付録-2

Topographic Survey Report

TABLE OF CONTENTS Page No.

List of tables

List of Figure

ACCOMPANYING CHARTS

Chart No.	Scale	Description
OSaS_P19415_SOWiL_Mum_Bathy_01	1:5000	Bathymetry Chart - Route 1
OSaS_P19415_SOWiL_Mum_Bathy_02	1:5000	Bathymetry Chart - Route 2 & Route 3

Terminology	Definition
Client	ORIENTAL CONSULTANT GLOBAL CO. LTD. TOKYO, JAPAN
Consultant	SOWiL Limited
Survey Requirement	Topographical Survey and Bathymetric survey between Mumbai and Navi Mumbai Sea for MTHL
Acoustic penetration	The ability of acoustic waves to travel through the subsurface.
Acoustic reflector	A subsurface that causes the velocity of seismic waves to change.
Bedding/Layering	A stratified or layered feature associated with sedimentary rocks and/or loose sediments.
Bedform	Any oscillatory topographic deviations from a flat bed produced by fluid movement including wave and current activity, generally in a sandy domain.
Bedrock	The solid rock lying beneath superficial material such as gravels or soils.
Chart Datum	A level so low that the tide will not frequently fall below it. British Hydrographic Office interprets it as the approximate level of Lowest Astronomical Tide (LAT).
Clay	A complex mineral assemblage with particle size <0.002 mm
Cohesive sediment	Sediments, typically clay and/or silt that resist separation due to nature of bonds between fine-grained particles.
Loose sediment	Not cemented sediment, either cohesive or not.
LAT	This is the lowest level to which sea level can be predicted to fall under normal meteorological conditions and under any combination of astronomical conditions. LAT is not an extreme level, as meteorological conditions can cause a lower level: the level under these conditions is known as a storm surge or negative surge.
MSL	Mean Sea Level.
Offshore Areas	Water depths from 10 metres to maximum water depths
Rock outcrop	Rock that is exposed at the seafloor.
Sand	A detrital particle larger than a silt grain and smaller than gravel, having a diameter in the range of 0.062 mm to 2 mm.
Sound wave	Undulations produced by fluid movement (waves and currents) over sediments, generally with > 25 metre.
Silt	A detrital particle finer than very fine sand and coarser than clay, in the range of 0.004 mm to 0.062 mm.
Slumping area	The slipping or sliding down of a mass of sediment relatively soon after its deposition in a sub-aqueous slope.
Subcropping	Rock/basement covered by a layer of loose sediment less 1 metre thick and where rock may be intermittently exposed at the seabed surface

EXECUTIVE SUMMARY

SOWiL Ltd. was contracted by Oriantal Consultant Global Co. Ltd. Japan vide service agreement between them on 2nd May 2015 to carry out topographic survey for land on either side of proposed Mumbai Trans harbour Link (MTHL) alignment and Bathymetrical survey along the MTHL between Mumbai and Navi Mumbai. Also additional bathymetrical profile one on upstream and another on downstream of proposed MTHL alignment.

Topographic Survey on landside was commence on 12th May and completed on 22th May. Bathematical survey was commenced on 3rd May and completed on 6th May. The survey vessel approach was limited near the shore due to shallow depth. Remaining portion of survey area was completed with a land survey on 3rd and 7th June 2015 .

Total station instrument was used for the land survey. A multibeam echo sounder was used for delineating the bathymetry of the survey area. A total of three routes were surveyed.

This report describes the results of topographical land survey and the multibeam survey conducted for the project.

All the co-ordinates in the reports for land survey was with respect to MSL and charts are referenced to WGS 84 Datum, UTM Projection, the details of which are given in this report.

Bathymetry has been reduced to mean sea level (MSL) using tide data obtained from the ATG installed at Prong's Reef light house.

The proposed MTHL route is named as Route 1 and survey routes north and south of Route 1 are named as Route 2 and Route 3 respectively.

1. INTRODUCTION

Mumbai Trans Harbor Link (MTHL), also known as Sewri-Nhava Sheva Trans Harbor Link, is a proposed 22 km, freeway grade road bridge connecting the Indian city of Mumbai with Navi Mumbai. It would be the longest sea bridge in India after completion. The bridge will begin in Sewri, Mumbai and cross Thane Creek north of Elephanta Island and will terminate at Chirle village, near Nhava Sheva. The road will be linked to the Mumbai Pune Expressway in the east, and to the proposed Western Freeway along the west coast of Mumbai.

SOWiL Ltd. was contracted by Oriental Consultant Global Co. Ltd. Japan vide service agreement between them on 2nd May 2015 to carry out topographic survey for land on either side of proposed Mumbai Trans harbor Link (MTHL) alignment and Bathymetrical survey along the MTHL between Mumbai and Navi Mumbai. Also additional bathymetrical profile one on upstream and another on downstream of proposed MTHL alignment. The results are described in this report.

Survey was based on the survey area details provided by the client .Topographic survey on land was carried out by the total station survey instrument. A locally hired survey boat ML Afrah was used for the bathymetry survey. The weather was not very favorable in the afternoons during the survey period.

2. SURVEY LOCATION

The survey area specified by the client is shown in the Google image below. The coordinates of the survey routes were extracted from the drawing provided by the client.

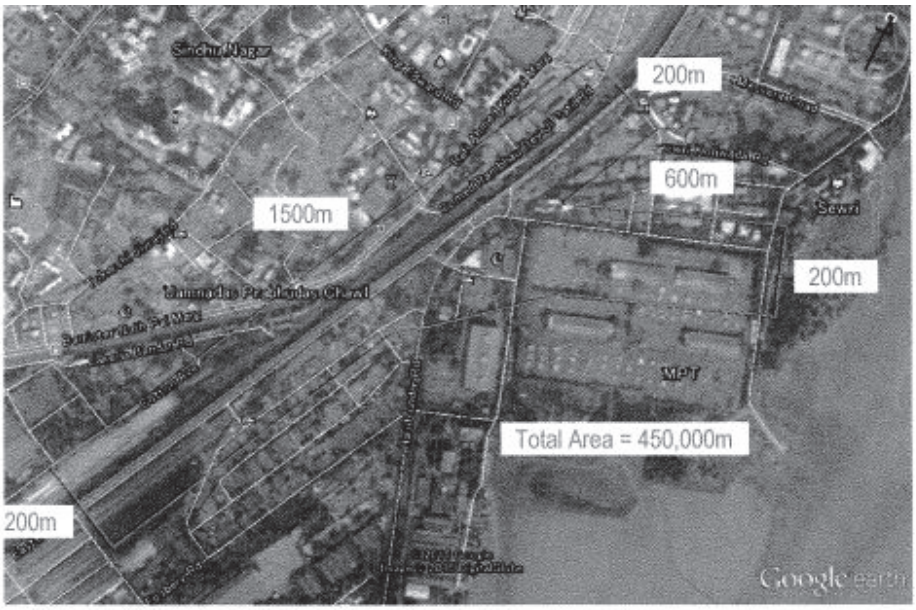


Figure 1:- Plane Survey at Eastern freeway Interchange

Figure 2:- MTHL alignment through Sea Area.

Figure 3:- Shivaji Nagar Survey area.

Figure 4:- Survey area at Chirle

The coordinates for the proposed bridge route (Route 1) are as follows:

Sr.No.	Points	Easting	Northing	Brg/Radius
1	SOL Sewri	274270.9	2101852	
2	TP1	274852.4	2102100	BRG 67
	CP1	275515.6	2100427	R 1800m
3	TP2	276351.4	2102021	
4	TP3	278029.5	2101124	BRG 118
	CP2	279207.8	2103329	R 2500m
5	TP4	279351.1	2100833	
6	TP5	285197.6	2101169	BRG 87
	CP3	285438.3	2096976	R 4200m
7	TP6	288132.4	2100198	
8	TP7	290003.5	2098634	BRG 130
	CP4	289362.1	2097867	R 1000
9	TP8	290263.1	2098300	
10	TP9	290841.9	2097097	BRG 154
	CP5	291382.6	2097357	R 600
11	TP10	291108	2096824	
12	TP11	291666.1	2096537	BRG 117
	CP6	291391.4	2096003	R 600
13	TP12	291990.5	2096038	
14	TP13	292014.7	2095615	BRG 177
	CP7	292414	2095638	R 400
15	TP14	292331.7	2095247	
16	EOL Chirle	292790.3	2095150	BRG 102

Table 1: Main bridge route - coordinates

Notes: SOL = Start of line
EOL = End of line
TP = Tangent Point
CP = Centre Point of curvature
Brg = Bearing of line from previous point
R = Radius of curvature of curved section

The co-ordinates of the control points, A-D, provided by the client for additional routes for seabed profiling are given below:

Survey Route	Points	Easting	Northing
Route 2	A	284033.6	2104918
	B	291903	2100254
Route 3	C	274629.6	2100246
	D	284195.2	2096810

Table 2: Additional routes - coordinates

3. SCOPE OF WORK

3.1 General

The survey scope of work, as understood from the specifications provided by the client included the plane survey by total station centerline profile leveling survey, cross section survey and mapping and reporting. Each field survey work was carried out on land and sea.

