24.26 The contractor shall extend all facilitations and cooperation for other contractors for simultaneous execution of other works in the area entrusted by Mormugao Port Trust.

25. INSURANCE

25.1 Insurance for Works

- 25.1.1 The Contractor shall effect and maintain at its own cost the insurances specified in Clause 25.10 below and as per the requirements under Applicable Laws.
- 25.1.2 Subject to the provisions of Clause 26 the Contractor shall, in accordance with the provisions of this Agreement, be liable to bear the cost of any loss or damage that does not fall within the scope of this Clause 25 or cannot be recovered from the insurers.
- 25.1.3 Save and except as provided in Clause 25.1.4, the Contractor shall fully indemnify, hold harmless and defend the Employer from and against any and all losses, damages, costs,charges and/or claims with respect to:

- i) the death of or injury to any person; or
- ii) the loss of or damage to any property,

that may arise out of or in consequence of any breach by the Contractor of this Agreement during the execution of the Works or the remedying of any Defects therein.

25.1.4 Notwithstanding anything in Clause 25.1.3, the Employer shall fully indemnify the Contractor from and against any and all losses, damages, costs, charges, proceedings and/or claims arising out of or with respect to:

- a) the use or occupation of land or any part thereof by the Employer;
- b) the damage to property which is the unavoidable result of the execution and completion of the Works, or the remedying of any Defects therein, in accordance with this Agreement; and
- c) the death of or injury to persons or loss of or damage to property resulting from any act or neglect of the Employer, its agents, servants or other contractors, not being employed by the Contractor.

Provided, however, that in the event of any injury or damage as a result of the contributory negligence of the Contractor, the Employer shall be liable to indemnify the Contractor from and against any and all losses, damages, costs, charges, proceedings and/or claims to the extent as proportionate to the liability of the Employer, its servants or agents or other contractors not associated with the Contractor in such injury or damage.

25.1.5 Without prejudice to the provisions of Clauses 25.1.3 and 25.1.4, the Contractor shall maintain or effect such third party insurances as may be required under Applicable Laws.

25.1.6 Professional Indemnity Insurance Policy (PI) for minimum amount equal to the estimated project cost, valid/effective till the completion of five (5) years after issue of Taking Over Certificate, shall be submitted by the selected contractor before signing of the contract. Bidders have to submit an undertaking to comply with the above requirement, at the time of Bid submission.

25.2 Notice to the Employer

No later than 15 (fifteen) days after the date of receipt of Letter of Award, the Contractor shall by notice furnish to the Employer, in reasonable detail, information in respect of the insurances that it proposes to effect and maintain in accordance with this Clause 25. Within 15 (fifteen) days of receipt of such notice, the Employer may require the Contractor to effect and maintain such other insurances as may be necessary pursuant hereto, and in the event of any difference or disagreement relating to any such insurance, the dispute resolution procedure shall apply.

25.3 Evidence of Insurance Cover

25.3.1 All insurances obtained by the Contractor in accordance with this Clause 25 shall be maintained with insurers on terms consistent with Good Industry Practice. Within 30 (thirty) days from the Commencement Date, the Contractor shall furnish to the Employer not arised true copies of the certificate(s) of insurance, copies of insurance policies and premia payment receipts in respect of such insurance, and no such insurance shall be cancelled, modified, or allowed to expire or lapse until the expiration of at least 45 (forty-five) days after notice of such proposed cancellation, modification or non- renewal has been delivered by the Contractor to the Employer.

25.3.2 The Contractor shall procure and ensure the adequacy of the insurances at all times in accordance with the provisions of this Agreement.

25.4 Remedy for failure to insure

If the Contractor shall fail to effect and keep in force all insurances for which it is responsible pursuant hereto, the Employer shall have the option to either keep in force any such insurances, and pay such premia and recover the costs thereof from the Contractor, or in the event of computation of a Termination Payment, treat an amount equal to the Insurance Cover as deemed to have been received by the Contractor.

25.5 Waiver of subrogation

All insurance policies in respect of the insurance obtained by the Contractor pursuant to this Clause 25 shall include a waiver of any and all rights of subrogation or recovery of the insurers there under against, inter alia, the Employer, and its assigns, successors, undertakings and their subsidiaries, Affiliates, employees, insurers and underwriters, and of any right of the insurers to any set-off or counterclaim or any other deduction, whether by attachment or otherwise, in respect of any liability of any such person insured under any such policy or in any way connected with any loss, liability or obligation covered by such policies of insurance.

25.6 Contractor's waiver

The Contractor hereby further releases, assigns and waives any and all rights of subrogation or recovery against, inter alia, the Employer and its assigns, undertakings and their subsidiaries, Affiliates, employees, successors, insurers and underwriters,

which the Contractor may otherwise have or acquire in or from or in any way connected with any loss, liability or obligation covered by policies of insurance maintained or required to be maintained by the Contractor pursuant to this Agreement (other than third party liability insurance policies) or because of deductible clauses in or inadequacy of limits of any such policies of insurance.

25.7 Cross liabilities

Any such insurance maintained or effected in pursuance of this Clause 25 shall include a cross liability clause such that the insurance shall apply to the Contractor and to the Employer as separately insured.

25.8 Accident or injury to workmen

Notwithstanding anything contained in this Agreement, it is hereby expressly agreed between the Parties that the Employer shall not be liable for or in respect of any damages or compensation payable to any workman or other person in the employment of the Contractor or Sub-contractor, save and except as for death or injury resulting from any act, omission or default of the Employer, its agents or servants. The Contractor shall indemnify and keep indemnified the Employer from and against all such claims, proceedings, damages, costs, charges, and expenses whatsoever in respect of the above save and except for those acts, omissions or defaults for which the Employer shall be liable.

25.9 Insurance against accident to workmen

The Contractor shall effect and maintain during the Agreement such insurances as may be required to insure the Contractor's personnel and any other persons employed by it on the Project from and against any liability incurred in pursuance of this Clause 25 Provided that for the purposes of this Clause 25.9, the Contractor's personnel/any person employed by the Contractor shall include the Sub-contractor and its personnel. Provided further that in respect of any persons employed by any Sub-contractor, the Contractor's obligations to insure as aforesaid under this Clause 25.9 shall be discharged if the Sub-contractor shall have insured against any liability in respect of such persons in such manner that the Employer is indemnified under the policy. The Contractor shall require such Sub-contractor to produce before the Employer, when required, such policy of insurance and the receipt for payment of the current premium within 10 (ten) days of such demand being made by the Employer.

25.10 Application of insurance proceeds

The proceeds from all insurance claims, except for life and injury, shall be applied for any necessary repair, reconstruction, reinstatement, replacement, improvement, delivery or installation of the Project and the provisions of this Agreement in respect of construction of Works shall apply *mutatis mutandis* to the Works undertaken out of the proceeds of insurance.

25.11 Compliance with policy conditions

The Contractor hereby expressly agrees to fully indemnify the Employer from and against all losses and claims arising from the Contractor's failure to comply with conditions imposed by the insurance policies effected in accordance with this agreement.

25.12 Insurance to be maintained by the contractor

25.12.1 Insurance during Construction Period

- i) The Contractor shall effect and maintain at its own cost, from the Commencement Date till the date of issue of the Completion Certificate, the following insurances for any loss or damage occurring on account of Non Political Event of Force Majeure, malicious act, accidental damage, explosion, fire and terrorism:
 - (a) insurance of Works, Plant and Materials and an additional sum of [15% (fifteen per cent)] of such replacement cost to cover any additional costs of and incidental to the rectification of loss or damage including professional fees and the cost of demolishing and removing any part of the Works and of removing debris of whatsoever nature; and
 - (b) insurance for the Contractor's equipment brought onto the Site by the Contractor, for a sum sufficient to provide for their replacement at the Site.
- ii) The insurance under paragraph 25.12.1 (i) (a) and (b) above shall cover the Employer and the Contractor against all loss or damage from any cause arising under paragraph 25.12.1 other than risks which are not insurable at commercial terms.

25.12.2 Insurance for Contractor's Defects Liability

The Contractor shall effect and maintain insurance cover for the Works from the date of issue of the Completion Certificate until the end of the Defects Liability Period for any loss or damage for which the Contractor is liable and which arises from a cause occurring prior to the issue of the Completion Certificate. The Contractor shall also maintain other insurances for maximum sums as may be required under Applicable Laws and in accordance with Good Industry Practice.

25.12.3 Insurance against injury to persons and damage to property

- 1.2 The Contractor shall insure against its liability for any loss, damage, death or bodily injury, or damage to any property (except things insured under the paragraphs 25.12.1 and 25.12.2 above or to any person (except persons insured under Clause 25.9), which may arise out of the Contractor's performance of this Agreement. This insurance shall be for a limit per occurrence of not less than the amount specified below with no limit on the number of occurrences.

The insurance cover shall be not less than: **Rs. 15,00,000/-**

- 1.3 The insurance shall be extended to cover liability for all loss and damage to the Employer's property arising out of the Contractor's performance of this Agreement excluding:
 - (a) the Employer's right to have the construction works executed on, over,

- under, in or through any land, and to occupy this land for the Works; and
- (b) damage which is an unavoidable result of the Contractor's obligations to execute the Works.

25.12.4 Insurance to be in joint names

The insurance under paragraphs 25.12.1 to 25.12.3 above shall be in the joint names of the Contractor and the Employer.

26. FORCE MAJEURE

26.1 Force Majeure

As used in this Agreement, the expression "**Force Majeure**" or "**Force Majeure Event**" shall mean occurrence in India of any or all of Non-Political Event, Indirect Political Event and Political Event, as defined in Clauses 26.2, 26.3 and 26.4 respectively, if it affects the performance by the Party claiming the benefit of Force Majeure (the "**Affected Party**") of its obligations under this Agreement and which act or event (a) is beyond the reasonable control of the Affected Party, and (b) the Affected Party could not have prevented or overcome by exercise of due diligence and following Good Industry Practice, and (c) has Material Adverse Effect on the Affected Party.

26.2 Non-Political Event

A Non-Political Event shall mean one or more of the following acts or events:

- (a) act of God, epidemic, extremely adverse weather conditions, lightning, earthquake, landslide, cyclone, flood, volcanic eruption, chemical or radioactive contamination or ionising radiation, fire or explosion (to the extent of contamination or radiation or fire or explosion originating from a source external to the Site);
- (b) strikes or boycotts (other than those involving the Contractor, Sub-contractors or their respective employees/representatives, or attributable to any act or omission of any of them) interrupting supplies and services to the Project for a continuous period of 24 (twenty-four) hours and an aggregate period exceeding 10 (ten) days in an Accounting Year, and not being an Indirect Political Event set forth in Clause 26.3;
- (c) any failure or delay of a Sub-contractor but only to the extent caused by another Non-Political Event;
- (d) any judgement or order of any court of competent jurisdiction or statutory Employer made against the Contractor in any proceedings for reasons other than

- (i) failure of the Contractor to comply with any Applicable Law or Applicable Permit, or (ii) on account of breach of any Applicable Law or Applicable Permit of any contract, or (iii) enforcement of this Agreement, or (iv) exercise of any of its rights under this Agreement by the Employer; or (v) breach of its obligations by the Contractor under its sub-contracts;
- (e) the discovery of geological conditions, toxic contamination or archaeological remains on the Site that could not reasonably have been expected to be discovered through a site inspection; or
- (f) any event or circumstances of a nature analogous to any of the foregoing.

26.3 Indirect Political Event

An Indirect Political Event shall mean one or more of the following acts or events:

- (g) an act of war (whether declared or undeclared), invasion, armed conflict or act of foreign enemy, blockade, embargo, riot, insurrection, terrorist or military action, civil commotion or politically motivated sabotage;
- (h) industry-wide or State-wide strikes or industrial action for a continuous period of 24 (twenty-four) hours and exceeding an aggregate period of 10 (ten) days in an Accounting Year;
- (i) any civil commotion, boycott or political agitation which prevents construction of the Project by the Contractor for an aggregate period exceeding 10 (ten) days in an Accounting Year;
- (j) failure of the Employer to permit the Contractor to continue with its Construction Works, with or without modifications, in the event of stoppage of such work after discovery of any geological or archaeological finds;
- (k) any failure or delay of a Sub-contractor to the extent caused by any Indirect Political Event;
- (l) any Indirect Political Event that causes a Non-Political Event; or
- (m) any event or circumstances of a nature analogous to any of the foregoing.

26.4 Political Event

A Political Event shall mean one or more of the following acts or events by or on account of any Government Instrumentality:

- (n) Change in Law, only if consequences thereof cannot be dealt with under and in accordance with the provisions of Clause 31 [change in law- added]

- (o) compulsory acquisition in national interest or expropriation of any Project Assets or rights of the Contractor or of the Sub-contractors;
- (p) unlawful or unauthorised or without jurisdiction revocation of, or refusal to renew or grant without valid cause, any clearance, licence, permit, authorisation, no objection certificate, consent, approval or exemption required by the Contractor or any of the Sub-contractors to perform their respective obligations under this Agreement; provided that such delay, modification, denial, refusal or revocation did not result from the Contractor's or any Sub-contractor's inability or failure to comply with any condition relating to grant, maintenance or renewal of such clearance, licence, authorisation, no objection certificate, exemption, consent, approval or permit;
- (q) any failure or delay of a Sub-contractor but only to the extent caused by another Political Event; or
- (r) any event or circumstances of a nature analogous to any of the foregoing.

26.5 Duty to report Force Majeure Event

Upon occurrence of a Force Majeure Event, the Affected Party shall by notice report such occurrence to the other Party forthwith. Any notice pursuant hereto shall include full particulars of:

- (a) the nature and extent of each Force Majeure Event which is the subject of any claim for relief under this Clause with evidence in support thereof;
- (b) the estimated duration and the effect or probable effect which such Force Majeure Event is having or will have on the Affected Party's performance of its obligations under this Agreement;
- (c) the measures which the Affected Party is taking or proposes to take for alleviating the impact of such Force Majeure Event; and
- (d) any other information relevant to the Affected Party's claim.

The Affected Party shall not be entitled to any relief for or in respect of a Force Majeure Event unless it shall have notified the other Party of the occurrence of the Force Majeure Event as soon as reasonably practicable, and in any event no later than 10 (ten) days after the Affected Party knew, or ought reasonably to have known, of its occurrence, and shall have given particulars of the probable material effect that the Force Majeure Event is likely to have on the performance of its obligations under this Agreement.

For so long as the Affected Party continues to claim to be affected by such Force Majeure Event, it shall provide the other Party with regular (and not less than weekly) reports containing information as required by Clause 26.5.1, and such other information as the other Party may reasonably request the Affected Party

to provide.

26.6 Effect of Force Majeure Event on the Agreement

Upon the occurrence of any Force Majeure

- (a) prior to the Appointed Date, both Parties shall bear their respective Force Majeure costs.
- (b) after the Appointed Date, the costs incurred and attributable to such event and directly relating to this Agreement (the “**Force Majeure costs**”) shall be allocated and paid as follows:
 - (i) upon occurrence of a Non-Political Event, the Parties shall bear their respective Force Majeure costs and neither Party shall be required to pay to the other Party any costs thereof;
 - (ii) upon occurrence of an Indirect Political Event, all Force Majeure costs attributable to such Indirect Political Event, and not exceeding the Insurance Cover for such Indirect Political Event, shall be borne by the Contractor, and to the extent Force Majeure costs exceed such Insurance Cover, one half of such excess amount shall be reimbursed by the Employer to the Contractor for the Force Majeure events; and
 - (iii) upon occurrence of a Political Event, all Force Majeure costs attributable to such Political Event shall be reimbursed by the Employer to the Contractor.

For the avoidance of doubt, Force Majeure costs may include costs directly attributable to the Force Majeure Event, but shall not include debt repayment obligations, if any, of the Contractor.

Save and except as expressly provided in this Clause 26, neither Party shall be liable in any manner whatsoever to the other Party in respect of any loss, damage, cost, expense, claims, demands and proceedings relating to or arising out of occurrence or existence of any Force Majeure Event or exercise of any right pursuant hereto.

Upon the occurrence of any Force Majeure Event during the Construction Period, the Project Completion Schedule for and in respect of the affected Works shall be extended on a day for day basis for such period as performance of the Contractor’s obligations is affected on account of the Force Majeure Event or its subsisting effects, as may be determined by the Employer’s Engineer.

Force Majeure costs for any event which results in any offsetting compensation being payable to the Contractor by or on behalf of its Sub-contractors shall be reduced by such amounts that are payable to the Contractor by its Sub-contractors.

26.7 Termination Notice for Force Majeure Event

If a Force Majeure Event subsists for a period of 60 (sixty) days or more within a continuous period of 120 (one hundred and twenty) days, either Party may in its discretion terminate this Agreement by issuing a Termination Notice to the other Party without being liable in any manner whatsoever, save as provided in this Clause 26, and upon issue of such Termination Notice, this Agreement shall, notwithstanding anything to the contrary contained herein, stand terminated forthwith; provided that before issuing such Termination Notice, the Party intending to issue the Termination Notice shall inform the other Party of such intention and grant 15 (fifteen) days time to make a representation, and may after the expiry of such 15 (fifteen) days period, whether or not it is in receipt of such representation, in its sole discretion issue the Termination Notice.

26.8 Dispute resolution

In the event that the Parties are unable to agree in good faith about the occurrence or existence of a Force Majeure Event, such Dispute shall be finally settled in accordance with the dispute resolution procedure; provided that the burden of proof as to the occurrence or existence of such Force Majeure Event shall be upon the Party claiming relief and/ or excuse on account of such Force Majeure Event.

26.9 Excuse from performance of obligations

If the Affected Party is rendered wholly or partially unable to perform its obligations under this Agreement because of a Force Majeure Event, it shall be excused from performance of such of its obligations to the extent it is unable to perform on account of such Force Majeure Event; provided that:

- (s) the suspension of performance shall be of no greater scope and of no longer duration than is reasonably required by the Force Majeure Event;
- (t) the Affected Party shall make all reasonable efforts to mitigate or limit damage to the other Party arising out of or as a result of the existence or occurrence of such Force Majeure Event and to cure the same with due diligence; and
- (u) when the Affected Party is able to resume performance of its obligations under this Agreement, it shall give to the other Party notice to that effect and shall promptly resume performance of its obligations hereunder.

27. Change in Law

27.1 If as a result of Change in Law, the Contractor suffers any additional costs in the execution of the Works or in relation to the performance of its other obligations under this

Agreement, the Contractor shall, within 15 (fifteen) days from the date it becomes reasonably aware of such addition in costs, notify the Employer with a copy to the Employer's Engineer of such additional costs due to Change in Law.

- 27.2 If as a result of Change in Law, the Contractor benefits from any reduction in costs for the execution of this Agreement or in accordance with the provisions of this Agreement, either Party shall, within 15 (fifteen) days from the date it becomes reasonably aware of such reduction in costs, notify the other Party with a copy to the Employer's Engineer of such reduction in costs due to Change in Law. Employer's Engineer shall, within 15 (fifteen) days from the date of receipt of notice from the Contractor or the Employer, as the case may be, determine any addition or reduction to the Contract Price, as the case may be, due to the Change in Law.

FORM-5C(AMENDED):
DETAILS OF SIMILAR WORKS EXECUTED ON EPC CONTRACT

Sl. No.	Name & Location of Project	Owner's Complete address including Telephone and Fax No. with Contact Person	Value of Contract	Duration of Contract			Details of work including major items of works involved	Reference No. & Date of Letter of Intent & Completion Certificate enclosed
				Commencement Date	Scheduled Completion Date	Actual Completion Date		
1	2	3	4	5	6	7	8	9

Note:

- (1) The Bidder to furnish the details of each assignment in the format given under Form-5A.
- (2) Bidder to enclose Completion Certificate issued by owner, either in original or certified by a Notary Public or equivalent certifying authority.

DATE:

BIDDER'S SIGNATURE WITH STAMP

FORM 13 (AMENDED)

PROFORMA OF PRE-CONTRACT INTEGRITY PACT

General

This Pre-Bid Pre-Contract Agreement (hereinafter called the Integrity Pact) is made on _____ day of the month of _____ 20__, between the Board of Trustees of Cochin Port Trust acting through Shri. _____, (Designation of the Officer), Cochin Port Trust (hereinafter called the 'EMPLOYER', which expression shall mean and include, unless the context otherwise requires, his successors in office and assigns) of the First Part and M/s. _____ represented by Shri. _____, Chief Executive Officer / Authorised signatory (hereinafter called the "BIDDER" which expression shall mean and include, unless the context otherwise requires, his successors and permitted assigns) of the Second Part.

WHEREAS the 'EMPLOYER' has invited Bids for the project of "Construction of International and Domestic Cruise Terminal and Other Allied Facilities at Mormugao Port, Goa through EPC contract"(Tender No. T15/ T-1946/2021-C)" (hereinafter referred to as the "Project") and the BIDDER is submitting his Bid for the Project and

WHEREAS the BIDDER is a Private Limited company/Public Limited company/Government undertaking/registered partnership firm/Proprietary firm/ Joint Venture firm constituted in accordance with the relevant law in the matter and the 'EMPLOYER' is Cochin Port Trust.

NOW, THEREFORE,

To avoid all forms of corruption by following a system that is fair, transparent and free from any influence/prejudiced dealings prior to, during and subsequent to the currency of the contract to be entered into with a view to:-

Enabling BIDDERS to abstain from bribing or indulging in any corrupt practice in order to secure the contract by providing assurance to them that their competitors will also abstain from bribing and other corrupt practices and the 'EMPLOYER' will commit to prevent corruption, in any form, by its officials by following transparent procedures.

The parties hereto hereby agree to enter into this Integrity Pact and agree as follows:

Commitments of the 'EMPLOYER'

1.1 The 'EMPLOYER' undertakes that no official of the 'EMPLOYER', connected directly or indirectly with the contract, will demand, take a promise for or accept, directly or through intermediaries, any bribe, consideration, gift, reward, favour or any material or immaterial benefit or any other advantage from the BIDDER, either for themselves or for any person, organisation or third party related to the contract in exchange for an advantage in the bidding process, bid evaluation, contracting or implementation process related to the contract.

1.2 The 'EMPLOYER' will, during the pre-contract stage, treat all BIDDERS alike and will provide to all the same information and will not provide any such information to any particular BIDDER which could afford an advantage to that particular BIDDER in comparison to other BIDDERS.

1.3 All the officials of the 'EMPLOYER' will report to the appropriate Government office any attempted or completed breaches of the above commitments as well as any substantial suspicion of such a breach.

2. In case any such preceding misconduct on the part of such official(s) is reported by the BIDDER to the 'EMPLOYER' with full and verifiable facts and the same is prima facie found to be correct by the 'EMPLOYER' necessary disciplinary proceedings, or any other action as deemed fit, including criminal proceedings may be initiated by the 'EMPLOYER' and such a person shall be debarred from further dealings related-to the contract

process. In such a case while an enquiry is being conducted by the 'EMPLOYER' the proceedings under the contract would not be stalled.

Commitments of BIDDERS

3. The BIDDER commits itself to take all measures necessary to prevent corrupt practices, unfair means and illegal activities during any stage of its bid or during any pre-contract or post-contract stage in order to secure the contract and in particular commit itself to the following:-
 - 3.1 The BIDDER will not offer, directly or through intermediaries, any bribe, gift, consideration, reward, favour, any material or immaterial benefit or other advantage, commission, fees, brokerage or inducement to any official of the 'EMPLOYER' connected directly or indirectly with the bidding process, or to any person, organisation or third party related to the contract in exchange for any advantage in the bidding, evaluation, contracting and implementation of the contract.
 - 3.2 The BIDDER further undertakes that it has not given, offered or promised to give, directly or indirectly any bribe, gift, consideration, reward, favour, any material or immaterial benefit or other advantage, commission, fees, brokerage or inducement to any official of the 'EMPLOYER' or otherwise in procuring the Contract or forbearing to do or having done any act in relation to the obtaining or execution of the contract or any other contract with the EMPLOYER for showing or forbearing to show favour or disfavour to any person in relation to the contract or any other contract with the EMPLOYER
 - 3.3 The BIDDER undertakes that he will disclose the name and address of agents and representatives including the name and address of agents and representatives of foreign principals or associates, if there is any.
 - 3.4 The BIDDER undertakes that it shall disclose the payments to be made by them to agents/brokers or any other intermediary, in connection with this bid/contract.
 - 3.5 The BIDDER further confirms and declares to the 'EMPLOYER' that the BIDDER has not engaged any individual or firm or company whether Indian or foreign to intercede, facilitate or in any way to recommend to the EMPLOYER or any of its functionaries, whether officially or unofficially to the award of the contract to the BIDDER, nor has any amount been paid, promised or intended to be paid to any such individual, firm or company in respect of any such intercession, facilitation or recommendation.
 - 3.6 The BIDDER, confirms and declares to the 'EMPLOYER' that either while presenting the bid or during pre-contract negotiations or before signing the contract, will disclose any payments he has made, is committed to or intends to make to officials of the 'EMPLOYER' or their family members, agents, brokers or any other intermediaries in connection with the contract and the details of services agreed upon for such payments.
 - 3.7 The BIDDER confirms and declares to the 'EMPLOYER' that it will not collude with other parties interested in the contract to impair the transparency, fairness and progress of the bidding process, bid evaluation, contracting and implementation of the contract.
 - 3.8 The BIDDER confirms and declares to the 'EMPLOYER' that it will not accept any advantage in exchange for any corrupt practice, unfair means and illegal activities.
 - 3.9 The BIDDER confirms and declares to the 'EMPLOYER' it will not use improperly, for purposes of competition or personal gain, or pass on to others, any information provided by the 'EMPLOYER' as part of the business relationship, regarding plans, technical proposals and business details, including information contained in any electronic data carrier. The BIDDER also undertakes to exercise due and adequate care lest any such information is divulged.
 - 3.10 The BIDDER commits to refrain from giving any complaint directly or through any other manner without supporting it with full and verifiable facts.

- 3.11 The BIDDER confirms and declares to the 'EMPLOYER' that he shall not instigate or cause to instigate any third person to commit any of the actions mentioned above.
- 3.12 The BIDDER confirms and declares to the 'EMPLOYER' that if the BIDDER or any employee of the BIDDER or any person acting on behalf of the BIDDER, either directly or indirectly, is a relative of any of the officers of the 'EMPLOYER' or alternatively, if any relative of an officer of the 'EMPLOYER' has financial interest/stake in the BIDDER/BIDDER's firm, he shall disclose the same at the time of submitting the bid.
- The term 'relative' for this purpose would be as defined in Section 6 of the Companies Act 1956.
- 3.13 The BIDDER confirms and declares to the 'EMPLOYER' that he shall not lend to or borrow any money from or enter into any monetary dealings or transactions, directly or indirectly, with any employee of the 'EMPLOYER'.
- 3.14 The BIDDER further confirms and declares to the 'EMPLOYER' that after signing IP he/she shall not approach the Courts while representing the matters to IEMs and he/she will await their decision in the matter.

4. Previous Transgression

- 4.1 The BIDDER declares that no previous transgression occurred in the last three years immediately before signing of this Integrity Pact, with any other company in any country in respect of any corrupt practices envisaged hereunder or with any Public Sector Enterprise in India or any Government Department in India that could justify BIDDER's exclusion from the tender process.
- 4.2 The BIDDER agrees that if it makes incorrect statement on this subject, BIDDER can be disqualified from the tender process or the contract, if already awarded, can be terminated for such reason.

5. Earnest Money (Security Deposit)

- 5.1 While submitting commercial Bid, the Bidders shall furnish an EMD Declaration in the prescribed format.
- 5.3 In case of the successful BIDDER, a Performance Security in the form of Bank Guarantee valid till 60 days after the end of defect liability period will also be furnished to the EMPLOYER 'within-21 days of Letter of Acceptance of the Bid by the 'EMPLOYER.
- 5.4 In case of the successful BIDDER, a clause would also be incorporated in the Article pertaining to Performance Security in the Project Contract that the provisions of Sanctions for Violation shall be applicable for forfeiture of Performance Security in case of a decision by the EMPLOYER to forfeit the same without assigning any reason for imposing sanction for violation of this Pact.
- 5.5 No interest shall be payable by the 'EMPLOYER' to the BIDDER on Security Deposit for the period of its currency.

6. Sanctions for Violations

- 6.1 Any breach of the aforesaid provisions by the BIDDER or any one employed by it or acting on its behalf (whether with or without the knowledge of the BIDDER) shall entitle the 'EMPLOYER' to take all or any one of the following actions, wherever required:-
- (i) To immediately call off the pre contract negotiations without assigning any reason or giving any compensation to the BIDDER. However, the proceedings with the other BIDDER(s) would continue.
- (ii) The Security Deposit/Performance Bond shall stand forfeited either fully or partially, as decided by the 'EMPLOYER' and the 'EMPLOYER' shall not be required to assign any reason therefore.
- (iii) To immediately cancel the contract, if already signed, without giving any compensation to the BIDDER.

(iv) If the EMPLOYER has disqualified the BIDDER from the bidding process according to Section-4 prior to the award, the EMPLOYER is entitled to demand and recover the damages equivalent to 2% of the Contract value, or the amount equivalent to Performance Security, whichever is higher.

If the EMPLOYER has terminated the Contract according to Section-4, or if the EMPLOYER is entitled to terminate the Contract according to Section-4, the EMPLOYER shall be entitled to demand and recover from the Contractor, liquidated damages equivalent to 5% of the Contract value, or the amount equivalent to Performance Security, whichever is higher.

The BIDDER agrees and undertakes to pay the said amounts, without protest or demur, subject only to the condition that, if the BIDDER/Contractor can prove and establish that the termination of the Contract after the Contract award has caused no damage or less damage than the amount of the liquidated damages, the BIDDER/Contractor shall compensate the BUYER/ EMPLOYER, only to the extent of the damage in the amount proved.

(v) To debar the BIDDER from participating in future bidding processes of the Government of India for a minimum period of five years, which may be further extended at the discretion of the 'EMPLOYER'

(vi) To recover all sums paid in violation of this Pact by BIDDER(s) to any middle man or agent or broker with a view to securing the contract.

6.2 The 'EMPLOYER' will be entitled to take all or any of the actions mentioned at para 6.1(i) to (vii) of this Pact also on the Commission by the BIDDER or any one employed by it or acting on its behalf (whether with or without the knowledge of the BIDDER), of an offence as defined in Chapter IX of the Indian Penal code, 1860 or Prevention of Corruption Act, 1988 or any other statute enacted for prevention of corruption.

6.3 In case of a final decision by the EMPLOYER to the effect that a breach of the provisions of this Pact has been committed by the BIDDER, it shall be binding and therefore, notified to the BIDDER forthwith. However, the BIDDER can approach the Independent Monitor(s) appointed for the purposes of this Pact in appeal, under intimation to the EMPLOYER, within a period not later than of one month of the date of such notification. In such cases, the decision of the Independent Monitor(s) will be final, conclusive and binding on both the BIDDER and the EMPLOYER.

7. Fall Clause

7.1 The BIDDER undertakes that it has not performed/is not performing **Similar Project** at a price lower than that offered in the present bid in respect of any other Ministry/Department of the Government of India or PSU and if it is found at any stage that **Similar Project** was performed by the BIDDER to any other Ministry/Department of the Government of India or a PSU at a lower price, then that very price, with due allowance for elapsed time, will be applicable to the present case and the difference in the cost would be refunded by the BIDDER to the 'EMPLOYER', if the contract has already been concluded.

“**Similar Project**” means a Project with similar location, topography, soil conditions, scope of work, terms and conditions of Contract and such other aspects which would have material effect on the Tender Price.

8. Independent Monitors

8.1 The 'EMPLOYER' has appointed the following Independent Monitors (hereinafter referred to as Monitors) for this Pact in consultation with the Central Vigilance Commission.

Name : Shri. P R Ravikumar, IRS (Retd.)

Address: Akshath, No.84,

First Avenue, Kumaranasan Nagar,
Elamkulam (PO), Ernakulam - 682020
Email : p_r_ravikumar@yahoo.com

- 8.2 The task of the Monitors shall be to review independently and objectively, whether and to what extent the parties comply with the obligations under this Pact.
- 8.3 The Monitors shall not be subject to instructions by the representatives of the parties and perform their functions neutrally and independently.
- 8.4 Both the parties accept that the Monitors have the right to access all the documents relating to the project/bidding, including minutes of meetings.
- 8.5 As soon as the Monitor notices, or has reason to believe, a violation of this Pact, he will so inform the Authority designated by the EMPLOYER,
- 8.6 The BIDDER(s) accepts that the Monitor has the right to access without restriction to all Project documentation of the EMPLOYER, including that provided by the BIDDER. The BIDDER will also grant the Monitor, upon his request and demonstration of a valid interest, unrestricted and unconditional access to his project documentation. The same is applicable to Subcontractors. The Monitor shall be under contractual obligation to treat the information and documents of the BIDDER/Subcontractor(s) with confidentiality.
- 8.7 The EMPLOYER, will provide to the Monitor sufficient information about all meetings among the parties related to the Project provided such meetings could have an impact on the contractual relations between the parties. The parties will offer to the Monitor the option to participate in such meetings.
- 8.8 The Monitor will submit a written report to the designated Authority of EMPLOYER within 8 to 10 weeks from the date of reference or intimation to him by the EMPLOYER/ BIDDER and, should the occasion arise, submit proposals for correcting problematic situations.

9. Facilitation of Investigation

In case of any allegation of violation of any provisions of this pact or payment of commission, the EMPLOYER or its agencies shall be entitled to examine all the documents including the Books of Accounts of the BIDDER and the BIDDER shall provide necessary information and documents in English and shall extend all possible help for the purpose of such examination.

10. Law and Place of Jurisdiction

This Pact is subject to Indian Law.' The place of performance and jurisdiction is the seat of the EMPLOYER

11. Other Legal Actions

The actions stipulated in this Integrity Pact are without prejudice to any other legal action that may follow in accordance with the provisions of the extant law in force relating to any civil or criminal proceedings.

12. Validity

- 12.1 The validity of this Integrity Pact shall be from date of its signing and extend upto 5 years or the complete execution of the contract to the satisfaction of both the EMPLOYER and the BIDDER, including warranty period/defect liability period, whichever is later. In case BIDDER is unsuccessful, this Integrity Pact shall expire after six months from the date of the signing of the contract.
- 12.2 Should one or several provisions of this Pact turn out to be invalid; the remainder of this Pact shall remain valid. In this case, the parties will strive to come to an agreement to their original intentions.

13. The parties hereby sign this Integrity Pact at _____ on _____

EMPLOYER

Name of the Officer.

Designation

Deptt./MINISTRY/PSU

BIDDER

CHIEF EXECUTIVE OFFICER/

Authorised representative

Witness

1. _____

2. _____

Witness

1. _____

2. _____,

* Provisions of these clauses would need to be amended/ deleted in line with the policy of the EMPLOYER in regard to involvement of Indian agents of foreign bidders.

FORM A

FORM OF AGREEMENT

AGREEMENT No.....of 20.....

AGREEMENT FOR THE WORK OF

CONSTRUCTION OF INTERNATIONAL AND DOMESTIC CRUISE TERMINAL AND OTHER ALLIED FACILITIES AT MORMUGAO PORT TRUST, GOA, THROUGH ENGINEERING, PROCUREMENT AND CONSTRUCTION (EPC) CONTRACT”

THIS AGREEMENT IS MADE on this day of BETWEEN THE BOARD OF TRUSTEES OF COCHIN PORT TRUST , a body corporate under the Major Port Trust Act, 1963 having office on Willingdon Island, Cochin – 682009 represented by its *Chief Engineer/*Deputy Chief Engineer/*Superintending Engineer Shri..... S/o Aged years residing at Village Taluk District (hereinafter referred to as the Employer which expression shall include his successors, assignees and administrators in the office) of the one part and M/s. represented by Shri. aged S/o residing at Village Taluk District(hereinafter referred as “Contractors” which expression shall include their successors, assignees and administrators) of the other part.

WHEREAS the Employer invited Bids for vide Tender Notice Date and the Contractor submitted a Bid for the same giving the amount subject to the terms and conditions etc. of the Bid document.

AND WHEREAS the said Bid submitted by the Contractor has been accepted by the Employer vide Letter of Award bearing No dated, issued to the Contractor while accepting their Bid.

NOW THESE PRESENTS WITNESSETH and the parties hereby agree as follows.

1. The Bid submitted by the Contractor for execution for the Board, of the work specified in the underwritten memorandum within the time and at the tendered cost specified in such memorandum at the amount specified in the schedule attached hereto and in accordance in all respects with the contract in writing referred to in Clause 16 of the “General Conditions of Contract” and with such materials as are provided for, by and in all other respects in accordance with such conditions is accepted.
2. It is mutually understood and agreed that, notwithstanding that the works has been sectioned, every part of it shall be deemed to be supplementary to and complementary of every other part and shall be read with it or into it.
3. The Contractor agreed to abide by and fulfill all the terms and provisions of the said Conditions of Contract or in default thereof forfeit and pay to the Board the sum of money mentioned in the said conditions.

4. The sum of Rs...../- [Rupees.....only) has been deposited by the Contractor with Financial Adviser and Chief Accounts Officer of the Port Trust as Performance Security (a) the full value of which is to be absolutely forfeited to the Board in office without prejudice to any other rights or remedies of the said Board in office should the Contractor fail to commence the work specified in underwritten memorandum or should the Contractor not deposit the full amount of security deposit specified in underwritten memorandum otherwise the said sum of Rs...../- shall be retained by the Board as on account of such security deposit as aforesaid or (b) the full value of which shall be retained by the Board on account of the security deposit to execute all the works referred to in the tender documents upon the terms and conditions contained or referred to therein.
5. It is mutually agreed that the tender submitted in its entirety shall form part of this agreement. Apart from the Bid, the following shall also form part of the agreement
 - (a) The Letter of Acceptance ;
 - (b) Bill of Quantities and
 - (c) Letters exchanged between the Employer and the Tenderer upto the issue of Letter of Acceptance as separately listed and annexed here to.
 - (d) Replies to Prebid queries and amendments issued, if any.

MEMORANDUM

- | | |
|--|--|
| a) General description of work | : Construction of International and Domestic Cruise Terminal and Other Allied facilities at Mormugao Port Trust, Goa, through EPC contract |
| b) Estimated cost | : Rs.7900 lakhs |
| c) Tendered cost | : Rs. |
| d) Earnest Money | : Nil
However, EMD Declaration as per Form 12 shall be furnished. |
| e) Performance Security / Security Deposit | : Rs.....(3% of the value of the Contract awarded or the value of the work done whichever is higher). |
| f) Percentage, if any, to be deducted from the bills | : In case, where the value of work done exceeds Contract Value, Additional Security Deposit @ 3% of the excess amount will be deducted from the respective RA Bills, while making the payment. |

- g) Time allowed for commencement of work from the date of issue of work order : **15 (Fifteen)** days
- h) Time allowed for the work from the date of commencement of work. : **18 (Eighteen)** months
- i) Schedule, specifications, conditions, drawings etc. as per contents sheet attached. :

IN WITNESS WHEREOF THE CONTRACTOR hereunto set his hand and seal on behalf of M/s..... and on behalf of the Board of Trustees of COCHIN PORT TRUST, the CHIEF ENGINEER has set his hand and seal and common seal of Trustees has been hereunto affixed the day and year first written above.

CONTRACTOR

- (Retain only the authority signing the agreement)

Signed, sealed and delivered by

Shri.....of M/s.

(Common Seal of the Firm)

Signed and affixed seal in the presence of :

1) Signature with address :

2) Signature with address :

EMPLOYER

Signed, sealed and delivered by the

CHIEF ENGINEER

Cochin Port Trust

On behalf of Board of

Trustees of Port of Cochin.

Signed and affixed the common seal of

Board of Trustees of the Port of Cochin

In the presence of

1)

2)

FORMAT -1(AMENDED)

**PROFORMA OF BANK GUARANTEE FOR PERFORMANCE GUARANTEE/
SECURITY DEPOSIT**

(To be executed on non-judicial Stamp Paper of appropriate value)

[The bank, as requested by the successful Tenderer, shall fill in this form in accordance with the instructions indicated]

In consideration of the Board of Trustees of the Port of *[insert name of Port]* incorporated by the Major Port Trusts Act, 1963 as amended by Major Port Trust (Amendment) Act 1974 (hereinafter called "The Board" which expression shall unless excluded by or repugnant to the context or meaning thereof be deemed to include the Board of Trustees of the Port of *[insert name of Port]*, its successors and assigns) having agreed to exempt _____ (hereinafter called the "Contractor")'

(Name of the Contractor/s)

from the demand under the terms and conditions of the Contract, vide _____ 's letter No. _____

(Name of the Department)

date _____ made between the Contractors and the Board for execution of _____ covered under Tender No. _____ dated _____ (hereinafter called "the said contract") for the payment of Security Deposit in cash or Lodgement of Government Promissory Loan Notes for the due fulfilment by the said Contractors of the terms and conditions of the said Contract, on production of a Bank Guarantee for Rs. _____ (Rupees _____) only we, the (Name of the Bank and Address) _____

_____ (hereinafter referred to as "the Bank") at the request of the Contractors do hereby undertake to pay to the Board an amount not exceeding Rs. _____ (Rupees _____) only against any loss or damage caused to or suffered or which would be caused to or suffered by the Board by reason of any breach by the Contractors of any of the terms and conditions of the said contract.

2. We, _____, _____, do hereby

(Name of Bank)

(Name of Branch)

undertake to pay the amounts due and payable under this guarantee without any demur merely on a demand from the Board stating that the amount claimed is due by way of loss or damage caused to or which would be caused to or suffered by the Board by reason of any breach by the Contractors of any of the terms and conditions of the said contract or by reason of the Contractors failure to perform the said contract. Any such demand made on the Bank shall be conclusive as regards the amount due and payable by the Bank under this Guarantee. However, our liability under this guarantee shall be restricted to any amount not exceeding Rs. _____ (Rupees _____) only.

3. We, _____(Name of Bank and Branch)_____, undertake to pay to the

Board any money so demanded notwithstanding any dispute or disputes raised by the Contractor(s) in any suit or proceeding pending before any Court or Tribunal relating thereto our liability under this present being absolute and unequivocal. The payment so made by us under this bond shall be a valid discharge of our liability for payment there under and the Contractor(s) shall have no claim against us for making such payment.

4. We, _____(Name of Bank and Branch) further agree with the Board that the guarantee herein contained shall remain in full force and effect during the period that would be taken for performance of the said contract and that it shall continue to be enforceable till all the dues of the Board under or by virtue of the said contract have been fully paid and its claims satisfied or discharged or till the

(Name of the user department)

of the said certifies that the terms and conditions of the said contract have been fully and properly carried out by the said Contractors and accordingly discharge this guarantee. PROVIDED HOWEVER that the Bank shall be the request of the Board but at the cost of the Contractors, renew or extend this guarantee for such further period or periods as the Board may require from time to time.

5. We, _____ further agree with the Board

(Name of Bank and Branch)

that the Board shall have the fullest liberty without our consent and without affecting in any manner our obligations hereunder to vary any of the terms and conditions of the said contract or to extend the time of performance by the said contract or to extend the time of performance by the said Contractors from time to time or to postpone for any time or from time to time any of the powers exercisable by the Board against the said Contractors and to forebear or enforce any of the terms and conditions relating to the said contract and we shall not be relieved from our liability by reason of any such variation or extensions being granted to be Contractors or for any forbearance, act or omission on the part of the Board or any indulgence shown by the Board to the Contractors or by any such matter or thing whatsoever which under the law relating to sureties would, but for this provision, have effect of so relieving us.

6. This guarantee will not be discharged due to the change in the constitution of the Bank or the Contractor(s).

7. It is also hereby agreed that the Courts in *[insert city]* would have exclusive jurisdiction in respect of claims, if any, under this Guarantee.

8. We, _____ Bank lastly undertake not to revoke this guarantee during its currency except with the previous consent of the Board in writing.

9. Notwithstanding anything contained herein :

a) Our liability under this Bank Guarantee shall not exceed Rs. _____

(Rupees _____ only);

b) this Bank Guarantee shall be valid upto ___* _____; and

c) we are liable to pay the guarantee 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).”

Date _____ day of _____ 20

For (Name of Bank)

(Name)

Signature

* The date will be thirty (30) days after the end of the period of Defect Liability as specified in the Contract.

PROFORMA OF BANK GUARANTEE FOR ADVANCE

(To be submitted on Non-Judicial Stamp Paper of appropriate value)

Bank Guarantee No _____ dated _____

Amount of Guarantee Rs. _____

Guarantee cover from _____ to _____

Last date of lodgment of claim

In consideration of Board of Trustees of Cochin Port Trust (hereinafter called "Port Trust") which expression shall include all their successors and assignees having agreed to pay advance of Rs. _____ (Rupees _____ only) repayable with interest @ _____ % per annum to _____ (Name & Address of contractor) (hereinafter called the "CONTRACTOR") which expression shall include their successors and assignees for the contract for the work of _____ (Name of work) evidenced by the offer of the Contractor dated..... and accepted by the Port Trust forming the contract and the work order No..... dated,..... for the work of (name of work) issued by the Port Trust and the formal stamped agreement to be entered into between parties in the above, the said amount and interest being recoverable from the running bills of the contractor on pro-rata basis as per terms of agreement, we (Name of Bank) having our Head office at (hereinafter referred to as "the Bank") do hereby undertake to pay The Cochin Port Trust an amount of Rs.....(Rupees.....only) with interest against any loss or damage caused to or would be caused to or suffered by the Port Trust by reason of any breach by the said contractor of any of the terms or conditions contained in the said agreement, making it impossible or difficult to recover the said mobilization advance of Rs.....(Rupees.....only) or part thereof or interest thereon we (Name of the Bank)do hereby undertake to pay the amounts due and payable under the guarantee without any demur, merely on demand of The Cochin Port Trust by reason of any breach by the said contractor of any of the terms and conditions contained in the said agreement or by the reason of contractor's failure to perform the said agreement. Any such demand made on the Bank shall be conclusive not only as regards to contractor's failure but also as regards the amount due and payable by the Bank under this guarantee. However, our liability under this guarantee will be restricted to an amount of Rs.....(Rupees..... only) with interest as per the agreement.