Survey on land area

i) Carrie out plane table survey using total station.
ii) Profile leveling survey
iii) Mapping
iv) Collecting information of reference point base level including mean sea level (MSL), chart datum (CD).
v) Photograph of field work
vi) Making drawings
vii) Reporting

Survey on sea Area

i) Provision of survey vessel, personnel, equipment including the positioning equipment and sufficient consumables for the period of survey
ii) Mobilization of a suitable marine spread comprising a survey boat at site for carrying out the survey operations in the proposed location.
iii) Carry out bathymetric survey of the complete 16500mX50m corridor using a multibeam echo sounder.
iv) Carry out topographic survey, where the marine survey is restricted along the route.
v) Carry out bathymetric survey of the two routes, which are about 8 km each, using a multibeam echo sounder.
vi) Process all the survey data and prepare final reports and charts at base office in Navi Mumbai.
vii) The final report will include a description of the bathymetry and seabed profile of the specified routes.

All survey work shall be carried out as per the detailed scope of work and sound professional practices.

3.2 Survey Design

The survey plan designed as per the requirement of the client is given below.

Land Area

Target area Mumbai side – Easter freeway interchange: 450,000 sq.m.
Shiwri Side------ Shivajinagar interchange: 600,000 sq.m.
Chirley Interchange 1,040,000 sq.m.
Navi Mumbai road 1,100,000sq.m.(5,500mx200m)

Sea Area

Target area –Road alignment :825,000 sq.m. (16,500mx50m)

3.2.1 Centerline/Profile leveling Survey

Centerline/Profile leveling survey for instructed lines by the Engineer using the topographic equipments. The length of the lines for centerline leveling survey is followings;

Land

Target Area: Main Road, Mumbai side: l,000m
Eastern freeway 1,500m
Main Road Navi Mumbai side 5,500m
At shivajinagar Interchange 600m
At Chirley Interchange 1,300m
The line for hydrological analysis – 1,200 m

Sea Area

Target area the lines for hydrological analysis 16,540 m.

3.2.2 Cross section

Main Road – main line 17,500(75 line x50m)

Cross roads on land
Eastern freeway: 3,750m (75linex50m)
At shivajinagar Interchange: 1,500m(30 line x 50m)
At Chirle Interchange: 3,250(65 line x50m)

Bathymetric survey

1. Route 1 was surveyed by running two lines using a multibeam echo sounder with an offset of 15m with respect to centre line to cover the required 16500X50m area.
2. Route 2 and Route 3 were surveyed by a single run along their centre lines using a multibeam echo sounder.

4. SURVEY CONTROL

4.1 Geodesy

The survey operations were conducted in the WGS 84 Spheroid, UTM Projection, based on the geodetic parameters presented below. All co-ordinates quoted within this document are with reference to it.

Grid projection	U.T.M zone 43, Northern hemisphere
Latitude of origin	0° equator
Longitude of origin	75° E
False easting	500000 m
False northing	0m
Scale factor on CM	0.9996
Unit	International (m)
Spheroid	**WGS 84**
Semi-major axis (a)	6 378 137.000 m
Semi-minor axis (b)	6 356 752.314 m
Flattening (f)	298.257223563

Table 3 :- –Geodetic parameter

4.2 Vertical Control

Tidal data for all the areas of survey was obtained from the observed tides at Prong's Reef light house. The depth soundings were reduced to Mean Sea Level (MSL), with the help of these tide readings. The following figures show the tide curves (above chart datum) for the days on which the survey was carried out: Mean Sea Level is 2.51m above chart datum (CD).

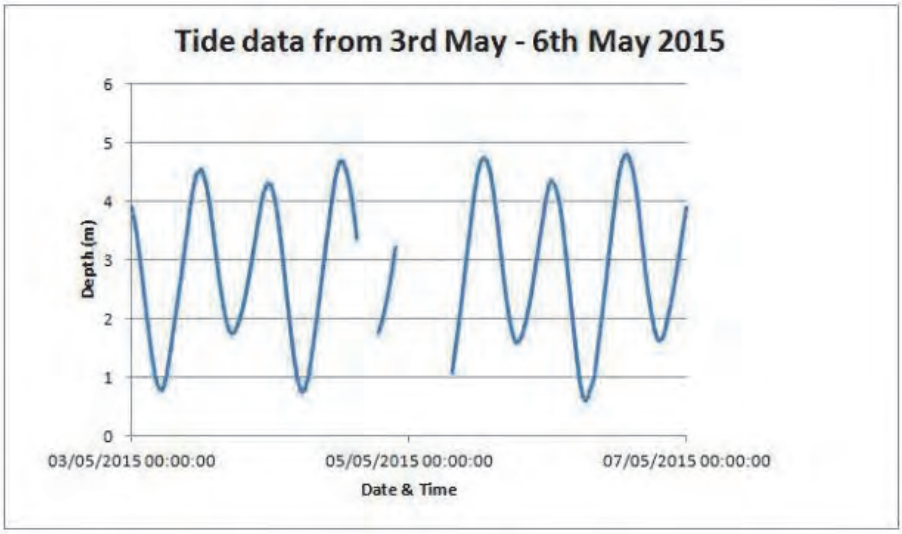


Figure 4A- Tide data from 3rd - 6th May 2015

GPS point co-ordinate (w.r.t. to MSL)

Nhava-Sheva Side			
code	Easting	Northing	RL
GPS3	290717.0470	2098124.4430	6.256
A-25	290533.2421	2098031.9197	4.161
Sewri Side			
code	Eaasting	Northing	RL in m
GPS1	274697.2980	2102049.2090	3.952
CP1	274676.3067	2102068.3715	4.577

Table 4:- GPS Point Co-ordinate On Nhava -Seva Side And Sewri Site

5. PERSONNEL

The following survey personnel were involved in the survey.

Topographic Survey		
Name	**Designation**	**Duration**
Binno Kuruvilla	Chief Surveyor consultant	Project Duration
Prakash Gode	Surveyor	Project Duration
Hari	Surveyor Assistant	Project Duration
Bathymetric survey		
Ravikant RAI	Party Chief	Project Duration
UNNIKRISHNAN K. U.	Hydrographic Surveyor	Project Duration
Atinderpal SINGH	Survey Engineer	Project Duration
Sangramjeet BEHERA	Survey Engineer	Project Duration
Usha KADAM	Data Processor (at base office)	Project Duration
Samson CHACKO	Sr. Data Processor (at base office)	Project Duration

Table 5:-Survey Personal

5.1 HSE Management System

The project manager took responsibility for all HSE related issues during the survey. Prior to survey, the party chief carried out a safety briefing for the survey personnel. The survey operations were performed in day-light hours and regular safety “tool-box” meetings were conducted to ensure smooth deck operations for the deployment and recovery of survey sensors. All HSE related measures were fully implemented to the survey team during the course of the survey.

6. SURVEY EQUIPMENT DETAILS

6.1 Land Survey

Topographical survey

The topographical survey was carried out using Total survey Equipment.

GPS point marking

GPS benchmark on two sides of MTHL alignment Two on Sewri side and other Two on Nhava-Sheva side was marked using the GPS instrument.

6.2 Sea Survey

Bathemetric Survey

The survey work was carried out using the vessel named ML Afrah. The equipment used for the survey is described below.

6.2 .1 DGPS Positioning and Navigation

A Veripos positioning system was used for vessel positioning and for tracking the deployed sensors. Other positioning data, including vessel's heading data were logged at 1-second updates in the QINSy navigation software. The position and offset information calculated by the navigation system were stored in the navigation computer and used for post processing. The system provided the necessary output to the surveyors' terminal and to the helmsman monitor for smooth navigation. It collected, displayed, and logged various positions and quality information, event marks at 25m intervals and additional on-line quality assessment. These data were displayed graphically in real-time and were available for subsequent post-processing.

6.2.2 Gyro Compass

An SG Brown Meridian surveyor gyrocompass was used to provide vessel heading information to the navigation system. The alignment and calibration of the heading sensor on board ML Afrah was performed before the mobilisation of the vessel. The sensor was calibrated by comparing the vessel heading against a known baseline. The vessel heading was established by taking simultaneous bow and stern offset measurement readings.

6.2.3 Single Beam Echo Sounder system

Bathymetry data was acquired using a dual frequency 33/210 kHz Echotrac DF 3200 MK III single beam echo sounder. A hard copy (paper) record was produced in real-time, annotated with line name, fix number, time and date. The digital output was logged by the navigation computer for post-processing. The system was heave compensated using a DMS 05 unit.

Calibration

The echo sounder was calibrated at the survey location by conducting a bar-check. The bar-check is carried out by lowering a horizontal steel plate to a known, fixed depth below the water surface and directly below the echo sounder transducer. Reflections from the plate at different depths are then recorded and adjustments made to the settings for sound velocity and draft to get accurate results. A bar-check was carried out once a day (provided with the Mobilisation Report) for the duration of the survey and the average speed of sound obtained was entered into the unit.