We, (Name of the Bank) further agree the guarantee herein contained will remain in full force and affect during the period that would be taken for the recovery of the loan and that it shall continue to be live and enforceable till all the amounts due with interest thereon have been fully recovered and its claims satisfied or discharged or till The Cochin Port Trust certifies that the amount outstanding under the advance has been fully recovered from the contractor and accordingly discharged the guarantees. Unless a demand or claim under this guarantee is made on us in writing on or before (date of the expiry) we shall be discharged from all liability under this guarantee thereafter.

We, (Name of the Bank) further agree with the Port Trust that the Port Trust shall have the fullest liberty without or consent and without affecting in any manner or obligation hereunder to vary any of the terms and conditions regarding the recovery or repayment and we shall not relieved from our liability by reason of any such variation or extension being granted to the said contractor or any forbearance, act or omission on the part of Cochin Port Trust or any indulgence by the Port Trust to the contractor or in such matter or things

whatsoever which under the law relating to sureties would but for this provision have the effect of so relieving us.

Notwithstanding anything contained herein:

- (i) Our liability under this bank guarantee shall not exceed Rs.....(Rupees.....)
- (ii) This bank guarantee shall be valid upto.....
- (iii) Our liability to make payment shall arise and we are liable to pay the guaranteed amount or any part thereof under this guarantee, only if you serve upon us a written claim or demand in terms of this guarantee on or before.....

We, (Name of the Bank) lastly undertake not to revoke this guarantee during its currency except with the previous consent of the Port Trust in writing.

Dated this the.....day of.....(year)

For (Name of Bank)

(Signature)

PROFORMA OF SCHEDULES (Modified)

Reference to General Conditions of contract.

Name of work: Construction of International and Domestic Cruise Terminal and other allied facilities at Mormugao Port Trust , Goa through EPC Contract

Estimated cost of work : Rs 7900 lakhs.

Performance Guarantee : 3% of tendered value.

SCHEDULE 'F'

GENERAL RULES : Officer inviting tender – Chief Engineer, Cochin Port Trust,

& DIRECTIONS

Definitions:

2(iv) Engineer-in-Charge : Chief Engineer, Cochin Port Trust

2(v) Accepting Authority : Board of Trustees, Cochin Port Trust or its authorised representative

2(viii) Department : Civil Engineering Dept. of Cochin Port Trust

Clause 1

(iii) Time allowed for submission of Performance Guarantee, programme chart (Time and progress)and applicable labour licenses, registration with EPFO, ESIC and BOCW welfare board or proof of applying thereof from the date of issue of letter of acceptance : 21 days

(iv) Maximum allowable extension with late fee @ 0.05% per day of Performance Guarantee amount beyond the period provided is : 15 days

Clause 2

Authority for fixing compensation under Clause 2 : Chief Engineer,
CoPT

Clause 5

Number of days from the date of issue of letter of acceptance
for reckoning date of start : 15 days

Time allowed for execution of work : 18 Months

Authority to decide:

- (i) Extension of time : Chairperson/Chief Engineer, CoPT
- (ii) Rescheduling of mile stones : Chairperson /Chief Engineer, CoPT
- (iii) Shifting of date of start in case
of delay in handing over of site : Chairperson /Chief Engineer, CoPT

**Schedule of rate of recovery for delay in
submission of the modified programme
in terms of delayed days**

: to be decided by Chief Engineer,
CoPT but not less than 0.001 % of
Contract amount.

Clause 7

Each Interim payment will be made as per payment scheduled as per mile stone .Or as per contractor's Work Breakdown Structures, however such payment will be made only after minimum one month and on completion of work with executed value 2 % of the contract amount.

Clause 7 A

Whether clause 7A shall be applicable : Yes

Clause 8A

Whether clause 8A shall be applicable : Yes

Clause 10B(ii)

Whether Clause 10 B (ii) shall be applicable : Yes

Clause 10B(iii)

Whether Clause 10 B (iii) shall be applicable: Yes

Clause 16

Competent Authority for deciding reduced rates : Engineer – in- Charge

Clause 19 C

Authority to decide penalty for each default : Engineer – in- Charge

Clause 19 D

Authority to decide penalty for each default : Engineer – in- Charge

Clause 19 G

Authority to decide penalty for each default : Engineer – in- Charge

Clause 19 K

Authority to decide penalty for each default : Engineer – in- Charge

Clause 32

Requirement of Technical Representative(s) and recovery Rate

Sl. No.	Designation / Qualification of Technical Staff	Number	Min. Experience (years)	Rate at which of recovery shall be made from the contractor in the event of not fulfilling.
1	Project Manager Graduate Engineer	1	20 (and having experience of one similar nature of work)	Rs.60,000/- per month

2	Dy. Project Manager Graduate Engineer	2	12 (and having experience of one similar nature of work)	Rs.40,000/- per month
3	Project / Site Engineer (Civil) Graduate Engineer or Diploma Engineer	2	5 or 10 respectively	Rs.25,000/- per month
4	Project / Site Engineer (Ele. / Mechanical) Graduate Engineer or Diploma Engineer	2	5 or 10 respectively	Rs.25,000/- per month
5	Quality Engineer Graduate Engineer	2	8	Rs.25,000/- per month
6	Surveyor Diploma Engineer	1	8	Rs.15,000/- per month
7	Project Planning / Billing Engineer Graduate Engineer	2	6	Rs.20,000/- per month

Note:-

1. Assistant Engineers retired from Government/PSU services that are holding Diploma will be treated at par with Graduate Engineers.
2. Diploma holder with minimum 10 years relevant experience with a reputed construction company may be treated at par with Graduate Engineers for the purpose of such deployment subject to the condition that such diploma holders should not exceed 50% of requirement of Graduate Engineers.

Clause 36

- (i) Schedule/statement for determining theoretical quantity of cement & bitumen on the basis of Schedule of Rates published by C.P.W.D.
- (ii)** Variations permissible on theoretical quantities:

- (a) Cement

- For works with estimated cost put to tender not more than Rs. 25 lakh 3% plus/minus.

- For works with estimated cost put to tender more than Rs. 25 lakh 2% plus/minus.

- (b) Bitumen All Works 2.5% plus & only & nil on minus side, if applicable

- (c) Steel Reinforcement and structural steel sections for each diameter, section and category 2% plus/minus

- (d) All other materials. Nil

FORM- 19:

FORMAT FOR POWER OF ATTORNEY FOR AUTHORISED SIGNATORY OF THE FIRM TO SIGN JOINT VENTURE AGREEMENT

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

By this Power-of-Attorney executed on thisday of(month) of 2021, *(Name and address of the first partner to be filled in.....)* hereby authorize Mr./Ms. *(.....Name and Address of the person to be filled in.....)* for signing the Joint Venture Agreement to be entered with (i) *(.....Name of the second partner to be filled in.....)*, (ii) on behalf of *(.....Name of the third partner to be filled in.....)* for the work of “Construction of International and Domestic Cruise Terminal and Other Allied Facilities at Mormugao Port, Goa through EPC contract “(Tender No. T15/ T-1946/2021-C)”.

Specimen Signature

Attested

Signature :

Name & Designation :

seal

Common seal of the firm :

(Signature, name and seal of the certifying authority/Notary Public)



Mormugao Port Trust

*GEOTECHNICAL INVESTIGATION FOR THE PROPOSED SITE FOR
DEVELOPMENT OF BERTH NO. 7*

REPORT: 215/08

JULY 2008

REPORT ISSUE STATUS

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Mormugao Port Trust

CIVIL ENGINEERING DEPARTMENT,
ADMINISTRATIVE OFFICE BUILDING,
HEADLAND SADA,
GOA – 400 001

Fugro Geotech Ltd

Plot No 51, Sector 06
Sanpada
Navi-Mumbai – 400 705
Maharashtra (INDIA)

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FUGRO GEOTECH LTD.

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1.0 INTRODUCTION

1.1 Project Description

As the **Mormugao Port Trust (MPT)** is planning to develop Mormugao Harbour, Fugro Geotech Ltd was commissioned to conduct detailed geotechnical investigation so as to establish the sub surface soil and rock strata and to carry out engineering analysis to develop soil and rock data for use in design of the various structures.

1.2 Project Objective

The broad objectives of investigation are as follows:

- To investigate geotechnical properties in soil/rock at the proposed site offshore seabed.
- To obtain the engineering properties of soil/rock and classification of soil/rock.

Fugro Geotech Ltd. (Fugro) was commissioned by MPT Work Order No CE.WKS-730/5495 dated 5th January 2008, to carry out detailed geotechnical investigation for proposed berth no 7. The principal objectives of the geotechnical investigation were to obtain adequate information on the sea bed conditions, the type and strength of the soils below the seabed and other geotechnical details of relevance to enable arriving at the design parameters for foundation of the proposed new structures. The entire work was carried out under supervision of the MPT. The data obtained from the field as well as laboratory investigations based on the findings of the geotechnical investigations are presented in this engineering report (Report No. 215/08).The vicinity map is given on Plate 1.

1.3 Scope of Work

The scope of work for the geotechnical investigation campaign comprised the drilling of 1 land borehole and 9 marine boreholes, carrying out standard penetration tests, collection of disturbed and undisturbed samples of soils, logging visually identifiable lithological and engineering characteristics of the soil samples, testing the samples in laboratory for their classification, index and engineering properties and preparation and submission of engineering report. The equipment and manpower were mobilized and the field investigations commenced for the proposed site for development of Berth No.7 on 15th February 2008. The entire work was carried out by Fugro under the technical supervision of client's representatives. List of the land and marine boreholes along with their coordinates, reduced levels w.r.t. CD and termination depths are tabulated in Table-1 and 2 respectively.



The scope of work for the site investigation project included the following:

- Drilling of 1 land borehole and 9 marine boreholes to termination depth (TD) of -33.06 m w.r.t CD for land boreholes and -27.56 m to -45.76 m w.r.t CD for marine boreholes.
- Logging and collection of samples.
- Carrying out standard penetration tests in soil.
- Collection of disturbed and undisturbed samples of soils encountered.
- Collection of core samples of rocks encountered.
- Logging visually identifiable lithological and engineering characteristics of soil samples.
- Testing selected soil and rock samples in laboratory for their classification, index and engineering properties.
- Analysing the field and laboratory data to develop the design and construction recommendations.
- Submission of engineering report.

2.0 FIELD INVESTIGATION

The field investigation works were carried out using a pontoon mounted with drilling rig for marine boreholes. The following activities, carried out in chronological sequence, comprised the fieldwork for the project:

- Mobilization of pontoon mounted drill rig with water pump, testing tools, power pack and accessories for marine boreholes
- Drilling of boreholes on land was carried out using cable percussion drilling method
- Positioning of the borehole locations using Fugro's "DGPS"
- Floating out and shifting of the pontoon using tug and tow boats
- Boring in soil from seabed level with SPT at specified intervals with drill rig on the pontoon
- Rock coring using double/triple tube core barrel using rotary drilling and storage of cores
- Collecting undisturbed sample of cohesive soils & disturbed sample of non-cohesive soils
- Visual inspection and litho-logging of the samples obtained from the boreholes
- Packing, labeling and dispatching the samples to laboratory
- Taking photographs of the core samples

Locations of the boreholes are presented on the location map on Plate 2 & 2a. The borehole logs are presented in Appendix A on plates A1 thru A22. The standards notations represented are: SPT- Standard Penetration Test, BS-Bulk Samples, WS-Wash Samples, UDS-Undisturbed Samples, and DS-Disturbed Samples.



Table 1 Land Borehole Location

S No	BH No	Geodetic Coordinates		UTM Coordinates		Depth of BH w.r.t. EGL (m)	EGL w.r.t. CD (m)	Rock elevation w.r.t CD (m)	TD w.r.t. CD (m)
		Latitude	Longitude	Northing	Easting				
Land Borehole									
1	LBH-1	15°24'42.8"	73°47'50.2"	370940	1704243	37.50	4.44	-25.86	-33.06

C.D - Chart Datum, T.D - Termination Depth, E.G.L - Existing Ground Level

Table 2 Summary of Marine Borehole Locations

S No	BH No	Geodetic Coordinates		UTM Coordinates		Depth of BH w.r.t. SBL (m)	SBL w.r.t. CD (m)	Rock elevation w.r.t CD (m)	TD w.r.t. CD (m)
		Latitude	Longitude	Northing	Easting				
Marine Boreholes									
1	MBH-A1	15°24'45.1"	73°47'51.8"	370989	1704311	40.00	-5.757	--	-45.76
2	MBH-A2	15°24'43.5"	73°47'55.2"	371091	1704265	22.50	-6.332	-22.86	-28.83
3	MBH-A3	15°24'44.4"	73°47'56.4"	371126	1704292	28.00	-7.040	-24.04	-35.04
4	MBH-A4	15°24'46.6"	73°47'53.5"	371041	1704357	28.50	-6.098	-30.10	-34.60
5	MBH-B1	15°24'46.3"	73°47'25.0"	370192	1704355	27.00	-2.756	-23.99	-29.76
6	MBH-B2	15°24'50.7"	73°47'23.0"	370131	1704492	27.30	-4.270	-31.33	-33.63
7	MBH-B3	15°24'54.3"	73°47'21.3"	370082	1704602	25.50	-3.234	-23.79	-29.77
8	MBH-B4	15°25'05.7"	73°47'34.1"	370465	1704950	24.50	-3.060	-24.08	-27.56
9	MBH-C1	15°24'37.1"	73°48'05.5"	371396	1704066	24.00	-6.880	-24.88	-30.88

C.D - Chart Datum, T.D - Termination Depth, S.B.L-Sea Bed Level

2.1 Borehole Positioning

The marine boreholes were positioned using Differential Geographic Positioning System. The DGPS system was calibrated against the already fixed Benchmark provided by the client.

2.2 Boring / Drilling

The boring /drilling works were carried out at locations as given in Table-1 & 2. A hydraulically operated drilling rig with supporting water pump was mounted on the platform. The boreholes were advanced in soil using cable percussion/rotary method and rock by diamond coring. Clear water was generally used as the flushing medium. Temporary steel casing supported the borehole walls. Sampling comprised collection of undisturbed samples using thin walled Shelby tubes in cohesive soils, alternating with disturbed bagged samples obtained from SPT split spoon sampler and shoe. Sampling frequency was 1.50 m depending on strata variability and design considerations. On reaching very hard rock strata triple tube core barrel of Nx size fitted with diamond bits was used to advance the hole. These samples thus obtained were then carefully retrieved from the core barrel and carefully packed using cling films and wax. The boreholes were terminated on reaching the requisite depths on the advice of the



supervising engineers. The drilling accessories and tools used were in conformity with BS: 4019 or relevant IS codes.

2.3 Standard Penetration Tests

Standard Penetration Tests (SPT) were carried out using a split spoon sampler complete with a drive shoe and drive head fitted with a non-return valve. The basis of the test consists of dropping of a hammer of mass 63.5 kg on to a drive head from a height of 750 mm (as specified in I.S. Code of Practice). An auto trip hammer capable of dropping the weight freely on the anvil over a fixed height of 750mm was used to assure the quality of the test. The number of such blows (N) necessary to achieve a penetration of the split spoon sampler of 300mm (after its penetration under gravity and below the seating drive) is regarded as the penetration resistance. The blow counts for each 75 mm penetration were recorded. Small disturbed samples of soil were obtained from the split spoon sampler after completion of the tests.

The borehole records with visual lithologs, SPT 'N' values and laboratory test results are enclosed in Appendix-A and B.

2.4 TCR, SCR and RQD

The quantitative description of fracture state of rock masses are indicated using a number of indices as determined from the borehole cores. Total Core Recovery (TCR) is the percentage ratio of core recovered (whether solid, intact with full diameter, or non-intact) to the total length of core run. Solid Core Recovery (SCR) is the percentage ratio of solid core recovered to the total length of the core run. Rock Quality Designation (RQD) is a quantitative index based on core recovery procedure that incorporates only those pieces of core 100mm or more in length. It is the total length of solid core pieces, each greater than 100mm between natural fractures, expressed as a percentage of the total length of core run. It is also a measure of drill core quality and it disregards the influence of orientation, continuity, joint thickness and gauge.

The borehole records with visual lithologs, TCR, SCR, RQD values and laboratory test results are enclosed in Appendix-A and B.

3.0 LABORATORY TESTS

The laboratory test programme was directed primarily towards the determination of engineering and index properties of soils and rocks encountered at site.

3.1 Laboratory tests on soil samples

Disturbed samples in SPT split spoon and undisturbed samples in thin walled Shelby tubes were collected from the boreholes. The soil samples were visually identified and described, thereafter packed, labeled, sealed and dispatched to the laboratory. The laboratory tests were carried out as per relevant parts of Indian Standard Code of Practice. The summary of laboratory test results on soil are presented in Appendix-B in plates-B1 and B2.

Table 3 List of I.S. Codes followed for laboratory tests on soil samples

S No	Test Designation	No. of tests performed	Applicable Standards	Presented in Plates
1	Sieve Analysis	32	IS:2720 (PART -4)	Plates B4 thru B12
2	Hydrometer Analysis	27	IS:2720 (PART -4)	Plates B4 thru B12
3	Atterberg Limit	22	IS:2720 (PART- 5)	Plates B13 thru B19
4	Specific Gravity	32	IS:2720 (PART- 3)	Plate B1
5	Moisture Content	15	IS:2720 (PART- 2)	Plate B1
6	Wet and Dry Density	15	IS:2720 (PART- 9)	Plate B1
7	Triaxial Shear Test (UU)	13	IS:2720 (PART- 11)	Plates B20 thru B71
8	Lab Vane Shear Test	2	IS:2720 (PART- 30)	Plates B72 thru B73
9	Consolidation Test	1	IS:2720 (PART- 15)	Plate B74

3.1.1 Sieve Analysis

The Sieve Analysis was carried out on Thirty Two (32) soil samples in accordance with IS: 2720(Part-4) by wet sieving method. Particularly in SPT samples the quantity of soil sample available for testing is typically 100 gm. This sample quantity is considered representative of soil where grain size ranges upto 4.75 mm (Coarser sand size). This test gives indicative values of the particle size distribution, which are shown in curves as presented in Appendix B on Plates B4 through B12.

3.1.2 Sedimentation / Hydrometer Analysis

Sedimentation analysis was performed on Twenty Seven (27) soil samples in accordance with the hydrometer method described in IS: 2720 (PART-4). The analysis provides an estimate of the particle size distribution for the fine fraction (<75 μ m) of a soil sample. The analysis was performed by monitoring the rate of settlement of soil particles initially suspended uniformly in distilled water. The rate of settlement, which is monitored by observing the change in fluid density with the hydrometer device, is related to the size of particles settling out of suspension. The test results are presented in Appendix B on Plates B4 through B12.

3.1.3 Atterberg Limits

The Atterberg Limits comprising liquid limit, plastic limit and plasticity index were determined on Twenty Two (22) soil samples in accordance with the relevant methods described in IS:2720 (PART-5). The liquid limit has been determined using the Casagrande apparatus method. In accordance with the Standard, soil sample preparation included removal of soil particles retained on the 425µm sieve. Accordingly, where significant quantities of coarser particles are present, it should be recognized that the Atterberg Limits results are representative of the relatively fine soil fraction, and not of the complete soil sample. The test results are presented in Appendix B on Plates B13 through B19.

3.1.4 Moisture Content & Density

Moisture content, bulk density and dry densities were determined for Fifteen (15) soil samples, in accordance with the procedures of IS:2720 (Part 2) and IS:2720 (Part 9) .The results are summarized in Appendix-B on Plate B1.

3.1.5 Particle Density / Specific Gravity

The specific gravity was determined for Thirty Two (32) soil samples in accordance with the small pycnometer method described in IS:2720 (Part 3). Prior to testing, samples were ground down, if necessary, so as to pass the 2mm sieve. The test results are summarized in Appendix B on Plate B1.

3.1.6 Triaxial Compression (Unconsolidated Undrained)

Undrained shear strength parameters were determined for Thirteen (13) soil samples by rapid unconsolidated-undrained (UU) triaxial compression testing, in accordance with the methods of IS:2720 (Part 11). Testing on undisturbed samples was carried out on test 38mm & 100mm diameter specimen trimmed from thin-walled tube samples. Prior to loading, confining cell pressures were applied to test specimens in the triaxial cell, without consolidation. During testing, no change in sample moisture content is allowed, and pore pressures were monitored. Undrained shear strength parameters have been interpreted from Mohr circles. The results are presented on Appendix B in Plates 20 through 71.

3.1.7 Laboratory Vane Shear Strength

Laboratory vane tests were carried out on Two (2) cohesive soil specimens which were very soft and not amenable to triaxial shear testing in accordance with the method described on IS:2720 (Part 30). The test was carried out on undisturbed sample, contained within a steel sample container, using a vane of height 24mm and diameter 12mm. The peak and remoulded shear strengths were determined

using the relationship:

$$\tau = \frac{T}{\pi d^2 \left(\frac{h}{2} + \frac{d}{6} \right)}$$

Where, τ = the vane shear strength (KPa)
 T = Torque (N-mm)
 h = height of Vane blade (mm)
 d = diameter of Vane blade (mm)

The test records are presented on Appendix-B in Plates B 72 through B 73.

3.1.8 Consolidation

The consolidation properties of soil were determined for One (1) soil sample by vertical drainage both to top and bottom surfaces. The consolidation tests were carried out in accordance with IS: 2720 (Part-15). Volume change after every stress application (0.2, 0.5, 1, 2, 4, 8, 4, 2, 1 kg/cm²) is recorded at intervals of 0, ½, 1, 4, 9, 16, 25, 36, 49, 64min; 1½, 2, 4, 8 and 24 hours. The values of coefficient of consolidation c_v and the coefficient of volume change m_v were calculated. The test results are presented on Appendix-B in Plate B74.

3.2 Laboratory tests on rock samples

Tests were carried out on rock cores obtained by drilling using triple tube core barrel, which were necessary to be tested in the laboratory from strength consideration. The rock samples were prepared for testing in the laboratory in accordance with IS: 9179:1979. The test results so obtained were tabulated for engineering characterization of rock samples. Water absorption, Unit Weight, Point load strength Index test and uniaxial compression test on the rock samples were conducted as per relevant Indian Standards. The summary of the laboratory test results on rock are presented in Appendix-B in Plate B3.

Table 4 List of I.S. codes followed for laboratory tests on rock samples

Test Designation	Qty	Applicable Standards	Presented in Plates
Saturated Moisture Content	9	IS:13030-1991	Plate B3
Moisture Absorption	9	IS:13030-1991	Plate B3
Porosity	8	IS:13030-1991	Plate B3
Unit Weight	9	IS:13030-1991	Plate B3
Specific Gravity	9	IS:13030-1991	Plate B3
Point Load Index	1	IS:8764-1991	Plate B3
Uniaxial Compressive Strength	8	IS:9143-1979	Plate B3

3.2.1 Unit Weight, Specific Gravity and Porosity of Rock

Unit Weight, Specific Gravity and Porosity of Rock specimen were determined by using saturation and buoyancy technique in accordance with the methods of IS: 13030. The summaries of the results are presented on Appendix B in Plate B3.

3.2.2 Point Load Index Test

A total of One (1) point load Index test were performed on selected rock specimens in accordance with the method suggested by IS:8764 (1991). The tests were performed on diametrically loaded, trimmed core samples and on irregularly fractured core samples. The results of rock test are reported in summary of rock test results as point load strength index $I_{s(50)}$. Uniaxial compressive strength may be predicted by following relationship.

$$UCS/ I_{s(50)} = 22$$

Where, $I_{s(50)}$ = Corrected Point load strength index. The test results are presented on Appendix B in Plate B3.

3.2.3 Uniaxial Compression Test

Uniaxial compressive strength (saturated) for a total of Eight (8) cylindrical rock specimens was determined in accordance with the method suggested by IS:9143 (1979). The uniaxial compressive strength of the specimens were corrected for a height to diameter ratio of two for specimens whose height to diameter ratio was other than two using the following relationship.

$$q_c \text{ (corrected)} = (q_c 0.889) / (0.778 + (0.222D/H))$$

Where q_c = Uncorrected Uniaxial Compressive Strength

D = Diameter of the specimen tested

H = Height of the specimen tested

The test results are presented on Appendix B in Plate B3.

4.0 GENERAL SITE CONDITIONS

4.1 Regional Geology

The Deccan traps occupy the coast and the interior north of Goa upto Rajasthan. But over a good part of Gujarat coast, they are overlain by tertiary sediments. The coastal plain in this area consists of

different types of depositional land forms which are the result of the operation of different geomorphic processes. The geology around the area of investigation basically consists of rocks of volcanic origin known as Deccan Traps, forming a series of step like terraces. These rocks extend over an area of about 50,000 sq.km. Thicknesses, however, vary considerably at different places. The Deccan Traps primarily consist of Basalts.

5.0 SUBSURFACE SOIL CONDITION

5.1 Land/Marine Borehole Logs

Land/Marine Borehole logs were developed based on field test data, visual observation and laboratory test results. These logs are presented on plates A -1 thru A - 20, in Appendix - A. These borehole locations are as shown in Table 1.vicinity map is presented on Plate -1.Location plan is presented on Plate -2.

5.2 Generalized Subsurface Stratigraphy

The sub-surface stratification and the soil types encountered at this site have been described in detail in the borehole records presented on Appendix A. There were 10 boreholes recorded. The soil has been classified according to the IS Code of Practice. These borehole locations are as shown in the Plate-2. For the purpose of ease of visualization, these boreholes have been divided into 5 sections as shown in Table 5. Generalized subsurface stratigraphy of these sections is presented on Plate -3 thru 6.

Table 5 List of Boreholes with Sectional Details

Section No	BOREHOLE No
1-1	MBH - A 4, MBH - A 3 , MBH - C1
2-2	MBH - B3 , MBH -B4
3-3	MBH - B1, MBH - B2, MBH - B3
4-4	MBH - A1, MBH - A2
5-5	LBH - 1

The soil layers of these sections have been shown on Table 6, 9, 12, 15 & 18.The thickness of various strata encountered with minimum, maximum and average height of the layers shown in the boreholes is summarized in Table 7, 10, 13, 16 & 19. Generalised subsurface soil profile adopted in section 1-1, 2-2, 3-3, 4-4 and 5-5 are given in Table 8,11,14,17& 20.

Table 6 Generalized Soil/Rock Layers of Section 1-1

S No	Soil Description	Designated As
1	Very soft to soft, dark grey to yellowish grey, silty CLAY with few gravel	LAYER 1
2	Very stiff to very hard, dark grey to yellowish grey, silty CLAY with some sand	LAYER 2
3	Medium dense to very dense, yellowish brown to reddish brown, fine to coarse SAND with few gravel	LAYER 3
4	Hard, dark grey to grey, silty CLAY with gravel and weathered rock fragments	LAYER 4
5	Extremely weak to strong, greenish grey to dark grey, highly to moderately weathered, extremely to closely spaced BASALT with inclined and vertical joint	LAYER 5

Table 7 Details of Boreholes Drilled and Thickness of Strata Encountered in Section 1-1

LAYER No		BOREHOLE No			Min	Max	Avg
		SECTION 1-1					
		MBH-A4	MBH-A3	MBH-C1			
Thickness of Strata (m)	LAYER 1	7.50	4.50	10.50	4.50	10.50	7.50
	LAYER 2	4.50	6.00	--	--	6.00	3.50
	LAYER 3	9.00	6.50	4.50	4.50	9.00	7.00
	LAYER 4	3.00	--	3.00	--	3.00	2.00
	LAYER 5	4.50	11.00	6.00	4.50	11.00	7.00
Total Depth (m)		28.50	28.00	24.00			

For Section 1-1 comprising boreholes MBH-A4, MBH-A3 & MBH-C1 in general the subsoil comprises of Layer 1 of Very soft to soft, dark grey to yellowish grey, silty CLAY with few gravel for depths ranging from 4.50 to 10.50 m w.r.t. SBL with SPT N - values ranging from 1 to 4; this is followed by Layer 2 of Very stiff to very hard, dark grey to yellowish grey, silty CLAY with some sand for depths ranging from 4.50 to 12.00 m with SPT N - values ranging from 15 to 34 ;this is followed by Layer 3 of Medium dense to very dense, yellowish brown to reddish brown, fine to coarse SAND with few gravel for depth ranging from 10.50 to 21.00m with SPT N - values ranging from 30 to refusal ; this is followed by Layer 4 of Hard, dark grey to grey, silty CLAY with gravel and weathered rock fragments for depth ranging from 15.00 to 24.00m with SPT N - values ranging from 93 to refusal. The boreholes terminate in Layer 5 of Extremely weak to strong, greenish grey to dark grey, highly to moderately weathered, extremely to closely spaced BASALT with inclined and vertical joint for depths ranging from 17.00m – 28.50 m.

Table 8 Generalised Subsurface Soil/Rock Profile adopted in Section 1-1

Layer No.	Soil Layers used for Modeling	Thickness of Strata (m)	SPT "N" value	c (KPa)	Φ (°)	γ_b (KN/m ³)	q_c (MN/m ²)
1	Very soft to soft, dark grey to yellowish grey, silty CLAY with few gravel	7.50	1 - 4	6-15	0-3	14-15.6	--
2	Very stiff to very hard, dark grey to yellowish grey, silty CLAY with some sand	3.50	15 - 34	56	7	19.6	--
3	Medium dense to very dense, yellowish brown to reddish brown, fine to coarse SAND with few gravel	7.00	30 - >100	--	--	--	--
4	Hard, dark grey to grey, silty CLAY with gravel and weathered rock fragments	2.00	93 - >100	--	--	--	--
5	Extremely weak to strong, greenish grey to dark grey, highly to moderately weathered, extremely to closely spaced BASALT with inclined and vertical joint	7.00	--	--	--	--	8-101

C - Cohesion, Φ - Angle of internal friction, q_c - Uniaxial compressive strength of rock, γ_b - Bulk unit Weight of soil

Table 9 Generalized Soil/Rock Layers of Section 2-2

S No	Soil Description	Designated As
1	Very loose, brownish grey, slightly clayey SAND with shell fragments / very soft, dark grey, silty CLAY with some sand	LAYER 1
2	Medium dense to very dense, brownish grey to yellowish brown, fine to medium SAND	LAYER 2
3	Hard, brownish grey to yellowish grey, silty CLAY with some sand and laterite pieces	LAYER 3
4	Very dense, brown, medium SAND	LAYER 4
5	Extremely weak to moderately weak, yellowish grey to dark grey, highly to moderately weathered, extremely to very closely spaced BASALT with inclined and vertical joint	LAYER 5

Table 10 Details of Boreholes Drilled and Thickness of Strata Encountered in Section 2-2

LAYER No		BOREHOLE No		Min	Max	Avg
		SECTION 2-2				
		MBH-B3	MBH-B4			
Thickness of Strata (m)	LAYER 1	7.50	--	--	7.50	4.00
	LAYER 2	9.00	16.50	9.00	16.50	13.00
	LAYER 3	3.00	1.50	1.50	3.00	2.50
	LAYER 4	--	3.00	--	3.00	1.50
	LAYER 5	6.00	3.50	3.50	6.00	5.00
Total Depth (m)		25.50	24.50			

For Section 2-2 comprising boreholes MBH-B3 & MBH-B4 in general the subsoil comprises of Layer 1 of Very loose, brownish grey, slightly clayey SAND with shell fragments / very soft ,dark grey, silty CLAY with some sand for depth ranging from 0.00 to 7.50m w.r.t. SBL with SPT N - values ranging from 0 to 2; this is followed by Layer 2 of Medium dense to very dense, brownish grey to yellowish brown, fine to medium SAND for depth ranging from 0.00 to 16.50m with SPT N - values ranging from 27 to 83 ;this is followed by Layer 3 of Hard, brownish grey to yellowish grey, silty CLAY with some sand and laterite pieces for depth ranging from 16.50 to 19.50 m with SPT N - values ranging from 83 to 88 ; this is followed by Layer 4 of Very dense, brown, medium SAND for depth ranging from 18.00 to 21.00m with SPT N - values ranging from 88 to refusal. The boreholes terminate in Layer 5 of Extremely weak to moderately weak, yellowish grey to dark grey, highly to moderately weathered, extremely to very closely spaced BASALT with inclined and vertical joint for depths ranging from 19.50m – 25.50 m.

Table 11 Generalised Subsurface Soil/Rock Profile adopted in Section 2-2

Layer No.	Soil Layers used for Modeling	Thickness of Strata (m)	SPT "N" value	c (KPa)	Φ (°)	γ_b (KN/m ³)	q_c (MN/m ²)
1	Very loose, brownish grey, slightly clayey SAND with shell fragments / very soft ,dark grey, silty CLAY with some sand	4.00	0-2	--	--	--	--
2	Medium dense to very dense, brownish grey to yellowish brown, fine to medium SAND	13.00	27-83	--	--	--	--
3	Hard, brownish grey to yellowish grey, silty CLAY with some sand and laterite pieces	2.50	83-88	--	--	--	--
4	Very dense, brown, medium SAND	1.50	88->100	--	--	--	--
5	Extremely weak to moderately weak, yellowish grey to dark grey, highly to moderately weathered, extremely to very closely spaced BASALT with inclined and vertical joint	5.00	--	--	--	--	5.5

C - Cohesion, Φ - Angle of internal friction, q_c - Uniaxial compressive strength of rock, γ_b -Bulk unit Weight of soil

Table 12 Generalized Soil/Rock Layers of Section 3-3

S No	Soil Description	Designated As
1	Very loose to dense, brownish grey, fine to medium SAND	LAYER 1
2	Very soft to soft, dark grey ,silty CLAY with some sand	LAYER 2
3	Very dense, brownish grey to yellowish grey, slightly clayey, fine to coarse SAND	LAYER 3
4	Hard, yellow to yellowish grey, silty CLAY mix some gravel and sand /Residual soil	LAYER 4
5	Extremely weak to strong, greenish grey to reddish grey, highly to moderately weathered, highly fractured, extremely closely spaced to closely spaced BASALT with inclined and vertical joint	LAYER 5

Table 13 Details of Boreholes Drilled and Thickness of Strata Encountered in Section 3-3

LAYER No		BOREHOLE No			Min	Max	Avg
		SECTION 3-3					
		MBH-B3	MBH-B2	MBH-B1			
Thickness of Strata (m)	LAYER 1	4.50	3.00	4.50	3.00	4.50	4.00
	LAYER 2	3.00	6.00	4.50	3.00	6.00	4.50
	LAYER 3	9.00	15.00	1.50	1.50	15.00	8.50
	LAYER 4	3.00	1.00	10.50	1.00	10.50	5.00
	LAYER 5	6.00	2.30	6.00	2.30	6.00	5.00
Total Depth (m)		25.50	27.30	27.00			

For Section 3-3 comprising boreholes MBH-B3 , MBH-B2 & MBH-B1 in general the subsoil comprises of Layer 1 of Very loose to dense, brownish grey, fine to medium SAND for depth ranging from 0.00 to 4.50m w.r.t. SBL with SPT N - values ranging from 0 to 48; this is followed by Layer 2 of Very soft to soft, dark grey ,silty CLAY with some sand for depth ranging from 3.00 to 9.00 m with SPT N - values ranging from 2 to 5 ;this is followed by Layer 3 of Very dense, brownish grey to yellowish grey, slightly clayey, fine to coarse SAND for depth ranging from 7.50 to 24.00 m with SPT N - values ranging from 47 to 100 ; this is followed by Layer 4 of Hard, yellow to yellowish grey, silty CLAY mix some gravel and sand /Residual soil for depth ranging from 10.50 to 25.00m with SPT N - values ranging from 4 to refusal. The boreholes terminate in Layer 5 of Extremely weak to strong, greenish grey to reddish grey, highly to moderately weathered, highly fractured, extremely closely spaced to closely spaced BASALT with inclined and vertical joint for depths ranging from 19.50m – 27.30 m.

Table 14 Generalised Subsurface Soil/Rock Profile adopted in Section 3-3

Layer No.	Soil Layers used for Modeling	Thickness of Strata (m)	SPT "N" value	c (KPa)	Φ (°)	γ_b (KN/m ³)	q_c (MN/m ²)
1	Very loose to dense, brownish grey, fine to medium SAND	4.00	0-48	--	--	--	--
2	Very soft to soft, dark grey ,silty CLAY with some sand	4.50	2-5	12-17	4-5	14-16.4	--
3	Very dense, brownish grey to yellowish grey, slightly clayey, fine to coarse SAND	8.50	47-100	--	--	--	--
4	Hard, yellow to yellowish grey, silty CLAY mix some gravel and sand /Residual soil	5.00	62- >100	--	--	--	--
5	Extremely weak to strong, greenish grey to reddish grey, highly to moderately weathered, highly fractured, extremely closely spaced to closely spaced BASALT with inclined and vertical joint	5.00	--	--	--	--	51.2

C - Cohesion, Φ - Angle of internal friction, q_c - Uniaxial compressive strength of rock, γ_b -Bulk unit Weight of soil

Table 15 Generalized Soil/Rock Layers of Section 4-4

S No	Soil Description	Designated As
1	Very soft to firm ,dark grey silty CLAY	LAYER 1
2	Stiff to hard, yellowish brown to brownish grey, slightly sandy, silty CLAY with few gravel	LAYER 2
3	Very dense, brown, silty ,coarse SAND with gravel and weathered rock fragments	LAYER 3
4	Extremely weak to moderately weak ,greenish grey to grey, completely weathered to moderately weathered ,highly fractured, very closely spaced BASALT with inclined and vertical joint	LAYER 4

Table 16 Details of Boreholes Drilled and Thickness of Strata Encountered in Section 4-4

LAYER No		BOREHOLE No		Min	Max	Avg
		SECTION 4-4				
		MBH-A1	MBH-A2			
Thickness of Strata (m)	LAYER 1	7.50	7.50	7.50	7.50	7.50
	LAYER 2	32.5	6.00	6.00	32.5	10.00
	LAYER 3	--	3.00	--	3.00	1.50
	LAYER 4	--	6.00	--	6.00	3.00
Total Depth (m)		40.00	22.50			

For Section 4-4 comprising boreholes MBH-A1 & MBH-A2 in general the subsoil comprises of Layer 1 Very soft to firm ,dark grey silty CLAY for depth ranging from 0.00 to 7.50m w.r.t. SBL with SPT N - values ranging from 2 to 6; this is followed by Layer 2 Stiff to hard, yellowish brown to brownish grey, slightly sandy, silty CLAY with few gravel for depth ranging from 7.50 to 40.00 m with SPT N - values ranging from 12 to refusal ;this is followed by Layer 3 of Very dense, brown, silty ,coarse SAND with gravel and weathered rock fragments for depth ranging from 13.50 to 16.50 m with SPT N - values ranging from 74 to refusal.The boreholes terminate in Layer 4 of Extremely weak to moderately weak ,greenish grey to grey, completely weathered to moderately weathered ,highly fractured, very closely spaced BASALT with inclined and vertical joint for depths ranging from 16.50m – 22.50 m.

Table 17 Generalised Subsurface Soil/Rock Profile adopted in Section 4-4

Layer No.	Soil Layers used for Modeling	Thickness of Strata (m)	SPT "N" value	c (kPa)	Φ (°)	γ_b (kN/m ³)	q_c (MN/m ²)
1	Very soft to firm ,dark grey silty CLAY	7.50	2-6	10-18	4-6	13.8-17.3	--
2	Stiff to hard, yellowish brown to brownish grey, slightly sandy, silty CLAY with few gravel	10.00	12->100	--	--	--	--
3	Very dense, brown, silty ,coarse SAND with gravel and weathered rock fragments	1.50	74->100	--	--	--	--
4	Extremely weak to moderately weak ,greenish grey to grey, completely weathered to moderately weathered ,highly fractured, very closely spaced BASALT with inclined and vertical joint	3.00	--	--	--	--	60

C - Cohesion, Φ - Angle of internal friction, q_c - Uniaxial compressive strength of rock, γ_b -Bulk unit Weight of soil

Table 18 Generalized Soil/Rock Layers of Section 5-5

S No	Soil Description	Designated As
1	Made up ground (Loose to dense, yellowish brown to reddish grey, coarse SAND and gravel and shell fragments)	LAYER 1
2	Very soft , greenish grey, clayey SILT/ silty CLAY with shell fragments	LAYER 2
3	Very stiff , yellowish grey to yellowish red, silty CLAY with gravel	LAYER 3
4	Dense, reddish brown, GRAVEL with shell / Very dense ,red, silty SAND with few gravel	LAYER 4
5	Hard, yellowish grey to dark grey, silty CLAY	LAYER 5
6	Extremely weak to strong, dark grey, highly weathered to slightly weathered ,extremely closely to widely spaced BASALT with inclined and vertical joint	LAYER 6

Table 19 Details of Boreholes Drilled and Thickness of Strata Encountered in Section 5-5

LAYER No		BOREHOLE No
		SECTION 5-5
		LBH-1
Thickness of Strata (m)	LAYER 1	4.50
	LAYER 2	6.00
	LAYER 3	4.50
	LAYER 4	3.00
	LAYER 5	12.00
	LAYER 6	7.50
Total Depth (m)		37.50

For Section 5-5 comprising borehole LBH-1 in general the subsoil comprises of Layer 1 Made up ground

(Loose to dense, yellowish brown to reddish grey, coarse SAND and gravel and shell fragments) for depth ranging from 0.00 to 4.50m w.r.t. EGL with SPT N - values ranging from 10 to 30; this is followed by Layer 2 Very soft , greenish grey, clayey SILT/ silty CLAY with shell fragments for depth ranging from 4.50 to 10.50 m with SPT N - values ranging from 2 to 5 ;this is followed by Layer 3 of Very Very stiff , yellowish grey to yellowish red, silty CLAY with gravel for depth ranging from 10.50 to 15.00 m with SPT N - values ranging from 27 to 31;this is followed by Layer 4 of Dense, reddish brown, GRAVEL with shell / Very dense ,red, silty SAND with few gravel for depth ranging from 15.00 to 18.00 m with SPT N - values ranging from 35 to 115;this is followed by Layer 5 of Hard, yellowish grey to dark grey, silty CLAY for depth ranging from 18.00 to 30.30 m with SPT N - values ranging from 43 to refusal.The boreholes terminate in Layer 6 of Extremely weak to strong, dark grey, highly weathered to slightly weathered ,extremely closely to widely spaced BASALT with inclined and vertical joint for depths ranging from 30.30 to 37.50 m.

Table 20 Generalised Subsurface Soil/Rock Profile adopted in Section 5-5

Layer No.	Soil Layers used for Modeling	Thickness of Strata (m)	SPT "N" value	c (kPa)	Φ (°)	γ_b (kN/m ³)	q_c (MN/m ²)
1	Made up ground (Loose to dense, yellowish brown to reddish grey, coarse SAND and gravel and shell fragments)	4.50	10-30	--	--	--	--
2	Very soft to firm, greenish grey, clayey SILT/ silty CLAY with shell fragments	6.00	2-5	20-23	2	15.1-15.3	--
3	Very stiff , yellowish grey to yellowish red, silty CLAY with gravel	4.50	27-31	--	--	--	--
4	Dense, reddish brown, GRAVEL with shell / Very dense ,red, silty SAND with few gravel	3.00	35-115	--	--	--	--
5	Hard, yellowish grey to dark grey, silty CLAY	12.00	432->100	--	--	--	--
6	Extremely weak to strong, dark grey, highly weathered to slightly weathered ,extremely closely to widely spaced BASALT with inclined and vertical joint	7.50	--	--	--	--	72.1

C - Cohesion, Φ - Angle of internal friction, q_c - Uniaxial compressive strength of rock, γ_b -Bulk unit Weight of soil

6.0 FOUNDATION DESIGN RECOMMENDATIONS

6.1 Foundation Design Criteria

A suitable foundation for any structure must satisfy two basic independent criteria with respect to the underlying foundation soils. First, the foundation must have an adequate factor of safety against exceeding the bearing capacity of the foundation soils. Second, the vertical movements of the foundation due to settlement or swelling of the foundation soils must be within tolerable limits for the structure. We consider that the subsurface conditions at this site are suitable for supporting the proposed structures on pile foundations.

6.2 Foundation Type

We understand that jetty and various marine structures will be constructed in 7th berth area. We consider that the subsurface conditions at this site are suitable for supporting the proposed structures on pile foundations. Boreholes have been grouped into 5 sections as shown in Table 21.

Table 21 List of Boreholes with Sectional Details

Section No	BOREHOLE No	Recommended Foundation System
1-1	MBH -A4,MBH - A3 & MBH-C1	Pile Foundation (Berth)
2-2	MBH - B3 & MBH -B4	Pile Foundation (Berth)
3-3	MBH - B3 , MBH -B2 & MBH-B1	Pile Foundation (Berth)
4-4	MBH-A1 & MBH-A2	Filling (Ground improvement with stone column/PVD and Pile Foundation)
5-5	LBH-1	Pile Foundation (Heavy Machine Structure)

7.0 Pile Foundation

We recommend bored cast in situ pile with steel liner upto rock stratum. Since it is marine condition dense concrete is advisable for pile. The calculation of load bearing capacity of the pile is given below.

7.1 Computational Method

The ultimate compressive capacity, Q , for a given pile penetration is taken as the sum of the skin friction on the pile wall, Q_s , and the end bearing on the pile tip, Q_p , so that:

$$Q = Q_s + Q_p = f A_s + q A_p$$

Where,
 A_s = Embedded surface area
 A_p = Pile end area
 f = Unit skin friction
 q = unit end bearing

Procedures used to compute values of f and q are discussed in the following paragraphs. When computing ultimate tensile capacity, the end bearing term in the above equation is neglected.

7.2 Unit Skin Friction and Unit End Bearing

We computed the unit skin friction and unit end bearing in cohesive, granular soils and rock using the procedure described in the IS 2911(Part-1) for soil and 14593:1998 for rock as follows:



a) Piles in cohesive soils

The ultimate bearing capacity of piles (Q_u) in cohesive soil is calculated by the following equation:

$$Q_u = C_p \cdot N_c \cdot A_p + \alpha \cdot C_s \cdot A_s$$

Where,

- Q_u = Ultimate load capacity of piles, kN
- Q_s = Safe load capacity of piles, kN = Q_u / F_s
- C_p = Cohesion of the soil at tip of the pile, kN/m²
- N_c = bearing capacity factor (equal to 9)
- C_s = Average cohesion throughout the length of the pile, kN/m²
- α = Adhesion factor (Governed by pile material and soil)
- F_s = 2.5 (factor of safety)
- A_p = Cross-sectional area of pile toe in m²
- A_s = Surface area of pile shaft in m² = $\pi D L_s$
- L_s = Length of pile shaft in m

b) Piles in non-cohesive soils

The ultimate bearing capacity of piles (Q_{ult}) in non-cohesive soil is calculated by the following equation:

$$Q_{ult} = (P_d N_q + \frac{1}{2} B \gamma N_\gamma) A_p + (\sum K P_d \tan \delta) A_s$$

Where,

- P_d = Effective overburden stress at tip of the pile, kN (Limiting value of overburden stress=15B)
- N_q = Bearing capacity factor adopted as per IS: 2911 (Part-1)
- N_γ = Bearing capacity factor adopted as per IS:6403
- B = Size of the pile in m
- γ = Effective unit weight of soil at pile toe
- A_p = Cross-sectional area of pile toe in m²
- K = Lateral earth pressure coefficient (K=1)
- δ = $3/4 * \Phi$
- Φ = Angle of internal friction
- A_s = Surface area of pile shaft in m²
- Q_s = Safe load capacity of piles, kN = Q_u / F_s
- F_s = 2.5 (factor of safety)

c) Piles in Rock based on Uniaxial Compressive Strength

The safe pile capacity is calculated from the equation:

$$Q_s = q_c N_j N_d A_p + q_c \pi D L_s \alpha \beta$$

Where,

- Q_s = Safe load capacity of piles, tonnes
- q_c = Uniaxial compressive strength of rock, t/m^2
- N_d = Depth factor = $0.8 + 0.2 (L_s / D) = 1.2$
- N_j = Empirical coefficient depending on the spacing of discontinuities = 0.1
(IS: 12070:1987)
- A_p = Area of pile toe in m^2
- D = Diameter of pile, in m
- L_s = Socket length into the rock, in m ($L_s = 2D$)
- α, β = Correction factor = 0.1 & 0.4

Pile shall be terminated in rock stratum, with minimum uniaxial compressive strength of 10 MPa for a minimum length of 2 pile diameter.

7.3 Lateral Load Capacity of Piles**a) Lateral capacity of piles in section 1-1, 2-2, 3-3& 4-4 (Marine piles)**

Socketing of piles in rock needed to resist lateral and axial forces. Piles may have to be socketed in rock to resist mainly the bending moment and horizontal forces. Bending moment and horizontal force calculation is carried out for special cases (case1: moment at top of rock when horizontal force at top of rock=0. case2: horizontal force at top of rock when moment at top of rock=0.) (Ref. Foundation Design Manual by Dr. N. V. Nayak; page no: 3.82)

Case1: $H = 0$ i.e. no horizontal force
 $M = (L^2 \sigma / 6)$

Case2: $M = 0$ i.e. no moment
 $H = (L \sigma / 4)$
 $\sigma = \sigma_1$ (lesser value of σ_c & σ_1 shall be adopted)
 σ_c = Permissible compressive strength in concrete (30,000 kN/m²)
 σ_1 = Permissible compressive strength in rock (10,000 kN/m²)
 L = Socket length ($L = 2D$)
 D = Diameter of the pile



H=Horizontal force at top of rock
M=Moment at top of rock

Table 22 Moment and Lateral force at top of Rock

Pile diameter (m)	Moment at top of rock when lateral force at top of rock=0 (kN-m)	Lateral force(kN) at top of pile when pile length=20m with FOS=3	Lateral force at top of rock when moment at top of rock=0 (kN)
1.0	6667	110	5000
1.2	11520	120	7200
1.4	18293	304	9800

(1) According to IS 2911(Part-IV), allowable lateral load on a vertical pile can be taken as 2 to 5 % of the allowable vertical load given in section 8.7

(2) Structural lateral capacity of marine pile considering as free standing column without any lateral support shall be determined. This shall be compared with values recommended in section 8.7 and Table-22 and lesser of three shall be adopted.

b) Lateral capacity of piles in section 5-5 (Land piles)

The lateral load capacity of pile is calculated based on IS: 2911 (Part 1/Sec 2) (Reese and Matlock approach) for fixed head piles with an allowable deflection of 6mm:

$$y_{max} = \frac{1}{EI} \{ (P_t \cdot T^3) \cdot A_y + (M_t \cdot T^3) \cdot B_y \}$$

Where,

- y_{max} = Deflection at the pile head
- E = Elastic Modulus of Pile Material (30000 N/cm²)
- η_h = Constant of Soil Modulus =0.146 (IS:2911(Part1/Sec2))
- T = Relative Stiffness Factor = $(EI/\eta_h)^{1/5}$
- P_t = Lateral load at the Pile Head
- M_t = Moment at the Pile Head
- A_y, B_y = Deflection Coefficients by Reese & Matlock approach (2.435 & 1.623)

Table 23 Lateral load capacities of pile in section 5-5

E (N/cm²)	3000000		
η (kg/cm²)	0.260		
η (N/cm²)	2.600		
Length (cm)	3200		
Diameter (cm)	100	120	140
Moment of Inertia (cm⁴)	4908738.521	10178760.2	18857409.9
EI (x10¹⁰) (N-cm²)	1.47262E+13	3.05363E+13	5.65722E+13
T = (EI/η)^{1/5} (cm)	355.3231971	411.1199557	465.0782072
P_t (kN) free head (6mm deflection)	70	95	125
P_t (kN) fixed head	80	105	135

* Reese and Matlock approach

7.4 Uplift Resistance of Pile

The ultimate uplift resistance (Q_{uu}) is the sum of the frictional adhesion resistance. Weight of the pile is not considered in calculation.

$$Q_{uu} = A_s f_s$$

Where,

- Q_{uu} = Ultimate uplift resistance
- f_s = Ultimate shaft-shear resistance
- A_s = Surface area of pile shaft
- F_s = 2.5 (factor of safety)

7.5 Chiseling Criteria

As mentioned previously a rock socket length of $2xD$ (D = Pile diameter) should be provided in the bearing stratum, the socketing zone will start when chisel penetration is less than 10 cm for a chisel energy of 400 ton-m/m² of pile cross section. Length of socket will be counted below the depth of last satisfactory trial. Additional, chisel penetrations should be less than 10 cm for chisel energy of 750 ton-m/m² of pile cross section at the end of the 3D socketing zone. Piles can be terminated earlier if chisel penetrations should be less than 10 cm for chisel energy of 2250 ton-m/m² of pile cross section. Sample calculations to calculate chisel energy are shown below.

a) Considering a pile of 1000mm diameter

Area of pile = 0.785 m².

Let the weight of chisel be 1 ton. If fall of chisel is limited to 2.0 meters, Energy of each blow = 1.0 ton x 2.0 ton-meter. The energy of 1000 ton-meter/ m² is converted into equivalent energy for 1000mm diameter pile.

Equivalent energy = (1000 x 0.785) t/m² = 785 t.m/m²

To achieve this number of blows required of 1.0 ton chisel with 2.0m fall = 785/2 = 39 blows.

The no. of blows is increased to account for submerged weight of chisel and wire rope tension on drum while releasing the chisel. So the chiseling criteria for 1000mm diameter pile will be as follows:

The penetration shall be less than 10 cm for 40 blows of chisel with weight of 1 ton and falling through a height of 2.0 meter.

Note: Generally 100 blows can be applied within 15 minutes. While checking the chiseling criteria, the chisel shall be withdrawn after 100 blows, hole cleaned and penetration measured.

7.6 Soil Parameter used for design in section 1-1,2-2, 3-3 ,4-4 & 5-5

Soil parameters for the cohesive soil, granular soil and rock at the site are based on soil type and SPT values and laboratory test results. We have used the following soil parameters, as given in Table 24 to 28, for developing various pile design recommendations.

Table 24 Soil Parameter used for design in Section 1-1

Soil Type	Thickness of Strata (m)	Elevation w.r.t CD		C (kPa)	Φ (°)	γ _b (KN/m ³)	α (Tension)	α (compression)	δ	K _s	N _c for Φ=0	N _q	N _γ	'qc' (MN/m ²)
		From	To											
Very soft to soft, dark grey to yellowish grey, silty CLAY with few gravel	7.50	-6	-13.5	--	--	14	0.5	0.7	--	--	--	--	--	--
Very stiff to very hard, dark grey to yellowish grey, silty CLAY with some sand	3.50	-13.5	-17	56	7	19	0.25	0.3	--	--	--	--	--	--
Medium dense to very dense, yellowish brown to reddish brown, fine to coarse SAND with few gravel	7.00	-17	-24	--	35	20	--	--	26	1	--	56	48	--
Hard, dark grey to grey, silty CLAY with gravel and weathered rock fragments	2.00	-24	-26	200	--	20	0.25	0.3	--	--	--	--	--	--
Extremely weak to strong, greenish grey to dark grey, highly to moderately weathered, extremely to closely spaced BASALT with inclined and vertical joint	7.00	-26	-33	--	--	--	--	--	--	--	--	--	--	10

C - Cohesion, Φ - Angle of internal friction, q_c - Uniaxial compressive strength of rock, γ_b - Bulk unit Weight of soil

Table 25 Soil Parameter used for design in Section 2-2

Soil Type	Thickness of Strata (m)	Elevation w.r.t CD		C (kPa)	ϕ (°)	γ_b (kN/m ³)	α (Tension)	α (compression)	θ	K _s	N _c for $\phi=0$	N _q	N _{γ}	'qc' (MN/m ²)
		From	To											
Very loose, brownish grey, slightly clayey SAND with shell fragments / very soft ,dark grey,silty CLAY with some sand	4.00	-3	-7	--	--	16	0.5	0.7	--	--	9	--	--	--
Medium dense to very dense, brownish grey to yellowish brown, fine to medium SAND	13.00	-7	-20	--	35	20	--	--	26	1	--	56	48	--
Hard, brownish grey to yellowish grey, silty CLAY with some sand and laterite pieces	2.50	-20	-22.5	200	--	20	0.25	0.3	--	--	--	--	--	--
Very dense, brown, medium SAND	1.50	-22.5	-24	--	36	22	--	--	27	1	--	54	60	--
Extremely weak to moderately weak, yellowish grey to dark grey, highly to moderately weathered, extremely to very closely spaced BASALT with inclined and vertical joint	5.00	-24	-29	--	--	--	--	--	--	--	--	--	--	10

C - Cohesion, Φ - Angle of internal friction, q_c - Uniaxial compressive strength of rock, γ_b -Bulk unit Weight of soil

Table 26 Soil Parameter used for design in Section 3-3

Soil Type	Thickness of Strata (m)	Elevation w.r.t CD		C (kPa)	ϕ (°)	γ_b (kN/m ³)	α (Tension)	α (compression)	θ	K _s	N _c for $\phi=0$	N _q	N _{γ}	'qc' (MN/m ²)
		From	To											
Very loose to dense, brownish grey, fine to medium SAND	4.00	-3	-7	--	--	16	--	--	22.5	1	--	28	22.4	--
Very soft to soft, dark grey ,silty CLAY with some sand	4.50	-7	-11.5	--	--	14	0.5	0.7	--	--	--	--	--	--
Very dense, brownish grey to yellowish grey, slightly clayey, fine to coarse SAND	8.50	-11.5	-20	--	36	20	--	--	27	1	--	54	60	--
Hard, yellow to yellowish grey, silty CLAY mix some gravel and sand /Residual soil	5.00	-20	-25	200	--	20	0.25	0.30	--	--	--	--	--	--
Extremely weak to strong, greenish grey to reddish grey, highly to moderately weathered, highly fractured, extremely closely spaced to closely spaced BASALT with inclined and vertical joint	5.00	-25	-30	--	--	--	--	--	--	--	--	--	--	10

C - Cohesion, Φ - Angle of internal friction, q_c - Uniaxial compressive strength of rock, γ_b -Bulk unit Weight of soil



Table 27 Soil Parameter used for design in Section 4-4

Soil Type	Thickness of Strata (m)	Elevation w.r.t CD		C (kPa)	ϕ (°)	γ_b (KN/m ³)	α (Tension)	α (compression)	δ	K _s	N _c for $\phi=0$	N _q	N _{γ}	'qc' (MN/m ²)
		From	To											
Very soft to firm ,dark grey silty CLAY	7.50	-6	-13.5	--	--	14	0.5	0.7	--	--	--	--	--	--
Stiff to hard, yellowish brown to brownish grey, slightly sandy, silty CLAY with few gravel	10.00	-13.5	-23.5	100	--	18	0.3	0.4	--	--	--	--	--	--
Very dense, brown, silty ,coarse SAND with gravel and weathered rock fragments	1.50	-23.5	-25	--	36	20	--	--	27	1	--	54	60	--
Extremely weak to moderately weak ,greenish grey to grey, completely weathered to moderately weathered ,highly fractured, very closely spaced BASALT with inclined and vertical joint	3.00	-25	-28	--	--	--	--	--	--	--	--	--	--	10

C - Cohesion, Φ - Angle of internal friction, q_c - Uniaxial compressive strength of rock, γ_b -Bulk unit Weight of soil

Table 28 Soil Parameter used for design in Section 5-5

Soil Type	Thickness of Strata (m)	Elevation w.r.t CD		C (kPa)	ϕ (°)	γ_b (KN/m ³)	α (Tension)	α (compression)	δ	K _s	N _c for $\phi=0$	N _q	N _{γ}	'qc' (MN/m ²)
		From	To											
Made up ground (Loose to dense, yellowish brown to reddish grey, coarse SAND and gravel and shell fragments)	4.50	+4.5	0.0	--	--	--	--	--	22.5	1	--	28	22.4	--
Very soft , greenish grey, clayey SILT/ silty CLAY with shell fragments	6.00	0.0	-6.0	20	2	15	0.5	0.7	--	--	--	--	--	--
Very stiff , yellowish grey to yellowish red, silty CLAY with gravel	4.50	-6.0	-10.5	100	--	--	0.3	0.4	--	--	--	--	--	--
Dense, reddish brown, GRAVEL with shell / Very dense ,red, silty SAND with few gravel	3.00	-10.5	-13.5	--	36	--	--	--	27	1	--	54	60	--
Hard, yellowish grey to dark grey, silty CLAY	12.00	-13.5	-25.5	150	--	--	0.25	0.30	--	--	--	--	--	--
Extremely weak to strong, dark grey, highly weathered to slightly weathered ,extremely closely to widely spaced BASALT with inclined and vertical joint	7.50	-25.5	33.0	--	--	--	--	--	--	--	--	--	--	10

C - Cohesion, Φ - Angle of internal friction, q_c - Uniaxial compressive strength of rock, γ_b -Bulk unit Weight of soil

Note:

- 1) δ is taken equal to $\frac{3}{4} \phi$
- 2) K_s =1.0 (As per IS 2911 (Part/sec2))
- 3) γ used is the average value estimated from the laboratory determinations for cohesive soil and for sandy soil value estimated from the average SPT N –value.
- 4) Values of cohesion C have been taken from lower values of laboratory tests.
- 5) N_c in cohesion strata is taken as 9.0

- 6) The Φ Value of 28 to 36° for silty SAND is derived using lower bound SPT“N” for this layer.
- 7) The end bearing of the pile should be checked for safe working stress of concrete used.
- 8) Very soft, silty CLAY and Loose clayey SAND/silty SAND layer is not considered for pile capacity calculation.
- 9) $q_c = 10\text{MPa}$ is average value estimated from the laboratory result. In section 1-1 & 2-2 the uniaxial compressive strength value of the basalt ranges from 5.5 to 101.8 MPa. In other sections q_c is more than 10MPa

7.7 Recommended Safe Pile Capacities

Table 29 Recommended Safe vertical downward, uplift and lateral Pile Capacity in section 1-1

Soil Type at pile termination Elevation	Pile termination Elevation w.r.t CD (m)	1 m dia pile			1.2 m dia pile			1.4 m dia pile		
		Vertical downward capacity (kN)	Uplift capacity (kN)	Lateral capacity (kN)	Vertical downward capacity (kN)	Uplift capacity (kN)	Lateral capacity (kN)	Vertical downward capacity (kN)	Uplift capacity (kN)	Lateral capacity (kN)
Medium dense to very dense, yellowish brown to reddish brown, fine to coarse SAND with few gravel	-21	2000	200	60	2900	240	90	3950	280	120
Extremely weak to strong ,greenish grey to dark grey, highly to moderately weathered, extremely to closely spaced BASALT with inclined and vertical joint	-28	3850	1300	110	5500	1850	160	7350	2450	220

Table 30 Recommended Safe vertical downward, uplift and lateral Pile Capacity in section 2-2

Soil Type at pile termination Elevation	Pile termination Elevation w.r.t CD (m)	1 m dia pile			1.2 m dia pile			1.4 m dia pile		
		Vertical downward capacity (kN)	Uplift capacity (kN)	Lateral capacity (kN)	Vertical downward capacity (kN)	Uplift capacity (kN)	Lateral capacity (kN)	Vertical downward capacity (kN)	Uplift capacity (kN)	Lateral capacity (kN)
Medium dense to very dense, brownish grey to yellowish brown, fine to medium SAND	-15	2700	310	80	3100	370	90	4200	400	120
Extremely weak to moderately weak, yellowish grey to dark grey, highly to moderately weathered, extremely to very closely spaced BASALT with inclined and vertical joint	-26	5750	3250	170	4750	4100	230	10000	5050	300



Table 31 Recommended Safe vertical downward, uplift and lateral Pile Capacity in section 3-3

Soil Type at pile termination Elevation	Pile termination Elevation w.r.t CD (m)	1 m dia pile			1.2 m dia pile			1.4 m dia pile		
		Vertical downward capacity (kN)	Uplift capacity (kN)	Lateral capacity (kN)	Vertical downward capacity (kN)	Uplift capacity (kN)	Lateral capacity (kN)	Vertical downward capacity (kN)	Uplift capacity (kN)	Lateral capacity (kN)
Very dense, brownish grey to yellowish grey, slightly clayey, fine to coarse SAND	-18	4950	310	140	7100	370	210	9700	430	290
Extremely weak to strong, greenish grey to reddish grey, highly to moderately weathered, highly fractured, extremely closely spaced to closely spaced BASALT with inclined and vertical joint	-27	4290	1700	120	5950	2250	170	7900	2900	230

Table 32 Recommended Safe vertical downward, uplift and lateral Pile Capacity in section 4-4

Soil Type at pile termination Elevation	Pile termination Elevation w.r.t CD (m)	1 m dia pile			1.2 m dia pile			1.4 m dia pile		
		Vertical downward capacity (kN)	Uplift capacity (kN)	Lateral capacity (kN)	Vertical downward capacity (kN)	Uplift capacity (kN)	Lateral capacity (kN)	Vertical downward capacity (kN)	Uplift capacity (kN)	Lateral capacity (kN)
Stiff to hard, yellowish brown to brownish grey, slightly sandy, silty CLAY with few gravel	-20	2060	490	60	2800	580	80	3650	680	110
Extremely weak to moderately weak ,greenish grey to grey, completely weathered to moderately weathered ,highly fractured, very closely spaced BASALT with inclined and vertical joint	-27	4000	1400	120	6000	1900	180	7600	2500	220

Table 33 Recommended Safe vertical downward, uplift and lateral Pile Capacity in section 5-5

Soil Type at pile termination Elevation	Pile termination Elevation w.r.t CD (m)	1 m dia pile			1.2 m dia pile			1.4 m dia pile		
		Vertical downward capacity (kN)	Uplift capacity (kN)	Lateral capacity (kN)	Vertical downward capacity (kN)	Uplift capacity (kN)	Lateral capacity (kN)	Vertical downward capacity (kN)	Uplift capacity (kN)	Lateral capacity (kN)
Hard, yellowish grey to dark grey, silty CLAY	-20	1650	470	70	2200	570	95	2900	660	125
Extremely weak to strong, dark grey, highly weathered to slightly weathered ,extremely closely to widely spaced BASALT with inclined and vertical joint	-28	4350	1650	70	6050	2300	95	8000	2850	125

7.8 Expected value of consolidation settlement and Time-duration for 90% consolidation of soft clay layer in section 5-5 & 4-4

In Section 5-5 comprising of borehole LBH-1 the subsoil comprises of Layer 1 Made up ground (Loose to dense, yellowish brown to reddish grey, coarse SAND and gravel and shell fragments) for depth ranging from 0.00 to 4.50m w.r.t. EGL; this is followed by Layer 2 Very soft, greenish grey, clayey SILT/ silty CLAY with shell fragments for depth ranging from 4.50 to 10.50 m. In this layer the expected value of settlement is about 0.75 to 1.25m with 12 year duration for present load condition with out ground improvement (For single drainage condition).

In Section 4-4 comprising of boreholes MBH-A1 & MBH-A2 the subsoil comprises of Layer 1 Very soft to firm, dark grey silty CLAY for depth ranging from 0.00 to 7.50m w.r.t. SBL .Section 4-4 area is resorted for filling. The expected thickness of filling is 11m (6m filling in water & 5m filling above water). In this layer the expected value of settlement is about 1.25 to 1.75m with 100 year duration for 11m fill with out ground improvement (For single drainage condition).

7.9 Foundation recommendation for Section 5-5 & 4-4

Section 5-5 area is resorted for heavy machine structures. The soft clay layer beneath the made up surface layer will undergo consolidation settlement if loaded. Hence pile foundation is preferred in this area. The negative skin friction will act on the pile due to the settlement of this soft layer, which will reduce the pile capacity calculated in the previous sections.

In the case of shallow foundation in this area, proper treatment of the soft clay layer is to be carried out to reduce the consolidation settlement. Different types of treatment methods preferred in the area are:

1) Stone Columns

Stone column will increase the load bearing capacity of soft clay layer. The process generally consists of water jetting a vibrofloat into the soft clay layer to make a circular hole that extends through the clay to firmer soil. The hole is then filled with imported gravel. After stone column is constructed; a fill material should always be placed over the ground surface and compacted before the foundation is constructed. The stone column tends to reduce the settlement of foundations at allowable loads. Stone columns work more effectively when they are used to stabilize a large area where the undrained shear strength of the subsoil is in the range of 10 to 50 kN/m².

2) Prefabricated Vertical Drains

Vertical drains are installed in order to accelerate time of consolidation settlement and gain in strength of soft cohesive soil. Without installing vertical drains bearing failure may occur during placement of the fill and the settlement of clay soils may extend over many years.

7.10 Filling in section 4-4 area

Section 4-4 area is resorted for filling. Layer 1 in this section is very soft to firm, dark grey, silty CLAY with thickness of 7.5m and unconfined compressive strength of 10KPa and expected thickness of filling is 11m. Before filling this area, the soft layer shall be removed or ground improvement techniques need to be employed. It is expected that about 5m fill can be placed in submerged condition without shear failure. (Detailed stability calculations need to be performed to determine the thickness of fill that can be placed with out shear failure). But here the expected filling is about 11m.Hence the soft layer of clay should be treated by any one of the methods mentioned in the previous section.

8.0 CODES

These specifications conform to the latest Indian Standards on Soils and Foundations as below.

LIST OF INDIAN STANDARDS

- 1) IS:1498 - Classification and Identification of Soils for General Engineering Purposes
- 2) IS:1892 - Code of Practice for Site Investigations for Foundations
- 3) IS:2131 - Method of Standard Penetration Test for Soils
- 4) IS:2132 - Code of Practice for Thin Walled Tube Sampling of Soils
- 5) IS:2720 (1) - Methods of Test for Soil - Preparation of Dry Soil Sample for Various Test
- 6) IS:2720 (3) - Methods of Test for Soil- Determination of Specific Gravity
- 7) IS:2720 (4) - Methods of Test for Soil- Grain Size Analysis
- 8) IS:2720 (5) - Methods of Test for Soil- Determination of Liquid limit & Plastic limit
- 9) IS:2720 (11) - Methods of Test for Soil- Determination of unconsolidated undrained shear strength parameters
- 10) IS:2720 (30) - Methods of Test for Soil- Laboratory vane shear test
- 11) IS:8764 - Method of Determination of Point Load Strength Index of Rocks
- 12) IS:9143 - Method of Determination of Unconfined Compressive Strength of Rock Materials
- 13) IS:10082- Method of Determination of Tensile Strength by indirect tests on rock specimens
- 14) IS:9179 - Method of Preparation for Rock Specimen in Laboratory Tests
- 15) IS:13030 - Method of Testing for Water Content, Porosity, Density & Related Properties of Rock Materials

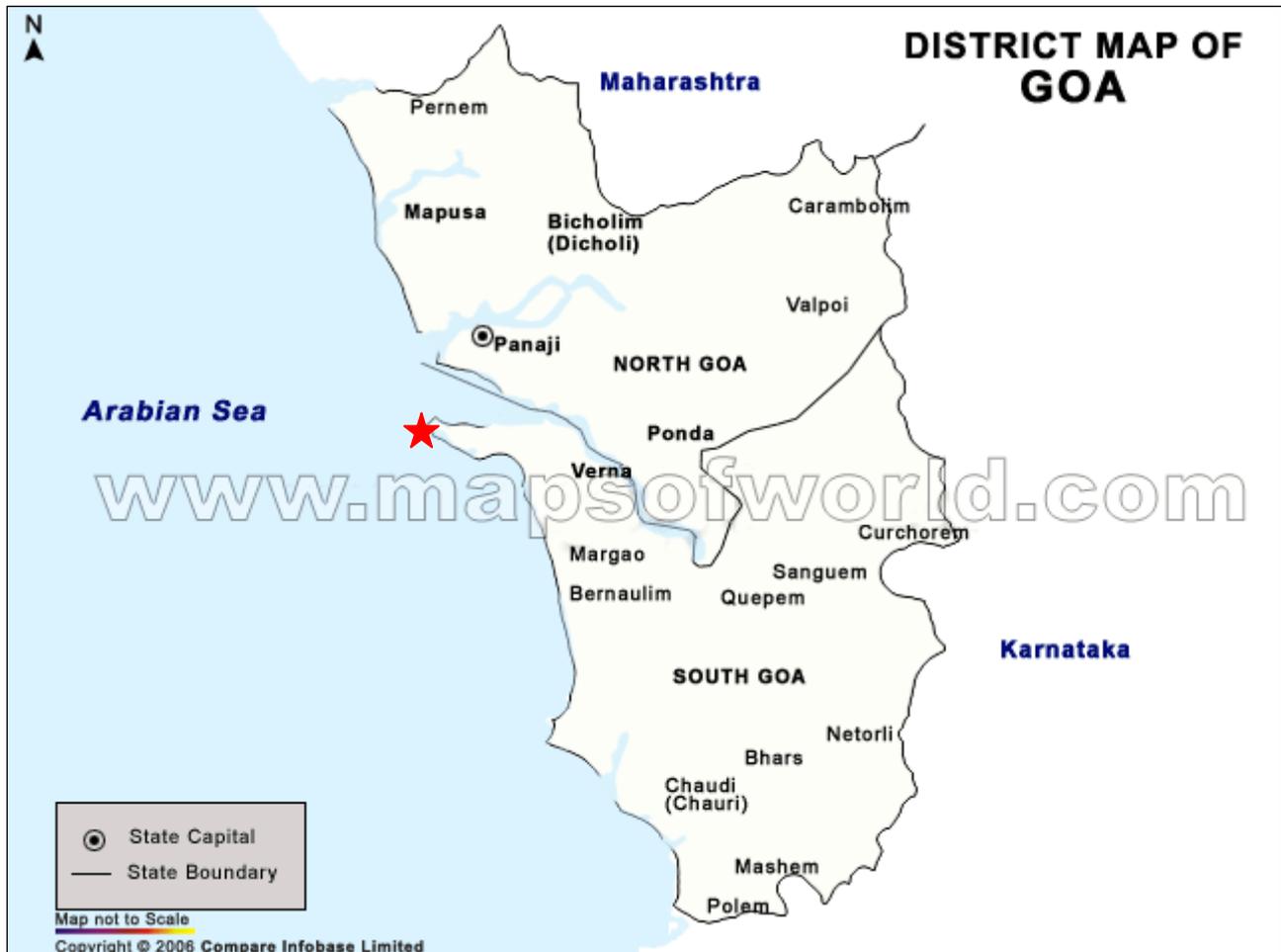


9.0 CONCLUSIONS

The report contains a brief description of the scope of work, details of the field investigations conducted, the procedures adopted, the relevant codes and standards followed to carry out the tests and the results. The results reported here are dependent on the test locations and time at which the tests were conducted. We have prepared this report exclusively for **MPT**. The conclusions and recommendations presented in this report may not apply for different locations. We thank the management and staff of **MPT** for entrusting this work to us and for their wholehearted cooperation and support in executing the project.

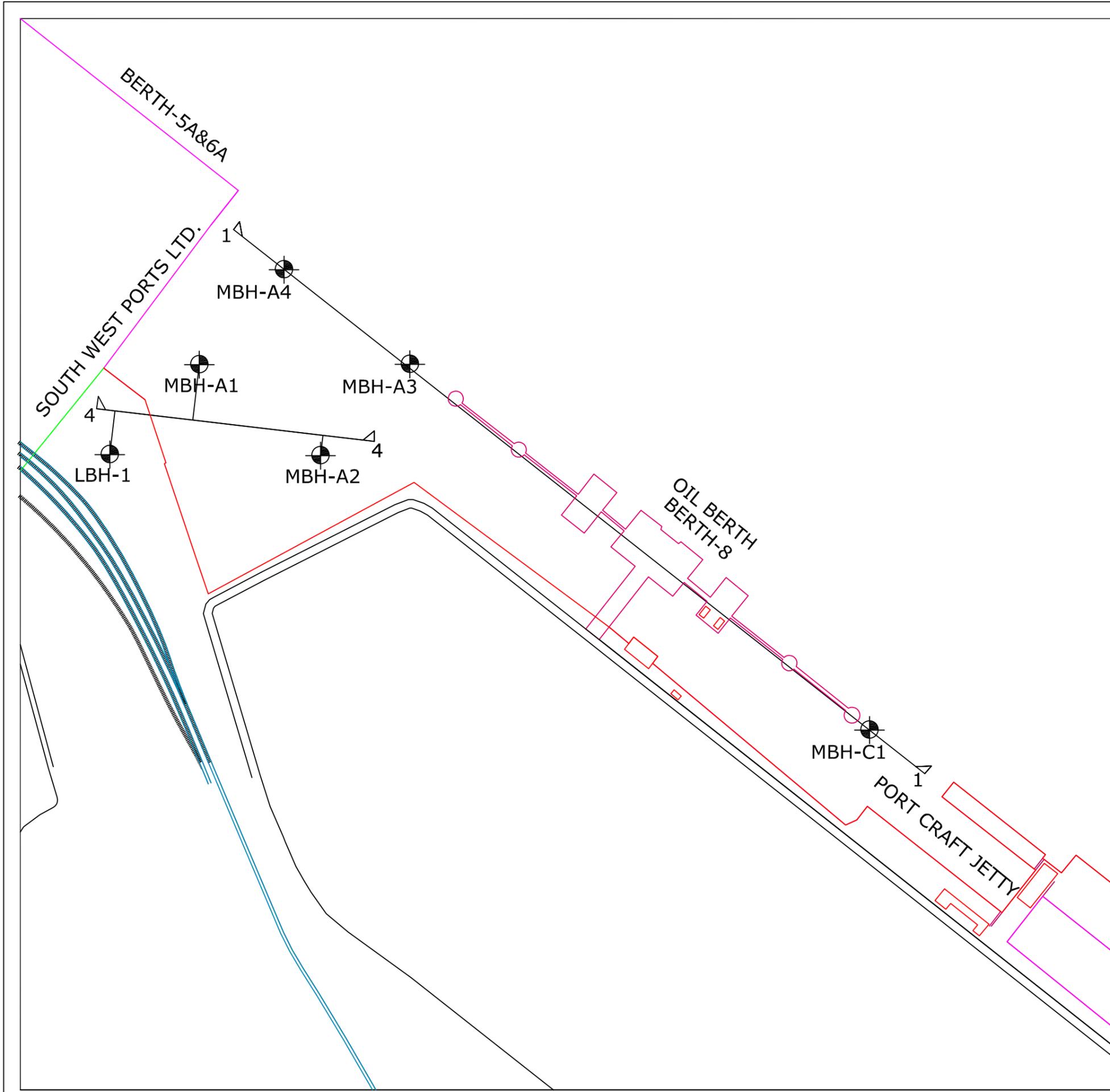
**ENGINEERING ILLUSTRATIONS
AND SKETCHES**

VICINITY MAP



★ Investigated Area

Project: Geotechnical Investigation for Berth No.7 at Mormugao



Sr. No.	Land Borehole	Co-ordinates	
		Northing	Easting
1.	LBH-01	370940.1	1704243.6

Sr. No.	Marine Borehole	Co-ordinates	
		Northing	Easting
1.	MBH-A1	0370989	1704311
2.	MBH-A2	0371091	1704265
3.	MBH-A3	0371126	1704292
4.	MBH-A4	0371041	1704357
5.	MBH-C1	0371396	1704066

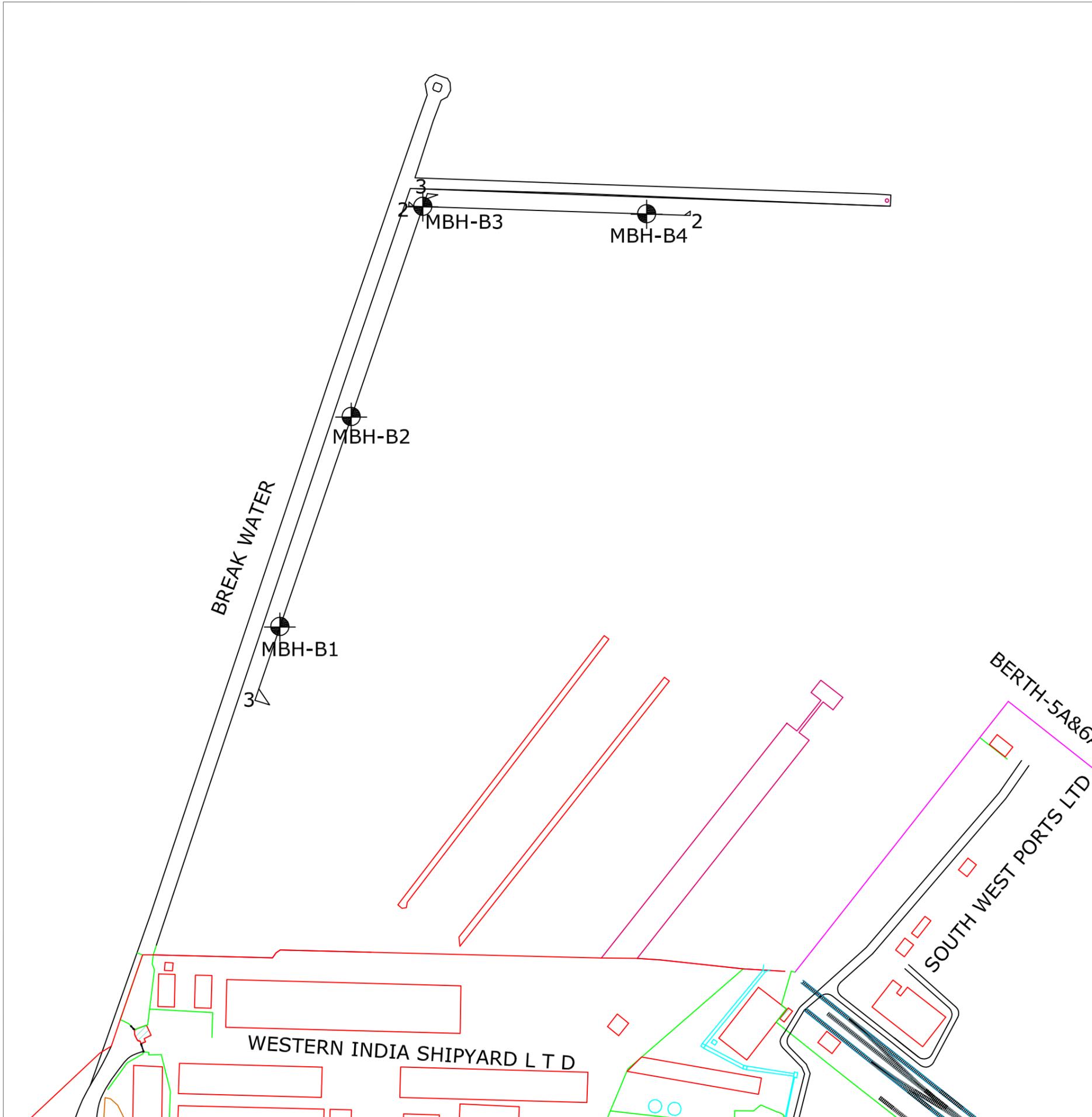
LEGENDS :  BOREHOLE

PROJECT: Geotechnical Investigation for the proposed site for development of Berth No.7

CLIENT : Mormugao Port Trust .

BOREHOLE LOCATION PLAN

	FUGRO GEOTECH LTD. Plot # 51, Sector 06 Sanpada New Mumbai - 400 705 Maharashtra (INDIA) Tel : +91 2265168662 / 5674 Fax : +91 22 27684634 e-mail : fugro@vsnl.com			
	DATE:	REV. NO.	Dwn. By.	Chk. By.
14/07/08	R0	T.V.G.	K.M.	S.M.



Sr. No.	Marine Borehole	Co-ordinates	
		Northing	Easting
1.	MBH-B1	0370192	1704355
2.	MBH-B2	0370131	1704492
3.	MBH-B3	0370082	1704602
4.	MBH-B4	0370465	1704950

LEGENDS :  BOREHOLE

PROJECT: Geotechnical Investigation for the proposed site for development of Berth No.7

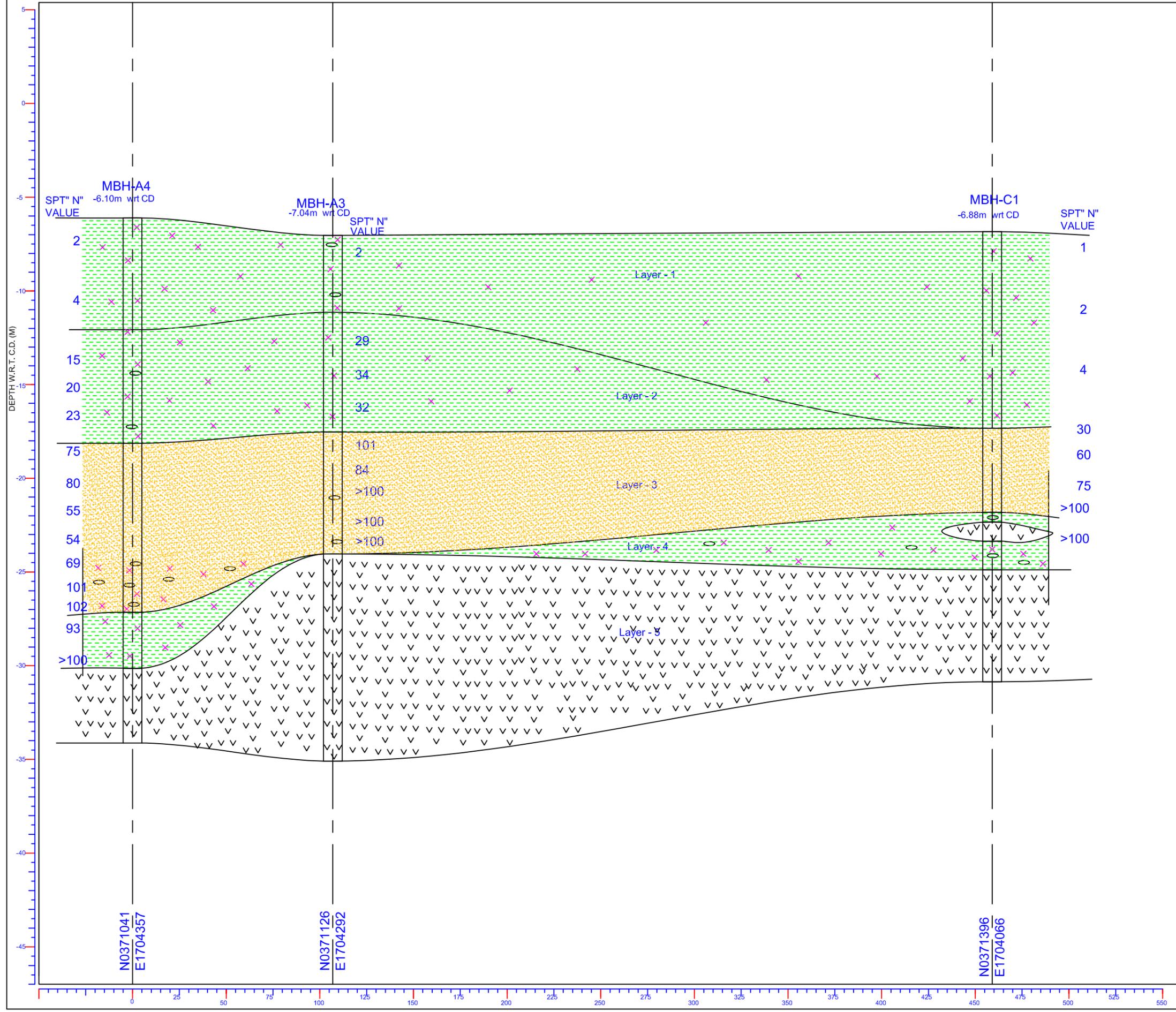
CLIENT : Mormugao Port Trust .

BOREHOLE LOCATION PLAN

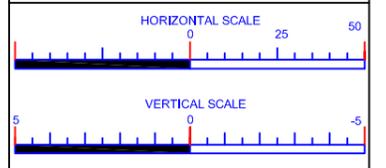


FUGRO GEOTECH LTD.
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 e-mail : fugro@vsnl.com

DATE: 14/07/08	REV. NO. R0	Dwn. By. T.V.G.	Chk. By. K.M.	Aprd. By. S.M.
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- LEGENDS :**
- Very soft to very hard, brownish grey to yellowish grey, silty CLAY with gravel & some sand.
 - Very dense, yellowish grey to reddish brown, fine to coarse SAND with gravel & laterite pieces.
 - Residual soil.
 - Extremely weak to strong, greenish grey to dark grey, highly to moderately weathered, extremely to closely spaced BASALT with inclined & vertical joint.