6.2.4 Multi Beam Echo Sounder

A GeoAcoustics Geoswath Plus multibeam echo sounder (250 kHz, as per client requirement) was used to delineate the topography of the seabed in order to locate any object that may be seen to disturb the general seabed. Measured sound velocity and observed tide was fed into the system during data processing.

6.2.5 Sound Velocity Probe

An AML SV Plus sound velocimeter was used to obtain a sound velocity profile of the entire water column every morning before the start of the survey. The average velocity obtained was used to calibrate the single beam as well as the multi beam echo sounders.
6.7 ATG and Tide Pole Tides were observed using a Valeport Tidemaster tide gauge. The observed tidal data was used to correct the acquired bathymetric soundings to Mean Sea Level.

6.2.6 ATG and Tide Pole

Tides were observed using a Valeport Tidemaster tide gauge. The observed tidal data was used to correct the acquired bathymetric soundings to Mean Sea Level.

Figure 5- GPS instrument

Figure 6--- Survey Vessel Ml-Alfra

7. DATA PROCESSING AND INTERPRETATION

7.1 Topographical Survey.

Total station instrument has capability to calculated reduced levels and coordinates with reference to benchmark. All the data is imported to autocad format to construct the profile and cross section.

7.2 Navigation Data

Navigation data was processed using QINSy software. Raw DGPS and gyro data were processed and merged to form an edited vessel track file. The final navigation data was reviewed in AutoCAD to confirm the validity of equipment position versus ship position and to aid in the correlation between navigation data and chart location.

7.3 Bathymetric Data

Multi beam echo sounder

The vertical datum for all bathymetric measurements was Mean Sea Level (MSL). Observed tidal data at Prong's Reef light house was used to reduce the acquired bathymetric soundings to MSL.

GeoSwath Plus multi beam echo sounder data was processed in the GeoSwath+ package itself.

Recorded depth data was corrected for transducer draft and changes in acoustic velocity through the water mass as measured by the sound velocity probe.

Seabed Gradient Classification

The following terms were used to describe the seabed gradients while explaining the bathymetry of the area of survey at and around the breakwater.

CLASSIFICATION	GRADIENT (in terms of Degrees and Slope Interval)	
Very Gentle	<1°	< 1 in 57
Gentle	1° – 4.9°	1 in 57 to 1 in 11.7
Moderate	5° – 9.9°	1 in 11.7 to 1 in 5.7
Steep	10° – 14.9°	1 in 5.7 to 1 in 3.7
Very Steep	>15°	> 1 in 3.7

Table 6: Classification of gradients

Gradients documented in the report should be taken as an indication of general slopes for the area. The localised gradients, particularly near features such as depressions or trenches may occasionally be steeper.

Single beam echo sounder

Single beam data from the Echotrac MKIII echo sounder was processed using the QINSy navigation package and this data was mainly used for navigation purposes. Recorded depth data was adjusted for transducer draft and changes in acoustic velocity through the water mass as measured during the bar-check.

This report was prepared following the data processing and interpretation phase, at OSaS's data processing centre in Navi Mumbai.

7.4 Charting

The results of the survey are presented in two charts as follows:

Chart No.	Scale	Description
OSaS_P19415_SOWiL_Mum_Bathy_01	1:5000	Bathymetry Chart - Route 1
OSaS_P19415_SOWiL_Mum_Bathy_02	1:5000	Bathymetry Chart - Route 2 & Route 3

Table 7:- Charting table

8. DISCUSSION OF SURVEY RESULTS

The descriptions below pertain to the results of the multibeam echo sounder survey conducted in the three survey routes as per the coordinates provided by the client.

The water depths mentioned in this report and associated charts are reduced to mean sea level (MSL) using the observed tide at Prong's Reef light house. The negative depths are depths below MSL and positive depths area heights above MSL. The tide-corrected bathymetry is contoured at 1m intervals to clearly bring out the undulating topography of the seafloor within the survey area. The descriptions below pertain to the results of the multibeam echo sounder survey conducted in the three survey routes as per the coordinates provided by the client. The water depths mentioned in this report and associated charts are reduced to mean sea level (MSL) using the observed tide at Prong's Reef light house. The negative depths are depths below MSL and positive depths area heights above MSL. The tide-corrected bathymetry is contoured at 1m intervals to clearly bring out the undulating topography of the seafloor within the survey area.

8.1 Route 1

8.1.1 Marine Survey

Refer to Chart No. OSaS_P19415_SOWiL_Mum_Bathy_01

Survey route 1 is the proposed MTHL bridge route. For ease of reporting, the description is based on the kilometre post (KP) of the survey route. The survey is restricted west of KP 1.65 due to shallow depth and exposed rocks. Permanent fishing stakes on the eastern side of the survey area restricted the shoreward approach of survey vessel after KP 15.37.

A minimum water depth of -0.1m below MSL is observed at the western part of the survey area while a maximum depth of -10.0m below MSL is observed in the centre part of the survey area. The highest depth contours of -1m is observed in the western part of the survey area around KP2.5. Beyond this point the seabed slopes gently towards the -2m contour at KP3.04.

A rocky headland, approximately 425m wide and covered by mangroves, is observed at KP3.35. The survey vessel had to maneuver around this headland and depth contours of -1m below MSL are observed around this area.

The seabed shows an irregular surface with a depth difference of 1m from KP3.74 to KP4.06. Beyond this point the seabed is smooth up to KP4.61. Between KP4.61 and KP4.94 the seabed is irregular and the depth contour changes from -2m to -4m. Beyond this point the

seabed slopes very gently towards east down to the -9m contour with an average gradient of 1 in 171 up to KP6.01, interrupted by an irregular seabed due to Pirpau jetty at KP5.84. The depth then decreases gently beyond KP6.01 and reaches -7m contour at KP6.14. Between KP6.14 to KP7.78 the seabed is smooth within a contour level of -7m. It slopes towards east from KP7.78 to KP7.93 with an average gradient of 1 in 75 and attains a depth contour level of -9m. Beyond KP7.93, the water level decreases towards east up to KP12.35 where it reaches a depth contour level of -5m and continues up to KP13.48 with a local rise of seabed from KP12.35 to 12.69. Beyond. KP13.48, the water level decreases towards southeast along the route and reaches a minimum contour level of -2 at the south eastern limit of the survey vessel approach at KP15.37.

8.1.2 Topographic Survey

A topographic survey was conducted in the areas inaccessible to the marine survey before KP1.65 and after KP15.37.

In the western end of the survey area, the topographic survey results a maximum elevation of 2.6m above MSL near Sewri wharf at KP0.5. Beyond KP0.5 the elevation decreases gradually and reaches a minimum contour level of 0m at KP1.37 and remains same up KP1.55. The depth further decreases towards east and reaches a maximum depth of -0.1 below MSL at the marine survey limit in the western end.

In the eastern end of the survey area, a maximum elevation of 0.6m above MSL is observed in the extreme end of the survey limits at KP16.45. From KP16.45 the elevation decreases gradually towards northwest and reaches a maximum depth of -1.80m at marine survey limit in the eastern end.

8.2 Route 2

Refer to Chart No. OSaS_P19415_SOWiL_Mum_Bathy_02

Survey route 2 is north of the proposed MTHL bridge route. A minimum water depth of -0.3m below MSL is observed at the northwestern end of the survey route while a maximum depth of -9.1m is observed in the southeastern part of the area. From this minimum depth in the northwestern part, the depth increases gradually towards southeast and reaches a maximum contour level of -8m with an average gradient of 1 in 272. Thereafter the seabed shows an average gradient of 1 in 381 towards southeast and reaches a depth contour of -2m from contour -8m. The seabed exhibits an increase in depth with an average gradient of 1 in 45 and reaches a maximum contour level of -8m before the depth decreases gradually towards southeast and attain a minimum contour level of -2m.

8.3 Route 3

Refer to Chart No. OSaS_P19415_SOWiL_Mum_Bathy_02

Survey route 3 is south of the proposed MTHL bridge route. 1540m of survey route was not accessible due to the obstruction caused by Elephanta Island. A minimum water depth of -1.9m below MSL is observed near the northwest of Elephanta Island which is in the southeastern part of the survey route. A maximum depth of -19.8m is observed at the extreme southeastern part of the survey route. The depth at the northwestern extremity of the survey boat approach is -3.1m, rapidly dipping to the -4m contour, again gently increasing to -3m with a gradient of 1 in 199. Thereafter the depth increases to a contour level of -7m and again reduces to -3m. The central part of the route shows a minimum depth contour of -3m after which the seabed slopes gently towards southeast with an average gradient of 1 in 80, reaching a maximum contour of -14m. Beyond this point the depth decreases further southeast and reaches a minimum depth contour of -2m with an average gradient of 1 in 83 near the northwest of Elephanta Island. The route continues on the south east side of Elephanta Island with a contour level of -3m and increases southeastwards with an average gradient of 1 in 51 and reaches a maximum contour level of -19m at the end of the approach of the survey boat.

9. OBSERVATIONS

The following observations were identified within the survey areas.

1. Survey route 1 is the proposed MTHL bridge route. A minimum water depth of -0.1m below MSL is observed at the western part of the survey area while a maximum depth of -10m below MSL is observed in the centre part of the survey area.

2. Topographic survey conducted in the western and eastern end of the survey route 1. In the western end a maximum elevation of 2.6m above MSL and a maximum depth of -0.1m below MSL is observed while a maximum elevation of 0.6m above MSL and a maximum depth of -1.80m below MSL is observed in the eastern end..

3. Survey route 2 is north of the proposed MTHL bridge route. A minimum water depth of -0.3m below MSL is observed at the northwestern end of the survey route while a maximum depth of -9.1m below MSL is observed in the southeastern part of the area.

4. Survey route 3 is south of the proposed MTHL bridge route. A minimum water depth of -1.9m below MSL is observed near the northwest of Elephanta Island which is at the southeastern part of the survey route. A maximum depth of -19.8m observed at the extreme southeastern part of the survey route

5. Permanent fishing stakes in the eastern side of the survey area restricted the further approach of survey vessel beyond KP15.37.

6. The survey was restricted at either end of the route due to shallow depth and exposed rocks. These gaps were filled by a land survey team.

10. EXTRACTS OF SURVEY RECORDS

The following figure shows the sun illuminated image of survey routes from multibeam echo sounder data:

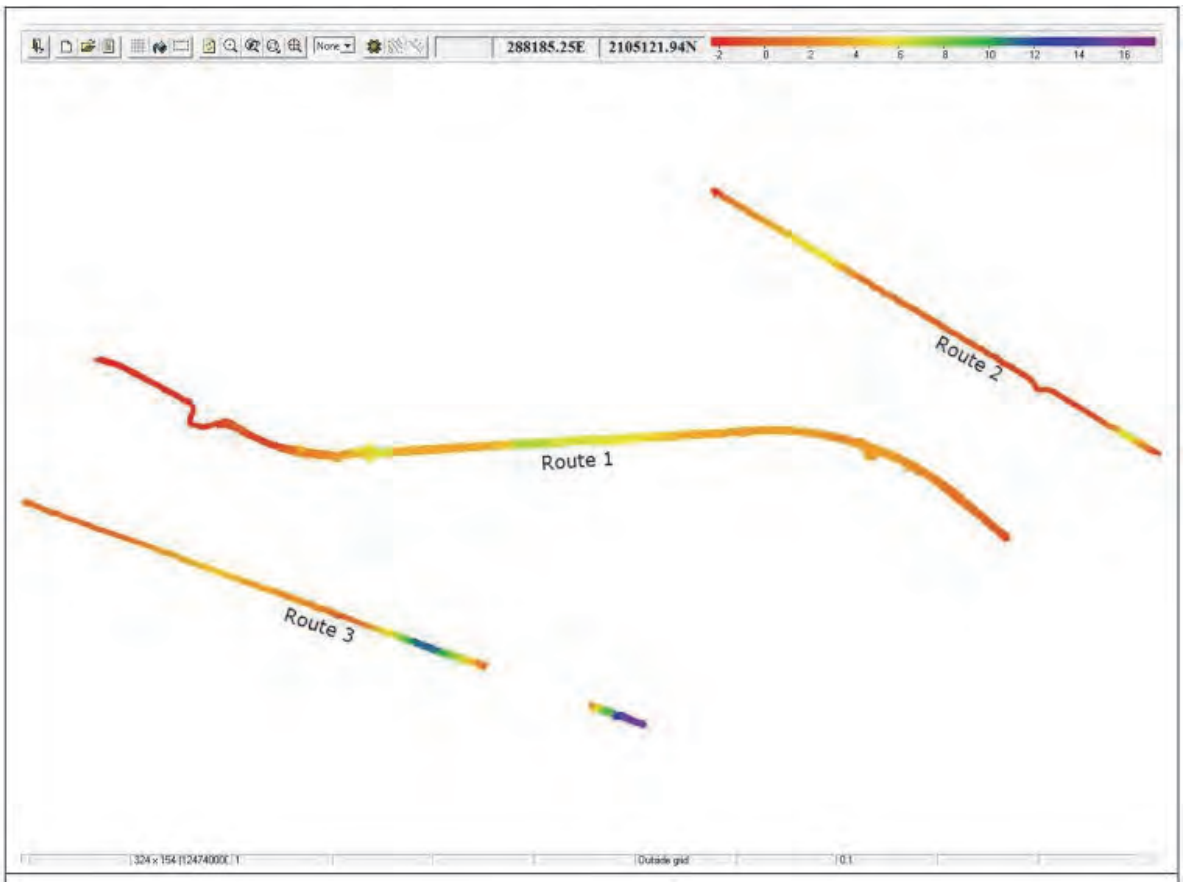


Figure 7Sun illuminated multibeam image of survey routes

11. FIELD PHOTOGRAPHS

Figure 8:-topographic survey work at Seweri Site

Figure 9 GPS point no. 1 on Sewri site at MBPT

Figure 10:- GPS point 2 on Sewri site at Koliwada Road

Figure 11:-topographic survey work at JNPT site NH4B

Figure 12 . Survey work at Chirle

Figure 13 . Central railway line crossing the alignment of MTHL at Jasai

Figure 14. Figure showing the alignment of MTHL at Ghavan Gaon

Figure 15 :- Figure showing the alignment of MTHL at Ghavan Gaon

Bathymetric Survey Photo

Figure 16 Exposed headland at KP3.35

Figure 17 Another view of exposed headland at KP3.35

Figure 18 Pir Pau Jetty at KP5.88

Figure 19 Exposed fishing stakes at KP15.70

Annexure -1 --------MOBILISATION REPORT

1 Introduction

This report documents the mobilisation and calibrations carried out by OSaS on board ML Afrah for bathymetric survey for the Mumbai Trans Harbour Link route from Sewri, Mumbai to Chirle, Navi Mumbai.

The survey vessel was already mobilised for an ongoing project at JNPT. The testing and tuning of the survey equipment, including Gyro and DGPS calibration were carried out on 16 th April 2015. Multi beam echo sounder calibrations were carried out on 18th April.

2 HSE Checks

A safety induction was given by the party chief prior to sailing, detailing personnel responsibilities in the event of an emergency, muster station locations and procedures, life jacket locations, safety gear locations and procedures and signals for emergencies. Additional life jackets were placed in work areas to provide easy access for working crew. Back deck procedures were explained and enforced with no single man operations and all non-essential personnel keeping clear of operations. PPE included safety boots, hardhats and cover-all for all personnel involved in back deck operations.

3 Survey Equipment

3.1 Navigation and Positioning

Item	Quantity
Veripos LD-2 DGPS system with cables	1
Navigation computer with QINSy software	1
SG Brown Meridian gyro Compass	1
Moxa 8-port cable	2

Table8:- Navigation and Positioning equipment

3.2 Single Beam Echo Sounder

Item	Quantity
33/200 kHz Odom Echotrac DF 3200 MK III	1
Dual frequency transducer and mounting pole	1
TSS DMS-05 motion sensor unit	1
Bar check	1

Table 9:-Single beam eco sounder

3.3 Multibeam Echo Sounder system

Item	Quantity
Geoswath+ 250 KHz transducer	1
Geoswath+ acquisition unit	1
AML SV Plus sound velocity probe	1

Table -10 Multibeam Echo Sounder system

3.4 Automatic Tide Gauge

Item	Quantity
Valeport Tidemaster automatic tide gauge	1
Transducer & cable	1
Memory module	1

Table 11:- Automatic Tide Gauge

3.5 Miscellaneous

Item	Quantity
Power distribution box and cable	5
Stabilizer	2
6 KVA generator	2
Computer	1
Laptop	1
LCD monitor	3
24V power supply	2
Serial extensions and RS232 cables	2 sets
Helmets / life jackets	5

Table 12:- Miscellaneous

4 Vessel Offsets

The equipment offsets for the vessel ML Afrah are given in Figure 9

XYZ Offsets In metres

Offset Name	X	Y	Z
COG	0.00	0.00	0.00
DGPS	3.75	-1.34	1.30
SBES	3.35	0.41	-1.00
MBES	3.75	-1.34	-1.30