NOTES :
See plate No. 1 for location of section line

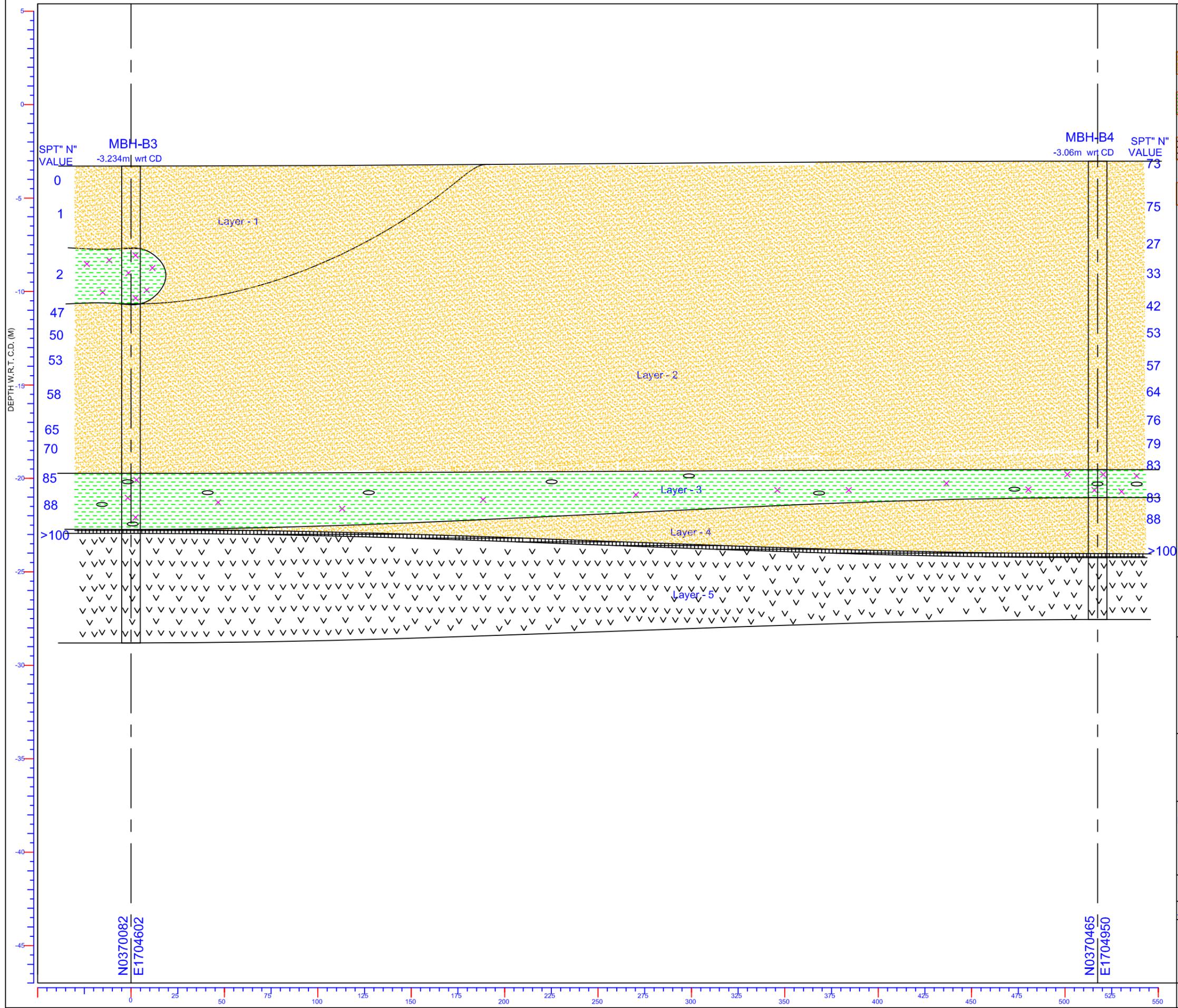
PROJECT : Geotechnical Investigation for the proposed site for development of Berth No.7

CLIENT : Mormugao Port Trust

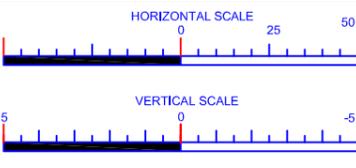
SECTION : 1-1

FUGRO GEOTECH LTD.
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e-mail: fugro@vsnl.com

DATE: 31/03/08	Scale: X = 1 : 100 Y = 1 : 1000	REV. NO: R0	Dwn. By: T.V.G.	Chk. By: K.M.	Appt. By: K.M.
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- LEGENDS :**
- Very loose to very dense, brownish grey to yellowish brown, fine to coarse SAND.
 - Very soft to very hard, dark grey to yellowish grey, silty CLAY with some sand & gravel.
 - Residual soil.
 - Extremely weak to moderately weak, yellowish grey to dark grey, highly to moderately weathered, very closely spaced BASALT with inclined & vertical joint.



NOTES :
See plate No. 1 for location of section line

PROJECT : Geotechnical Investigation for the proposed site for development of Berth No.7

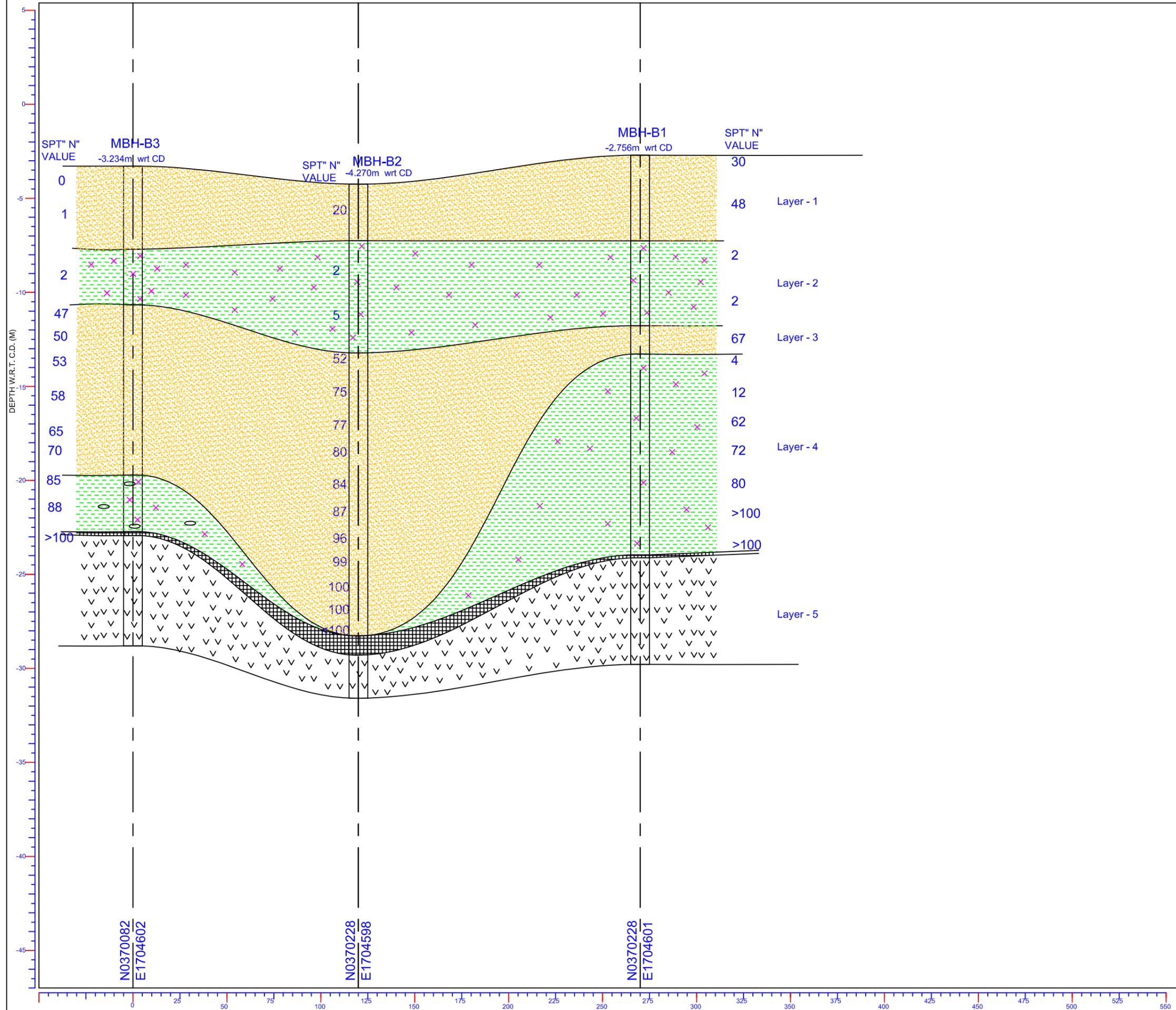
CLIENT : Mormugao Port Trust .

SECTION : 2-2

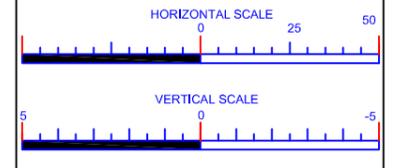
FUGRO GEOTECH LTD.

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DATE: 31/03/08	Scale: X=1:100 Y=1:1000	REV. NO. R0	Drawn By: T.V.G.	Chk. By: K.M.	Appr. By: K.M.
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- LEGENDS :**
- Very loose to dense brownish grey to yellowish brown, fine to medium SAND.
 - Very soft to very hard, dark grey to yellowish grey, silty CLAY with some sand.
 - Residual soil.
 - Extremely weak to moderately strong, greenish grey to grey, highly to moderately weathered extremely to very closely spaced BASALT with inclined & vertical joint.



NOTES :
See plate No. 1 for location of section line

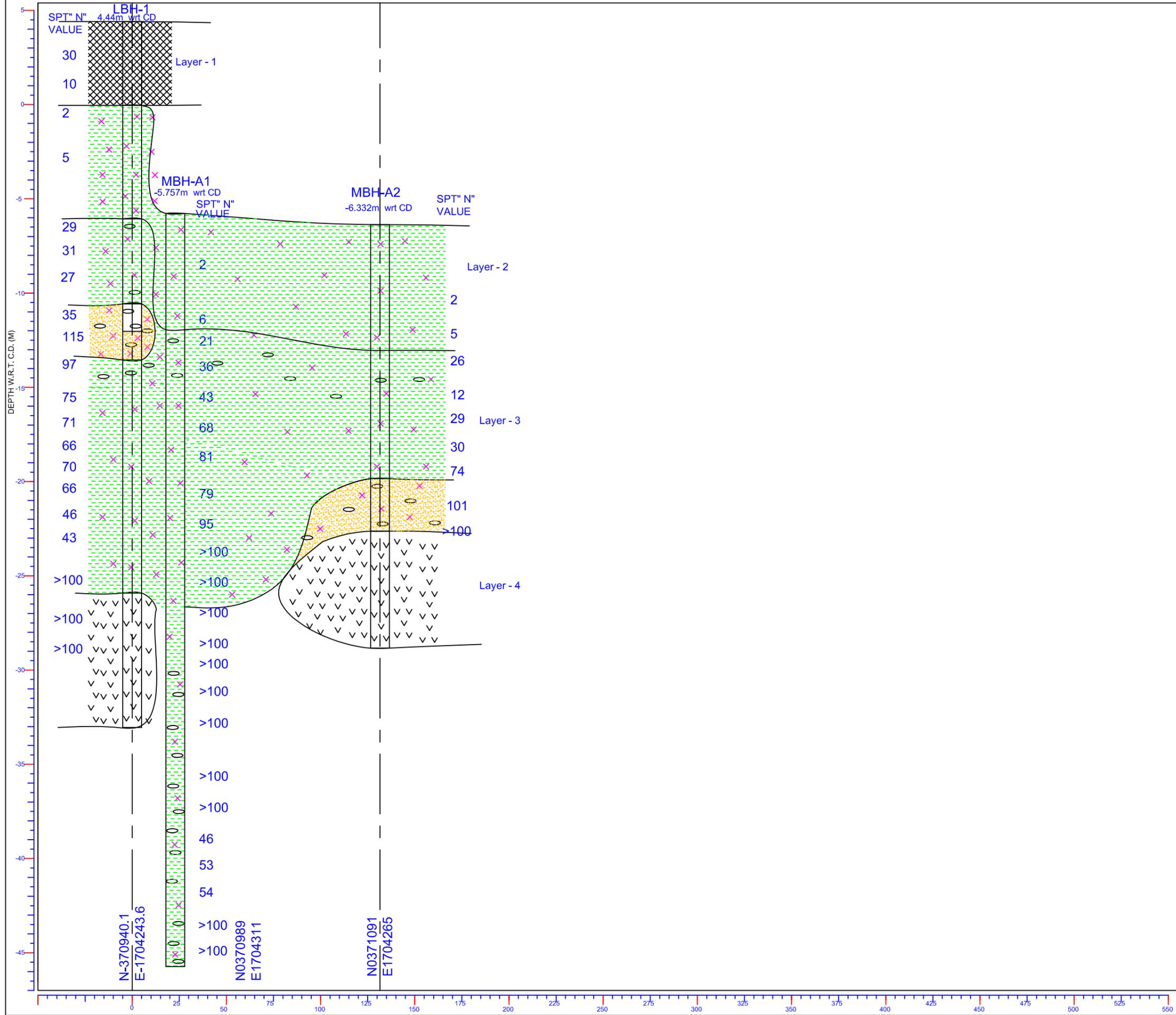
PROJECT : Geotechnical Investigation for the proposed site for development of Berth No.7

CLIENT : Mormugao Port Trust .

SECTION : 3-3

FUGRO GEOTECH LTD.
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 Fax : +91 22 27684634
 e-mail : fagro@vsnl.com

DATE: 31/03/08	Scale: X = 1 : 100 Y = 1 : 1000	REV. NO. RO	Dwn. By. T.V.G.	Chk. By. K.M.	Aprd. By. K.M.
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LEGENDS :

- Made up ground.
- Very soft to very hard, greenish grey to dark grey slightly fine sandy, silty CLAY.
- Very soft to very hard, yellowish red to yellowish brown, silty CLAY with gravel & laterite.
- Very dense, reddish brown to brown, silty SAND with gravel & weathered rock fragment.
- Extremely weak to strong, greenish grey to dark grey, highly to moderately weathered very closely to widely spaced BASALT with inclined & vertical joint.

HORIZONTAL SCALE
0 25 50

VERTICAL SCALE
5 0 -5

NOTES :
See plate No. 1 for location of section line

PROJECT : Geotechnical Investigation for the proposed site for development of Berth No.7

CLIENT : Mornugao Port Trust

SECTION : 4-4

FUGRO GEOTECH LTD.
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 e-mail: fugro@vsnl.com

DATE: 31/03/08	Scale: X=1:100 Y=1:1000	REV. NO. R0	Dwn. By. T.V.G.	Chk. By. K.M.	Aprd. By. K.M.
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APPENDIX - A



Project	: GEOTECHNICAL INVESTIGATION FOR THE PROPOSED SITE FOR DEVELOPMENT OF BERTH NO.7	Borehole No.	: LBH-1
Client	: Mormugao Port Trust	Job No.	: 215/08
Drilling Method	: Cable Percussion / Hydraulic Rotary	Equipment	: Rotary hydraulic rig
Casing size(mm)	: 150/100	Casing depth (m)	: 30.30 w.r.t SBL
Core Dia (mm)	: 50	T.D. (m)	: 37.50 w.r.t SBL
		Date	: 14/03/08-17/03/08

Field data										Laboratory data										
Depth below EGL(m)	Sample & in situ test depth (m)	Type	SPT 'N'	WG	FI	TCR %	SCR %	RQD %	Depth below EGL(m)	RL wrt CD (m)	Symbol	DESCRIPTION	CLAY, %	SILT, %	SAND, %	GRAVEL, %	W _L / I _p / MC, %	c _u kN/m ² / φ ^o (σ _v)	τ _v & τ _{v,r}	
0	0.00	█							0.00	4.44	█	Madeup ground (Filling of gravel, sand and clay etc)								
1	1.50-1.95	□	30						1.50	2.94	█	Medium dense to dense, yellowish to brown, coarse grained SAND with gravel and shell fragments (madeup ground)								
2	3.00-3.45	□	10						3.00	1.44	█	Loose, reddish grey, coarse grained SAND with shell (madeup ground)								
3	4.50-4.95	□	2						4.50	-0.06	⊗	Very soft, greensih grey clayey SILT								
4	6.00-6.45	█									⊗		24	61	14	1	64/29/79	22.6/2		
5	7.50-7.95	□	5						7.50	-3.06	⊗	Very soft, greensih grey, silty CLAY with shell fragments								
6	9.00-9.45	█									⊗		15	47	30	8	60/29/80	20.5/2		
7	10.50-10.95	□	29						10.50	-6.06	○	Very stiff, yellowish grey ,silty CLAY with gravel								
8	12.00-12.45	□	31						12.00	-7.56	○	Very stiff, yellowish red, silty CLAY with gravel								
9	13.50-13.95	□	27						13.00	-8.56	○	Very stiff, yellowish red ,silty CLAY with gravel								
10									15.00	-10.56	○									

Abbreviations & Symbols :

□ - SPT	█ - Rock Core
█ - UDS	⊖ - No Recovery
█ - DS	▨ - Soil Sample collected using Core Barrel
▨ - BS	⊗ - Field VST
★ - WS	

c _u - Undrained Cohesion
φ - Angle of Internal Friction
τ _v - Shear Strength
τ _{v,r} - Shear Strength of Remoulded Soil
WG - Weathering Grade
FI - Fracture Index
NI - Non Intact

W _L - Liquid Limit
I _p - Plasticity Index
NP - Non-Plastic
MC - Moisture Content
TCR - Total Core Recovery
SCR - Solid Core Recovery
RQD - Rock Quality Designation
RMR - Rock Mass Rating

T.D. - Termination Depth
EGL - Existing Ground Level
SBL - Sea Bed Level
CD - Chart Datum
MSL - Mean Sea Level
RL - Reduced Level

Water Depth (m) below CD

Date	Depth (m)



Project : GEOTECHNICAL INVESTIGATION FOR THE PROPOSED SITE FOR DEVELOPMENT OF BERTH NO.7	Borehole No. : LBH-1
Client : Mormugao Port Trust	Job No. : 215/08
Drilling Method : Cable Percussion / Hydraulic Rotary	Equipment : Rotary hydraulic rig
Casing size(mm) : 150/100	Casing depth (m) : 30.30 w.r.t SBL
Core Dia (mm) : 50	Date : 14/03/08-17/03/08
Co-ordinates : N-370940.1 , E-1704243.6	
R.L. (m) : 4.44 w.r.t CD	
T.D. (m) : 37.50 w.r.t SBL	

Field data										Laboratory data										
Depth below EGL(m)	Sample & in situ test depth (m)	Type	SPT 'N'	WG	FI	TCR %	SCR %	RQD %	Depth below EGL(m)	RL wrt CD (m)	Symbol	DESCRIPTION	CLAY, %	SILT, %	SAND, %	GRAVEL, %	W _L / I _p / MC, %	c _u , kN/m ² / φ ^o (or)	τ _v & τ _{v,r}	
15	15.00-15.45		35						15.00	-10.56		Dense, reddish brown, subangular to subrounded, fine to medium GRAVEL with shell								
16																				
17	16.50-16.87		115						16.50	-12.06		Very dense, red, slightly clayey, silty SAND with few GRAVEL	8	39	50	3	NP			
18																				
19	18.00-18.38		97						18.00	-13.56		Hard, reddish, silty CLAY with gravel								
20																				
21	19.50-19.95		75						19.50	-15.06		Hard, yellowish to bluish grey, silty CLAY								
22																				
23	21.00-21.45		71																	
24																				
25	22.50-22.95		66						22.50	-18.06		Hard, bluish grey, silty CLAY								
26																				
27	24.00-24.45		70																	
28																				
29	25.50-25.45		66																	
30																				
31	27.00-27.45		46						27.00	-22.56		Hard, dark grey, silty CLAY								
32																				
33	28.50-28.95		43																	
34																				
35	30.00								30.00	-25.56										

Abbreviations & Symbols :

- SPT
- Rock Core
- UDS
- DS
- BS
- WS
- No Recovery
- Soil Sample collected using Core Barrel
- Field VST

- c_u - Undrained Cohesion
- φ - Angle of Internal Friction
- τ_v - Shear Strength
- τ_{v,r} - Shear Strength of Remoulded Soil
- WG - Weathering Grade
- FI - Fracture Index
- NI - Non Intact

- W_L - Liquid Limit
- I_p - Plasticity Index
- NP - Non-Plastic
- MC - Moisture Content
- TCR - Total Core Recovery
- SCR - Solid Core Recovery
- RQD - Rock Quality Designation
- RMR - Rock Mass Rating

- T.D. - Termination Depth
- EGL - Existing Ground Level
- SBL - Sea Bed Level
- CD - Chart Datum
- MSL - Mean Sea Level
- RL - Reduced Level

Water Depth (m) below CD

Date	Depth (m)



Project : GEOTECHNICAL INVESTIGATION FOR THE PROPOSED SITE FOR DEVELOPMENT OF BERTH NO.7	Borehole No. : LBH-1
Client : Mormugao Port Trust	Job No. : 215/08
Drilling Method : Cable Percussion / Hydraulic Rotary	Equipment : Rotary hydraulic rig
Casing size(mm) : 150/100	Casing depth (m) : 30.30 w.r.t SBL
Core Dia (mm) : 50	Date : 14/03/08-17/03/08

Depth below EGL(m)	Sample & in situ test depth (m)	Type	SPT 'N'	Field data						Depth below EGL(m)	RL wrt CD (m)	Symbol	DESCRIPTION	Laboratory data					
				WG	FI	TCR %	SCR %	RQD %	CLAY, %					SILT, %	SAND, %	GRAVEL, %	W _L / I _p / MC, %	c _u , kN/m ² / φ ^o (or)	τ _v & τ _{v,r}
30	30.00-30.30		>100						30.00	-25.56	X	Hard, dark grey, silty CLAY	25	65	9	1	56/32/-		
31	30.30-31.50			IV	NI	25	0	0	30.30	-25.86	∨ ∨	Extremely weak to weak, dark grey, highly weathered, extremely closely spaced, BASALT							
32	31.50-31.70 31.70-33.00		>100	III-IV	NI	53	0	0	31.70	-27.26	∨ ∨ ∨ ∨	Weak to moderately weak, dark grey, moderately to highly weathered, very closely spaced BASALT							
34	33.00-33.03 33.03-34.50		>100	II-III	4	95	27	20	33.03	-28.59	∨ ∨ ∨ ∨	Moderately weak to moderately strong, dark grey, moderately to slightly weathered, closely spaced BASALT with veins of zeolite							
35	34.50-36.00			II	4	93	53	43	34.50	-30.06	∨ ∨ ∨ ∨	Moderately strong to strong, dark grey, moderately to slightly weathered, closely to medium spaced BASALT with inclined and vertical joint							
36	36.00-37.50			II	4	100	93	73	36.00	-31.56	∨ ∨ ∨ ∨	Moderately strong to strong, dark grey, moderately to slightly weathered, medium to widely spaced BASALT with inclined joint							
37									37.50	-33.06	∨ ∨ ∨ ∨								
38	Bore hole terminated at 37.50 m from SBL																		
39																			
40																			
41																			
42																			
43																			
44																			
45																			

Abbreviations & Symbols :									Water Depth (m) below CD		
□ - SPT	▨ - Rock Core	c _u - Undrained Cohesion	W _L - Liquid Limit	T.D. - Termination Depth	Date		Depth (m)				
■ - UDS	∩ - No Recovery	φ - Angle of Internal Friction	I _p - Plasticity Index	EGL - Existing Ground Level							
▤ - DS	▨ - Soil Sample collected using Core Barrel	τ _v - Shear Strength	NP - Non-Plastic	SBL - Sea Bed Level							
▥ - BS		τ _{v,r} - Shear Strength of Remoulded Soil	MC - Moisture Content	CD - Chart Datum							
★ - WS	⊗ - Field VST	WG - Weathering Grade	TCR - Total Core Recovery	MSL - Mean Sea Level							
		FI - Fracture Index	SCR - Solid Core Recovery	RL - Reduced Level							
		NI - Non Intact	RQD - Rock Quality Designation								
			RMR - Rock Mass Rating								



Project	: GEOTECHNICAL INVESTIGATION FOR THE PROPOSED SITE FOR DEVELOPMENT OF BERTH NO.7	Borehole No.	: MBH-A1
Client	: Mormugao Port Trust	Job No.	: 215/08
Drilling Method	: Cable Percussion / Hydraulic Rotary	Equipment	: Pontoon
Casing size(mm)	: 150/100	Casing depth (m)	: 38.53 w.r.t SBL
Core Dia (mm)	: 50	T.D. (m)	: 40.00 w.r.t SBL
		Date	: 29/02/08-04/03/08

Field data											Laboratory data									
Depth below SBL (m)	Sample & in situ test depth (m)	Type	SPT 'N'	WG	FI	TCR %	SCR %	RQD %	Depth below SBL (m)	RL wrt CD (m)	Symbol	DESCRIPTION	CLAY, %	SILT, %	SAND, %	GRAVEL, %	W _L / I _p / MC, %	c _u , kN/m ² / φ ^o (OR)	τ _v & τ _{v,r}	
0	0.00	█							0.00	-5.76	X	Very soft, dark grey, silty CLAY								
1	1.50-1.95	█									X		17	67	16	0	31/13/50	18.1/4		
2											X									
3	3.00-3.45	□	2								X									
4											X									
5	4.50-4.95	█							4.50	-10.26	X	Very soft, dark grey, silty CLAY	40	59	1	0	69/33/91	14.29/4		
6	6.00-6.45	□	6						6.00	-11.76	X	Firm, dark grey, silty CLAY with gravel								
7											X									
8	7.50-7.95	□	21						7.50	-13.26	X	Very stiff, yellowish brown, silty CLAY with gravel								
9											X									
10	9.00-9.45	□	36						9.00	-14.76	X	Hard, yellowish red to grey, silty CLAY with gravel and laterite								
11											X									
12	10.50-10.95	□	43								X									
13											X									
14	12.00-12.45	□	68						12.00	-17.76	X	Hard, grey, slightly fine sandy, silty CLAY								
15											X									
15	13.50-13.95	□	81						15.00	-20.76	X									

Abbreviations & Symbols :										Water Depth (m) below CD	
□	- SPT	█	- Rock Core	φ _u	- Undrained Cohesion	W _L	- Liquid Limit	T.D.	- Termination Depth	Date	Depth (m)
█	- UDS	□	- No Recovery	φ	- Angle of Internal Friction	I _p	- Plasticity Index	EGL	- Existing Ground Level		
█	- DS	█	- Soil Sample collected using Core Barrel	τ _v	- Shear Strength	NP	- Non-Plastic	SBL	- Sea Bed Level		
□	- BS	█		τ _{vr}	- Shear Strength of Remoulded Soil	MC	- Moisture Content	CD	- Chart Datum		
★	- WS	⊗	- Field VST	WG	- Weathering Grade	TCR	- Total Core Recovery	MSL	- Mean Sea Level		
				FI	- Fracture Index	SCR	- Solid Core Recovery	RL	- Reduced Level		
				NI	- Non Intact	RQD	- Rock Quality Designation				
						RMR	- Rock Mass Rating				



Project	: GEOTECHNICAL INVESTIGATION FOR THE PROPOSED SITE FOR DEVELOPMENT OF BERTH NO.7	Borehole No.	: MBH-A1
Client	: Mormugao Port Trust	Job No.	: 215/08
Drilling Method	: Cable Percussion / Hydraulic Rotary	Equipment	: Pontoon
Casing size(mm)	: 150/100	Casing depth (m) : 38.53 w.r.t SBL	R.L. (m) : -5.757 w.r.t CD
Core Dia (mm)	: 50	T.D. (m) : 40.00 w.r.t SBL	Date : 29/02/08-04/03/08

Field data										Laboratory data										
Depth below SBL (m)	Sample & in situ test depth (m)	Type	SPT 'N'	WG	FI	TCR %	SCR %	RQD %	Depth below SBL (m)	RL wrt CD (m)	Symbol	DESCRIPTION	CLAY, %	SILT, %	SAND, %	GRAVEL, %	W _L / I _p / MC, %	c _u , kN/m ² / φ ^o (0 ^o)	τ _v & τ _{v,r}	
30	30.00-30.08		>100						30.00	-35.76		Hard, dark grey, silty CLAY with gravel								
31	31.50-31.60		>100																	
33	33.00-33.45		46						33.00	-38.76		Hard, brown to grey, coarse sandy, silty CLAY with gravel								
34	34.50-34.95		53						34.50	-40.26		Hard, dark grey, silty CLAY								
36	36.00-36.45		54										24	55	21	0	50/22/-			
37	37.50-37.70		>100						37.50	-43.26		Hard, dark grey, silty CLAY with gravel								
38	38.50-38.53 38.53-40.00		>100						38.50	-44.26		Very dense, silty clayey GRAVEL								
40									40.00	-45.76		Bore hole terminated at 40.00 m from SBL								

Abbreviations & Symbols :

- SPT
- Rock Core
- UDS
- No Recovery
- DS
- Soil Sample collected using Core Barrel
- BS
- Field VST
- WS

- c_u - Undrained Cohesion
- φ - Angle of Internal Friction
- τ_v - Shear Strength
- τ_{v,r} - Shear Strength of Remoulded Soil
- WG - Weathering Grade
- FI - Fracture Index
- NI - Non Intact

- W_L - Liquid Limit
- I_p - Plasticity Index
- NP - Non-Plastic
- MC - Moisture Content
- TCR - Total Core Recovery
- SCR - Solid Core Recovery
- RQD - Rock Quality Designation
- RMR - Rock Mass Rating

- T.D. - Termination Depth
- EGL - Existing Ground Level
- SBL - Sea Bed Level
- CD - Chart Datum
- MSL - Mean Sea Level
- RL - Reduced Level

Water Depth (m) below CD

Date	Depth (m)



Project	: GEOTECHNICAL INVESTIGATION FOR THE PROPOSED SITE FOR DEVELOPMENT OF BERTH NO.7	Borehole No.	: MBH-A2
Client	: Mormugao Port Trust	Job No.	: 215/08
Drilling Method	: Cable Percussion / Hydraulic Rotary	Equipment	: Pontoon
Casing size(mm)	: 150/100	Casing depth (m) : 16.50 w.r.t SBL	T.D. (m) : 22.50 w.r.t SBL
Core Dia (mm)	: 50	Date	: 4/03/08 - 6/03/08

Field data											Laboratory data											
Depth below SBL (m)	Sample & in situ test depth (m)	Type	SPT 'N'	WG	FI	TCR %	SCR %	RQD %	Depth below SBL (m)	RL wrt CD (m)	Symbol	DESCRIPTION	CLAY, %	SILT, %	SAND, %	GRAVEL, %	W _L / I _p / MC, %	c _u , kN/m ² / φ ^o (OR)	τ _v & τ _{vr}			
15	15.00-15.42		101						15.00	-21.33	X	Very dense, brown, silty coarse SAND with gravel and rock fragments										
16	16.50-16.53		>100						16.50	-22.83	X	Very dense, grey, GRAVEL and weathered rock fragments										
17	16.53-18.00			IV-III	NI	24	0	0	16.53	-22.86	V	Extremely weak to weak, greenish grey, highly to moderately weathered, highly fractured, very closely spaced BASALT with inclined and vertical joint										
18	18.00-19.50			IV-III	NI	49	4	0			V											
19	19.50-21.00			III-II	NI	60	7	4	19.50	-25.83	V		Moderately weak to moderately strong, grey, moderately fractured, slightly weathered, very closely spaced BASALT with inclined and vertical joint filled by clay									
20	21.00-22.50			II	NI	93	10	8	22.50	-28.83	V											
Bore hole terminated at 22.50 m from SBL																						
23																						
24																						
25																						
26																						
27																						
28																						
29																						
30																						

Abbreviations & Symbols :

- - SPT
- - UDS
- ▨ - DS
- ▩ - BS
- ★ - WS
- ▩ - Rock Core
- ▩ - No Recovery
- ▩ - Soil Sample collected using Core Barrel
- ⊗ - Field VST

- c_u - Undrained Cohesion
- φ - Angle of Internal Friction
- τ_v - Shear Strength
- τ_{vr} - Shear Strength of Remoulded Soil
- WG - Weathering Grade
- FI - Fracture Index
- NI - Non Intact

- W_L - Liquid Limit
- I_p - Plasticity Index
- NP - Non-Plastic
- MC - Moisture Content
- TCR - Total Core Recovery
- SCR - Solid Core Recovery
- RQD - Rock Quality Designation
- RMR - Rock Mass Rating

- T.D. - Termination Depth
- EGL - Existing Ground Level
- SBL - Sea Bed Level
- CD - Chart Datum
- MSL - Mean Sea Level
- RL - Reduced Level

Water Depth (m) below CD

Date	Depth (m)



Project	: GEOTECHNICAL INVESTIGATION FOR THE PROPOSED SITE FOR DEVELOPMENT OF BERTH NO.7	Borehole No.	: MBH-A3
Client	: Mormugao Port Trust	Job No.	: 215/08
Drilling Method	: Cable Percussion / Hydraulic Rotary	Equipment	: Pontoon
Casing size(mm)	: 150/100	Casing depth (m) : 16.50 w.r.t SBL	T.D. (m) : 28.00 w.r.t SBL
Core Dia (mm)	: 50	Date	: 07/03/08-09/03/08

Field data										Laboratory data										
Depth below SBL (m)	Sample & in situ test depth (m)	Type	SPT 'N'	WG	FI	TCR %	SCR %	RQD %	Depth below SBL (m)	RL wrt CD (m)	Symbol	DESCRIPTION	CLAY, %	SILT, %	SAND, %	GRAVEL, %	W _L / I _p / MC, %	c _u , kN/m ² / φ ^o (OR)	τ _v & τ _{vr}	
0	0.00	█							0.00	-7.04	○	Soft, dark grey, silty CLAY with gravel								
1	1.50-1.95	□	2								○									
2											○									
3	3.00-3.45	█									○		33	60	6	1	68/37/90	13.35/3		
4											○									
5	4.50-4.95	█							4.50	-11.54	○	Stiff to hard, dark grey, silty CLAY with some sand	40	47	13	0	60/43/28	56.6/7		
6	6.00-6.45	□	29								○									
7											○									
8	7.50-7.95	□	34						7.50	-14.54	○	Hard, yellowish to brown grey, silty CLAY with some sand								
9											○									
10	9.00-9.45	□	32						9.00	-16.04	○	Hard, dark grey, silty CLAY with some fine sand								
11											○									
12	10.50-10.95	□	101						10.50	-17.54	○	Very dense, yellowish grey, SAND with laterite pieces								
13											○									
14	13.50-13.75	□	>100						13.50	-20.54	○	Very dense, reddish brown, coarse SAND with few gravel and quartz pieces	1		84	15				
15									15.00	-22.04	○									

Abbreviations & Symbols :										Water Depth (m) below CD	
□	- SPT	█	- Rock Core	c _u	- Undrained Cohesion	W _L	- Liquid Limit	T.D.	- Termination Depth	Date	Depth (m)
█	- UDS	□	- No Recovery	φ	- Angle of Internal Friction	I _p	- Plasticity Index	EGL	- Existing Ground Level		
█	- DS	█	- Soil Sample collected using Core Barrel	τ _v	- Shear Strength	NP	- Non-Plastic	SBL	- Sea Bed Level		
█	- BS	█	- Remoulded Soil	τ _{vr}	- Shear Strength of Remoulded Soil	MC	- Moisture Content	CD	- Chart Datum		
★	- WS	○	- Field VST	WG	- Weathering Grade	TCR	- Total Core Recovery	MSL	- Mean Sea Level		
				FI	- Fracture Index	SCR	- Solid Core Recovery	RL	- Reduced Level		
				NI	- Non Intact	RQD	- Rock Quality Designation				
						RMR	- Rock Mass Rating				



Project	: GEOTECHNICAL INVESTIGATION FOR THE PROPOSED SITE FOR DEVELOPMENT OF BERTH NO.7	Borehole No.	: MBH-A4
Client	: Mormugao Port Trust	Job No.	: 215/08
Drilling Method	: Cable Percussion / Hydraulic Rotary	Equipment	: Pontoon
Casing size(mm)	: 150/100	Casing depth (m) : 24.00 w.r.t SBL	T.D. (m) : 28.50 w.r.t SBL
Core Dia (mm)	: 50	Date	: 10/03/09 -13/03/08

Field data										Laboratory data										
Depth below SBL (m)	Sample & in situ test depth (m)	Type	SPT 'N'	WG	FI	TCR %	SCR %	RQD %	Depth below SBL (m)	RL wrt CD (m)	Symbol	DESCRIPTION	CLAY, %	SILT, %	SAND, %	GRAVEL, %	W _L / I _p / MC, %	c _u , kN/m ² / φ ^o (OR)	τ _v & τ _{v,r}	
0	0.00								0.00	-6.10		Very soft, dark grey, silty CLAY								
1	1.50-1.95		2																	
2																				
3	3.00-3.45																			
4	4.50-4.95		4						4.50	-10.60		Soft, dark grey, silty CLAY with some sand latrite pieces								
5																				
6	6.00-6.45												17	69	14	0	43/24/107	6.1 & 5.3		
7	7.50-7.95		15																	
8									7.50	-13.60		Very stiff, yellowish to dark grey, silty CLAY with gravel and some sand								
9	9.00-9.45		20																	
10	10.50-10.95		23																	
11																				
12	12.00-12.45		75						12.00	-18.10		Very dense, yellowish brown, fine to medium grained SAND	1		99	0				
13	13.50-13.95		80																	
14																				
15									15.00	-21.10										

Abbreviations & Symbols :

- SPT
- Rock Core
- No Recovery
- Soil Sample collected using Core Barrel
- Field VST

- c_u - Undrained Cohesion
- φ - Angle of Internal Friction
- τ_v - Shear Strength
- τ_{vr} - Shear Strength of Remoulded Soil
- WG - Weathering Grade
- FI - Fracture Index
- NI - Non Intact

- W_L - Liquid Limit
- I_p - Plasticity Index
- NP - Non-Plastic
- MC - Moisture Content
- TCR - Total Core Recovery
- SCR - Solid Core Recovery
- RQD - Rock Quality Designation
- RMR - Rock Mass Rating

- T.D. - Termination Depth
- EGL - Existing Ground Level
- SBL - Sea Bed Level
- CD - Chart Datum
- MSL - Mean Sea Level
- RL - Reduced Level

Water Depth (m) below CD

Date	Depth (m)



Project	: GEOTECHNICAL INVESTIGATION FOR THE PROPOSED SITE FOR DEVELOPMENT OF BERTH NO.7	Borehole No.	: MBH-A4
Client	: Mormugao Port Trust	Job No.	: 215/08
Drilling Method	: Cable Percussion / Hydraulic Rotary	Equipment	: Pontoon
Casing size(mm)	: 150/100	Casing depth (m)	: 24.00 w.r.t SBL
Core Dia (mm)	: 50	T.D. (m)	: 28.50 w.r.t SBL
		Date	: 10/03/09 -13/03/08

Field data											Laboratory data										
Depth below SBL (m)	Sample & in situ test depth (m)	Type	SPT 'N'	WG	FI	TCR %	SCR %	RQD %	Depth below SBL (m)	RL wrt CD (m)	Symbol	DESCRIPTION	CLAY, %	SILT, %	SAND, %	GRAVEL, %	W _L / I _p / MC, %	c _u , kN/m ² / φ° (OR)	τ _v & τ _{vr}		
15	15.00-15.45		55						15.00	-21.10		Very dense, yellowish brown, medium to coarse SAND									
16	16.50-16.95		54																		
17																					
18	18.00-18.45		69						18.00	-24.10	X	Very dense, brownish to grey, slightly clayey, silty coarse SAND with shell fragments and few gravel									
19	19.50-19.85		101								X		3	32	57	8					
20											X										
21	21.00-21.45		102						21.00	-27.10	X	Hard, dark grey, silty CLAY									
22	22.50-22.83		93								X										
23											X										
24	24.00-24.02		>100								X										
24	24.00-24.50			III-II	NI	96	10	0	24.00	-30.10	V	Moderately weak to moderately strong, dark grey, moderately to slightly weathered, highly fractured, extremely closely spaced BASALT with inclined and vertical Joint									
25	24.50-25.50			III-II	12	87	27	0			V V										
25	25.50-26.50			II	12	100	53	0			V V										
26	26.50-27.50			II	10	100	30	12			V V										
27	27.50-28.50			II	NI	95	8	0			V V										
28									28.50	-34.60											
29												Bore hole terminated at 28.50 m from SBL									
30																					

Abbreviations & Symbols :										Water Depth (m) below CD	
	- SPT		- Rock Core	c_u	- Undrained Cohesion	W_L	- Liquid Limit	$T.D.$	- Termination Depth	Date	Depth (m)
	- UDS		- No Recovery	ϕ	- Angle of Internal Friction	I_p	- Plasticity Index	EGL	- Existing Ground Level		
	- DS		- Soil Sample collected using Core Barrel	τ_v	- Shear Strength	NP	- Non-Plastic	SBL	- Sea Bed Level		
	- BS			τ_{vr}	- Shear Strength of Remoulded Soil	MC	- Moisture Content	CD	- Chart Datum		
	- WS		- Field VST	WG	- Weathering Grade	TCR	- Total Core Recovery	MSL	- Mean Sea Level		
				FI	- Fracture Index	SCR	- Solid Core Recovery	RL	- Reduced Level		
				NI	- Non Intact	RQD	- Rock Quality Designation				
						RMR	- Rock Mass Rating				



Project	: GEOTECHNICAL INVESTIGATION FOR THE PROPOSED SITE FOR DEVELOPMENT OF BERTH NO.7	Borehole No.	: MBH-B1
Client	: Mormugao Port Trust	Job No.	: 215/08
Drilling Method	: Cable Percussion / Hydraulic Rotary	Equipment	: Pontoon
Casing size(mm)	: 150/100	Casing depth (m) : 21.00 w.r.t SBL	T.D. (m) : 27.00 w.r.t SBL
Core Dia (mm)	: 50	Date	: 14/03/08-17/03/08

Field data										Laboratory data										
Depth below SBL (m)	Sample & in situ test depth (m)	Type	SPT 'N'	WG	FI	TCR %	SCR %	RQD %	Depth below SBL (m)	RL wrt CD (m)	Symbol	DESCRIPTION	CLAY, %	SILT, %	SAND, %	GRAVEL, %	W _L / I _p / MC, %	c _u , kN/m ² / φ ^o (OR)	τ _v & τ _{v,r}	
0	0.00	█							0.00	-2.76	█	Medium dense to dense,brown,fine SAND								
1	1.50-1.95	□	30																	
2																				
3	3.00-3.45	□	48						3.00	-5.76	█	Dense,brown,fine SAND								
4																				
5	4.50-4.95	□	2						4.50	-7.26	█	Soft,dark grey,silty CLAY								
6	6.00-6.45	█									×		42	56	2	0	55/25/105	14.2/4		
7											×									
8	7.50-7.95	□	2								×									
9											×									
9	9.00-9.45	□	67						9.00	-11.76	█	Very dense,brown,clayey,medium to coarse grained SAND with shell fragments								
10											█									
10	10.50-10.95	□	4						10.50	-13.26	█	Firm to stiff,dark grey,silty CLAY								
11											×									
12	12.00-12.45	█									×		30	59	8	3	53/31/65	16.9/4		
13											×									
13	13.50-13.95	□	12								×									
14											×									
15									15.00	-17.76	×									

Abbreviations & Symbols :										Water Depth (m) below CD	
□	- SPT	█	- Rock Core	φ _u	- Undrained Cohesion	W _L	- Liquid Limit	T.D.	- Termination Depth	Date	Depth (m)
█	- UDS	□	- No Recovery	φ	- Angle of Internal Friction	I _p	- Plasticity Index	EGL	- Existing Ground Level		
█	- DS	█	- Soil Sample collected using Core Barrel	τ _v	- Shear Strength	NP	- Non-Plastic	SBL	- Sea Bed Level		
□	- BS	█	- Remoulded Soil	τ _{vr}	- Shear Strength of Remoulded Soil	MC	- Moisture Content	CD	- Chart Datum		
★	- WS	⊗	- Field VST	WG	- Weathering Grade	TCR	- Total Core Recovery	MSL	- Mean Sea Level		
				FI	- Fracture Index	SCR	- Solid Core Recovery	RL	- Reduced Level		
				NI	- Non Intact	RQD	- Rock Quality Designation				
						RMR	- Rock Mass Rating				



Project	: GEOTECHNICAL INVESTIGATION FOR THE PROPOSED SITE FOR DEVELOPMENT OF BERTH NO.7	Borehole No.	: MBH-B2
Client	: Mormugao Port Trust	Job No.	: 215/08
Drilling Method	: Cable Percussion / Hydraulic Rotary	Equipment	: Pontoon
Casing size(mm)	: 150/100	Casing depth (m) : 24.00 w.r.t SBL	T.D. (m) : 27.30 w.r.t SBL
Core Dia (mm)	: 50	Date	: 18/03/08-20/03/08

Field data										Laboratory data										
Depth below SBL (m)	Sample & in situ test depth (m)	Type	SPT 'N'	WG	FI	TCR %	SCR %	RQD %	Depth below SBL (m)	RL wrt CD (m)	Symbol	DESCRIPTION	CLAY, %	SILT, %	SAND, %	GRAVEL, %	W _L / I _p / MC, %	c _u , kN/m ² / φ° (OR)	τ _v & τ _{v,r}	
0	0.00	█							0.00	-4.27		Medium dense, brownish grey, medium SAND								
1	1.50-1.95	□	20																	
2																				
3	3.00-3.45	█							3.00	-7.27	X	Very soft, dark grey, silty CLAY with some sand	25	55	20	0	31/21/46	11.5/4		
4											X									
5	4.50-4.95	□	2								X									
6	6.00-6.45	█							6.00	-10.27	X	Very soft, dark grey, slightly sandy, clayey SILT	36	59	5	0	56/24/99	13/5		
7											X									
8	7.50-7.95	□	5						7.50	-11.77	X	Very soft, dark grey, silty CLAY with shell fragments								
9											X									
10	9.00-9.45	□	52						9.00	-13.27		Very dense, brown, fine to medium SAND								
11	10.50-10.95	□	75						10.50	-14.77		Very dense, brown, slightly clayey, fine to medium SAND								
12	12.00-12.45	□	77																	
13	13.50-13.95	□	80																	
14																				
15									15.00	-19.27										

Abbreviations & Symbols :										Water Depth (m) below CD	
□	- SPT	█	- Rock Core	φ _u	- Undrained Cohesion	W _L	- Liquid Limit	T.D.	- Termination Depth	Date	Depth (m)
█	- UDS	□	- No Recovery	φ	- Angle of Internal Friction	I _p	- Plasticity Index	EGL	- Existing Ground Level		
█	- DS	□	- Soil Sample collected using Core Barrel	τ _v	- Shear Strength	NP	- Non-Plastic	SBL	- Sea Bed Level		
□	- BS	█		τ _{vr}	- Shear Strength of Remoulded Soil	MC	- Moisture Content	CD	- Chart Datum		
★	- WS	⊗	- Field VST	WG	- Weathering Grade	TCR	- Total Core Recovery	MSL	- Mean Sea Level		
				FI	- Fracture Index	SCR	- Solid Core Recovery	RL	- Reduced Level		
				NI	- Non Intact	RQD	- Rock Quality Designation				
						RMR	- Rock Mass Rating				



Project	: GEOTECHNICAL INVESTIGATION FOR THE PROPOSED SITE FOR DEVELOPMENT OF BERTH NO.7	Borehole No.	: MBH-B2
Client	: Mormugao Port Trust	Job No.	: 215/08
Drilling Method	: Cable Percussion / Hydraulic Rotary	Equipment	: Pontoon
Casing size(mm)	: 150/100	Casing depth (m)	: 24.00 w.r.t SBL
Core Dia (mm)	: 50	Date	: 18/03/08-20/03/08

Field data											Laboratory data									
Depth below SBL (m)	Sample & in situ test depth (m)	Type	SPT 'N'	WG	FI	TCR %	SCR %	RQD %	Depth below SBL (m)	RL wrt CD (m)	Symbol	DESCRIPTION	CLAY, %	SILT, %	SAND, %	GRAVEL, %	W _L / I _p / MC, %	c _u , kN/m ² / φ _v (°)	τ _v & τ _{vr}	
15	15.00-15.45		84						15.00	-19.27		Very dense, brownish grey, medium SAND								
16	16.50-16.95		87																	
18	18.00-18.45		96						18.00	-22.27		Very dense, brownish grey, coarse SAND with shell fragments	2	2	94	2				
19	19.50-19.95		99						19.50	-23.77		Very dense, brownish grey, slightly silty, clayey, coarse SAND								
20	21.00-21.50		100																	
21	22.50-23.00		100																	
22	24.00-24.02		>100						24.00	-28.27		Very dense, grey, medium grained GRAVEL (Residual soil)								
25	25.00-26.50			III	NI	40	0	0	25.00	-29.27		Extremely weak to weak, greenish grey, moderately weathered, highly fractured, extremely closely spaced BASALT with inclined and vertical joint								
26	26.50-27.00			III	NI	80	0	0												
27	27.00-27.30			III	NI	30	0	0	27.30	-31.57										
28	Bore hole terminated at 27.30 m from SBL																			

Abbreviations & Symbols :												Water Depth (m) below CD			
	- SPT		- Rock Core	c_u	- Undrained Cohesion	W_L	- Liquid Limit	T.D.	- Termination Depth	Date		Depth (m)			
	- UDS		- No Recovery	ϕ	- Angle of Internal Friction	I_p	- Plasticity Index	EGL	- Existing Ground Level						
	- DS		- Soil Sample collected using Core Barrel	τ_v	- Shear Strength	NP	- Non-Plastic	SBL	- Sea Bed Level						
	- BS			τ_{vr}	- Shear Strength of Remoulded Soil	MC	- Moisture Content	CD	- Chart Datum						
	- WS		- Field VST	WG	- Weathering Grade	TCR	- Total Core Recovery	MSL	- Mean Sea Level						
				FI	- Fracture Index	SCR	- Solid Core Recovery	RL	- Reduced Level						
				NI	- Non Intact	RQD	- Rock Quality Designation								
						RMR	- Rock Mass Rating								



Project	: GEOTECHNICAL INVESTIGATION FOR THE PROPOSED SITE FOR DEVELOPMENT OF BERTH NO.7	Borehole No.	: MBH-B3
Client	: Mormugao Port Trust	Job No.	: 215/08
Drilling Method	: Cable Percussion / Hydraulic Rotary	Equipment	: Pontoon
Casing size(mm)	: 150/100	Casing depth (m) : 19.50 w.r.t SBL	R.L. (m) : -3.234 w.r.t CD
Core Dia (mm)	: 50	T.D. (m) : 25.50 w.r.t SBL	Date : 21/03/08-25/03/08

Field data											Laboratory data										
Depth below SBL (m)	Sample & in situ test depth (m)	Type	SPT 'N'	WG	FI	TCR %	SCR %	RQD %	Depth below SBL (m)	RL wrt CD (m)	Symbol	DESCRIPTION	CLAY, %	SILT, %	SAND, %	GRAVEL, %	W _L / I _p / MC, %	c _u , kN/m ² / φ _v (or)	τ _v & τ _{v,r}		
15	15.00-15.45		70						15.00	-18.23		Very dense, yellowish brown, fine to medium SAND									
16	16.50-16.95		85						16.50	-19.73	X	Hard, yellowish grey, silty CLAY with some gravel and sand	14	50	22	14	39/18/-				
17											X										
18	18.00-18.45		88								X										
19	19.50-19.52		>100						19.50	-22.73	X	Very dense, grey, medium GRAVEL (Residual soil)									
20	19.52-21.00			IV	NI	27	0	0	19.52	-22.75	V	Extremely weak to weak, reddish grey, moderately weathered, highly fractured, extremely closely spaced BASALT									
21	21.00-22.50			III	NI	73	0	0	21.00	-24.23	V	Extremely weak to weak, grey, moderately weathered, highly fractured, extremely closely spaced BASALT with inclined and vertical joint									
22	22.50-23.00			III	NI	90	0	0			V										
23	23.00-24.00			II	18	100	11	0	23.00	-26.23	V	Weak to moderately weak, dark grey, highly fractured, slightly weathered, extremely closely spaced BASALT with inclined and vertical joint									
24	24.00-25.00			II	NI	90	25	10	24.00	-27.23	V										
25	25.00-25.50			II	NI	100	0	0	25.00	-28.23	V	Extremely weak to weak, dark grey, highly fractured, slightly weathered, very closely spaced BASALT with inclined and vertical joint									
									25.50	-28.73											
26	Bore hole terminated at 25.50 m from SBL																				
27																					
28																					
29																					
30																					

Abbreviations & Symbols :										Water Depth (m) below CD	
	- SPT		- Rock Core	c_u	- Undrained Cohesion	W_L	- Liquid Limit	T.D.	- Termination Depth	Date	Depth (m)
	- UDS		- No Recovery	ϕ	- Angle of Internal Friction	I_p	- Plasticity Index	EGL	- Existing Ground Level		
	- DS		- Soil Sample collected using Core Barrel	τ_v	- Shear Strength	NP	- Non-Plastic	SBL	- Sea Bed Level		
	- BS			τ_{VR}	- Shear Strength of Remoulded Soil	MC	- Moisture Content	CD	- Chart Datum		
	- WS		- Field VST	WG	- Weathering Grade	TCR	- Total Core Recovery	MSL	- Mean Sea Level		
				FI	- Fracture Index	SCR	- Solid Core Recovery	RL	- Reduced Level		
				NI	- Non Intact	RQD	- Rock Quality Designation				
						RMR	- Rock Mass Rating				



Project	: GEOTECHNICAL INVESTIGATION FOR THE PROPOSED SITE FOR DEVELOPMENT OF BERTH NO.7	Borehole No.	: MBH-B4
Client	: Mormugao Port Trust	Job No.	: 215/08
Drilling Method	: Cable Percussion / Hydraulic Rotary	Equipment	: Pontoon
Casing size(mm)	: 150/100	Casing depth (m) : 21.00 w.r.t SBL	T.D. (m) : 24.50 w.r.t SBL
Core Dia (mm)	: 50	Date	: 27/03/08-30/03/08

Field data											Laboratory data								
Depth below SBL (m)	Sample & in situ test depth (m)	Type	SPT 'N'	WG	FI	TCR %	SCR %	RQD %	Depth below SBL (m)	RL wrt CD (m)	Symbol	DESCRIPTION	CLAY, %	SILT, %	SAND, %	GRAVEL, %	W _L / I _p / MC, %	c _u , kN/m ² / φ ^o (σ ₁)	τ _v & τ _{v,r}
0	0.00	█							0.00	-3.06		Very dense, brownish grey, fine SAND							
1	1.50-1.95	□	73																
2													6		94	0			
3	3.00-3.45	□	75																
4																			
4.50-4.95		□	27						4.50	-7.56		Medium dense, brownish grey, clayey, coarse SAND with shell fragments							
5																			
6	6.00-6.45	□	33						6.00	-9.06		Dense, grey, fine SAND with shell fragments							
7																			
7.50-7.95		□	42																
8																			
9	9.00-9.45	□	53						9.00	-12.06		Very dense, yellowish brown, medium SAND							
10																			
10.50-10.95		□	57																
11																			
12	12.00-12.45	□	64										4		91	5			
13																			
13.50-13.95		□	76																
14																			
15									15.00	-18.06									

Abbreviations & Symbols :			Water Depth (m) below CD			
□ - SPT	█ - Rock Core	φ _u - Undrained Cohesion	W _L - Liquid Limit	T.D. - Termination Depth	Date	Depth (m)
█ - UDS	□ - No Recovery	φ - Angle of Internal Friction	I _p - Plasticity Index	EGL - Existing Ground Level		
█ - DS	█ - Soil Sample collected using Core Barrel	τ _v - Shear Strength	NP - Non-Plastic	SBL - Sea Bed Level		
█ - BS		τ _{vr} - Shear Strength of Remoulded Soil	MC - Moisture Content	CD - Chart Datum		
★ - WS	⊗ - Field VST	WG - Weathering Grade	TCR - Total Core Recovery	MSL - Mean Sea Level		
		FI - Fracture Index	SCR - Solid Core Recovery	RL - Reduced Level		
		NI - Non Intact	RQD - Rock Quality Designation			
			RMR - Rock Mass Rating			



Project	: GEOTECHNICAL INVESTIGATION FOR THE PROPOSED SITE FOR DEVELOPMENT OF BERTH NO.7	Borehole No.	: MBH-B4
Client	: Mormugao Port Trust	Job No.	: 215/08
Drilling Method	: Cable Percussion / Hydraulic Rotary	Equipment	: Pontoon
Casing size(mm)	: 150/100	Casing depth (m)	: 21.00 w.r.t SBL
Core Dia (mm)	: 50	Date	: 27/03/08-30/03/08

Field data											Laboratory data											
Depth below SBL (m)	Sample & in situ test depth (m)	Type	SPT 'N'	WG	FI	TCR %	SCR %	RQD %	Depth below SBL (m)	RL wrt CD (m)	Symbol	DESCRIPTION	CLAY, %	SILT, %	SAND, %	GRAVEL, %	W _L / I _p / MC, %	c _u , kN/m ² / φ ^o (or)	τ _v & τ _{vr}			
15	15.00-15.45		79						15.00	-18.06		Very dense, brown, fine to medium SAND										
16	16.50-16.95		83						16.50	-19.56	X X X X	Hard, yellow, silty CLAY with laterite pieces										
17																						
18	18.00-18.45		83						18.00	-21.06		Very dense, brown, medium SAND										
19	19.00-19.45		88										6		94	0						
20																						
21	21.00-21.02 21.02-22.00		>100	III	NI	50	0	0	21.00	-24.06		Very dense, grey, medium GRAVEL (Residual soil)										
22	22.00-23.50			II	20	83	38	8	21.02	-24.08	∨ ∨ ∨ ∨	Extremely weak to weak, yellowish grey to grey, highly fractured, moderately weathered, extremely closely spaced BASALT with inclined and vertical joint										
23									22.00	-25.06	∨ ∨ ∨	Moderately weak, yellowish grey to grey, moderately fractured, slightly weathered, very closely spaced, BASALT with inclined and vertical joint										
24	23.50-24.50			II	8	100	40	12	23.50	-26.56	∨ ∨	Moderately weak, grey, moderately fractured, slightly weathered, very closely spaced BASALT with inclined joint										
25									24.50	-27.56	∨											
Bore hole terminated at 24.50 m from SBL																						
26																						
27																						
28																						
29																						
30																						

Abbreviations & Symbols :										Water Depth (m) below CD	
	- SPT		- Rock Core	c_u	- Undrained Cohesion	W_L	- Liquid Limit	T.D.	- Termination Depth	Date	Depth (m)
	- UDS		- No Recovery	ϕ	- Angle of Internal Friction	I_p	- Plasticity Index	EGL	- Existing Ground Level		
	- DS		- Soil Sample collected using Core Barrel	τ_v	- Shear Strength	NP	- Non-Plastic	SBL	- Sea Bed Level		
	- BS			τ_{vr}	- Shear Strength of Remoulded Soil	MC	- Moisture Content	CD	- Chart Datum		
	- WS		- Field VST	WG	- Weathering Grade	TCR	- Total Core Recovery	MSL	- Mean Sea Level		
				FI	- Fracture Index	SCR	- Solid Core Recovery	RL	- Reduced Level		
				NI	- Non Intact	RQD	- Rock Quality Designation				
						RMR	- Rock Mass Rating				



Project	: GEOTECHNICAL INVESTIGATION FOR THE PROPOSED SITE FOR DEVELOPMENT OF BERTH NO.7	Borehole No.	: MBH-C1
Client	: Mormugao Port Trust	Job No.	: 215/08
Drilling Method	: Cable Percussion / Hydraulic Rotary	Equipment	: Pontoon
Casing size(mm)	: 150/100	Casing depth (m) : 18.00 w.r.t SBL	T.D. (m) : 24.00 w.r.t SBL
Core Dia (mm)	: 50	Date	: 31/03/08-02/03/08

Field data											Laboratory data									
Depth below SBL (m)	Sample & in situ test depth (m)	Type	SPT 'N'	WG	FI	TCR %	SCR %	RQD %	Depth below SBL (m)	RL wrt CD (m)	Symbol	DESCRIPTION	CLAY, %	SILT, %	SAND, %	GRAVEL, %	W _L / I _p / MC, %	c _u , kN/m ² / φ ^o (OR)	τ _v & τ _{v,r}	
0	0.00	█							0.00	-6.88	X	Very soft, yellowish grey, clayey SILT								
1	1.50-1.95	□	1								X									
2											X									
3	3.00-3.45	█									X		38	60	2	0	67/32/100	10.6/3		
4	4.50-4.95	□	2								X									
5											X									
6	6.00-6.45	█									X		35	64	1	0	78/45/97	15.43/2		
7											X									
8	7.50-7.95	□	4						7.50	-14.38	X	Soft, grey, silty CLAY								
9	9.00-9.45	█									X		6	32	62	0	NP			
10											X									
11	10.50-10.95	□	30						10.50	-17.38		Dense, brownish grey, slightly clayey SAND								
12																				
13	12.00-12.45	□	60						12.00	-18.88		Very dense, brown, fine SAND								
14	13.50-13.95	□	75																	
15									15.00	-21.88										

Abbreviations & Symbols :										Water Depth (m) below CD	
□	- SPT	█	- Rock Core	φ _u	- Undrained Cohesion	W _L	- Liquid Limit	T.D.	- Termination Depth	Date	Depth (m)
█	- UDS	□	- No Recovery	φ	- Angle of Internal Friction	I _p	- Plasticity Index	EGL	- Existing Ground Level		
█	- DS	█	- Soil Sample collected using Core Barrel	τ _v	- Shear Strength	NP	- Non-Plastic	SBL	- Sea Bed Level		
█	- BS	█	- Remoulded Soil Core Barrel	τ _{vr}	- Shear Strength of Remoulded Soil	MC	- Moisture Content	CD	- Chart Datum		
★	- WS	⊗	- Field VST	WG	- Weathering Grade	TCR	- Total Core Recovery	MSL	- Mean Sea Level		
				FI	- Fracture Index	SCR	- Solid Core Recovery	RL	- Reduced Level		
				NI	- Non Intact	RQD	- Rock Quality Designation				
						RMR	- Rock Mass Rating				



Project :	GEOTECHNICAL INVESTIGATION FOR THE PROPOSED SITE FOR DEVELOPMENT OF BERTH NO.7		Borehole No. :	MBH-C1	
Client :	Mormugao Port Trust	Job No. :	215/08	Co-ordinates :	N-371396, E-1704066
Drilling Method :	Cable Percussion / Hydraulic Rotary	Equipment :	Pontoon	R.L. (m) :	-6.88 w.r.t CD
Casing size(mm) :	150/100	Casing depth (m) :	18.00 w.r.t SBL	T.D. (m) :	24.00 w.r.t SBL
Core Dia (mm) :	50			Date :	31/03/08-02/03/08

Depth below SBL (m)	Sample & in situ test depth (m)	Type	Field data						Depth below SBL (m)	RL wrt CD (m)	Symbol	DESCRIPTION	Laboratory data						
			SPT 'N'	WG	FI	TCR %	SCR %	RQD %					CLAY, %	SILT, %	SAND, %	GRAVEL, %	W _L / I _p / MC, %	c _u kN/m ² / φ ₀ (0°)	τ _v & τ _{vr}
15	15.00-15.20		>100						15.00	-21.88	X	Very dense, dark grey, silty CLAY with gravel							
16	15.50-16.50			III	NI	55	0	0	15.50	-22.38	V V	Extremely weak, grey, moderately weathered, highly fractured, extremely closely spaced BASALT							
17	16.50-16.70		>100						16.50	-23.38	X X X X	Hard, grey, silty CLAY with gravel and weathered rock fragments							
18	18.00-19.50			III	NI	53	65	0	18.00	-24.88	V V	Extremely weak to weak, grey, moderately weathered, highly fractured, extremely closely spaced BASALT							
19	19.50-20.00			III	NI	60	0	0	19.50	-26.38	V V	Weak to moderately weak, grey, moderately weathered, highly fractured, extremely closed spaced BASALT with inclined and vertical joint							
20	20.00-21.50			III	NI	30	0	0											
21	21.50-23.00			III	NI	80	2	0	24.00	-30.88	V V								
22	23.00-24.00			III	NI	90	6	0											
24	Bore hole terminated at 24.00 m from SBL																		

Abbreviations & Symbols :				Water Depth (m) below CD			
□ - SPT	▨ - Rock Core	c _u - Undrained Cohesion	W _L - Liquid Limit	Date		Depth (m)	
▨ - UDS	⊘ - No Recovery	φ - Angle of Internal Friction	I _p - Plasticity Index				
▨ - DS	▨ - Soil Sample collected using Core Barrel	τ _v - Shear Strength	NP - Non-Plastic				
▨ - BS		τ _{vr} - Shear Strength of Remoulded Soil	MC - Moisture Content				
★ - WS	⊗ - Field VST	WG - Weathering Grade	TCR - Total Core Recovery				
		FI - Fracture Index	SCR - Solid Core Recovery				
		NI - Non Intact	RQD - Rock Quality Designation				
			RMR - Rock Mass Rating				
			T.D. - Termination Depth				
			EGL - Existing Ground Level				
			SBL - Sea Bed Level				
			CD - Chart Datum				
			MSL - Mean Sea Level				
			RL - Reduced Level				

APPENDIX - B



SUMMARY OF LABORATORY TEST RESULTS																			
PROJECT: Geotechnical Investigation for the Proposed Site for Development Of Berth No.7										Client:MPT			Mormugao Port Trust			Job No : 215/08			
										Method of Testing : IS Code			As per Indian Standards			Date : 30.04.2008			
BH. NO.	Sample Type	Test Depth w.r.t. EGL (m)		Test Depth w.r.t. CD (m)		CLASSIFICATION TESTS								DENSITY & MOISTURE CONTENT		Strength Parameters (kPa)			
		From	To	From	To	Specific Gravity	Atterberg Limits(%)			Particle Size Distribution(%)				Moisture Content (%)	Density (Mg/m ³)		UU Triaxial c / φ°	Lab Vane Shear τ _v / τ _{vr}	
							W _L	W _P	I _P	Clay	Silt	Sand	Gravel		Wet	Dry			
LBH-01	UDS	6.00	6.45	-1.56	-2.01	2.638	64	35	29	24	61	14	1	79	1.53	0.85	22.6/2	--	
	UDS	9.00	9.45	-4.56	-5.01	2.652	60	31	29	15	47	30	8	80	1.51	0.84	20.5/2	--	
	SPT	16.50	16.95	-12.06	-12.51	2.664	NP			8	39	50	3	--	--	--	--	--	
	SPT	30.00	30.45	-25.56	-26.01	2.648	56	24	32	25	65	9	1	--	--	--	--	--	
MBH-A1	UDS	1.50	1.95	-7.26	-7.71	2.657	31	18	13	17	67	16	0	55	1.73	1.12	18.1/4	--	
	UDS	4.50	4.95	-10.26	-10.71	2.642	69	36	33	40	59	1	0	91	1.38	0.72	14.29/4	--	
	SPT	22.50	22.95	-28.26	-28.71	2.652	42	22	20	12	64	24	0	--	--	--	--	--	
	SPT	36.00	36.45	-41.76	-42.21	2.653	50	28	22	24	55	21	0	--	--	--	--	--	
MBH-A2	UDS	1.50	1.95	-7.83	-8.28	2.645	61	33	28	33	64	3	0	95	1.57	0.81	--	9.7/6.1	
	UDS	4.50	4.95	-10.83	-11.28	2.651	53	24	29	27	57	16	0	77	1.55	0.88	11.0/6	--	
	SPT	12.00	12.45	-18.33	-18.78	2.664	50	19	31	6	65	27	2	--	--	--	--	--	
MBH-A3	UDS	3.00	3.45	-10.04	-10.49	2.641	68	31	37	33	60	6	1	90	1.41	0.74	13.35/3	--	
	UDS	4.50	4.95	-11.54	-11.99	2.638	60	17	43	40	47	13	0	28	1.96	1.53	56.6/7	--	
	SPT	13.50	13.95	-20.54	-20.99	2.668	NP				1	84	15	--	--	--	--	--	
MBH-A4	UDS	6.00	6.45	-12.10	-12.55	2.649	43	19	24	17	69	14	0	107	1.56	0.75	--	6.1/5.3	
	SPT	12.00	12.45	-18.10	-18.55	2.667	NP				1	99	0	--	--	--	--	--	
	SPT	19.50	19.95	-25.60	-26.05	2.671	NP			3	32	57	8	--	--	--	--	--	
MBH-B1	UDS	6.00	6.45	-8.76	-9.21	2.642	55	30	25	42	56	2	0	105	1.41	0.69	14.2/4	--	
	UDS	12.00	12.45	-14.76	-15.21	2.644	53	22	31	30	59	8	3	65	1.64	0.99	16.9/4	--	
	SPT	16.50	16.95	-19.26	-19.71	2.649	81	34	47	43	52	5	0	--	--	--	--	--	
	SPT	21.00	21.45	-23.76	-24.21	2.663	NP			5	69	23	3	--	--	--	--	--	
MBH-B2	UDS	3.00	3.45	-7.27	-7.72	2.642	31	10	21	25	55	20	0	46	1.45	0.99	11.5/4	--	
	UDS	6.00	6.45	-10.27	-10.72	2.648	56	32	24	36	59	5	0	99	1.46	0.73	13.0/5	--	
	SPT	18.00	18.45	-22.27	-22.72	2.667	NP			2	2	94	2	--	--	--	--	--	

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SUMMARY OF LABORATORY TEST RESULTS																		
PROJECT: Geotechnical Investigation for the Proposed Site for Development Of Berth No.7											Client:MPT			Mormugao Port Trust		Job No :	215/08	
											Method of Testing : IS Code			As per Indian Standards		Date :	30.04.2008	
BH. NO.	Sample Type	Test Depth w.r.t. EGL (m)		Test Depth w.r.t. CD (m)		CLASSIFICATION TESTS								DENSITY & MOISTURE CONTENT			Strength Parameters (kPa)	
		From	To	From	To	Specific Gravity	Atterberg Limits(%)			Particle Size Distribution(%)				Moisture Content (%)	Density (Mg/m ³)		UU Triaxial c / φ°	Lab Vane Shear τ _v / t _{vr}
							W _L	W _P	I _P	Clay	Silt	Sand	Gravel		Wet	Dry		
MBH-B3	SPT	6.00	6.45	-9.23	-9.68	2.652	36	20	16	13	51	36	0	--	--	--	--	--
	SPT	16.50	16.95	-19.73	-20.18	2.653	39	21	18	14	50	22	14	--	--	--	--	--
MBH-B4	SPT	3.00	3.45	-6.06	-6.51	2.668	NP			6	94		0	--	--	--	--	--
	SPT	12.00	12.45	-15.06	-15.51	2.666	NP			4	91		5	--	--	--	--	--
	SPT	19.50	19.95	-22.56	-23.01	2.670	NP			6	94		0	--	--	--	--	--
MBH-C1	UDS	3.00	3.45	-9.88	-10.33	2.648	67	35	32	38	60	2	0	100.0	1.40	0.70	10.6/3	--
	UDS	6.00	6.45	-12.88	-13.33	2.651	78	33	45	35	64	1	0	97.0	1.45	0.74	15.43/2	--
	UDS	9.00	9.45	-15.88	-16.33	2.658	NP			6	32		62	0	--	--	--	--
Prepared By AKJ						Checked By BS						Approved By AS						

Format No. FM-LAB-TEST-15	Revision No. 00	Revision Date NIL	Sheet No. 2 of 2
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SUMMARY OF ROCK TEST RESULTS															
Project :	Geotechnical Investigation for the Proposed Site for Development of Berth No.7											Job No. :	215/08		
Client :	Mormugao Port Trust					Location :	Mormugao			Date :	22.04.08				
BH No.	Depth w.r.t. SBL (m)		Depth w.r.t. C.D. (m)		Length (cm)	Diameter (cm)	Saturated Moisture Content (%)	Water Absorption (%)	Porosity (%)	Dry Unit Weight (g/cc)	Specific Gravity	Point Load Index Strength (Is) ₅₀ (MPa)	Corrected Uniaxial Compressive Strength (Saturated) MPa	Corrected Uniaxial Compressive Strength (Dry) MPa	
	From	To	From	To											
LBH-1	36.00	36.20	-31.56	-31.76	11.382	5.168	0.40	0.22	1.12	2.71	2.74	--	72.1	--	
MBH-A2	22.00	22.15	-28.33	-28.48	8.785	5.160	0.70	0.60	1.26	2.70	2.73	5.72	--	--	
MBH-A3	17.90	18.15	-24.94	-25.19	11.300	5.159	0.42	0.25		2.70	2.73		41.8		
MBH-A3	23.70	23.90	-30.74	-30.94	11.375	5.185	0.35	0.29	1.51	2.75	2.79	--	101.8	--	
MBH-A3	24.00	24.10	-31.04	-31.14	9.025	5.172	0.39	0.18	1.25	2.70	2.73	--	35.0	--	
MBH-A4	24.50	24.57	-30.60	-30.67	6.300	5.142	1.25	6.49	2.03	2.66	2.72	--	35.5	--	
MBH-A4	26.00	26.85	-32.10	-32.95	11.244	5.114	1.23	0.42	2.50	2.64	2.71	--	8.3	--	
MBH-B1	22.50	22.70	-25.26	-25.46	11.584	5.162	0.61	0.47	1.60	2.72	2.76	--	51.2	--	
MBH-B4	24.10	24.20	-27.16	-27.26	10.995	5.298	0.90	0.56	1.67	2.69	2.73	--	5.5	--	
Prepared By :		AKJ				Checked By :		BS			Approved By :		AS		

Format No.	Revision No.	Revision Date	Sheet No.
FM-LAB-TEST-14	00	NIL	1 of 1



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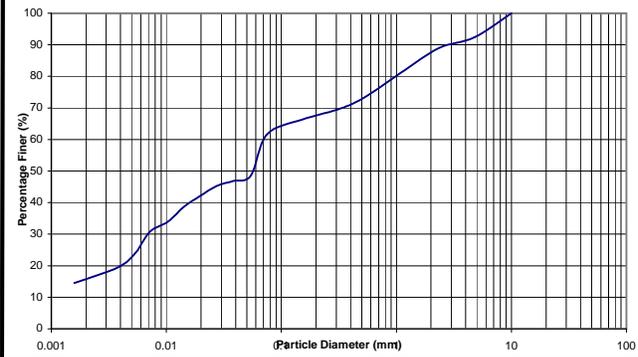
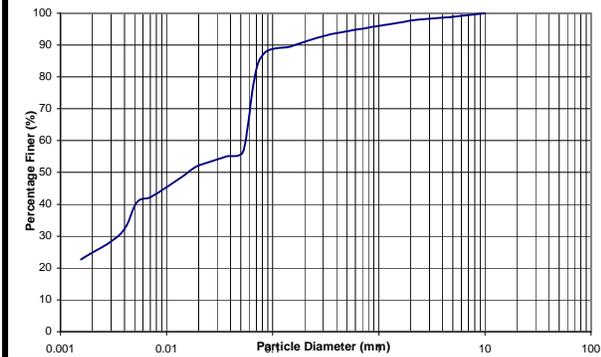
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Project :	Geotechnical Investigation for the Proposed Site for Development of Berth No.7	Job No.	215/08
Client :	Mormugao Port Trust	Method of Test	IS : 2720 (Part - 4)
		Date	22.04.08

BH. No.	Depth (m)	Sample ID No.	BH. No.	Depth (m)	Sample ID No.
LBH-01	6.00-6.45	0	LBH-01	9.00-9.45	0

Clay	Silt	Sand			Gravel
		Fine	Medium	Coarse	
24	61	9	4	1	1

Clay	Silt	Sand			Gravel
		Fine	Medium	Coarse	
15	47	10	15	5	8



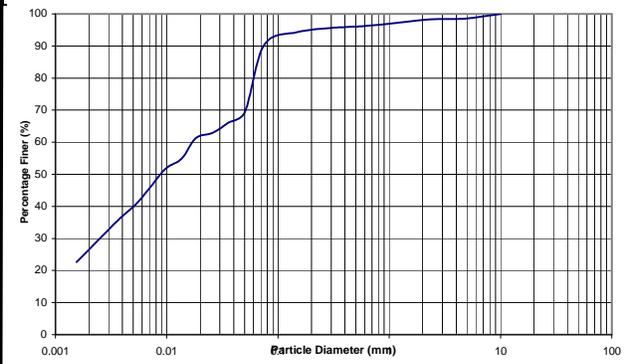
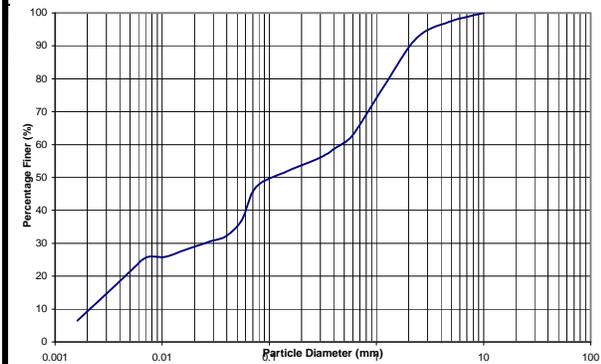
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--	--	--	--	--

D ₁₀	D ₃₀	D ₆₀	C _u	C _c
--	--	--	--	--

BH. No.	Depth (m)	Sample ID No.	BH. No.	Depth (m)	Sample ID No.
LBH-01	16.50-16.95	0	LBH-01	30.00-30.45	0

Clay	Silt	Sand			Gravel
		Fine	Medium	Coarse	
8	39	12	29	9	3

Clay	Silt	Sand			Gravel
		Fine	Medium	Coarse	
25	65	6	2	1	1



D ₁₀	D ₃₀	D ₆₀	C _u	C _c
0.002	0.025	0.463	201.587	0.592

D ₁₀	D ₃₀	D ₆₀	C _u	C _c
--	--	--	--	--

Prepared By	Checked By	Approved By
AKJ	BS	AS

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FM-LAB-TEST-06	01	17.07.2008	1 of 9



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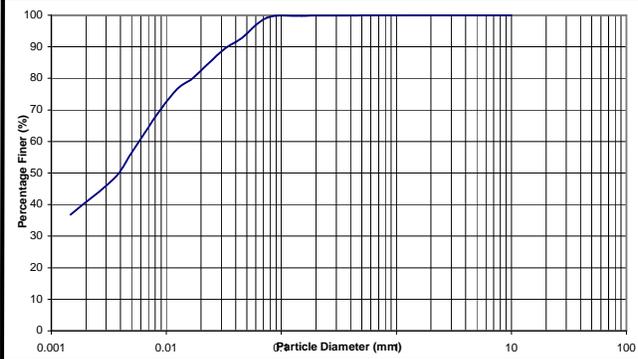
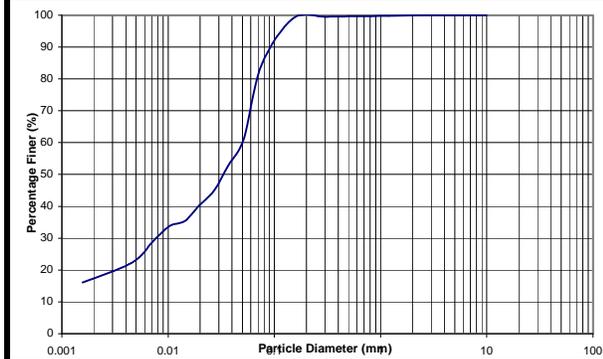
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Project :	Geotechnical Investigation for the Proposed Site for Development of Berth No.7	Job No.	215/08
Client :	Mormugao Port Trust	Method of Test	IS : 2720 (Part - 4)
		Date	22.04.08

BH. No.	Depth (m)	Sample ID No.	BH. No.	Depth (m)	Sample ID No.
MBH-A1	1.50-1.95	0	MBH-A1	4.50-4.95	0

Clay	Silt	Sand			Gravel
		Fine	Medium	Coarse	
17	67	16	0	0	0

Clay	Silt	Sand			Gravel
		Fine	Medium	Coarse	
40	59	1	0	0	0



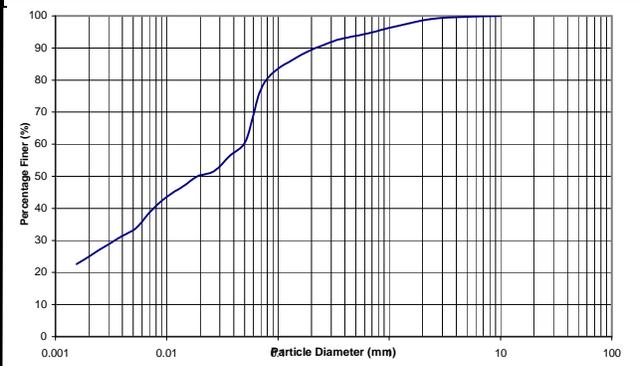
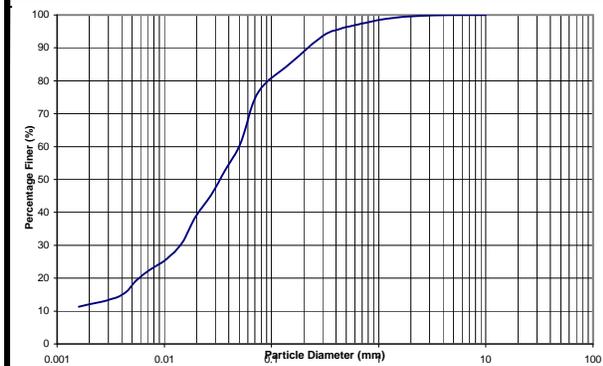
D ₁₀	D ₃₀	D ₆₀	C _u	C _c
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D ₁₀	D ₃₀	D ₆₀	C _u	C _c
--	--	--	--	--

BH. No.	Depth (m)	Sample ID No.	BH. No.	Depth (m)	Sample ID No.
MBH-A1	22.50-22.95	0	MBH-A1	36-36.45	0

Clay	Silt	Sand			Gravel
		Fine	Medium	Coarse	
12	64	19	4	1	0

Clay	Silt	Sand			Gravel
		Fine	Medium	Coarse	
24	55	14	5	2	0



D ₁₀	D ₃₀	D ₆₀	C _u	C _c
--	--	--	--	--

D ₁₀	D ₃₀	D ₆₀	C _u	C _c
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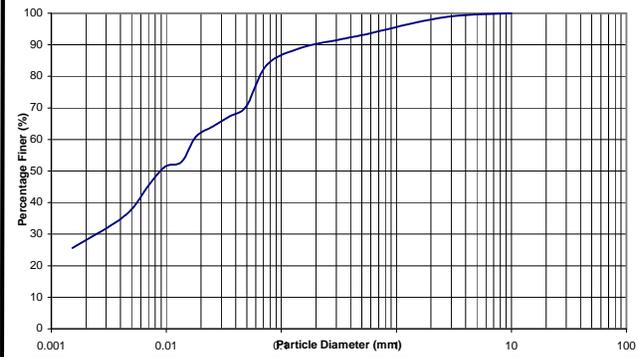
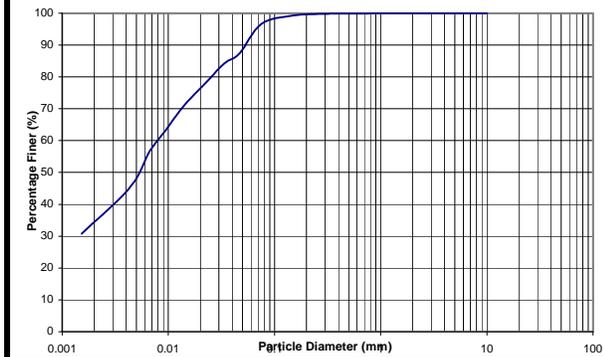
Title : Particle Size Distribution

Project :	Geotechnical Investigation for the Proposed Site for Development of Berth No.7	Job No.	215/08
Client :	Mormugao Port Trust	Method of Test	IS : 2720 (Part - 4)
		Date	22.04.08

BH. No.	Depth (m)	Sample ID No.	BH. No.	Depth (m)	Sample ID No.
MBH-A2	1.50-1.95	215M2/U2	MBH-A2	4.50-4.95	0

Clay	Silt	Sand			Gravel
		Fine	Medium	Coarse	
33	64	3	0	0	0

Clay	Silt	Sand			Gravel
		Fine	Medium	Coarse	
27	57	8	6	2	0



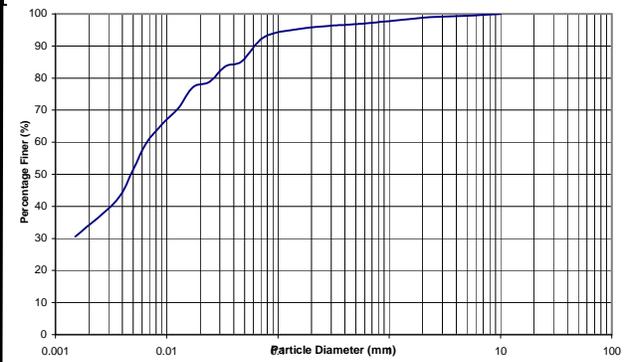
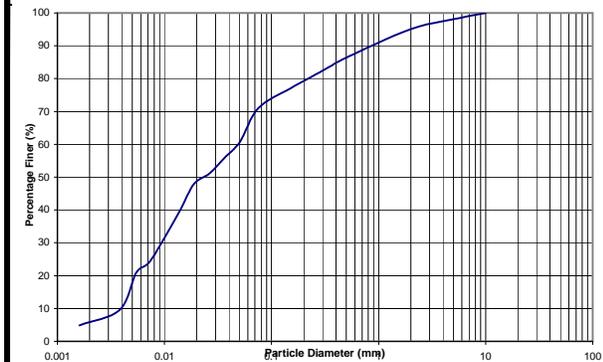
D ₁₀	D ₃₀	D ₆₀	C _u	C _c
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D ₁₀	D ₃₀	D ₆₀	C _u	C _c
--	--	--	--	--

BH. No.	Depth (m)	Sample ID No.	BH. No.	Depth (m)	Sample ID No.
MBH-A2	12.00-12.45	215/M2/S9	MBH-A3	3.00-3.45	0

Clay	Silt	Sand			Gravel
		Fine	Medium	Coarse	
6	65	14	10	3	2

Clay	Silt	Sand			Gravel
		Fine	Medium	Coarse	
33	60	4	2	0	1



D ₁₀	D ₃₀	D ₆₀	C _u	C _c
0.004	0.009	0.049	12.541	0.472

D ₁₀	D ₃₀	D ₆₀	C _u	C _c
--	--	--	--	--

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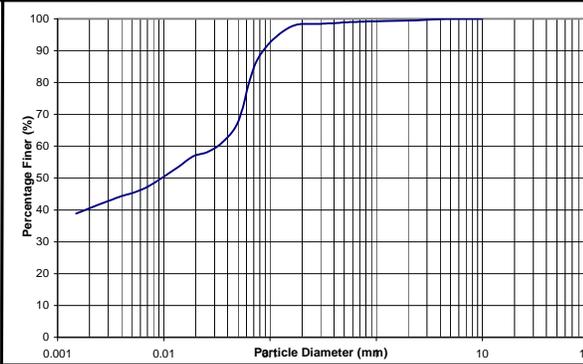
FUGRO GEOTECH LTD.