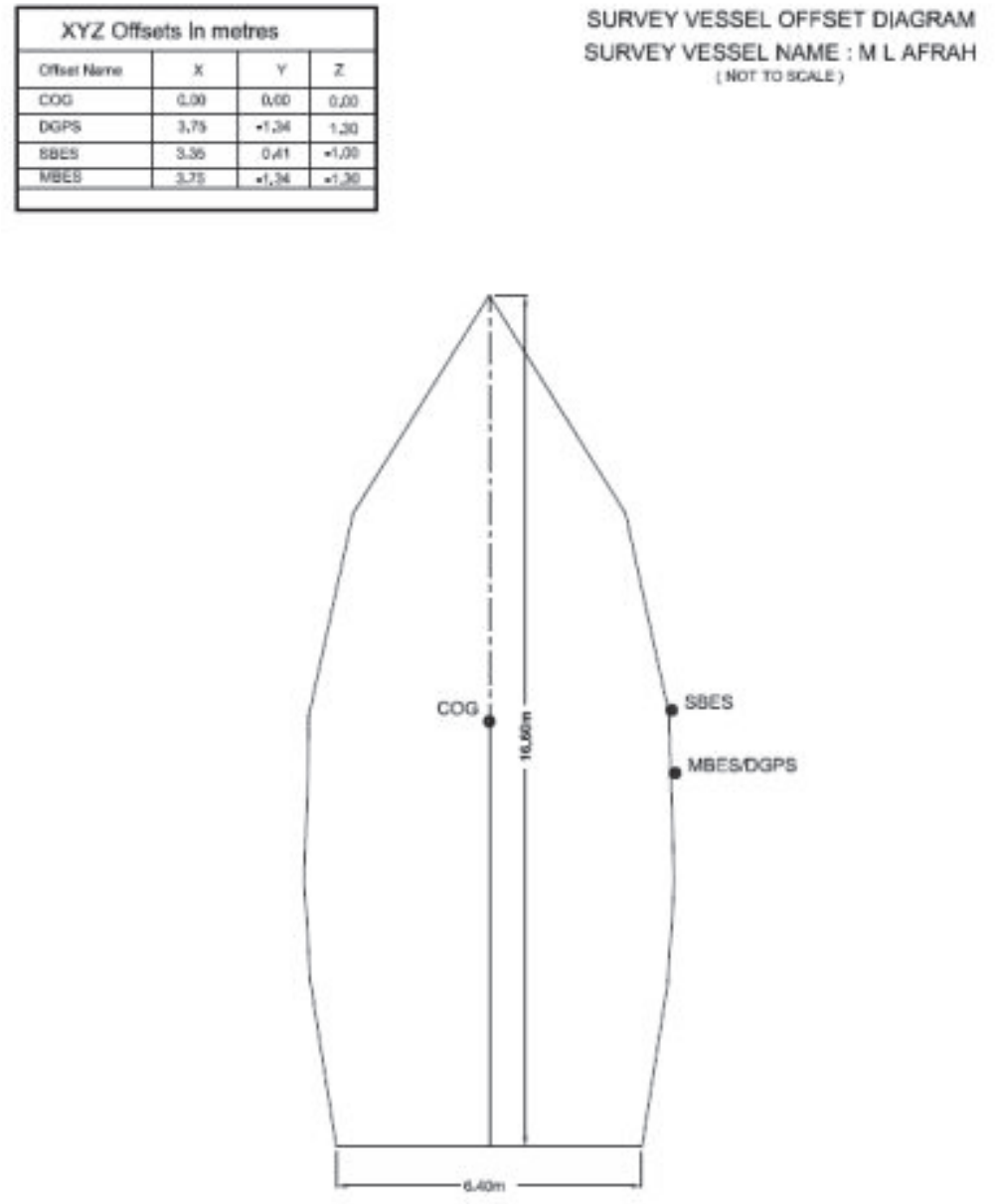


Figure 20—Survey Vessel offset diagram

5 DGPS Calibrations

The details of the DGPS calibration are as follows:

In order to determine the integrity and reliability of the positioning system, the system was checked for its consistency during mobilisation.

This position comparison check was conducted for the Veripos DGPS positioning system when the vessel ML Afrah was berthed at Landing jetty (JNPT) on 16th April 2015.

The antenna of the DGPS was set up at a point on the Landing Jetty the coordinates of which have already been established, for a period of 10 minutes and the position was logged in the QINSy software.

The difference was found to be within the permissible accuracy limit as mentioned in the DGPS position comparison shown in the table overleaf.

	DGPS POSITION COMPARISON	Form No	Sv32R
		Revision	0
		Date	1-Jan-2019
		Approved by	PKT

Job No	P19215	Project	Bathymetry & Seismic Survey
Client	JNPT	Vessel	ML Aftab
Location	Landing Jetty (JNPT, Mumbai)	Date	16-Apr-15

EQUIPMENT	PRIMARY		SECONDARY	
Item	Type	Serial No	Type	Serial No
GPS Receiver	LD 4 Veripos			
GPS Antenna				
RTCM Receiver				
RTCM Antenna				

PRIMARY DGPS CHECK		Given Location					
No	Time	Computed E	Computed N	Observed E	C-O	Observed N	C-O
1	16:40	283158.34	2095896.64	283158.39	-0.05	2095896.69	-0.05
2	16:41	283158.34	2095896.64	283158.37	-0.03	2095896.67	-0.03
3	16:42	283158.34	2095896.64	283158.38	-0.04	2095896.64	0.00
4	16:43	283158.34	2095896.64	283158.40	-0.06	2095896.63	0.01
5	16:44	283158.34	2095896.64	283158.36	-0.02	2095896.66	-0.02
6	16:45	283158.34	2095896.64	283158.36	-0.02	2095896.65	-0.01
7	16:46	283158.34	2095896.64	283158.38	-0.04	2095896.69	-0.05
8	16:47	283158.34	2095896.64	283158.38	-0.04	2095896.69	-0.05
9	16:48	283158.34	2095896.64	283158.36	-0.02	2095896.71	-0.07
10	16:49	283158.34	2095896.64	283158.35	-0.01	2095896.68	-0.04
Comments				Mean C-O	-0.03	Mean C-O	-0.03
				S.D.	0.01	S.D.	0.02

SECONDARY DGPS CHECK							
No	Time	Computed E	Computed N	Observed E	C-O	Observed N	C-O
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
Comments				Mean C-O		Mean C-O	
				S.D.		S.D.	

SIGNED			
Position	Name	Signature	Date
Engineer	Alinder Singh, Snr. Engineer		16-Apr-15
Party Chief	Praveen Kumar, Sr. Surveyor		16-Apr-15

Table 13 :- DGPS Position Comparison

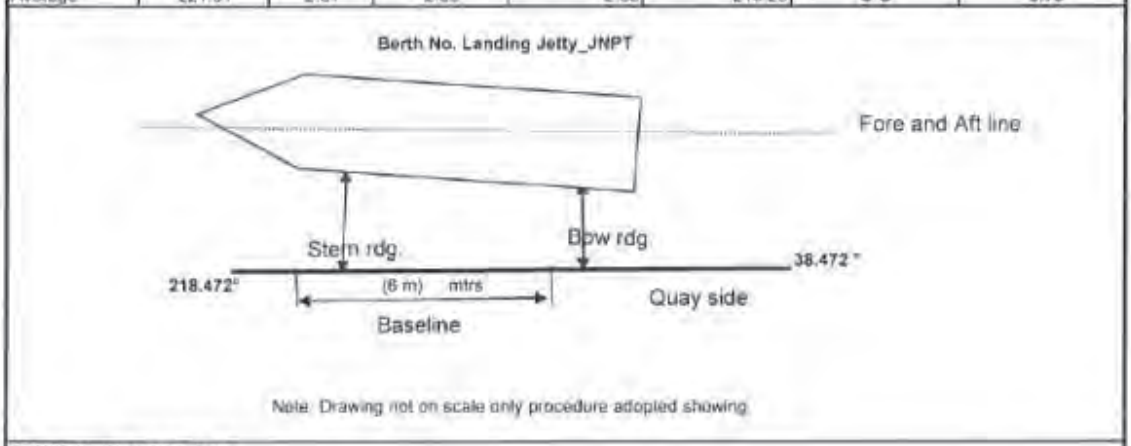
6 Gyro Compass Calibration

A Meridian Surveyor gyro compass was used to provide vessel heading information to the navigation system and single beam echo sounder. The vessel's heading data was logged in the QINSy navigation software. The gyro was calibrated at JNPT Landing Jetty during mobilisation.

	GYRO CALIBRATION (to be filled in Excel format only)	Form No:	SV37R
		Revision:	0
		Date	1-Jan-2010
		Approved By:	PKT

Vessel	Gyro	Location	Date
ML Afrah	Meridian	Landing Jetty (JNPT Mumbai)	16-Apr-15
Quay heading (true) 218.472	Baseline length(m) 6		Quayside on: Port

Observations				Calculations			C-O
Time	Gyro (true)	Bow	Stern	Calc. angle	Calculated Heading	Quay Heading	
15:52:00	221.6	2.79	2.52	2.58	219.02	218.472	-0.55
15:55:00	222.1	2.82	2.54	2.67	219.43	218.472	-0.96
15:57:00	222.2	2.78	2.53	2.39	219.81	218.472	-1.34
15:59:00	221.7	2.81	2.54	2.56	219.12	218.472	-0.65
16:01:00	221.6	2.84	2.55	2.77	218.83	218.472	-0.36
16:03:00	222.2	2.81	2.52	2.77	219.43	218.472	-0.96
16:05:00	222.0	2.83	2.53	2.86	219.14	218.472	-0.67
Average	221.91	2.81	2.53	2.66	219.26	C-O	-0.78



GENERAL INFORMATION

Project Name & No.	P19215
Client:	JNPT
Date of Survey	16-Apr-15
Vessel:	ML Afrah
Owner	Mr. Altaf
Projection:	UTM
Datum	WGS 84
Gyro SN:	

Signed			
Position	Name	Signature	Date
Surveyor	Unni K (Asst. Surveyor)		16-Apr-15
Party Chief	Praveen Kumar (Sr. Surveyor)		16-Apr-15

Table 14 Gyro Calibration

7 Single Beam Echo Sounder

The average speed of sound through the water column was input to the single beam echo sounder when a bar-check was performed before the start of survey operations. The following Figure 10 shows the bar check extracts of the Odom Echotrac MK III echo sounder used in ML Afrah.

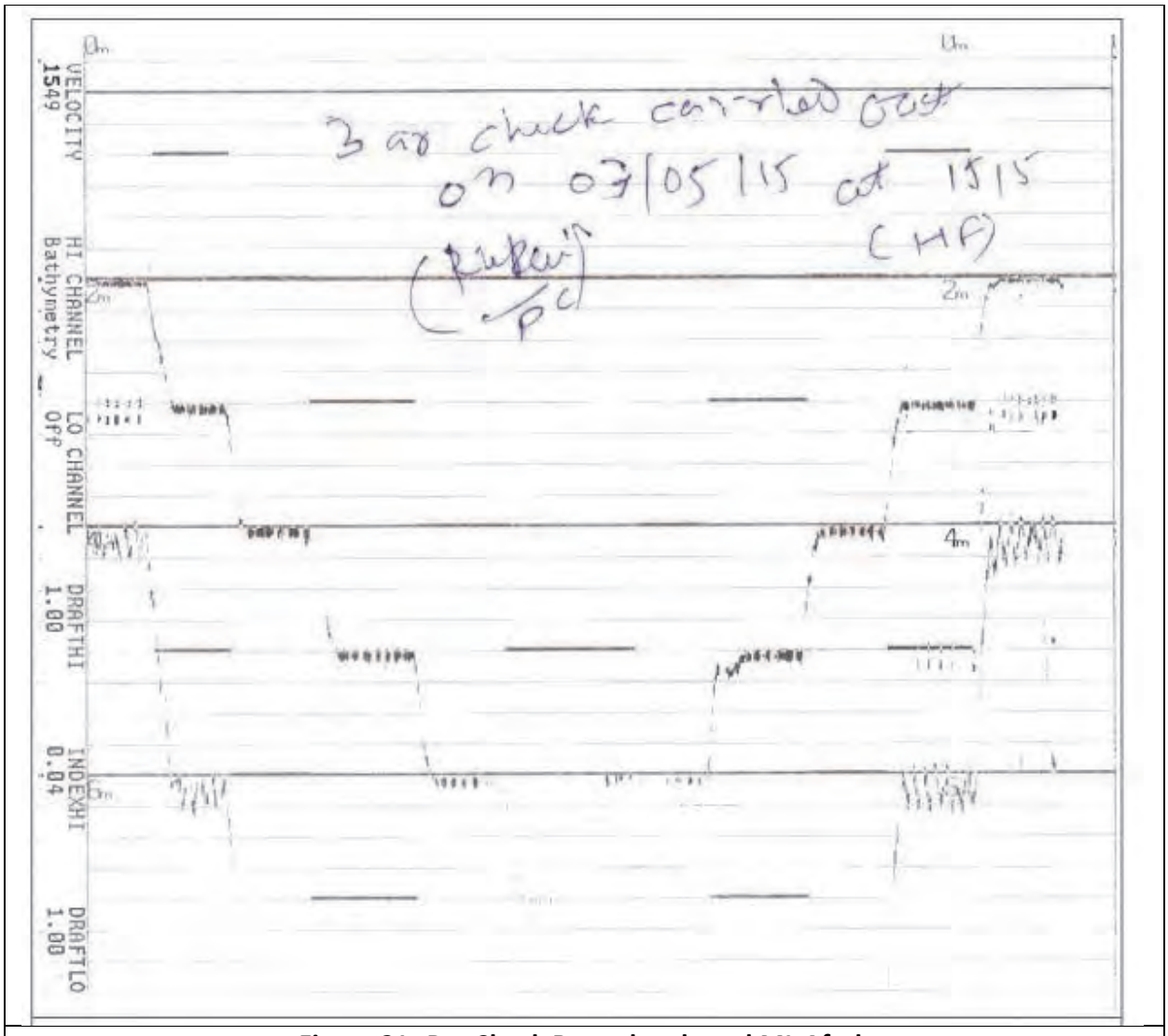


Figure 21:-Bar Check Record on board ML Afrah

8 MBES Calibration

The calibration (or patch test) of the Geoswath Plus (GS+) MBES was used to fix the time and angle offsets between the various positioning systems and the transducer head. This was done after mobilisation.

The system offsets were entered in the acquisition software prior to surveying and raw data acquisition. Some of these were easily measured and entered and others were corrected through the calibration procedure.

Entering Offsets:

The directly measured system offsets are:

--Transducer Sensor Offsets measured as the distance from the COG to the transducer point (X= -1.340, Y= -3.750 m, Z= -1.30m for ML Afrah).

-- Antenna Offsets measured as the distance from the COG to the Antenna (X= -1.340m,Y= -3.750 m and Z= 2.90 m from water line).

--Heave Offset measured as the vertical distance from the centre of the transducer to the water surface (Z= -1.30 m for ML Afrah).

---Time offset (latency) introduced by DGPS computer/ navigation computers or during the serial data transfers.

A DMS 05 motion reference unit provided compensation for vessel motion.

The sound velocity profile (SVP) file and observed tide files were used to get an accurate calibration from a patch test.

Antenna and Sensor Offsets

The antenna and the sensor offsets, measured with the aid of a measuring tape were entered in the Geoswath Plus data acquisition module along with the vessel dimensions. The figure below provides the measured antenna and sensor offsets.