Title : Particle Size Distribution

Project :	Geotechnical Investigation for the Proposed Site for Development of Berth No.7	Job No.	215/08
Client :	Mormugao Port Trust	Method of Test	IS : 2720 (Part - 4)
		Date	22.04.08

BH. No.	Depth (m)	Sample ID No.	BH. No.	Depth (m)	Sample ID No.
MBH-A3	4.50-4.95	215/M3/U3	MBH-A3	13.50-13.95	0

Clay	Silt	Sand			Gravel
		Fine	Medium	Coarse	
40	47	12	0	1	0



D ₁₀	D ₃₀	D ₆₀	C _u	C _c
--	--	--	--	--

Clay	Silt	Sand			Gravel
		Fine	Medium	Coarse	
	1	5	46	33	15



D ₁₀	D ₃₀	D ₆₀	C _u	C _c
0.568	2.133	2.023	3.561	3.962

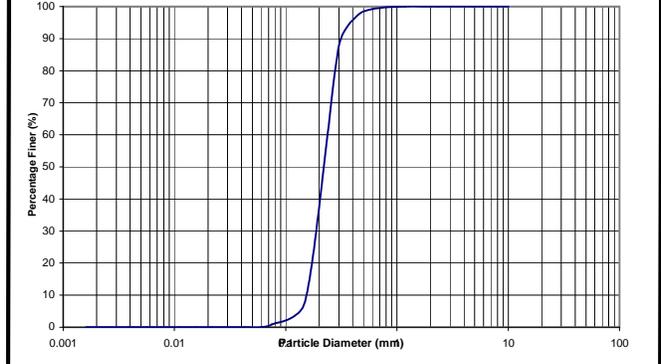
BH. No.	Depth (m)	Sample ID No.	BH. No.	Depth (m)	Sample ID No.
MBH-A4	6.00-6.45	215/M4/U3	MBH-A4	12.00-12.45	0

Clay	Silt	Sand			Gravel
		Fine	Medium	Coarse	
17	69	13	0	1	0



D ₁₀	D ₃₀	D ₆₀	C _u	C _c
--	--	--	--	--

Clay	Silt	Sand			Gravel
		Fine	Medium	Coarse	
	1	92	7	0	0



D ₁₀	D ₃₀	D ₆₀	C _u	C _c
0.153	0.191	0.248	1.613	0.961

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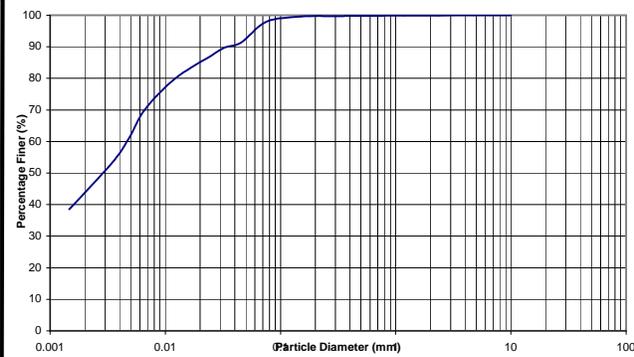
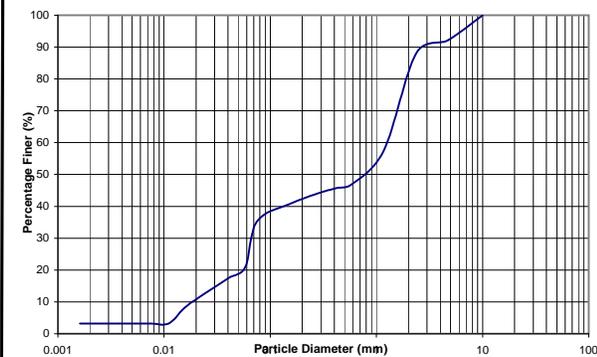
Title : Particle Size Distribution

Project :	Geotechnical Investigation for the Proposed Site for Development of Berth No.7	Job No.	215/08
Client :	Mormugao Port Trust	Method of Test	IS : 2720 (Part - 4)
		Date	22.04.08

BH. No.	Depth (m)	Sample ID No.	BH. No.	Depth (m)	Sample ID No.
MBH-A4	19.50-19.85	215/M4/S12	MBH-B1	6.00-6.45	0

Clay	Silt	Sand			Gravel
		Fine	Medium	Coarse	
3	32	11	33	13	8

Clay	Silt	Sand			Gravel
		Fine	Medium	Coarse	
42	56	2	0	0	0



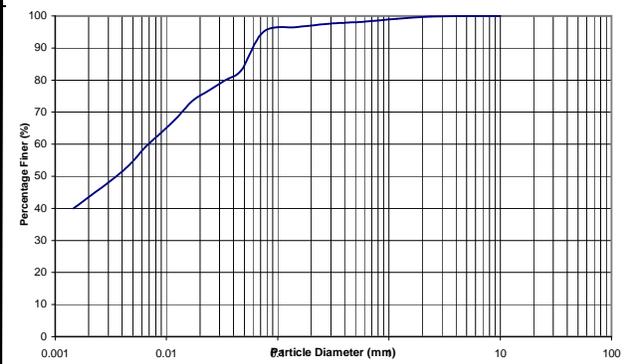
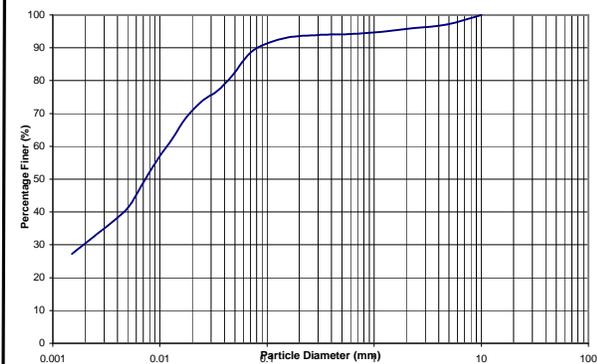
D ₁₀	D ₃₀	D ₆₀	C _u	C _c
0.307	0.069	1.273	4.153	0.012

D ₁₀	D ₃₀	D ₆₀	C _u	C _c
--	--	--	--	--

BH. No.	Depth (m)	Sample ID No.	BH. No.	Depth (m)	Sample ID No.
MBH-B1	12.00-12.45	0	MBH-B1	16.50-16.95	215/MB1/S11

Clay	Silt	Sand			Gravel
		Fine	Medium	Coarse	
30	59	5	2	1	3

Clay	Silt	Sand			Gravel
		Fine	Medium	Coarse	
43	52	3	2	0	0



D ₁₀	D ₃₀	D ₆₀	C _u	C _c
--	--	--	--	--

D ₁₀	D ₃₀	D ₆₀	C _u	C _c
--	--	--	--	--

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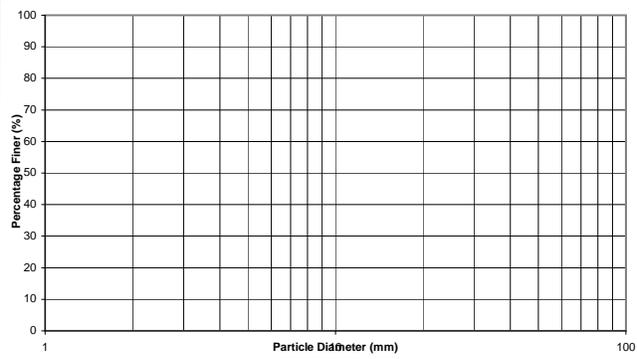
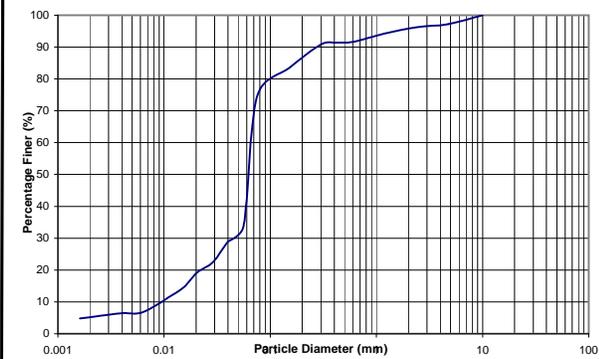
Title : Particle Size Distribution

Project :	Geotechnical Investigation for the Proposed Site for Development of Berth No.7	Job No.	215/08
Client :	Mormugao Port Trust	Method of Test	IS : 2720 (Part - 4)
		Date	22.04.08

BH. No.	Depth (m)	Sample ID No.	BH. No.	Depth (m)	Sample ID No.
MBH-B1	21.00-21.45	215/MB1/S14			

Clay	Silt	Sand			Gravel
		Fine	Medium	Coarse	
5	69	17	5	1	3

Clay	Silt	Sand			Gravel
		Fine	Medium	Coarse	



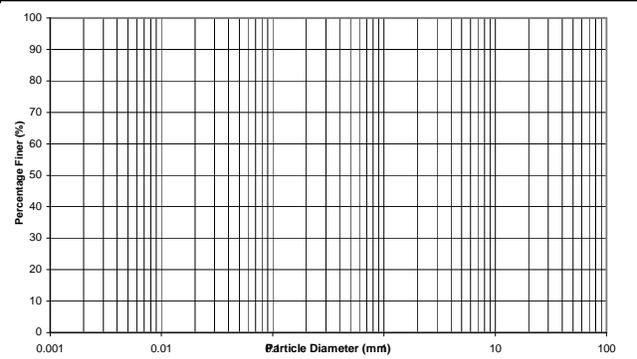
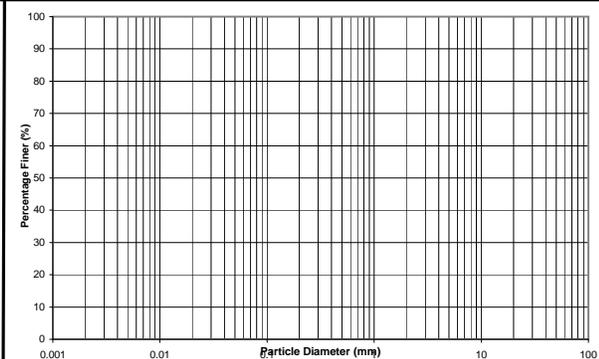
D ₁₀	D ₃₀	D ₆₀	C _u	C _c
0.293	0.054	-19.869	-67.868	-0.001

D ₁₀	D ₃₀	D ₆₀	C _u	C _c

BH. No.	Depth (m)	Sample ID No.	BH. No.	Depth (m)	Sample ID No.

Clay	Silt	Sand			Gravel
		Fine	Medium	Coarse	

Clay	Silt	Sand			Gravel
		Fine	Medium	Coarse	



D ₁₀	D ₃₀	D ₆₀	C _u	C _c

D ₁₀	D ₃₀	D ₆₀	C _u	C _c

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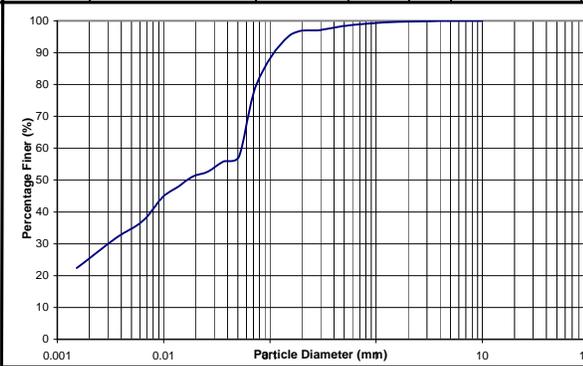
FUGRO GEOTECH LTD.

Title : Particle Size Distribution

Project :	Geotechnical Investigation for the Proposed Site for Development of Berth No.7	Job No.	215/08
Client :	Mormugao Port Trust	Method of Test	IS : 2720 (Part - 4)
		Date	22.04.08

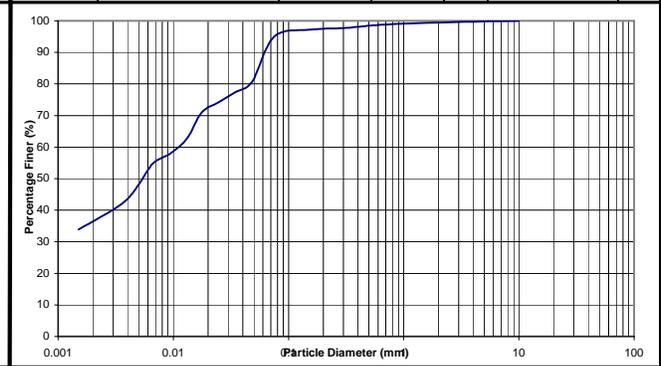
BH. No.	Depth (m)	Sample ID No.	BH. No.	Depth (m)	Sample ID No.
MBH-B2	3.00-3.45	0	MBH-B2	6.00-6.45	0

Clay	Silt	Sand			Gravel
		Fine	Medium	Coarse	
25	55	18	2	0	0



D ₁₀	D ₃₀	D ₆₀	C _u	C _c
--	--	--	--	--

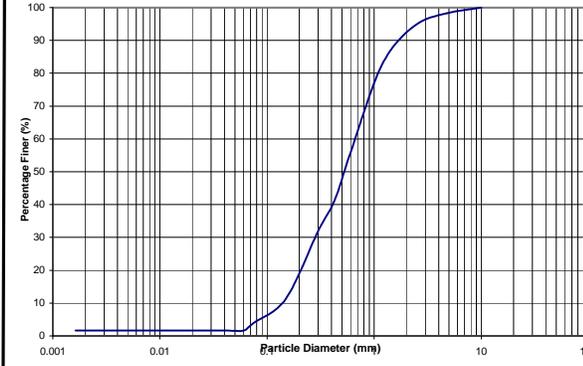
Clay	Silt	Sand			Gravel
		Fine	Medium	Coarse	
36	59	3	1	1	0



D ₁₀	D ₃₀	D ₆₀	C _u	C _c
--	--	--	--	--

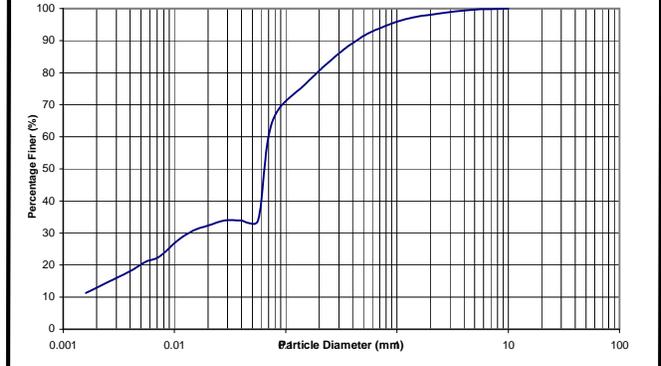
BH. No.	Depth (m)	Sample ID No.	BH. No.	Depth (m)	Sample ID No.
MBH-2	18.00-18.45	215/MB3/S3	MBH-B3	6.00-6.45	0

Clay	Silt	Sand			Gravel
		Fine	Medium	Coarse	
2	2	38	49	7	2



D ₁₀	D ₃₀	D ₆₀	C _u	C _c
0.136	0.287	0.691	5.074	0.871

Clay	Silt	Sand			Gravel
		Fine	Medium	Coarse	
13	51	25	9	2	0



D ₁₀	D ₃₀	D ₆₀	C _u	C _c
--	--	--	--	--

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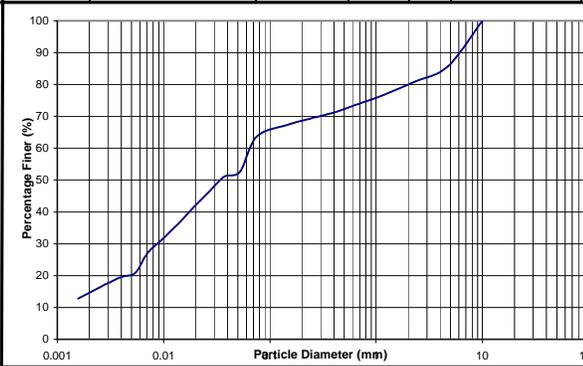
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Title : Particle Size Distribution

Project :	Geotechnical Investigation for the Proposed Site for Development of Berth No.7	Job No.	215/08
Client :	Mormugao Port Trust	Method of Test	IS : 2720 (Part - 4)
		Date	22.04.08

BH. No.	Depth (m)	Sample ID No.	BH. No.	Depth (m)	Sample ID No.
MBH-B3	16.50-16.95	0	MBH-B4	3.00-3.45	0

Clay	Silt	Sand			Gravel
		Fine	Medium	Coarse	
14	50	7	9	6	14



D ₁₀	D ₃₀	D ₆₀	C _u	C _c
--	--	--	--	--

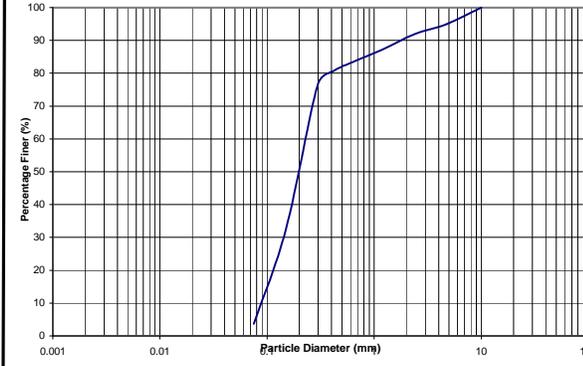
Clay	Silt	Sand			Gravel
		Fine	Medium	Coarse	
	6	89	5	0	0



D ₁₀	D ₃₀	D ₆₀	C _u	C _c
0.082	0.118	0.193	2.345	0.882

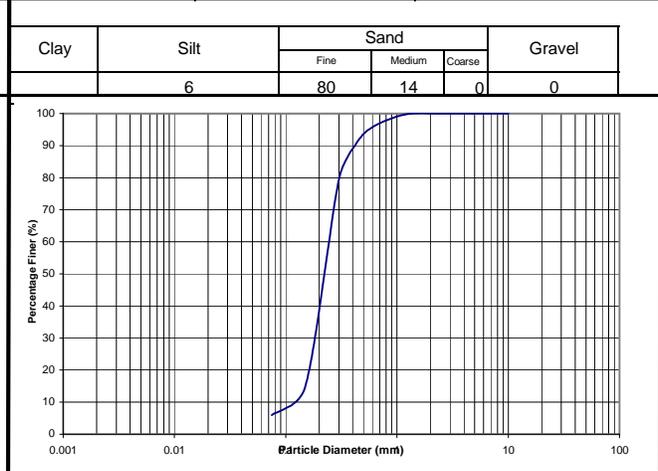
BH. No.	Depth (m)	Sample ID No.	BH. No.	Depth (m)	Sample ID No.
MBH-B4	12.00-12.45	215/MC1/U2	MBH-B4	19.50-19.95	0

Clay	Silt	Sand			Gravel
		Fine	Medium	Coarse	
	4	75	11	5	5



D ₁₀	D ₃₀	D ₆₀	C _u	C _c
0.091	0.143	0.243	2.657	0.926

Clay	Silt	Sand			Gravel
		Fine	Medium	Coarse	
	6	80	14	0	0



D ₁₀	D ₃₀	D ₆₀	C _u	C _c
0.109	0.185	0.255	2.332	1.232

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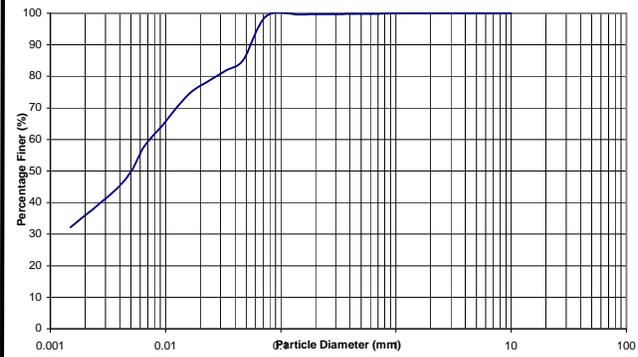
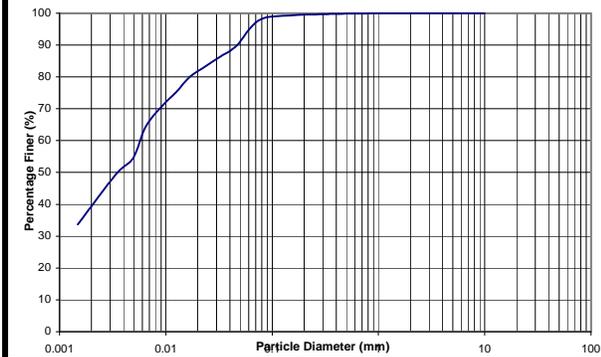
Title : Particle Size Distribution

Project :	Geotechnical Investigation for the Proposed Site for Development of Berth No.7	Job No.	215/08
Client :	Mormugao Port Trust	Method of Test	IS : 2720 (Part - 4)
		Date	0

BH. No.	Depth (m)	Sample ID No.	BH. No.	Depth (m)	Sample ID No.
MBH-C1	3.00-3.45	0	MBH-C1	6.00-6.45	0

Clay	Silt	Sand			Gravel
		Fine	Medium	Coarse	
38	60	2	0	0	0

Clay	Silt	Sand			Gravel
		Fine	Medium	Coarse	
35	64	1	0	0	0



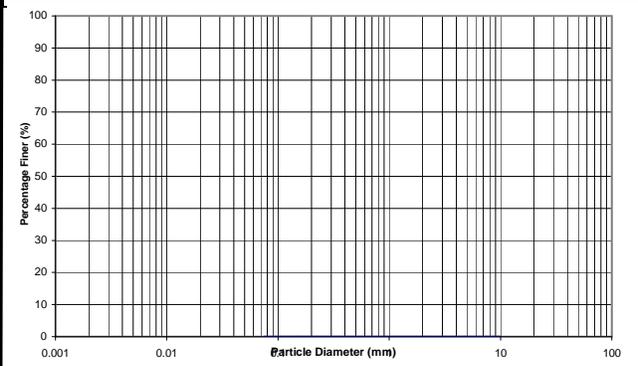
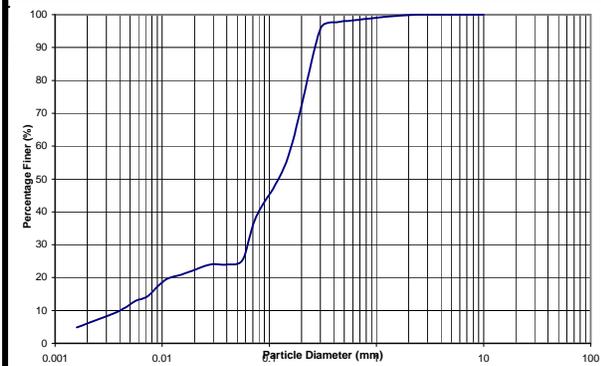
D ₁₀	D ₃₀	D ₆₀	C _u	C _c
--	--	--	--	--

D ₁₀	D ₃₀	D ₆₀	C _u	C _c
--	--	--	--	--

BH. No.	Depth (m)	Sample ID No.	BH. No.	Depth (m)	Sample ID No.
MBH-C1	9.00-9.45	0			

Clay	Silt	Sand			Gravel
		Fine	Medium	Coarse	
6	32	59	3	0	0

Clay	Silt	Sand			Gravel
		Fine	Medium	Coarse	



D ₁₀	D ₃₀	D ₆₀	C _u	C _c
0.004	0.063	0.162	40.152	6.066

D ₁₀	D ₃₀	D ₆₀	C _u	C _c

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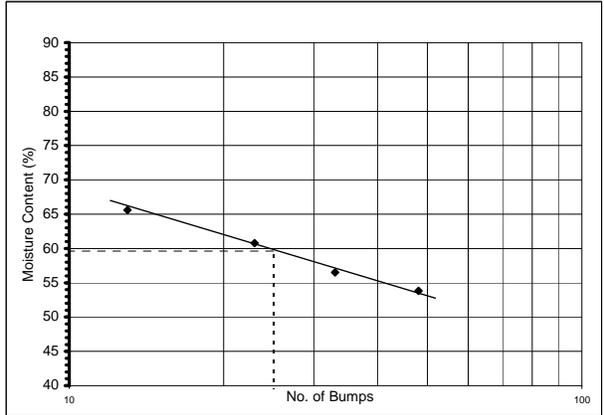
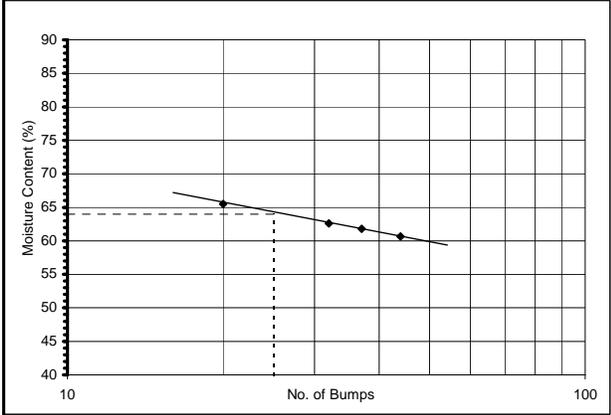
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Title : Atterberg Limit

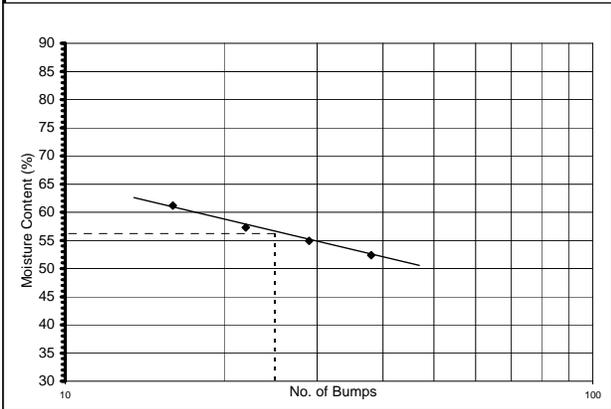
Liquid Limit (*Casagrande method*) and Plastic Limit

Project :	Geotechnical Investigation for the Proposed Site for Development of Berth No.7			Job No.	215/08
Client :	Mormugao Port Trust	Method of Test	IS : 2720 (Part - 4)	Date	22.04.08

BH. No.	Depth (m)	Sample ID No.		BH. No.	Depth (m)	Sample ID No.
LBH-01	6.00-6.45			LBH-01	9.00-9.45	
Liquid limit (%)	Plastic limit (%)	Plasticity index (%)		Liquid limit	Plastic limit	Plasticity index
64	35	29		60	31	29



BH. No.	Depth (m)	Sample ID No.		BH. No.	Depth (m)	Sample ID No.
LBH-01	30.00-30.45					
Liquid limit	Plastic limit	Plasticity index		Liquid limit	Plastic limit	Plasticity index
56	24	32				



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FM-LAB-TEST-01	01	17.07.2008	1 of 7



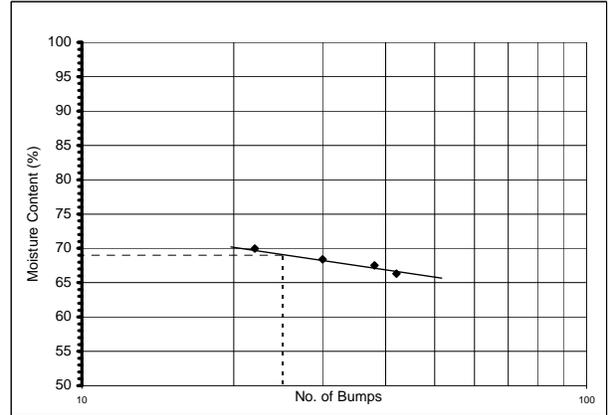
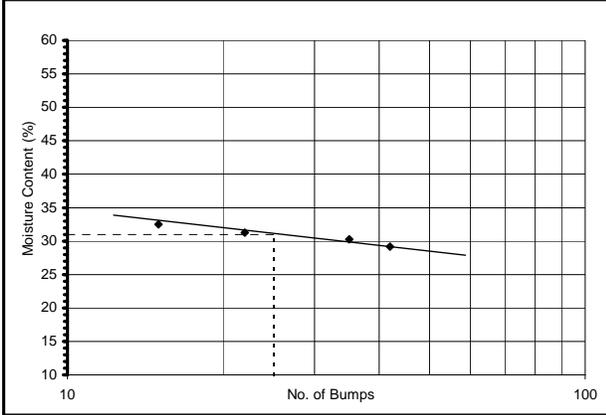
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Title : Atterberg Limit

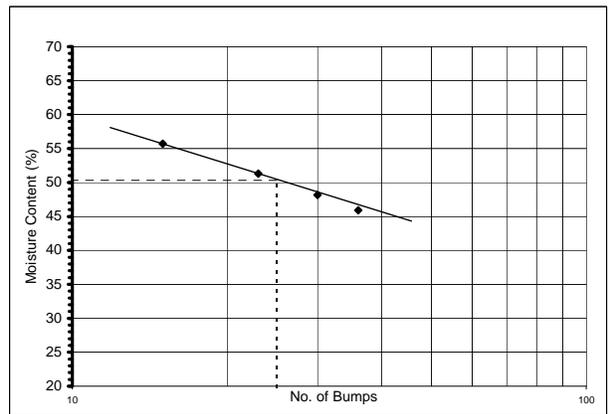
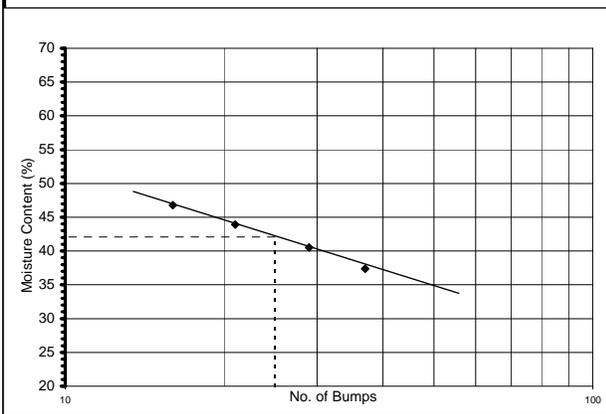
Liquid Limit (*Casagrande method*) and Plastic Limit

Project :	Geotechnical Investigation for the Proposed Site for Development of Berth No.7			Job No.	215/08
Client :	Mormugao Port Trust	Method of Test	IS : 2720 (Part - 4)	Date	22.04.08

BH. No.	Depth (m)	Sample ID No.	BH. No.	Depth (m)	Sample ID No.
MBH-A1	1.50-1.95		LBH-01	4.50-4.95	
Liquid limit (%)	Plastic limit (%)	Plasticity index (%)	Liquid limit	Plastic limit	Plasticity index
31	18	13	69	36	33



BH. No.	Depth (m)	Sample ID No.	BH. No.	Depth (m)	Sample ID No.
MBH-A1	22.50-22.95		MBH-A1	36-36.45	
Liquid limit	Plastic limit	Plasticity index	Liquid limit	Plastic limit	Plasticity index
42	22	20	50	28	22



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AKJ	BS	AS

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FM-LAB-TEST-01	01	17.07.2008	2 of 7



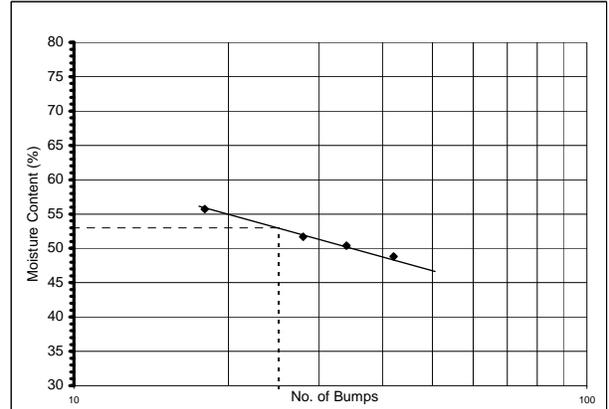
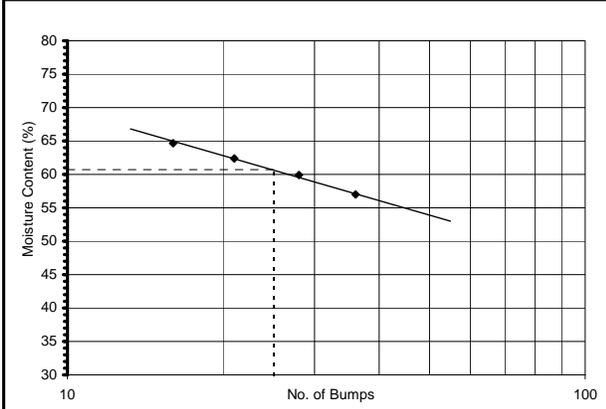
FUGRO GEOTECH LTD.

Title : Atterberg Limit

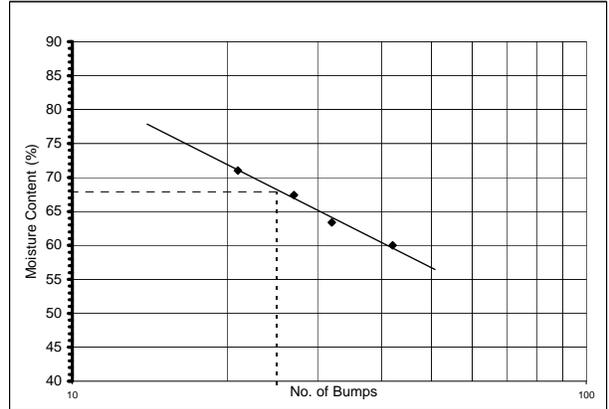
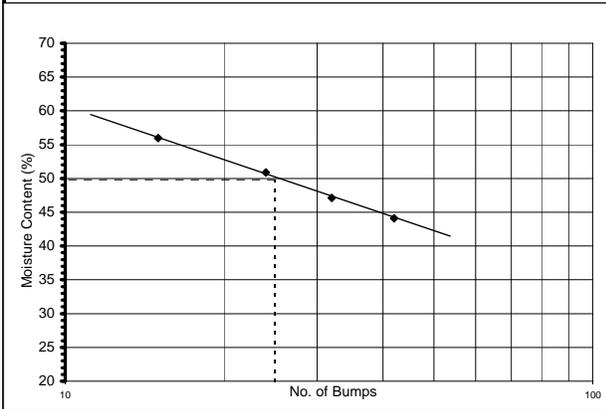
Liquid Limit (*Casagrande method*) and Plastic Limit

Project :	Geotechnical Investigation for the Proposed Site for Development of Berth No.7			Job No.	215/08
Client :	Mormugao Port Trust	Method of Test	IS : 2720 (Part - 4)	Date	22.04.08

BH. No.	Depth (m)	Sample ID No.	BH. No.	Depth (m)	Sample ID No.
MBH-A2	1.50-1.95		MBH-A2	4.50-4.95	
Liquid limit (%)	Plastic limit (%)	Plasticity index (%)	Liquid limit	Plastic limit	Plasticity index
61	33	28	53	24	29



BH. No.	Depth (m)	Sample ID No.	BH. No.	Depth (m)	Sample ID No.
MBH-A2	12.00-12.45		MBH-A3	3.00-3.45	
Liquid limit	Plastic limit	Plasticity index	Liquid limit	Plastic limit	Plasticity index
50	19	31	68	31	37



Prepared By	Checked By	Approved By
AKJ	BS	AS

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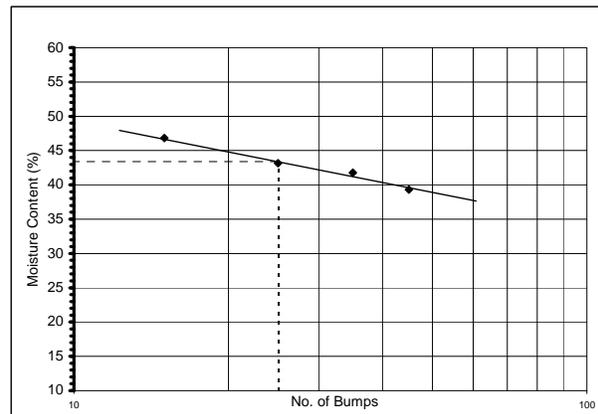
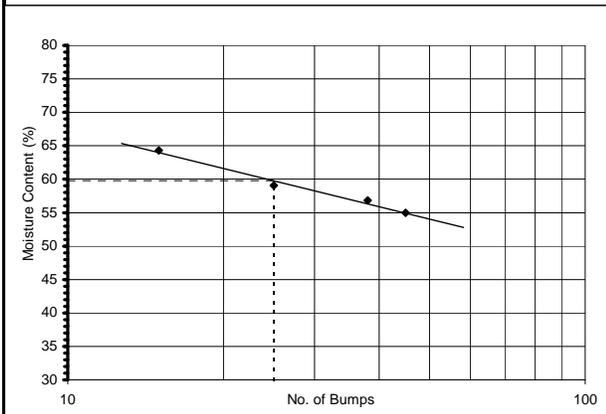
FUGRO GEOTECH LTD.

Title : Atterberg Limit

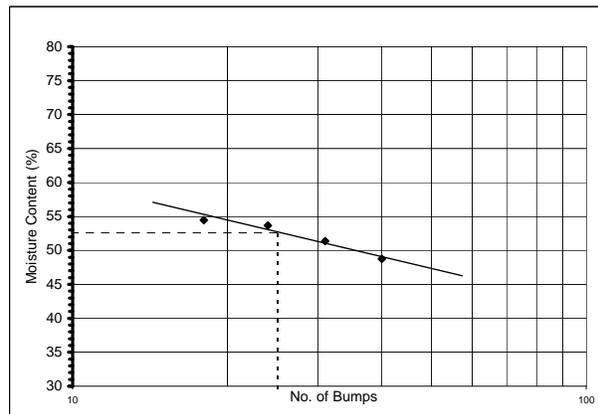
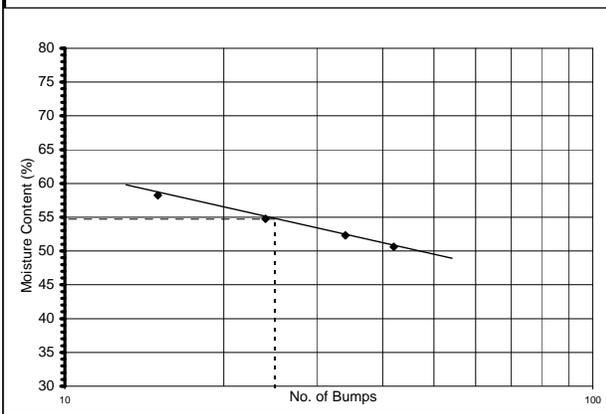
Liquid Limit (*Casagrande method*) and Plastic Limit

Project :	Geotechnical Investigation for the Proposed Site for Development of Berth No.7			Job No.	215/08
Client :	Mormugao Port Trust	Method of Test	IS : 2720 (Part - 4)	Date	22.04.08

BH. No.	Depth (m)	Sample ID No.		BH. No.	Depth (m)	Sample ID No.
MBH-A3	4.50-4.95			MBH-A4	6.00-6.45	
Liquid limit (%)	Plastic limit (%)	Plasticity index (%)		Liquid limit	Plastic limit	Plasticity index
60	17	43		43	19	24



BH. No.	Depth (m)	Sample ID No.		BH. No.	Depth (m)	Sample ID No.
MBH-B1	6.00-6.45			MBH-B1	12.00-12.45	
Liquid limit	Plastic limit	Plasticity index		Liquid limit	Plastic limit	Plasticity index
55	30	25		53	22	31



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AKJ	BS	AS

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FUGRO GEOTECH LTD.

Title : Atterberg Limit

Liquid Limit (<i>Casagrande method</i>) and Plastic Limit					
Project :	Geotechnical Investigation for the Proposed Site for Development of Berth No.7			Job No.	215/08
Client :	Mormugao Port Trust	Method of Test	IS : 2720 (Part - 4)	Date	22.04.08
BH. No.	Depth (m)	Sample ID No.	BH. No.	Depth (m)	Sample ID No.
MBH-B1	16.50-16.95				
Liquid limit (%)	Plastic limit (%)	Plasticity index (%)	Liquid limit	Plastic limit	Plasticity index
81	34	47			
BH. No.	Depth (m)	Sample ID No.	BH. No.	Depth (m)	Sample ID No.
Liquid limit	Plastic limit	Plasticity index	Liquid limit	Plastic limit	Plasticity index
Prepared By		Checked By		Approved By	
AKJ		BS		AS	
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Title : Atterberg Limit

Liquid Limit (<i>Casagrande method</i>) and Plastic Limit					
Project :	Geotechnical Investigation for the Proposed Site for Development of Berth No.7			Job No.	215/08
Client :	Mormugao Port Trust	Method of Test	IS : 2720 (Part - 4)	Date	22.04.08
BH. No.	Depth (m)	Sample ID No.	BH. No.	Depth (m)	Sample ID No.
MBH-B2	3.00-3.45		MBH-B2	6.00-6.45	
Liquid limit (%)	Plastic limit (%)	Plasticity index (%)	Liquid limit	Plastic limit	Plasticity index
31	10	21	56	32	24
BH. No.	Depth (m)	Sample ID No.	BH. No.	Depth (m)	Sample ID No.
MBH-B3	6.00-6.45		MBH-B3	16.50-16.95	
Liquid limit	Plastic limit	Plasticity index	Liquid limit	Plastic limit	Plasticity index
36	20	16	39	21	18
Prepared By	Checked By		Approved By		
AKJ	BS		AS		
Format No.	Revision No.	Revision Date	Sheet No.		
FM-LAB-TEST-01	01	17.07.2008	6 of 7		



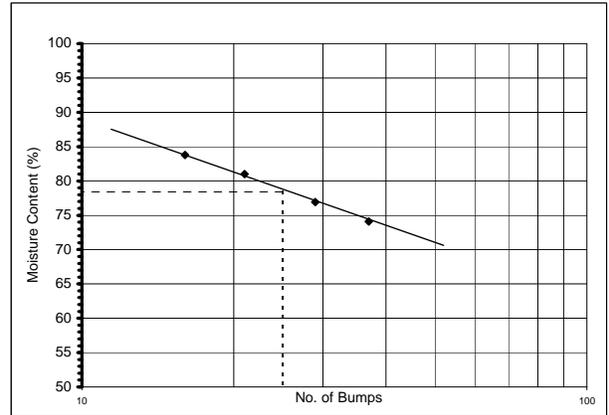
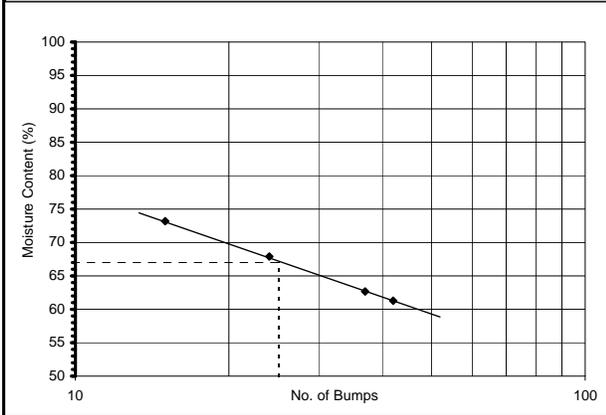
FUGRO GEOTECH LTD.

Title : Atterberg Limit

Liquid Limit (*Casagrande method*) and Plastic Limit

Project :	Geotechnical Investigation for the Proposed Site for Development of Berth No.7			Job No.	215/08
Client :	Mormugao Port Trust	Method of Test	IS : 2720 (Part - 4)	Date	22.04.08

BH. No.	Depth (m)	Sample ID No.		BH. No.	Depth (m)	Sample ID No.
MBH-C1	3.00-3.45			MBH-C1	6.00-6.45	
Liquid limit (%)	Plastic limit (%)	Plasticity index (%)		Liquid limit	Plastic limit	Plasticity index
67	35	32		78	33	45



BH. No.	Depth (m)	Sample ID No.		BH. No.	Depth (m)	Sample ID No.
Liquid limit	Plastic limit	Plasticity index		Liquid limit	Plastic limit	Plasticity index



Prepared By	Checked By	Approved By
AKJ	BS	AS

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Unconsolidated Undrained Triaxial Compression Test

Project: Geotechnical Investigation for the Proposed Site for Development of Berth No.7

Job No. :	215/08
BH. No.	LBH-1
Sample ID.	215/LBH1/U5
Test Depth (m)	6.00-6.45
Test Date	15/4/2008

Test method : **IS:2720 : Part XI**

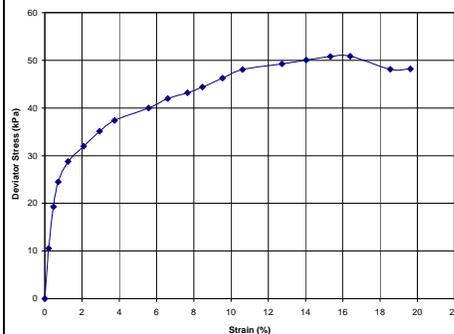
Type of specimen: UDS Nominal diameter 38 mm

Preparation procedure

Specimen details	Initially	After test		Sketch showing specimen location in original sample
Diameter D mm	38	Mass	132.24 g	
Area A_0 mm ²	1134.11	Dry mass	73.68 g	
Length L_0 mm	76	Moisture content	79 %	
Volume cm ³	86.19	Dry Density	0.85 g/cm ³	
Mass g	132.24			
Bulk Density g/cm ³	1.53			

Compression test

Machine no.		Rate of deformation 1.2 mm /min		Cell pressure 50 kPa	
Membrane thickness		Force device no.	Mean calibration		Load Factor
0.2 mm		28996	-		-
Deformation gauge reading	Compression of specimen ΔL mm	Strain (%) $\epsilon = \Delta L / L_0 \times 100$	Axial force P N	Corrected area $A = A_0 / (1 - \epsilon)$ mm ²	Measured deviator stress $(\sigma_1 - \sigma_3) = 1000 P / A$ kPa
0.00	0.00	0.00	0.00	1134.11	0.00
0.16	0.16	0.21	12.00	1136.51	10.56
0.35	0.35	0.46	22.00	1139.36	19.31
0.55	0.55	0.72	28.00	1142.38	24.51
0.95	0.95	1.25	33.00	1148.47	28.73
1.58	1.58	2.08	37.00	1158.19	31.95
2.24	2.24	2.95	41.00	1168.56	35.09
2.85	2.85	3.75	44.00	1178.30	37.34
4.23	4.23	5.57	48.00	1200.96	39.97
5.01	5.01	6.59	51.00	1214.15	42.00
5.82	5.82	7.66	53.00	1228.17	43.15
6.43	6.43	8.46	55.00	1238.94	44.39
7.25	7.25	9.54	58.00	1253.71	46.26
8.07	8.07	10.62	61.00	1268.85	48.08
9.68	9.68	12.74	64.00	1299.65	49.24
10.66	10.66	14.03	66.00	1319.14	50.03
11.65	11.65	15.33	68.00	1339.44	50.77
12.46	12.46	16.39	69.00	1356.51	50.87
14.10	14.10	18.55	67.00	1392.45	48.12
14.92	14.92	19.63	68.00	1411.14	48.19



Measured deviator stress	50.9	kPa
Membrane correction	1.73	kPa
Corrected deviator stress	49.1	kPa
Axial strain	16.4	%
Shear strength C_u	24.6	kPa

Tested By: G.J.

Checked By: A.S.



Unconsolidated Undrained Triaxial Compression Test

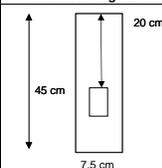
Project: Geotechnical Investigation for the Proposed Site for Development of Berth No.7

Job No. :	215/08
BH. No.	LBH-1
Sample No.	215/LBH1/U5
Test Depth (m)	6.00-6.45
Test Date	15/4/2008

Test method : **IS:2720 : Part XI**

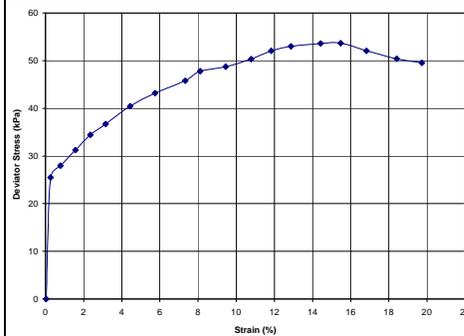
Type of specimen: UDS Nominal diameter 38 mm

Preparation procedure

Specimen details	Initially	After test		Sketch showing specimen location in original sample 
Diameter D mm	38	Mass	131.47 g	
Area A_0 mm ²	1134.11	Dry mass	73.50 g	
Length L_0 mm	76	Moisture content	79 %	
Volume cm ³	86.19	Dry Density	0.85 g/cm ³	
Mass g	131.47			
Bulk Density g/cm ³	1.53			

Compression test

Machine no.		Rate of deformation 1.2 mm /min		Cell pressure 100 kPa	
Membrane thickness 0.2 mm		Force device no. 28996	Mean calibration		Load Factor
Deformation gauge reading	Compression of specimen ΔL mm	Strain (%) $\epsilon = \Delta L / L_0 \times 100$	Axial force P N	Corrected area $A = A_0 / (1 - \epsilon)$ mm ²	Measured deviator stress ($\sigma_1 - \sigma_3$) = 1000 P / A kPa
0.03	0.03	0.04	0.00	1134.56	0.00
0.20	0.20	0.26	29.00	1137.11	25.50
0.59	0.59	0.78	32.00	1142.99	28.00
1.19	1.19	1.57	36.00	1152.16	31.25
1.79	1.79	2.36	40.00	1161.47	34.44
2.40	2.40	3.16	43.00	1171.10	36.72
3.38	3.38	4.45	48.00	1186.90	40.44
4.37	4.37	5.75	52.00	1203.30	43.21
5.57	5.57	7.33	56.00	1223.81	45.76
6.17	6.17	8.12	59.00	1234.32	47.80
7.18	7.18	9.45	61.00	1252.44	48.71
8.19	8.19	10.78	64.00	1271.09	50.35
8.99	8.99	11.83	67.00	1286.27	52.09
9.78	9.78	12.87	69.00	1301.61	53.01
10.96	10.96	14.42	71.00	1325.23	53.58
11.76	11.76	15.47	72.00	1341.73	53.66
12.79	12.79	16.83	71.00	1363.59	52.07
13.99	13.99	18.41	70.00	1389.98	50.36
15.00	15.00	19.74	70.00	1413.00	49.54



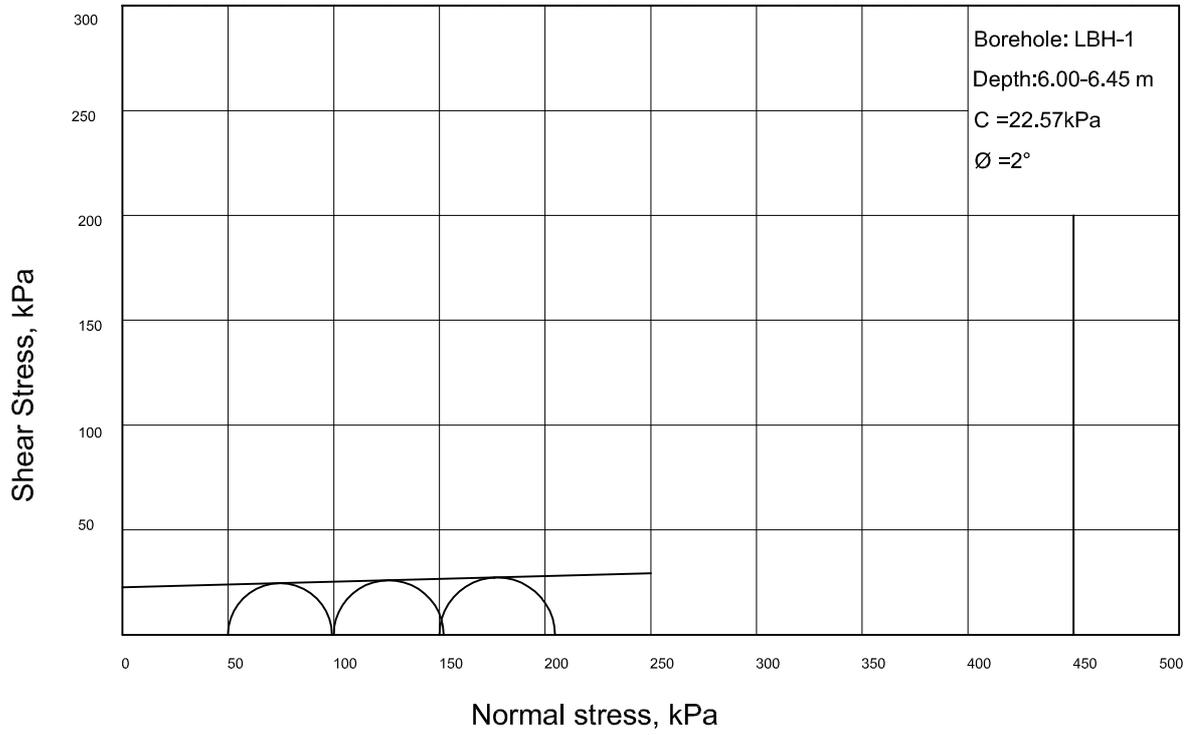
Measured deviator stress	53.7	kPa
Membrane correction	1.67	kPa
Corrected deviator stress	52.0	kPa
Axial strain	15.5	%
Shear strength C_u	26.0	kPa

Tested By: G.J.

Checked By: A.S.

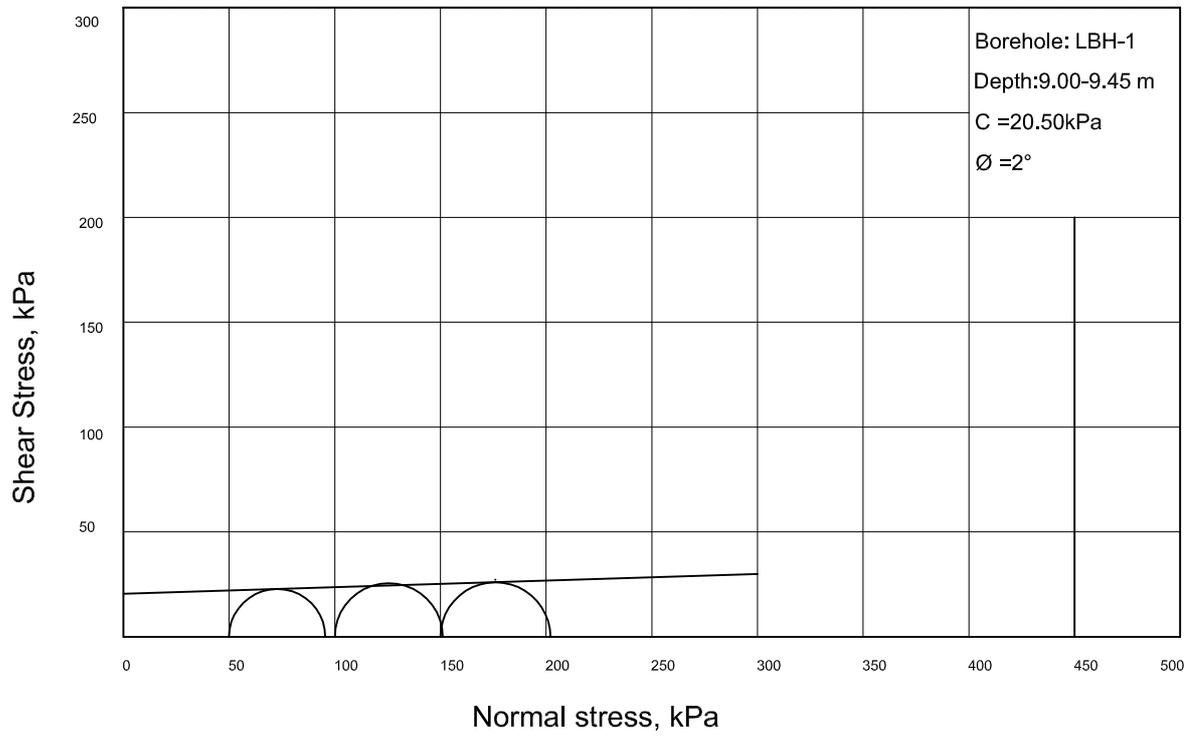
Project: Geotechnical Investigation for the Proposed Site for Development of Berth No.7

UU Triaxial Test (Mohr's Circle)



Project: Geotechnical Investigation for the Proposed Site for Development of Berth No.7

UU Triaxial Test (Mohr's Circle)





Unconsolidated Undrained Triaxial Compression Test

Project: Geotechnical Investigation for the Proposed Site for Development of Berth No.7

Job No. :	215/08
BH. No.	MBH-A1
Sample ID.	215/MBH1/U1
Test Depth (m)	1.50-1.95
Test Date	15/4/2008

Test method : IS:2720 : Part XI

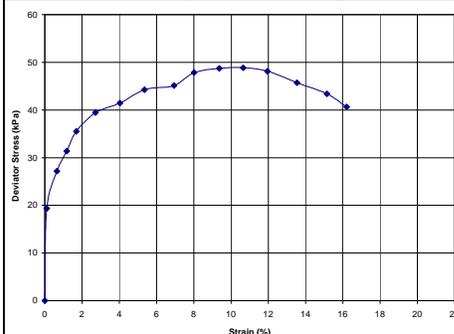
Type of specimen: UDS Nominal diameter 38 mm

Preparation procedure

Specimen details	Initially	After test		Sketch showing specimen location in original sample
Diameter D mm	38	Mass	148.72 g	
Area A_0 mm ²	1134.11	Dry mass	96.69 g	
Length L_0 mm	76	Moisture content	54 %	
Volume cm ³	86.19	Dry Density	1.12 g/cm ³	
Mass g	148.72			
Bulk Density g/cm ³	1.73			

Compression test

Machine no.		Rate of deformation 1.2 mm /min		Cell pressure 50 kPa	
Membrane thickness 0.2 mm		Force device no. 28996	Mean calibration -		Load Factor -
Deformation gauge reading	Compression of specimen ΔL mm	Strain (%) $\epsilon = \Delta L / L_0 \times 100$	Axial force P N	Corrected area $A = A_0 / (1 - \epsilon)$ mm ²	Measured deviator stress $(\sigma_1 - \sigma_3) = 1000 P / A$ kPa
0.00	0.00	0.00	0.00	1134.11	0.00
0.08	0.08	0.11	22.00	1135.31	19.38
0.49	0.49	0.64	31.00	1141.47	27.16
0.90	0.90	1.18	36.00	1147.71	31.37
1.29	1.29	1.70	41.00	1153.70	35.54
2.07	2.07	2.72	46.00	1165.87	39.46
3.07	3.07	4.04	49.00	1181.86	41.46
4.07	4.07	5.36	53.00	1198.29	44.23
5.28	5.28	6.95	55.00	1218.79	45.13
6.09	6.09	8.01	59.00	1232.91	47.85
7.12	7.12	9.37	61.00	1251.35	48.75
8.09	8.09	10.64	62.00	1269.22	48.85
9.08	9.08	11.95	62.00	1288.00	48.14
10.29	10.29	13.54	60.00	1311.71	45.74
11.51	11.51	15.14	58.00	1336.53	43.40
12.32	12.32	16.21	55.00	1353.53	40.63



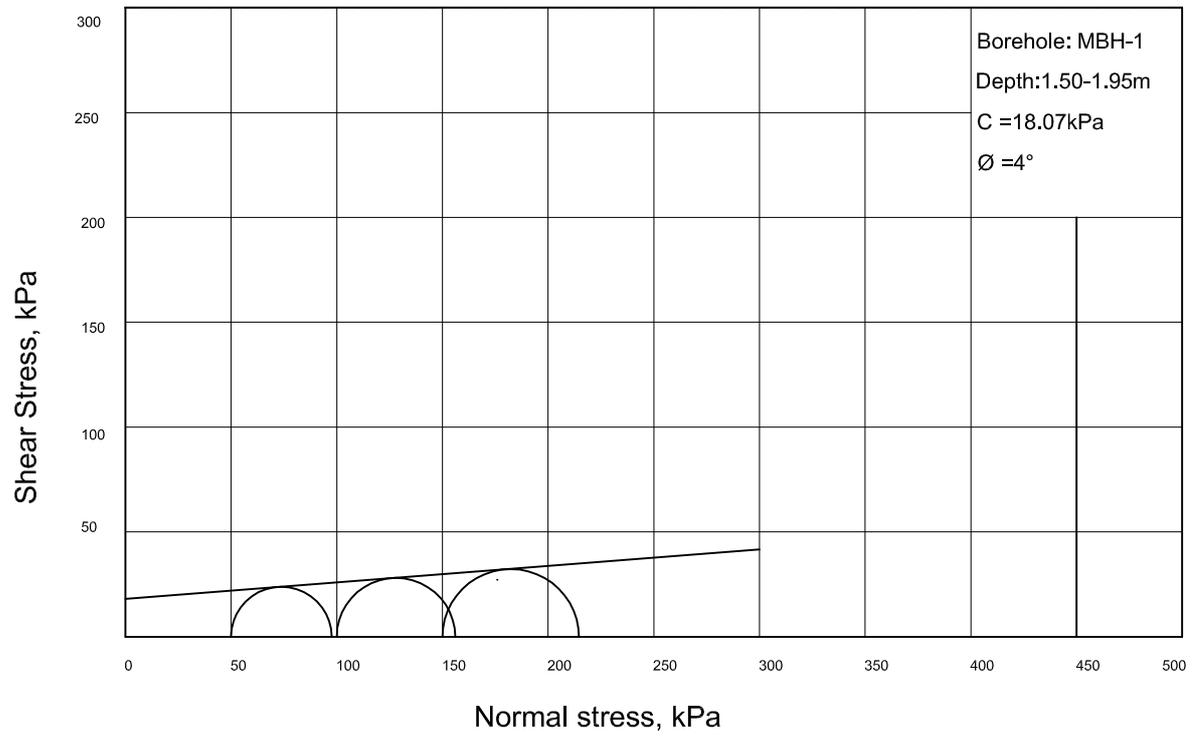
Measured deviator stress	48.8	kPa
Membrane correction	1.26	kPa
Corrected deviator stress	47.6	kPa
Axial strain	10.6	%
Shear strength C_u	23.8	kPa

Tested By: G.J.

Checked By: A.S.

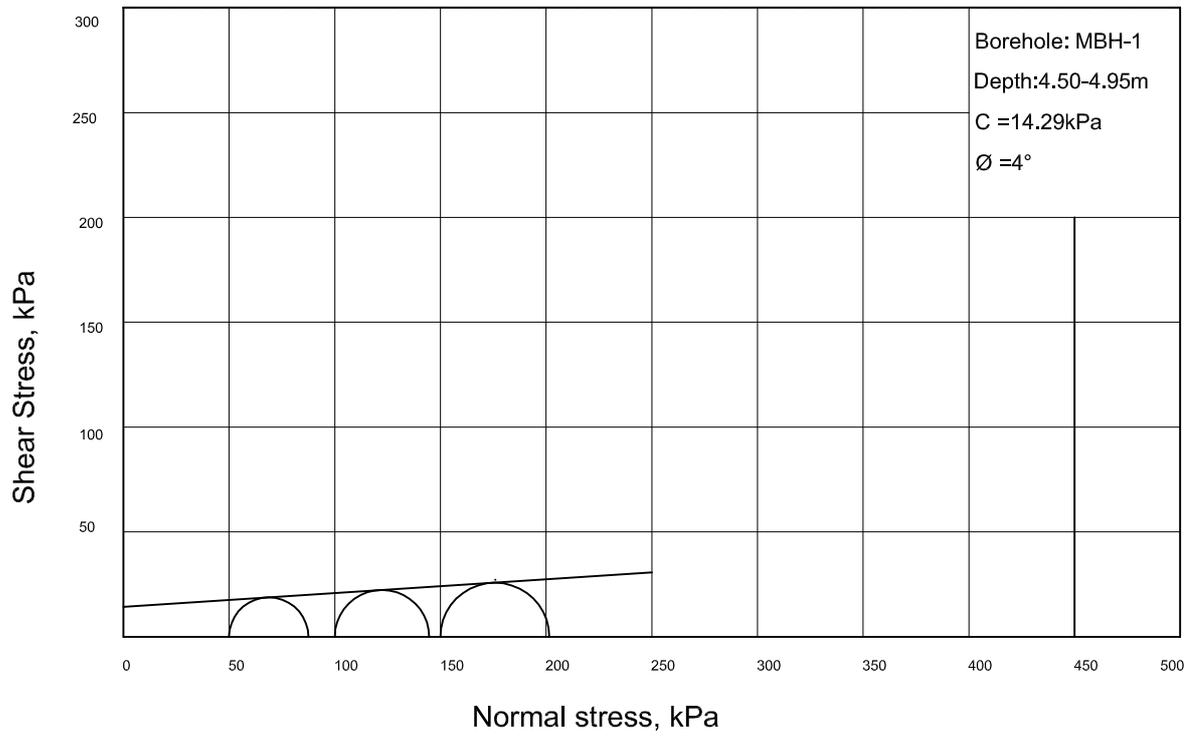
Project: Geotechnical Investigation for the Proposed Site for Development of Berth No.7

UU Triaxial Test (Mohr's Circle)



Project: Geotechnical Investigation for the Proposed Site for Development of Berth No.7

UU Triaxial Test (Mohr's Circle)





Unconsolidated Undrained Triaxial Compression Test

Project: Geotechnical Investigation for the Proposed Site for Development of Berth No.7

Job No. :	215/08
BH. No.	MBH-A2
Sample No.	215/MBH2/U3
Test Depth (m)	4.50-4.95
Test Date	15/4/2008

Test method : **IS:2720 : Part XI**

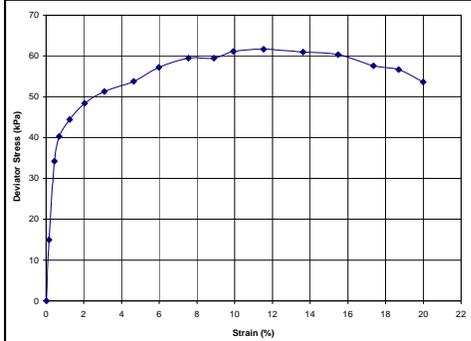
Type of specimen: UDS Nominal diameter 38 mm

Preparation procedure

Specimen details	Initially	After test		Sketch showing specimen location in original sample
Diameter D mm	38	Mass	133.07 g	
Area A_0 mm ²	1134.11	Dry mass	75.21 g	
Length L_0 mm	76	Moisture content	77 %	
Volume cm ³	86.19	Dry Density	0.87 g/cm ³	
Mass g	133.07			
Bulk Density g/cm ³	1.54			

Compression test

Machine no.		Rate of deformation 1.2 mm /min		Cell pressure 150 kPa	
Membrane thickness 0.2 mm		Force device no. 28996	Mean calibration		Load Factor
Deformation gauge reading	Compression of specimen ΔL mm	Strain (%) $\epsilon = \Delta L / L_0 \times 100$	Axial force P N	Corrected area $A = A_0 / (1 - \epsilon)$ mm ²	Measured deviator stress ($\sigma_1 - \sigma_3$) = 1000 P / A kPa
0.01	0.01	0.01	0.00	1134.26	0.00
0.12	0.12	0.16	17.00	1135.91	14.97
0.33	0.33	0.43	39.00	1139.06	34.24
0.53	0.53	0.70	46.00	1142.08	40.28
0.95	0.95	1.25	51.00	1148.47	44.41
1.55	1.55	2.04	56.00	1157.73	48.37
2.35	2.35	3.09	60.00	1170.30	51.27
3.53	3.53	4.64	64.00	1189.36	53.81
4.54	4.54	5.97	69.00	1206.17	57.21
5.74	5.74	7.55	73.00	1226.77	59.51
6.76	6.76	8.89	74.00	1244.84	59.45
7.55	7.55	9.93	77.00	1259.21	61.15
8.76	8.76	11.53	79.00	1281.87	61.63
10.35	10.35	13.62	80.00	1312.91	60.93
11.77	11.77	15.49	81.00	1341.94	60.36
13.19	13.19	17.36	79.00	1372.28	57.57
14.20	14.20	18.68	79.00	1394.70	56.64
15.19	15.19	19.99	76.00	1417.41	53.62

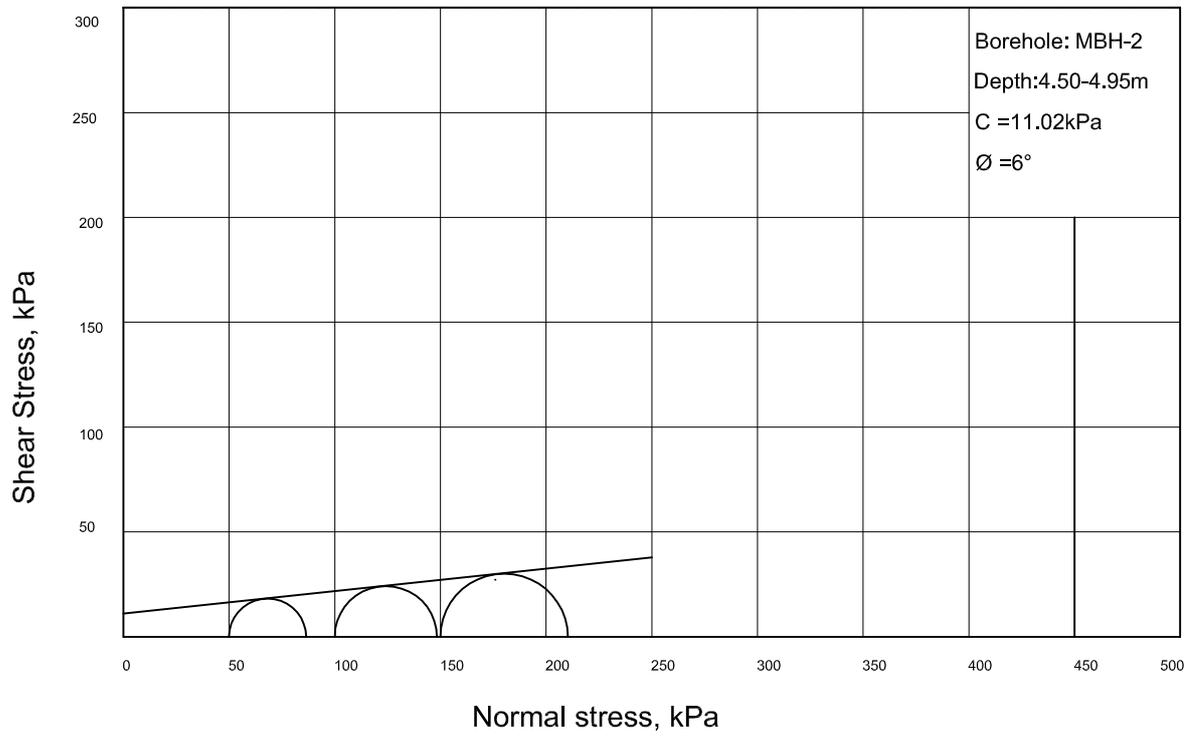


Measured deviator stress	61.6	kPa
Membrane correction	1.34	kPa
Corrected deviator stress	60.3	kPa
Axial strain	11.5	%
Shear strength C_u	30.1	kPa

Tested By: G.J. Checked By: A.S.

Project: Geotechnical Investigation for the Proposed Site for Development of Berth No.7

UU Triaxial Test (Mohr's Circle)



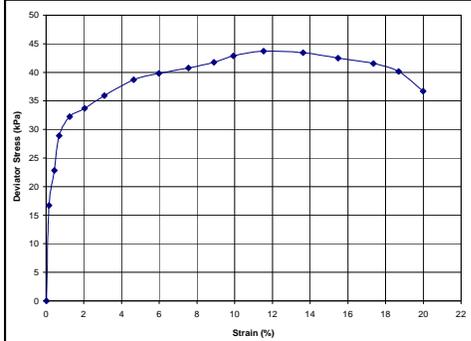


Unconsolidated Undrained Triaxial Compression Test		Job No. :	215/08
Project: Geotechnical Investigation for the Proposed Site for Development of Berth No.7		BH. No.	MBH-A3
		Sample No.	215/MBH3/U3
		Test Depth (m)	3.00-3.45
		Test Date	15/4/2008

Test method : IS:2720 : Part XI
 Type of specimen: UDS Nominal diameter 38 mm

Preparation procedure				Sketch showing specimen location in original sample
Specimen details	Initially	After test		
Diameter D mm	38	Mass	122.21 g	
Area A_0 mm ²	1134.11	Dry mass	64.44 g	
Length L_0 mm	76	Moisture content	90 %	
Volume cm ³	86.19	Dry Density	0.75 g/cm ³	
Mass g	122.21			
Bulk Density g/cm ³	1.42			

Compression test					
Machine no.		Rate of deformation 1.2 mm /min		Cell pressure 150 kPa	
Membrane thickness 0.2 mm		Force device no. 28996	Mean calibration -		Load Factor -
Deformation gauge reading	Compression of specimen ΔL mm	Strain (%) $\epsilon = \Delta L / L_0 \times 100$	Axial force P N	Corrected area $A = A_0 / (1 - \epsilon)$ mm ²	Measured deviator stress ($\sigma_1 - \sigma_3$) = 1000 P / A kPa
0.01	0.01	0.01	0.00	1134.26	0.00
0.12	0.12	0.16	19.00	1135.91	16.73
0.33	0.33	0.43	26.00	1139.06	22.83
0.53	0.53	0.70	33.00	1142.08	28.89
0.95	0.95	1.25	37.00	1148.47	32.22
1.55	1.55	2.04	39.00	1157.73	33.69
2.35	2.35	3.09	42.00	1170.30	35.89
3.53	3.53	4.64	46.00	1189.36	38.68
4.54	4.54	5.97	48.00	1206.17	39.80
5.74	5.74	7.55	50.00	1226.77	40.76
6.76	6.76	8.89	52.00	1244.84	41.77
7.55	7.55	9.93	54.00	1259.21	42.88
8.76	8.76	11.53	56.00	1281.87	43.69
10.35	10.35	13.62	57.00	1312.91	43.41
11.77	11.77	15.49	57.00	1341.94	42.48
13.19	13.19	17.36	57.00	1372.28	41.54
14.20	14.20	18.68	56.00	1394.70	40.15
15.19	15.19	19.99	52.00	1417.41	36.69

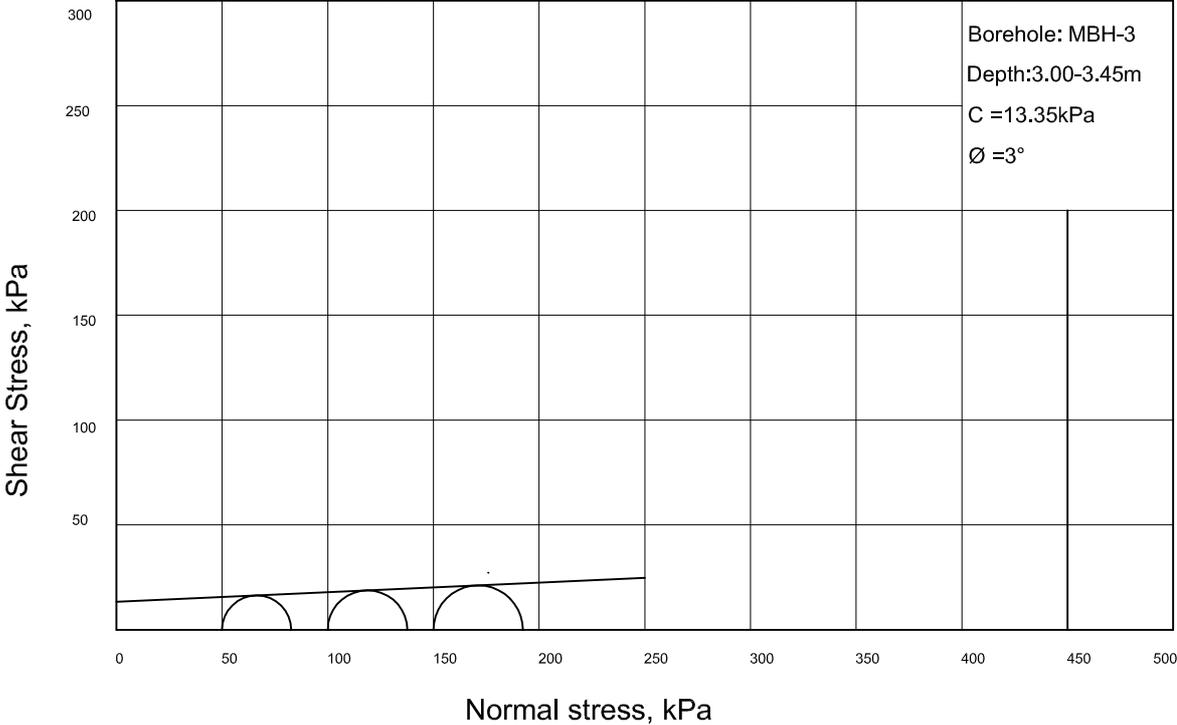


Measured deviator stress	43.7	kPa
Membrane correction	1.34	kPa
Corrected deviator stress	42.3	kPa
Axial strain	11.5	%
Shear strength C_u	21.2	kPa

Tested By: G.J. Checked By: A.S.

Project: Geotechnical Investigation for the Proposed Site for Development of Berth No.7

UU Triaxial Test (Mohr's Circle)





Unconsolidated Undrained Triaxial Compression Test

Project: Geotechnical Investigation for the Proposed Site for Development of Berth No.7

Job No. :	215/08
BH. No.	MBH-A3
Sample ID.	215/MBH3/U4
Test Depth (m)	4.50-4.95
Test Date	15/4/2008

Test method : **IS:2720 : Part XI**

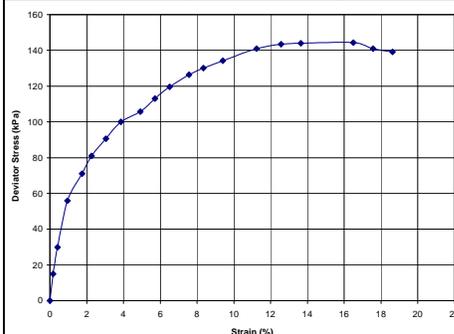
Type of specimen: UDS Nominal diameter 38 mm

Preparation procedure

Specimen details	Initially	After test		Sketch showing specimen location in original sample
Diameter D mm	38	Mass	168.87 g	
Area A_0 mm ²	1134.11	Dry mass	130.83 g	
Length L_0 mm	76	Moisture content	29 %	
Volume cm ³	86.19	Dry Density	1.52 g/cm ³	
Mass g	168.87			
Bulk Density g/cm ³	1.96			

Compression test

Machine no.		Rate of deformation 1.2 mm /min		Cell pressure 50 kPa	
Membrane thickness		Force device no.	Mean calibration		Load Factor
0.2 mm		28996	-		-
Deformation gauge reading	Compression of specimen ΔL mm	Strain (%) $\epsilon = \Delta L / L_0 \times 100$	Axial force P N	Corrected area $A = A_0 / (1 - \epsilon)$ mm ²	Measured deviator stress $(\sigma_1 - \sigma_3) = 1000 P / A$ kPa
0.00	0.00	0.00	0.00	1134.11	0.00
0.13	0.13	0.17	17.00	1136.06	14.96
0.32	0.32	0.42	34.00	1138.91	29.85
0.73	0.73	0.96	64.00	1145.11	55.89
1.33	1.33	1.75	82.00	1154.32	71.04
1.72	1.72	2.26	94.00	1160.38	81.01
2.32	2.32	3.05	106.00	1169.83	90.61
2.93	2.93	3.86	118.00	1179.59	100.03
3.74	3.74	4.92	126.00	1192.81	105.63
4.34	4.34	5.71	136.00	1202.80	113.07
4.95	4.95	6.51	145.00	1213.13	119.53
5.75	5.75	7.57	155.00	1226.94	126.33
6.34	6.34	8.34	161.00	1237.33	130.12
7.14	7.14	9.39	168.00	1251.71	134.22
8.54	8.54	11.24	180.00	1277.69	140.88
9.55	9.55	12.57	186.00	1297.11	143.40
10.36	10.36	13.63	189.00	1313.11	143.93
12.54	12.54	16.50	196.00	1358.22	144.31
13.35	13.35	17.57	194.00	1375.78	141.01
14.15	14.15	18.62	194.00	1393.58	139.21



Measured deviator stress	144.3	kPa
Membrane correction	1.74	kPa
Corrected deviator stress	142.6	kPa
Axial strain	16.5	%
Shear strength C_u	71.3	kPa

Tested By: G.J. Checked By: A.S.



Unconsolidated Undrained Triaxial Compression Test

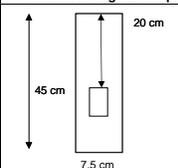
Project: Geotechnical Investigation for the Proposed Site for Development of Berth No.7

Job No. :	215/08
BH. No.	MBH-A3
Sample No.	215/MBH3/U4
Test Depth (m)	4.50-4.95
Test Date	15/4/2008

Test method : **IS:2720 : Part XI**

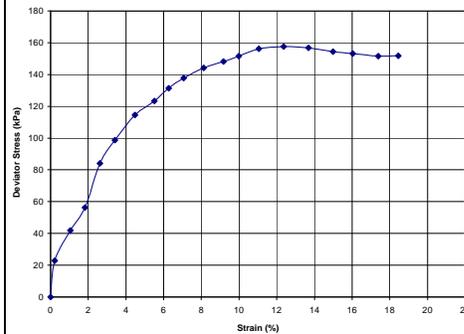
Type of specimen: UDS Nominal diameter 38 mm

Preparation procedure

Specimen details	Initially	After test		Sketch showing specimen location in original sample 
Diameter D mm	38	Mass	168.76 g	
Area A_0 mm ²	1134.11	Dry mass	131.77 g	
Length L_0 mm	76	Moisture content	28 %	
Volume cm ³	86.19	Dry Density	1.53 g/cm ³	
Mass g	168.76			
Bulk Density g/cm ³	1.96			

Compression test

Machine no.		Rate of deformation 1.2 mm /min		Cell pressure 100 kPa	
Membrane thickness 0.2 mm		Force device no. 28996	Mean calibration		Load Factor
Deformation gauge reading	Compression of specimen ΔL mm	Strain (%) $\epsilon = \Delta L / L_0 \times 100$	Axial force P N	Corrected area $A = A_0 / (1 - \epsilon)$ mm ²	Measured deviator stress ($\sigma_1 - \sigma_3$) = 1000 P / A kPa
0.00	0.00	0.00	0.00	1134.11	0.00
0.17	0.17	0.22	26.00	1136.66	22.87
0.79	0.79	1.04	48.00	1146.03	41.88
1.39	1.39	1.83	65.00	1155.24	56.27
1.99	1.99	2.62	98.00	1164.61	84.15
2.60	2.60	3.42	116.00	1174.29	98.78
3.40	3.40	4.47	136.00	1187.23	114.55
4.19	4.19	5.51	148.00	1200.29	123.30
4.77	4.77	6.28	159.00	1210.06	131.40
5.37	5.37	7.07	168.00	1220.34	137.67
6.18	6.18	8.13	178.00	1234.50	144.19
6.97	6.97	9.17	185.00	1248.63	148.16
7.59	7.59	9.99	191.00	1259.94	151.59
8.40	8.40	11.05	199.00	1275.04	156.07
9.40	9.40	12.37	204.00	1294.19	157.63
10.40	10.40	13.68	206.00	1313.91	156.78
11.39	11.39	14.99	206.00	1334.05	154.42
12.19	12.19	16.04	207.00	1350.77	153.25
13.21	13.21	17.38	208.00	1372.71	151.52
14.02	14.02	18.45	211.00	1390.65	151.73



Measured deviator stress	157.6	kPa
Membrane correction	1.42	kPa
Corrected deviator stress	156.2	kPa
Axial strain	12.4	%
Shear strength C_u	78.1	kPa

Tested By: G.J.

Checked By: A.S.



Unconsolidated Undrained Triaxial Compression Test

Project: Geotechnical Investigation for the Proposed Site for Development of Berth No.7

Job No. :	215/08
BH. No.	MBH-A3
Sample No.	215/MBH3/U4
Test Depth (m)	4.50-4.95
Test Date	15/4/2008

Test method : **IS:2720 : Part XI**

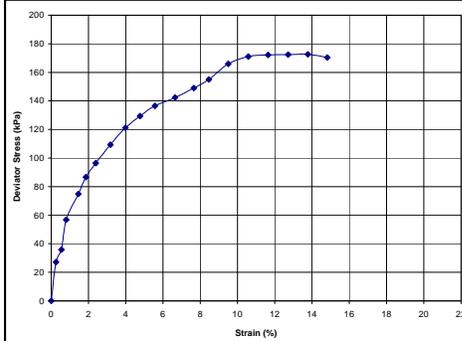
Type of specimen: UDS Nominal diameter 38 mm

Preparation procedure

Specimen details	Initially	After test		Sketch showing specimen location in original sample
Diameter D mm	38	Mass	169.46 g	
Area A_0 mm ²	1134.11	Dry mass	132.11 g	
Length L_0 mm	76	Moisture content	28 %	
Volume cm ³	86.19	Dry Density	1.53 g/cm ³	
Mass g	169.46			
Bulk Density g/cm ³	1.97			

Compression test

Machine no.		Rate of deformation 1.2 mm /min		Cell pressure 150 kPa	
Membrane thickness 0.2 mm		Force device no. 28996	Mean calibration		Load Factor
Deformation gauge reading	Compression of specimen ΔL mm	Strain (%) $\epsilon = \Delta L / L_0 \times 100$	Axial force P N	Corrected area $A = A_0 / (1 - \epsilon)$ mm ²	Measured deviator stress ($\sigma_1 - \sigma_3$) = 1000 P / A kPa
0.00	0.00	0.00	0.00	1134.11	0.00
0.20	0.20	0.26	31.00	1137.11	27.26
0.41	0.41	0.54	41.00	1140.27	35.96
0.61	0.61	0.80	65.00	1143.29	56.85
1.10	1.10	1.45	86.00	1150.77	74.73
1.42	1.42	1.87	100.00	1155.71	86.53
1.82	1.82	2.39	112.00	1161.94	96.39
2.42	2.42	3.18	128.00	1171.42	109.27
3.03	3.03	3.99	143.00	1181.21	121.06
3.63	3.63	4.78	154.00	1191.00	129.30
4.24	4.24	5.58	164.00	1201.13	136.54
5.05	5.05	6.64	173.00	1214.84	142.41
5.82	5.82	7.66	183.00	1228.17	149.00
6.43	6.43	8.46	192.00	1238.94	154.97
7.22	7.22	9.50	208.00	1253.17	165.98
8.04	8.04	10.58	217.00	1268.29	171.10
8.85	8.85	11.64	221.00	1283.59	172.17
9.67	9.67	12.72	224.00	1299.45	172.38
10.47	10.47	13.78	227.00	1315.32	172.58
11.27	11.27	14.83	227.00	1331.57	170.48

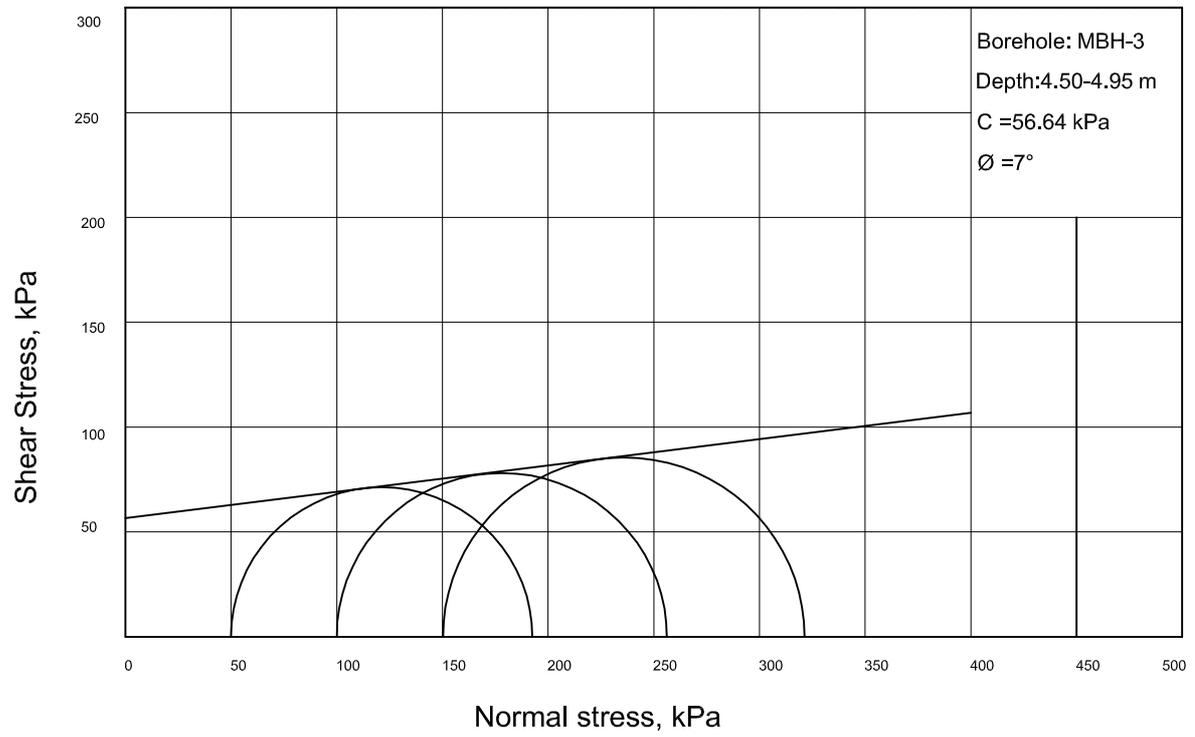


Measured deviator stress	172.6	kPa
Membrane correction	1.53	kPa
Corrected deviator stress	171.0	kPa
Axial strain	13.8	%
Shear strength C_u	85.5	kPa

Tested By: G.J. Checked By: A.S.

Project: Geotechnical Investigation for the Proposed Site for Development of Berth No.7

UU Triaxial Test (Mohr's Circle)





Unconsolidated Undrained Triaxial Compression Test

Project: Geotechnical Investigation for the Proposed Site for Development of Berth No.7

Job No. : 215/08

BH. No. **MBH-B1**

Sample No. **215/MBHB1/U4**

Test Depth (m) **6.00-6.45**

Test Date **15/4/2008**

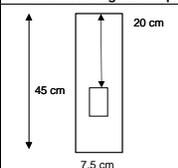
Test method : **IS:2720 : Part XI**

Type of specimen:

UDS

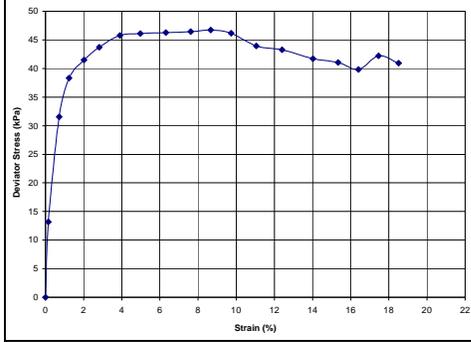
Nominal diameter 38 mm

Preparation procedure

Specimen details	Initially	After test		Sketch showing specimen location in original sample 
Diameter D mm	38	Mass	121.06 g	
Area A_0 mm ²	1134.11	Dry mass	59.40 g	
Length L_0 mm	76	Moisture content	104 %	
Volume cm ³	86.19	Dry Density	0.69 g/cm ³	
Mass g	121.06			
Bulk Density g/cm ³	1.40			

Compression test

Machine no.	Rate of deformation	Cell pressure			
-	1.2 mm /min	100 kPa			
Membrane thickness 0.2 mm	Force device no. 28996	Mean calibration -			
		Load Factor -			
Deformation gauge reading	Compression of specimen ΔL mm	Strain (%) $\epsilon = \Delta L / L_0 \times 100$	Axial force P N	Corrected area $A = A_0 / (1 - \epsilon)$ mm ²	Measured deviator stress ($\sigma_1 - \sigma_3$) = 1000 P / A kPa
0.00	0.00	0.00	0.00	1134.11	0.00
0.12	0.12	0.16	15.00	1135.91	13.21
0.55	0.55	0.72	36.00	1142.38	31.51
0.94	0.94	1.24	44.00	1148.32	38.32
1.54	1.54	2.03	48.00	1157.57	41.47
2.14	2.14	2.82	51.00	1166.97	43.70
2.97	2.97	3.91	54.00	1180.24	45.75
3.78	3.78	4.97	55.00	1193.47	46.08
4.79	4.79	6.30	56.00	1210.40	46.27
5.78	5.78	7.61	57.00	1227.47	46.44
6.59	6.59	8.67	58.00	1241.79	46.71
7.39	7.39	9.72	58.00	1256.27	46.17
8.40	8.40	11.05	56.00	1275.04	43.92
9.43	9.43	12.41	56.00	1294.77	43.25
10.65	10.65	14.01	55.00	1318.94	41.70
11.66	11.66	15.34	55.00	1339.64	41.06
12.47	12.47	16.41	54.00	1356.72	39.80
13.27	13.27	17.46	58.00	1374.03	42.21
14.07	14.07	18.51	57.00	1391.78	40.95



Measured deviator stress	46.7	kPa
Membrane correction	1.07	kPa
Corrected deviator stress	45.6	kPa
Axial strain	8.7	%
Shear strength C_u	22.8	kPa

Tested By: G.J.

Checked By: A.S.