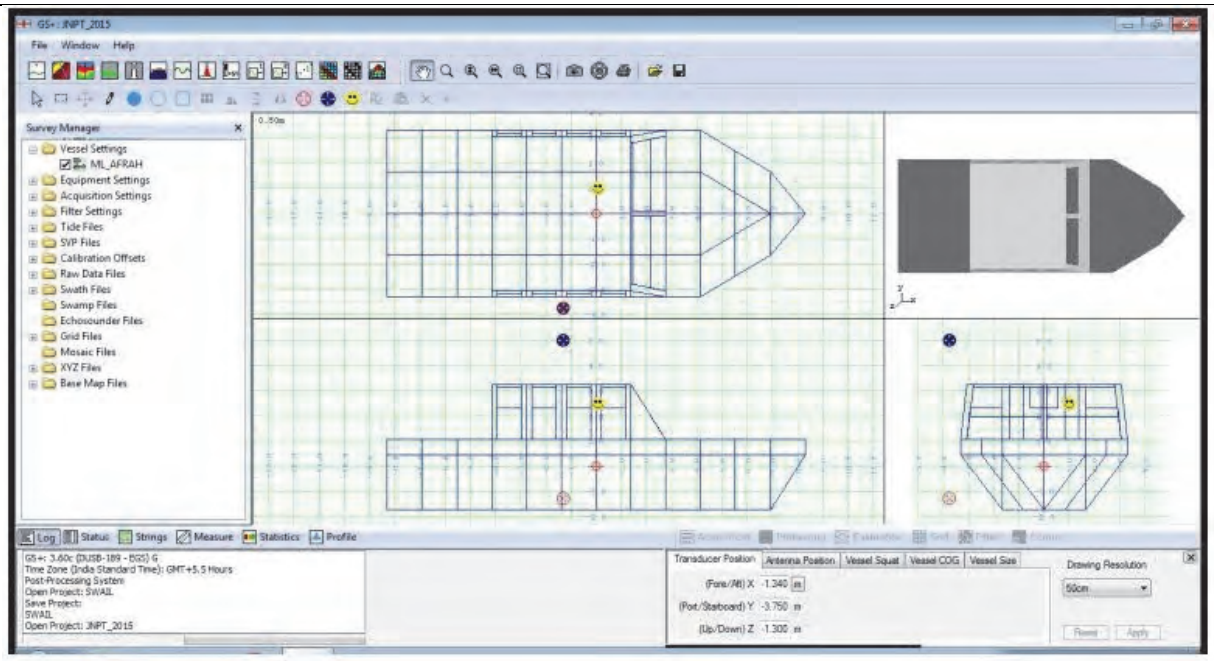


Figure 22:MBES Sensor offsets of ML Afrah

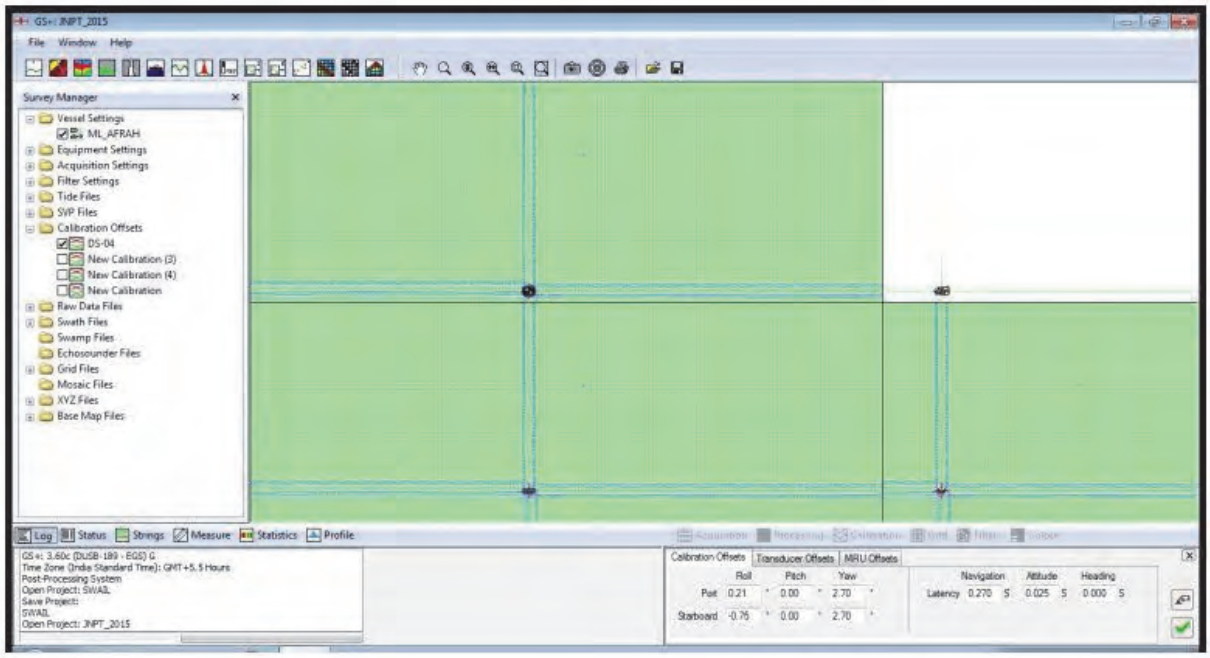


Figure 23:- Calibration offsets

The corrections for these parameters, obtained from the MBES calibration results, are given below:

Parameter	Values	
Latency	0.270s	Veripos LD-2 positioning system.
Port Roll	0.21°	TSS accuracy 0.05° in roll (~3.5cm at 40m)
Starboard Roll	-0.75°	TSS accuracy 0.05° in roll (~3.5cm at 40m)
Pitch	0.00°	
Yaw(Port)	2.70 °	Accuracy better than 0.2°
Yaw(Stbd)	2.70 °	Accuracy better than 0.2°

Table 15 MBES Calibration Results

Figure 13 provides the comparison grid before and after applying the calibration co-efficient.

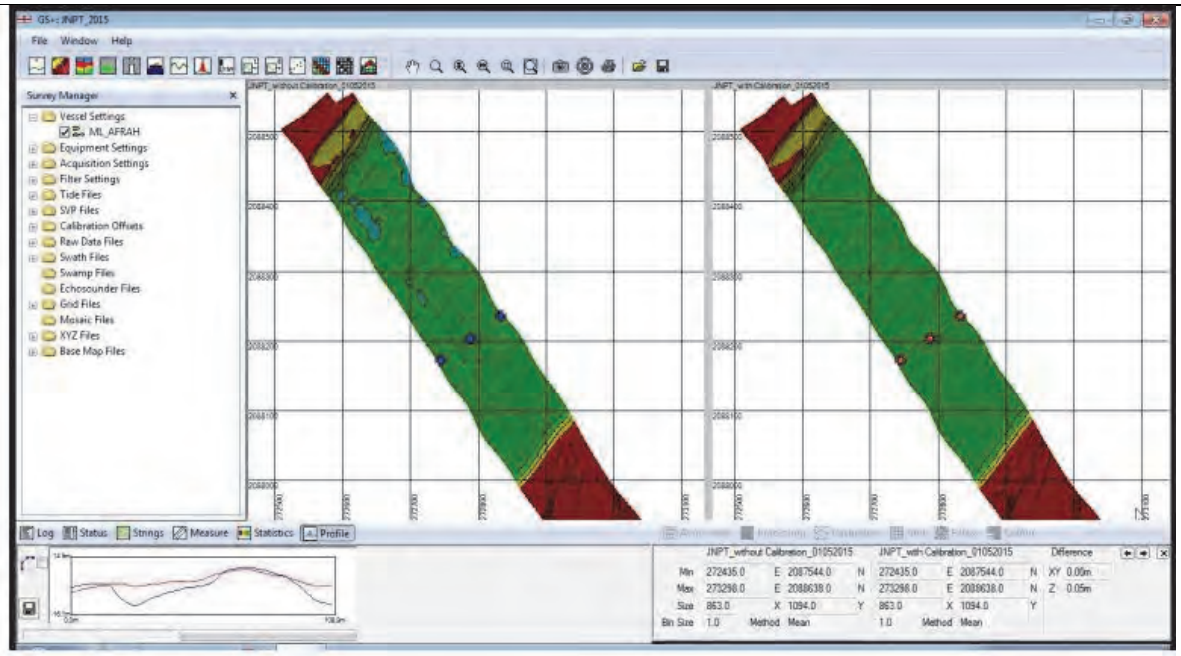


Figure 24. Calibration results with cross profile (left-Without calibration, right –with calibration)

9 Conclusions

Mobilisation for this project, including calibration and verification, were carried out on board ML Afrah in a safe and acceptable manner. All systems performed to the specifications throughout the duration of the survey.

付録-3

Geological Survey Report

ORIENTAL CONSULTANTS
Global Consulting for Sustainable Development

Draft Report

On

Geological Survey for the Preparatory Survey on the Project for Construction of Mumbai Trans Harbour Link

JOB NO. : IDEAL/028/015

August, 2015

Submitted By: **IDEAL GEOSERVICES PVT. LTD.**

B-303, Hermes Atrium, Plot # 57, Sector -11, CBD - Belapur, Navi Mumbai - 400614, Maharashtra, India
Tel : +91 22 65511401 e-mail : info@idealgeo.in

Geotechnical Investigation Report

THE PREPARATORY SURVEY ON THE PROJECT FOR CONSTRUCTION OF MUMBAITRANS HARBOUR LINK, MUMBAI

For

ORIENTAL CONSULTANTS
Global Consulting for Sustainable Development

6F, 3-12-1 Honmachi
Shibuya-Ku,Tokyo
Japan

Submitted By

IDEAL GEOSERVICES PRIVATE LIMITED

B-303, Hermes Atrium
Plot No.57, Sector-11, CBD-Belapur
Navi Mumbai – 400614
.Tel.: +91 22 65511401
E-mail: contact@idealgeo.in

Project No. IDEAL-028-015

Document No. : IDEAL-028-015 Geoechnical Investigation Report_Rev 0

Project Information	
Document Type :	Geotechnical Investigation Report
Project :	The Preparatory Survey on the Project For Construction of Mumbai Trans Harbour link, Mumbai
Client :	Oriental Consultants Global Co. Ltd
Project No. :	IDEAL-028-015
Document No. :	IDEAL-028-015 Geoechnical Investigation Report_Rev 0

Issued To: Oriental Consultants Global Co. Ltd	
For the Attention of :	Mr. Yoshiki Miyazaki / Mr. Y. Nozue
Address :	6F, 3-12-1 Honmachi Shibuya-Ku,Tokyo Japan 6F, 3-12-1 Honmachi
Tel : **Fax :** **Email :**	+81 3 6311 7894 +81 3 6311 8044 miyazaki-ys@oriconsul.com

Issued By: Ideal Geoservices Pvt. Ltd	
Dirrector :	Mr. Sunil Pingle
Address :	Ideal Geoservices Pvt. Ltd B-303,Hermes Atrium, Plot No 57, Sector-11, CBD Belapur, Navi Mumbai.
Tel : Email :	+91 22 65511401 contact@idealgeo.in

Revision Control					
Revision No.	**Description**	**Prepared By**	**Checked By**	**Approved By**	**Issue Date**
0	The Preparatory Survey on the Project For Construction of Mumbai Trans Harbour link, Mumbai	VN	KB	ST	18.08.2015

SQP Volume Description		
Volume Title	**Volume Title**	**Contents**
N/A	The Preparatory Survey on the Project For Construction of Mumbai Trans Harbour link, Mumbai	Results of Field and Laboratory Geotechnical Investigation

Service Warranty

The data presented within the report and associated charts/drawings have been acquired and processed to meet the requirements of the contract as agreed by the **Oriental Consultants Global Co. Ltd**. Any unauthorised use of the information presented within this report and charts/drawings is prohibited. Ideal Geoservices Pvt. Ltd. will not accept any liability if the data is used for purposes other than those agreed in the contract.

Table of Contents

List of Appendices

List of Tables

Page

Abbreviations & Acronyms

The following list of abbreviations and acronyms may be present within the document:

BARC	Bhabha Atomic Research Centre
CD	Chart Datum
dGPS	Differential Global Positioning System
IGPL	Ideal Geoservices Pvt Ltd
JNPT	Jawaharlal Nehru Port Trust
JUB	Jack Up Barge
MPT	Mumbai Port Trust
SBL	Sea Bed Level
SPT	Standard Penetration Test
TD	Termination Depth
UTM	Universal Transverse Mercator
UCS	Unconfined Compressive Strenght
WGS	World Geodetic System
WRT	With Respect To

Reference Colour Code

The following reference colour coding may be used within this procedure:

XXX	Reference to an independent external document.
XXX	Reference to another section or article within this document.
XXX	Important Note / Caution.