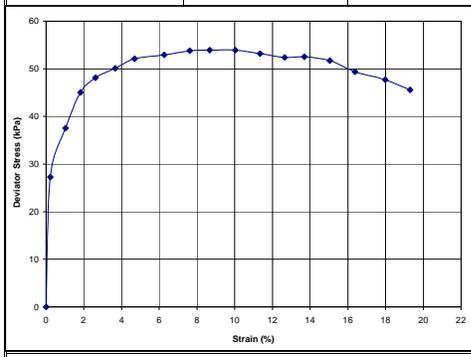


Unconsolidated Undrained Triaxial Compression Test		Job No. :	215/08
Project: Geotechnical Investigation for the Proposed Site for Development of Berth No.7		BH. No.	MBH-B1
		Sample No.	215/MBHB1/U4
		Test Depth (m)	6.00-6.45
		Test Date	15/4/2008

Test method : **IS:2720 : Part XI**
 Type of specimen: UDS Nominal diameter 38 mm

Preparation procedure				Sketch showing specimen location in original sample
Specimen details	Initially	After test		
Diameter D mm	38	Mass	122.56 g	
Area A_0 mm ²	1134.11	Dry mass	59.78 g	
Length L_0 mm	76	Moisture content	105 %	
Volume cm ³	86.19	Dry Density	0.69 g/cm ³	
Mass g	122.56			
Bulk Density g/cm ³	1.42			

Compression test		Rate of deformation 1.2 mm /min	Cell pressure 150 kPa		
Machine no. -		Force device no.	Mean calibration		Load Factor
Membrane thickness 0.2 mm		28996	-		-
Deformation gauge reading	Compression of specimen ΔL mm	Strain (%) $\epsilon = \Delta L / L_0 \times 100$	Axial force P N	Corrected area $A = A_0 / (1 - \epsilon)$ mm ²	Measured deviator stress ($\sigma_1 - \sigma_3$) = 1000 P / A kPa
0.00	0.00	0.00	0.00	1134.11	0.00
0.17	0.17	0.22	31.00	1136.66	27.27
0.78	0.78	1.03	43.00	1145.88	37.53
1.39	1.39	1.83	52.00	1155.24	45.01
1.99	1.99	2.62	56.00	1164.61	48.08
2.78	2.78	3.66	59.00	1177.17	50.12
3.57	3.57	4.70	62.00	1190.01	52.10
4.76	4.76	6.26	64.00	1209.89	52.90
5.79	5.79	7.62	66.00	1227.64	53.76
6.60	6.60	8.68	67.00	1241.97	53.95
7.62	7.62	10.03	68.00	1260.50	53.95
8.62	8.62	11.34	68.00	1279.20	53.16
9.61	9.61	12.64	68.00	1298.28	52.38
10.41	10.41	13.70	69.00	1314.11	52.51
11.43	11.43	15.04	69.00	1334.87	51.69
12.45	12.45	16.38	67.00	1356.30	49.40
13.66	13.66	17.97	66.00	1382.62	47.74
14.67	14.67	19.30	64.00	1405.39	45.54

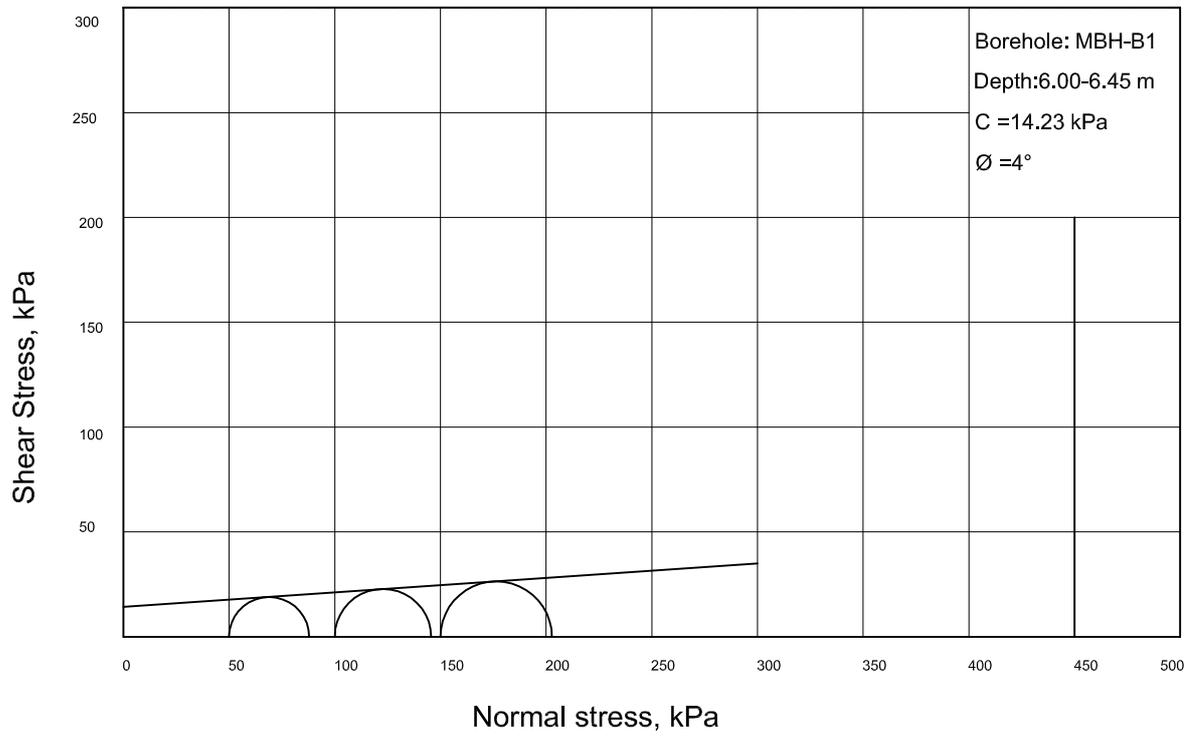


Measured deviator stress	53.9	kPa
Membrane correction	1.20	kPa
Corrected deviator stress	52.7	kPa
Axial strain	10.0	%
Shear strength C_u	26.4	kPa

Tested By: G.J. Checked By: A.S.

Project: Geotechnical Investigation for the Proposed Site for Development of Berth No.7

UU Triaxial Test (Mohr's Circle)





Unconsolidated Undrained Triaxial Compression Test

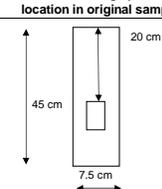
Project: Geotechnical Investigation for the Proposed Site for Development of Berth No.7

Job No. :	215/08
BH. No.	MBH-B1
Sample ID.	215/MBHB1/U8
Test Depth (m)	12.00 - 12.45
Test Date	15/4/2008

Test method : IS:2720 : Part XI

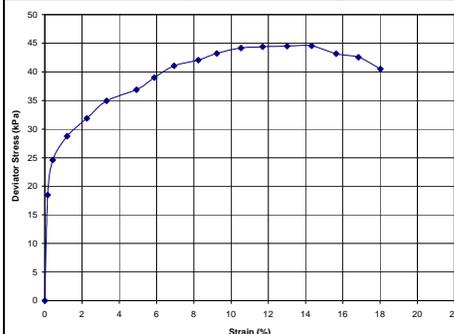
Type of specimen: UDS Nominal diameter 38 mm

Preparation procedure

Specimen details	Initially	After test		Sketch showing specimen location in original sample 
Diameter D mm	38	Mass	140.52 g	
Area A_0 mm ²	1134.11	Dry mass	85.25 g	
Length L_0 mm	76	Moisture content	65 %	
Volume cm ³	86.19	Dry Density	0.99 g/cm ³	
Mass g	140.52			
Bulk Density g/cm ³	1.63			

Compression test

Machine no.		Rate of deformation 1.2 mm /min		Cell pressure 50 kPa	
Membrane thickness 0.2 mm		Force device no. 28996	Mean calibration -		Load Factor -
Deformation gauge reading	Compression of specimen ΔL mm	Strain (%) $\epsilon = \Delta L / L_0 \times 100$	Axial force P N	Corrected area $A = A_0 / (1 - \epsilon)$ mm ²	Measured deviator stress $(\sigma_1 - \sigma_3) = 1000 P / A$ kPa
0.00	0.00	0.00	0.00	1134.11	0.00
0.12	0.12	0.16	21.00	1135.91	18.49
0.32	0.32	0.42	28.00	1138.91	24.58
0.91	0.91	1.20	33.00	1147.86	28.75
1.71	1.71	2.25	37.00	1160.22	31.89
2.52	2.52	3.32	41.00	1173.01	34.95
3.74	3.74	4.92	44.00	1192.81	36.89
4.47	4.47	5.88	47.00	1204.99	39.00
5.28	5.28	6.95	50.00	1218.79	41.02
6.26	6.26	8.24	52.00	1235.92	42.07
7.02	7.02	9.24	54.00	1249.53	43.22
8.00	8.00	10.53	56.00	1267.54	44.18
8.89	8.89	11.70	57.00	1284.35	44.38
9.88	9.88	13.00	58.00	1303.58	44.49
10.89	10.89	14.33	59.00	1323.80	44.57
11.89	11.89	15.64	58.00	1344.45	43.14
12.80	12.80	16.84	58.00	1363.81	42.53
13.69	13.69	18.01	56.00	1383.29	40.48



Measured deviator stress	44.6	kPa
Membrane correction	1.58	kPa
Corrected deviator stress	43.0	kPa
Axial strain	14.3	%
Shear strength C_u	21.5	kPa

Tested By: G.J.

Checked By: A.S.

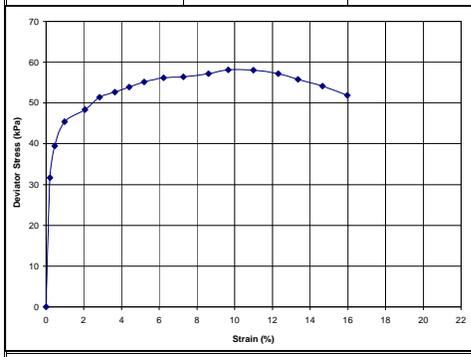


Unconsolidated Undrained Triaxial Compression Test		Job No. :	215/08
Project: Geotechnical Investigation for the Proposed Site for Development of Berth No.7		BH. No.	MBH-B1
		Sample No.	215/MBHB1/U8
		Test Depth (m)	12.00 - 12.45
		Test Date	15/4/2008

Test method : **IS:2720 : Part XI**
 Type of specimen: UDS Nominal diameter 38 mm

Preparation procedure				Sketch showing specimen location in original sample
Specimen details	Initially	After test		
Diameter D mm	38	Mass	140.89 g	
Area A_0 mm ²	1134.11	Dry mass	84.88 g	
Length L_0 mm	76	Moisture content	66 %	
Volume cm ³	86.19	Dry Density	0.98 g/cm ³	
Mass g	140.89			
Bulk Density g/cm ³	1.63			

Compression test					
Machine no.		Rate of deformation 1.2 mm /min		Cell pressure 150 kPa	
Membrane thickness 0.2 mm		Force device no. 28996	Mean calibration		Load Factor
Deformation gauge reading	Compression of specimen ΔL mm	Strain (%) $\epsilon = \Delta L / L_0 \times 100$	Axial force P N	Corrected area $A = A_0 / (1 - \epsilon)$ mm ²	Measured deviator stress ($\sigma_1 - \sigma_3$) = 1000 P / A kPa
0.00	0.00	0.00	0.00	1134.11	0.00
0.15	0.15	0.20	36.00	1136.36	31.68
0.35	0.35	0.46	45.00	1139.36	39.50
0.75	0.75	0.99	52.00	1145.42	45.40
1.56	1.56	2.05	56.00	1157.88	48.36
2.16	2.16	2.84	60.00	1167.29	51.40
2.77	2.77	3.64	62.00	1177.01	52.68
3.35	3.35	4.41	64.00	1186.41	53.94
3.95	3.95	5.20	66.00	1196.29	55.17
4.74	4.74	6.24	68.00	1209.55	56.22
5.53	5.53	7.28	69.00	1223.11	56.41
6.54	6.54	8.61	71.00	1240.90	57.22
7.34	7.34	9.66	73.00	1255.36	58.15
8.35	8.35	10.99	74.00	1274.10	58.08
9.35	9.35	12.30	74.00	1293.21	57.22
10.15	10.15	13.36	73.00	1308.93	55.77
11.14	11.14	14.66	72.00	1328.90	54.18
12.14	12.14	15.97	70.00	1349.71	51.86

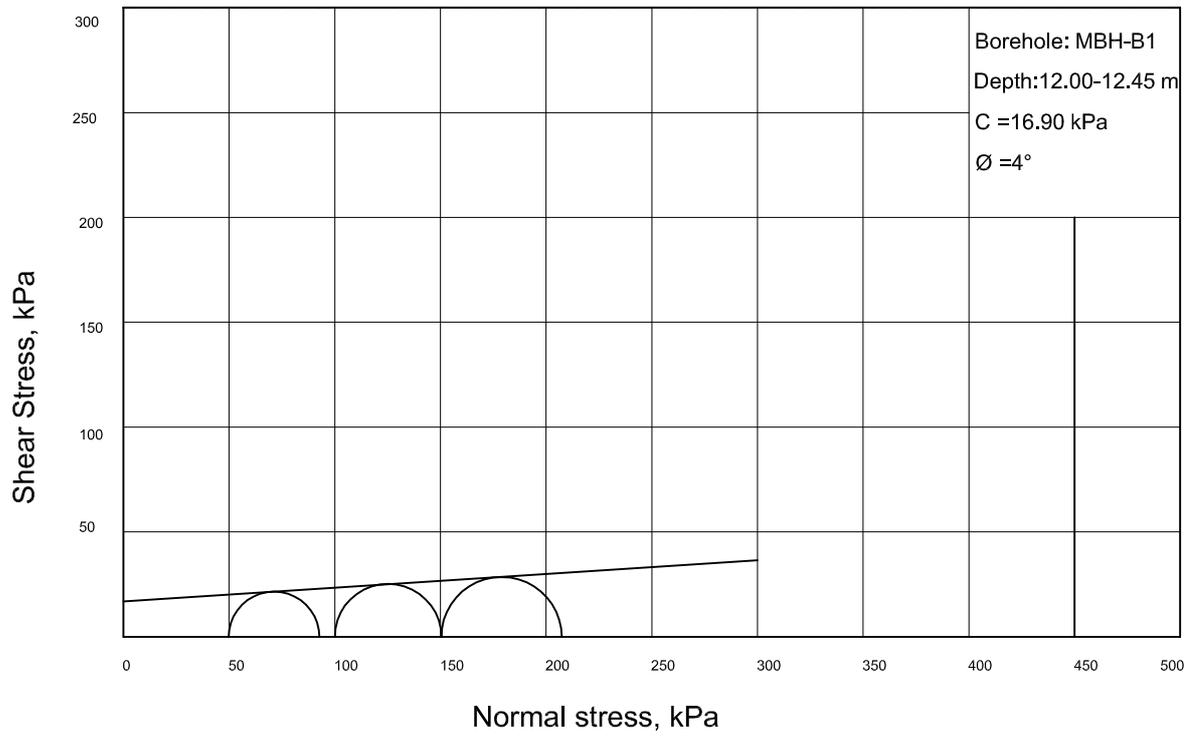


Measured deviator stress	58.2	kPa
Membrane correction	1.17	kPa
Corrected deviator stress	57.0	kPa
Axial strain	9.7	%
Shear strength C_u	28.5	kPa

Tested By: G.J. Checked By: A.S.

Project: Geotechnical Investigation for the Proposed Site for Development of Berth No.7

UU Triaxial Test (Mohr's Circle)





Unconsolidated Undrained Triaxial Compression Test

Project: Geotechnical Investigation for the Proposed Site for Development of Berth No.7

Job No. :	215/08
BH. No.	MBH-B2
Sample ID.	215/MBHB2/U2
Test Depth (m)	3.00-3.45
Test Date	15/4/2008

Test method : **IS:2720 : Part XI**

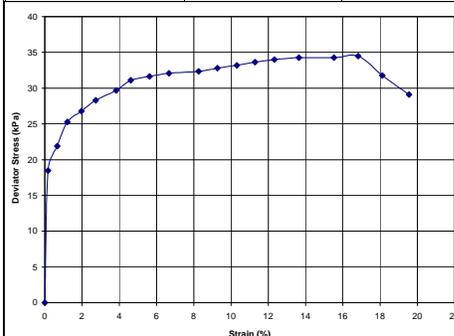
Type of specimen: UDS Nominal diameter 38 mm

Preparation procedure

Specimen details	Initially	After test		Sketch showing specimen location in original sample
Diameter D mm	38	Mass	124.87 g	
Area A_0 mm ²	1134.11	Dry mass	84.76 g	
Length L_0 mm	76	Moisture content	47 %	
Volume cm ³	86.19	Dry Density	0.98 g/cm ³	
Mass g	124.87			
Bulk Density g/cm ³	1.45			

Compression test

Machine no.		Rate of deformation 1.2 mm /min		Cell pressure 50 kPa	
Membrane thickness		Force device no.	Mean calibration		Load Factor
0.2 mm		28996	-		-
Deformation gauge reading	Compression of specimen ΔL mm	Strain (%) $\epsilon = \Delta L / L_0 \times 100$	Axial force P N	Corrected area $A = A_0 / (1 - \epsilon)$ mm ²	Measured deviator stress $(\sigma_1 - \sigma_3) = 1000 P / A$ kPa
0.00	0.00	0.00	0.00	1134.11	0.00
0.13	0.13	0.17	21.00	1136.06	18.48
0.51	0.51	0.67	25.00	1141.78	21.90
0.92	0.92	1.21	29.00	1148.01	25.26
1.49	1.49	1.96	31.00	1156.79	26.80
2.08	2.08	2.74	33.00	1166.03	28.30
2.91	2.91	3.83	35.00	1179.27	29.68
3.51	3.51	4.62	37.00	1189.03	31.12
4.27	4.27	5.62	38.00	1201.63	31.62
5.07	5.07	6.67	39.00	1215.18	32.09
6.27	6.27	8.25	40.00	1236.09	32.36
7.04	7.04	9.26	41.00	1249.89	32.80
7.84	7.84	10.32	42.00	1264.56	33.21
8.58	8.58	11.29	43.00	1278.44	33.63
9.37	9.37	12.33	44.00	1293.60	34.01
10.37	10.37	13.64	45.00	1313.31	34.26
11.79	11.79	15.51	46.00	1342.36	34.27
12.78	12.78	16.82	47.00	1363.38	34.47
13.77	13.77	18.12	44.00	1385.07	31.77
14.86	14.86	19.55	41.00	1409.76	29.08

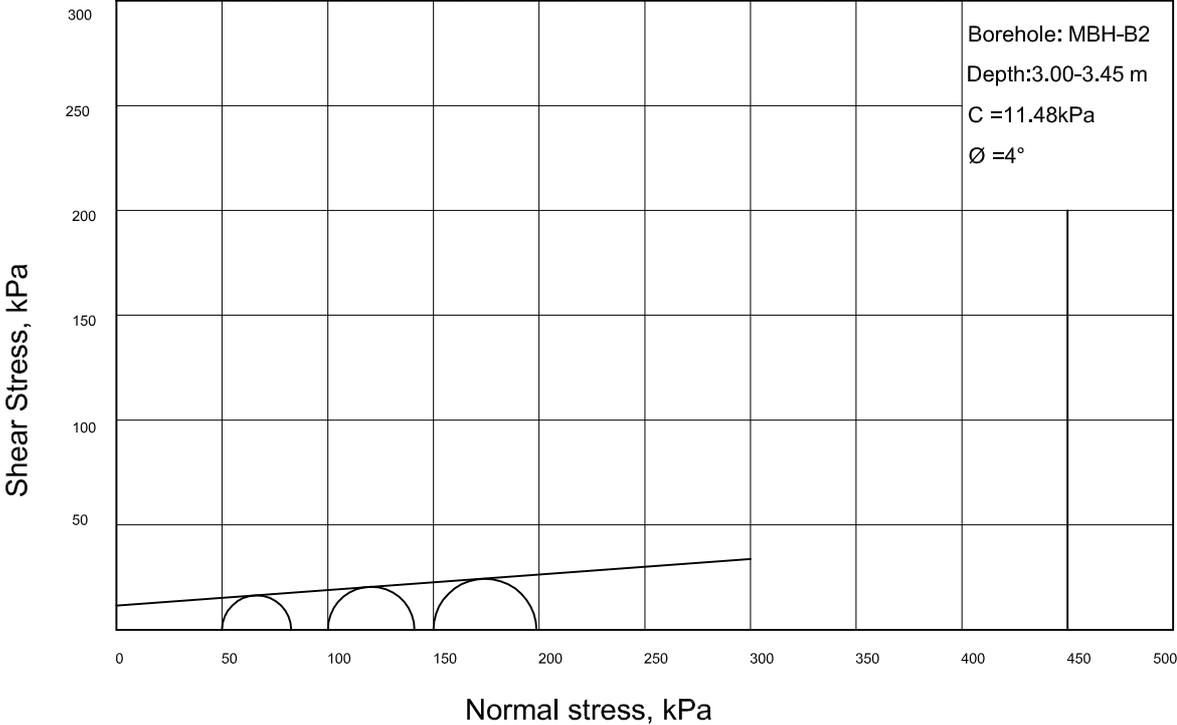


Measured deviator stress	34.5	kPa
Membrane correction	1.76	kPa
Corrected deviator stress	32.7	kPa
Axial strain	16.8	%
Shear strength C_u	16.4	kPa

Tested By: G.J. Checked By: A.S.

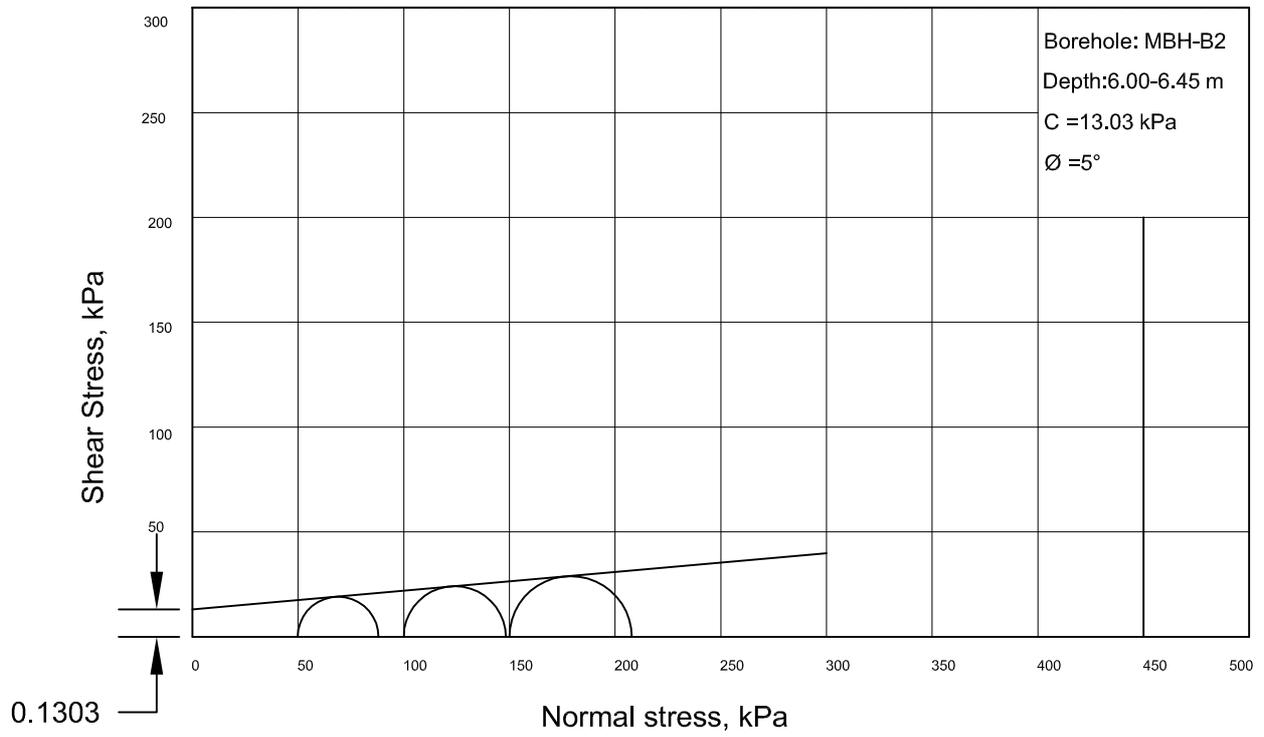
Project: Geotechnical Investigation for the Proposed Site for Development of Berth No.7

UU Triaxial Test (Mohr's Circle)



Project: Geotechnical Investigation for the Proposed Site for Development of Berth No.7

UU Triaxial Test (Mohr's Circle)





Unconsolidated Undrained Triaxial Compression Test

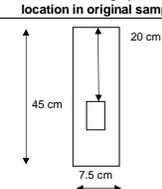
Project: Geotechnical Investigation for the Proposed Site for Development of Berth No.7

Job No. :	215/08
BH. No.	MBH-C1
Sample ID.	215/MBHC1/U2
Test Depth (m)	3.00 - 3.45
Test Date	15/4/2008

Test method : IS:2720 : Part XI

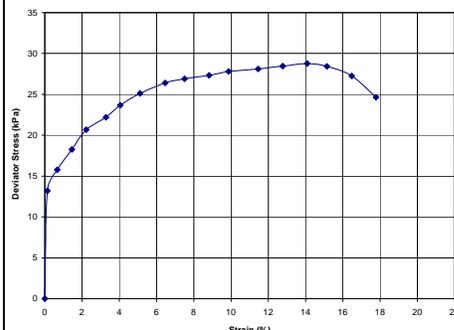
Type of specimen: UDS Nominal diameter 38 mm

Preparation procedure

Specimen details	Initially	After test		Sketch showing specimen location in original sample 
Diameter D mm	38	Mass	121.88 g	
Area A_0 mm ²	1134.11	Dry mass	60.98 g	
Length L_0 mm	76	Moisture content	100 %	
Volume cm ³	86.19	Dry Density	0.71 g/cm ³	
Mass g	121.88			
Bulk Density g/cm ³	1.41			

Compression test

Machine no.		Rate of deformation 1.2 mm /min		Cell pressure 50 kPa	
Membrane thickness 0.2 mm		Force device no. 28996	Mean calibration -		Load Factor -
Deformation gauge reading	Compression of specimen ΔL mm	Strain (%) $\epsilon = \Delta L / L_0 \times 100$	Axial force P N	Corrected area $A = A_0 / (1 - \epsilon)$ mm ²	Measured deviator stress $(\sigma_1 - \sigma_3) = 1000 P / A$ kPa
0.00	0.00	0.00	0.00	1134.11	0.00
0.11	0.11	0.14	15.00	1135.76	13.21
0.51	0.51	0.67	18.00	1141.78	15.76
1.10	1.10	1.45	21.00	1150.77	18.25
1.69	1.69	2.22	24.00	1159.91	20.69
2.49	2.49	3.28	26.00	1172.53	22.17
3.08	3.08	4.05	28.00	1182.02	23.69
3.89	3.89	5.12	30.00	1195.30	25.10
4.91	4.91	6.46	32.00	1212.45	26.39
5.70	5.70	7.50	33.00	1226.07	26.92
6.71	6.71	8.83	34.00	1243.94	27.33
7.50	7.50	9.87	35.00	1258.29	27.82
8.70	8.70	11.45	36.00	1280.72	28.11
9.70	9.70	12.76	37.00	1300.04	28.46
10.71	10.71	14.09	38.00	1320.15	28.78
11.51	11.51	15.14	38.00	1336.53	28.43
12.52	12.52	16.47	37.00	1357.79	27.25
13.51	13.51	17.78	34.00	1379.30	24.65



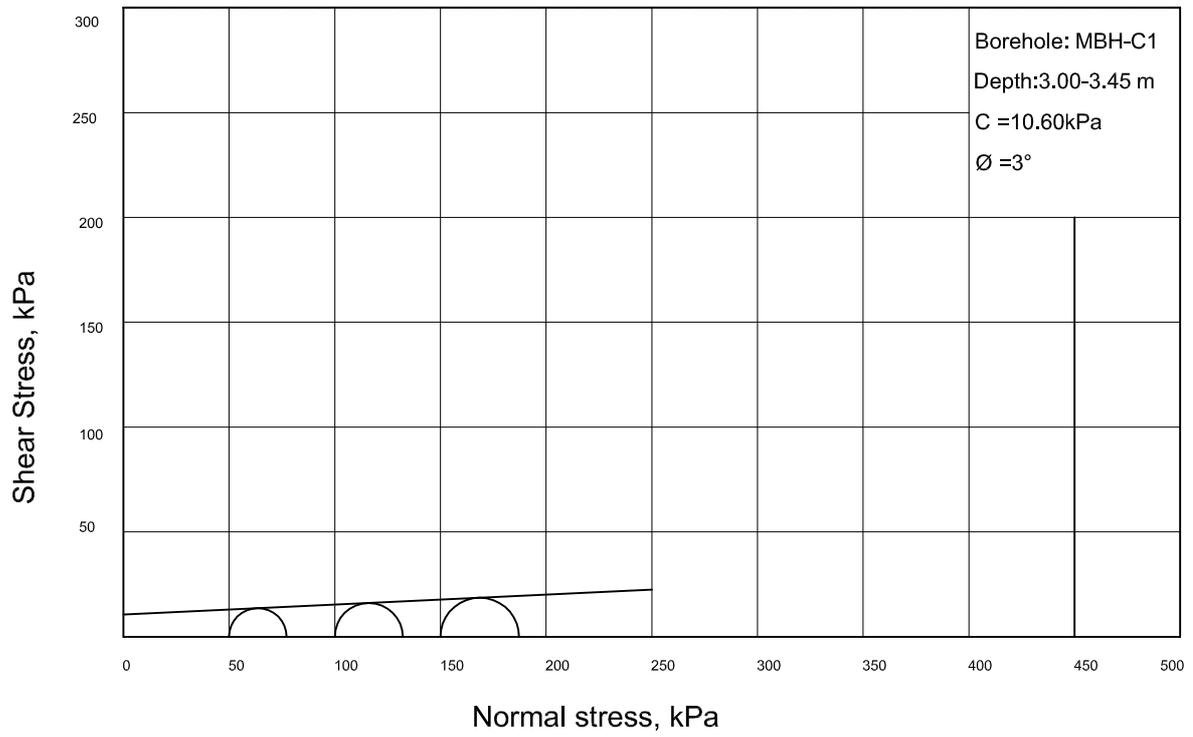
Measured deviator stress	28.8	kPa
Membrane correction	1.56	kPa
Corrected deviator stress	27.2	kPa
Axial strain	14.1	%
Shear strength C_u	13.6	kPa

Tested By: G.J.

Checked By: A.S.

Project: Geotechnical Investigation for the Proposed Site for Development of Berth No.7

UU Triaxial Test (Mohr's Circle)





Unconsolidated Undrained Triaxial Compression Test

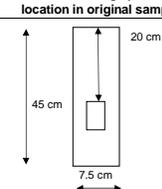
Project: Geotechnical Investigation for the Proposed Site for Development of Berth No.7

Job No. :	215/08
BH. No.	MBH-C1
Sample ID.	215/MBHC1/U4
Test Depth (m)	6.00 - 6.45
Test Date	15/4/2008

Test method : IS:2720 : Part XI

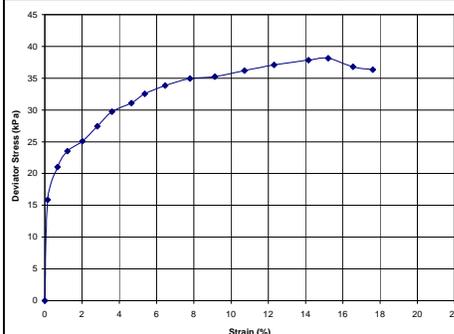
Type of specimen: UDS Nominal diameter 38 mm

Preparation procedure

Specimen details	Initially	After test		Sketch showing specimen location in original sample 
Diameter D mm	38	Mass	121.88 g	
Area A_0 mm ²	1134.11	Dry mass	60.98 g	
Length L_0 mm	76	Moisture content	100 %	
Volume cm ³	86.19	Dry Density	0.71 g/cm ³	
Mass g	121.88			
Bulk Density g/cm ³	1.41			

Compression test

Machine no. -		Rate of deformation 1.2 mm /min	Cell pressure 50 kPa		
Membrane thickness 0.2 mm		Force device no. 28996	Mean calibration -		Load Factor -
Deformation gauge reading	Compression of specimen ΔL mm	Strain (%) $\epsilon = \Delta L / L_0 \times 100$	Axial force P N	Corrected area $A = A_0 / (1 - \epsilon)$ mm ²	Measured deviator stress $(\sigma_1 - \sigma_3) = 1000 P / A$ kPa
0.00	0.00	0.00	0.00	1134.11	0.00
0.12	0.12	0.16	18.00	1135.91	15.85
0.52	0.52	0.68	24.00	1141.93	21.02
0.92	0.92	1.21	27.00	1148.01	23.52
1.53	1.53	2.01	29.00	1157.42	25.06
2.15	2.15	2.83	32.00	1167.13	27.42
2.74	2.74	3.61	35.00	1176.53	29.75
3.54	3.54	4.66	37.00	1189.52	31.10
4.08	4.08	5.37	39.00	1198.45	32.54
4.91	4.91	6.46	41.00	1212.45	33.82
5.92	5.92	7.79	43.00	1229.92	34.96
6.94	6.94	9.13	44.00	1248.08	35.25
8.15	8.15	10.72	46.00	1270.34	36.21
9.36	9.36	12.32	48.00	1293.41	37.11
10.76	10.76	14.16	50.00	1321.16	37.85
11.56	11.56	15.21	51.00	1337.57	38.13
12.57	12.57	16.54	50.00	1358.86	36.80
13.38	13.38	17.61	50.00	1376.44	36.33



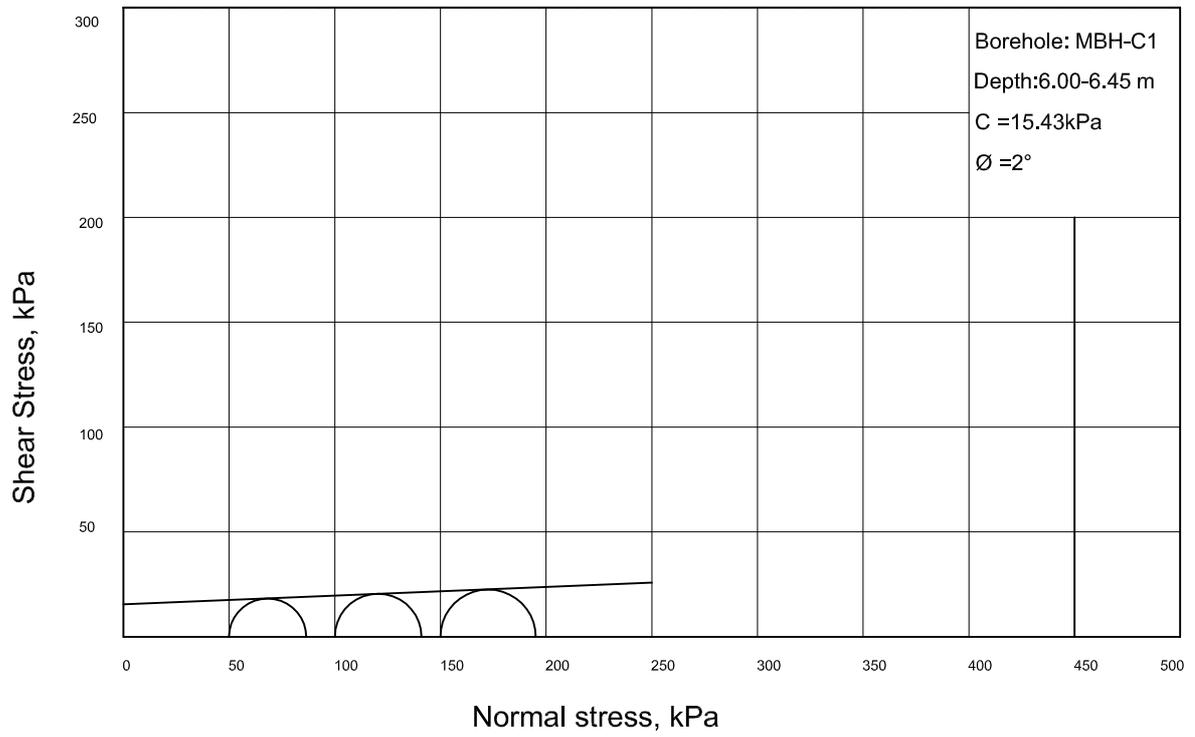
Measured deviator stress	38.1	kPa
Membrane correction	1.65	kPa
Corrected deviator stress	36.5	kPa
Axial strain	15.2	%
Shear strength C_u	18.2	kPa

Tested By: G.J.

Checked By: A.S.

Project: Geotechnical Investigation for the Proposed Site for Development of Berth No.7

UU Triaxial Test (Mohr's Circle)





FUGRO GEOTECH LTD.

Lab Vane Shear Test

PROJECT: Geotechnical Investigation for the Proposed Site for Development of Berth No.7	Job No. :	215/08
	BH. No.	MBH-02
Client : Mormugao Port Trust	Sample No.	215/M2/U2
	Test Depth (m)	1.50-1.95
	Test Date	21/04/2008

Test method : IS: 2720 (Part 30)

Type of specimen: UDS Nominal diameter 38 mm

Specimen details

Diameter D mm	38	Water Content %	95.0
Area A_0 mm ²	1134	Dry Density Mg/m ³	0.81
Length L_0 mm	76		
Volume cm ³	86.19		
Mass g	135.47		
Wet Density Mg/m ³	1.572		

Equipment Details

Width of Vane mm	12	Spring factor N-mm	200
Length of the Vane mm	24	Other details	-

Vane Test

Sample	Undisturbed	Remoulded
Initial angle (in degrees)	10	10
Final angle (in degrees)	65	45
Maximum angular rotation(in degrees)	55	35
Torque applied, M(in N-mm)	61.11	38.9
Vane shear strength, τ_v (in kPa)	9.66	6.14

Result

Vane shear strength of soil, τ_v (in kPa)	9.7
Vane shear strength of remoulded soil, τ_{vr} (in kPa)	6.1

Tested By : G.K.J

Prepared By : A.K.J

Approved By : A.S.



FUGRO GEOTECH LTD.

Lab Vane Shear Test

PROJECT: Geotechnical Investigation for the Proposed Site for Development of Berth No.7	Job No. :	215/08	
	BH. No.	MBH-04	
Client : Mormugao Port Trust	Sample No.	215/M2/U4	
	Test Depth (m)	6.00-6.45	
	Test Date	21/04/2008	
	Test method : IS: 2720 (Part 30)		
Type of specimen: UDS	Nominal diameter 38 mm		
Specimen details			
Diameter D mm	38	Water Content %	107.0
Area A_0 mm ²	1134	Dry Density Mg/m ³	0.75
Length L_0 mm	76		
Volume cm ³	86.19		
Mass g	134.40		
Wet Density Mg/m ³	1.559		
Equipment Details			
Width of Vane mm	12	Spring factor N-mm	200
Length of the Vane mm	24	Other details	-
Vane Test			
Sample	Undisturbed	Remoulded	
Initial angle (in degrees)	10	10	
Final angle (in degrees)	45	40	
Maximum angular rotation(in degrees)	35	30	
Torque applied, M(in N-mm)	38.89	33.3	
Vane shear strength, τ_v (in kPa)	6.14	5.27	
Result			
Vane shear strength of soil, τ_v (in kPa)	6.1		
Vane shear strength of remoulded soil, τ_{vr} (in kPa)	5.3		
Tested By : G.K.J	Prepared By : A.K.J	Approved By : A.S.	



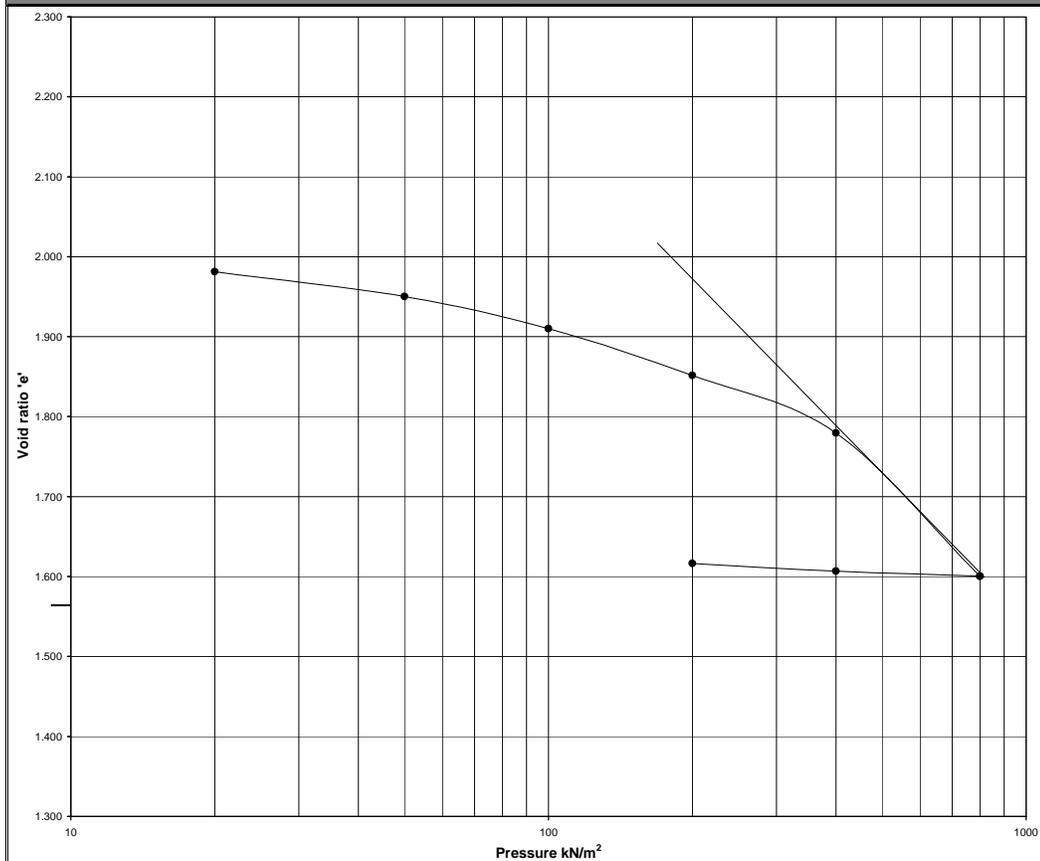
CONSOLIDATION TEST RESULTS

Project: Geotechnical Investigation for the Proposed Site for Development of Berth No.7

Job No. 215/08

BH-No	MBH-A2		Diameter of Specimen(cm)	6.0		Cc	0.594		
Depth	1.50-1.95		Area of Specimen, A	28.27		e ₀	2.006		
Wt. of Dry Soil	49.85		Specific Gravity of Sample	2.65					
Dial Gauge L.C.	0.002		Initial Height of Sample (H _i)	20					
Date	28.07.2007		Height of Solids (H _s)	6.65					
						Test Method : IS:2720 (PART - 15)			
Applied Pressure e (kN/m ²)	Final Dial Reading	Dial Change	Cumulative Compression ΔH (mm)	Specimen Height (H=H _i +ΔH) (mm)	Height of voids H-H _s (mm)	Void Ratio e=(H-H _s)/H _s	Coefficient of Consolidation C _v (cm ² /min)	Coefficient of Compressibility a _v (m ² /kN)	Coefficient of Volume Change m _v =(Δe/1+e ₀)/Δσ (m ² /kN)
0	3500	-82	-0.16	20.000	13.35	2.006			
20	3418	-104	-0.21	19.836	13.18	1.981	4.70E-03	1.233E-03	4.1000E-04
50	3314	-134	-0.27	19.628	12.97	1.950	8.40E-03	1.042E-03	3.4953E-04
100	3180	-194	-0.39	19.360	12.71	1.910	1.21E-02	8.056E-04	2.7308E-04
200	2986	-240	-0.48	18.971	12.32	1.851	6.50E-03	5.845E-04	2.0087E-04
400	2746	-595	-1.19	18.492	11.84	1.779	8.40E-03	3.601E-04	1.2628E-04
800	2151	21	0.04	17.302	10.65	1.601	1.06E-02	4.472E-04	1.6088E-04
400	2172	32	0.06	17.344	10.69	1.607		1.578E-05	6.0687E-06
200	2204	34	0.07	17.408	10.75	1.617		4.810E-05	1.8450E-05
0	2238			17.476	10.82	1.627			1.9531E-05

e - log σ Curve



Tested By	Checked By	Approved By
NA	BS	AS

APPENDIX - C

SOIL STRENGTH IN TERMS OF COMPACTNESS AND CONSISTENCY

Soil Type	Descriptive Term for Compactness/Relative Density	SPT “N” Values (Blows/300mm penetration)	
Sands and Gravel	Very Loose	0 - 4	
	Loose	4 - 10	
	Medium Dense	10 - 30	
	Dense	30 - 50	
	Very Dense	> 50	
Soil Type	Descriptive Term for Consistency	SPT “N” Values (Blows/300mm penetration)	Undrained Shear Strength (KPa)
Silts and Clays	Very Soft	< 2	< 25
	Soft	2 - 4	25 - 50
	Firm	4 - 8	50 - 100
	Stiff	8 - 15	100 - 200
	Very stiff	15 - 30	200 - 400
	Hard	> 30	> 400

CLASSIFICATION OF ROCK MATERIAL STRENGTH

Descriptive Term	Uniaxial Compressive Strength (MPa)	Approximate Point Load Strength Index values Is (50) for Volcanic Rocks (MPa)
Extremely weak	< 0.50	Generally not applicable
Very weak	0.50-1.25	
Weak	1.25-5	
Moderately weak	5-12.5	0.2-0.5
Moderately strong	12.5-50	0.5-2
Strong	50-100	2-4
Very strong	100-200	4-8
Extremely strong	>200	>8