EXECUTIVE SUMMARY

Site Location: MTHL – Proposed Alignment

Investigation Date: Commenced from 3rd June 2015.

Key observations:

The sea bed level at the locations where the boreholes are carried out varies from +0.9m CD to -5.60m CD.

The sub sea bed stratigraphy encountered is heterogeneous along the proposed alignment based on the boreholes drilled.

The sub sea bed stratigraphy comprises of top Layer of very soft CLAY in all boreholes except BH-04 and BH-06.

In BH-04 and BH-06 the top layer comprises of SAND.

The sub sea bed in general comprises of overburden followed by weak, highly weathered BASALT underlain by moderatley strong, fresh BASALT.

In BH-03 and BH-06 the rock is encountered at relatively shallow level of -7.40m CD.

In BH04 even at levels below -29.0m CD the rock encountered is weak with UCS value between 5.47MPA to 8.59MPA.

The reason for this relatively low compressive strength is as given below

BH. No	Elevation wrt CD(m)	Reason for low strength	Image
BH-04	-29.54	Because of secondary infillings of the vugs. Secondary infillings are of minerals like calcite, chlorite etc	
BH-04	-30.80	Because weathering extends through out the rock. In some part of the core the rock material is friable	

1. INTRODUCTION

Oriental Consultants Global Co. Ltd (Client) contracted **Ideal Geoservices Pvt. Ltd (Contractor)** to provide Geotechnical Investigation services for "The Preparatory Survey on the Project For Construction of Mumbai Trans Harbour link, Mumbai.

This report **'IDEAL-028-015 Geoechnical Investigation Report_Rev 0.'** presents the data obtained from the field as well as laboratory investigation along the proposed alignment. The Geotechnical Investigation field work was commenced on 3rd June 2015.

1.1. Reference Documentation

1. **Service Agreement dated April 30, 2015.**
2. **Technical Specifications document no *"The Preparatory Survey on the Project for Construction of Mumbai Trans Harbor Link Terms of Reference"*.**

1.2. Scope of Work

The principal objectives of the investigation were to obtain adequate information on the sub sea bed stratigraphy, the type and strength of the soils / rocks below the seabed and other geotechnical details of relevance to enable arriving at the design parameters for foundation of the proposed new structures and to ascertain the compressibility of soil. The entire work was carried out under the supervision of "**Oriental Consultants Global Co. Ltd** representatives.

In order to accomplish the above objectives the scope of work was to drill six (6) Nos. of boreholes upto a depth of 35.0/50.0m below the sea bed or 5.0m into rock with RQD >50% which ever is shallower. The scope of work also includes carrying out standard penetration tests, collection of disturbed and undisturbed samples of soils, logging visually identifiable lithological and engineering characteristics of the soil and rock samples, testing the samples in laboratory for their classification, index and engineering properties and preparation and submission of Geotechnical Investigation report.

The list of the geotechnical boreholes carried out at locations of various proposed structures is presented in **Table-1**.

Sr. No.	Proposed Structure	Boreholes
1	MTHL Bridge Alignment	BH-01 thru BH-06

Table 1: Details of Field Test Locations w.r.t. Proposed Structures

1.3. Schedule of Activities

Investigation Schedule, MTHL, Mumbai			
Sr. No.	Date		Detail of Activities
	From	To	
01	01-05-2015	05-06-2015	Obtaining Permissions from Reliance, MPT,JNPT,BARC, Police, Ambuja cements
02	03-06-2015	10-06-2015	Standby at BH-06 location due to objection by Reliance
03	11-06-2015	10-07-2015	Carrying out 6 Boreholes
04	11-07-2015	17-08-2015	Laboratory Testing, preparation and submission of report

Note: The work was intermittently stopped due to inclement weather and unfavourable sea conditions on account of monsoon and cyclonic activities

Table 2: Schedule of Activities

2. FIELD INVESTIGATION

The field investigation involves mobilization of Marine Spread with drilling rigs and drilling accessories mounted on it, marking the field test location and shifting the marine spread at the designated location, boring in soil, drilling in rock, carry out SPT, collection of UDS. A brief description of the various activities is given below.

2.1. Marine Spread

The marine spread comprises of JUB and two tug boats. The details of these are given below.

2.1.1. Jack Up barge – Aqua Star

A hydraulically elevated JUB "**Aqua Star"** having deck size 12.0m x 10.0m with spuds of length 24.0m was mobilized at the site. A Percussion boring rig along with a hydraulically operated rig supported with water pumps was mounted on the deck. The JUB was assembled at Reti Bunder in Belapur and was towed to the site and from one borehole to another using two Tug Boats named **"MV Dev Raj"** and **"MV Padma Gandha".**

2.2. Position Services

The coordinates of borehole locations were given by the client. The locations were identified at the site using **"Leica 420"** dGPS.

2.3. Setting up at Field Test Location

The location coordinates of the boreholes were supplied by the client. The borehole location was identified in the field using dGSP. A Markey buoy was then dropped at the designated location from the advance boat using dGPS.

The JUB was then towed to the location of the marker buoy using tug boats and was positioned at that location by lowering the hydraulically operated spuds. After Jacking at the location the location coordinates were again observed near the moonpool using the dGPS and these were then recorded as the actual location coordinate of that field test and are presented in Table 3.

The list of proposed and actual coordinates of the borehole locations is given in Table-3.

Sr. No.	B.H. No	Proposed		Actual		Remarks
		Easting (m)	Northing (m)	Easting (m)	Northing (m)	
1	BH-01	276633.00	2101870.00	284389.00	2101122.00	Location shifted because at the original location even during high tide water depth was not sufficient to tow the JUB
2	BH-02	281893.00	2100979.00	281555.00	2100932.00	Location shifted on the instruction of MPT as the original location was falling in the channel of the Old Pir Pau Jetty.
3	BH-03	286953.00	2100893.00	286953.00	2100893.00	
4	BH-04	287119.00	2100824.00	286846.00	2100932.00	Location shifted on the instruction of Ambuja Cement as the original location was falling at the centre of their channel
5	BH-05	287282.00	2100749.00	287282.00	2100749.00	
6	BH-06	288918.00	2099540.00	288918.00	2099540.00	

Table 3: Borehole Location Coordinates

2.4. Boring in Soil

Boring was done in accordance with *IS: 1892 -1979*. A Standard boring winch of 1.5 ton was used for boring in the overburden strata (soil strata) with 150mm dia boreholes. A standard boring winch consists of a drum with rotating wheel where the wire rope was released and tight and one end is through pulley mounted on the tripod. Other end of the wire rope was fixed with sinker bar and shell to bore in the soil. Percussion method was used for boring in the overburden. The winch deployed was generally suitable for all Geotechnical Investigation work and had an arrangement for driving and extraction of casing, boring with percussion method. The boring was continued upto the termination of the borehole.

2.5. Drilling in Rock

The borehole in rock was advanced using rotary drilling technique with the help of a hydraulic feed machine. The coring was done using a NX size double tube core barrel giving a borehole of size 76.0mm and core diameter of 54.5mm. The cores obtained were sequentially stored in the custom built core boxes.

2.6. Standard Penetration Tests (SPT)

SPT's 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 a hammer of mass 63.5 kg (623N) 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 (SPT "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 150 mm penetration were recorded. Small disturbed samples were obtained from the split spoon sampler after completion of the tests.

2.7. Undisturbed Soil Samples

Undisturbed Soil Samples were collected in cohesive soil using thin walled Shelby tubes having nominal diameter of 100mm and minimum length of 450mm.

2.8. Disturbed Soil Samples

Disturbed soil samples were collected from the bailer of the percussion boring.

3. LABORATORY TESTING

Selected soil samples, collected during boring of the boreholes were subjected to laboratory tests to determine the index and engineering characteristics as specified. The samples to be tested, type and

number of laboratory tests to be carried out were decided so as to derive the maximum relevant information. Disturbed samples in SPT split spoons and undisturbed samples in thin walled tubes were collected from the boreholes. The soil samples were visually identified and described in accordance with relevant IS codes and thereafter packed, labelled, sealed and dispatched to the laboratory. The classification, index property, NMC, specific gravity, density, chemical test, shear strength and consolidation tests were carried out on the soil samples. All these tests were carried out in our laboratory at Navi Mumbai, in accordance with relevant parts of Indian Standard Code of Practice. The list of IS and BS codes used is presented in **Table 4** below. The summary of the laboratory test results is presented on Appendix- B in plates B1 through B8. A brief discussion on the laboratory tests conducted is presented in the following sections.

Test Designation	Qty	Applicable Standards	Results Presented in
Tests on soil samples:			
Sieve Analysis	47	IS:2720 (PART -4)	Plates C-1 thru C-16
Hydrometer Analysis	31	-DO-	Do
Atterberg Limit	27	IS:9259 (PART- 5)	Plates C-17 to C-32
Specific Gravity	31	IS:2720 (PART-3)	Plates B-1 thru B-6
Natural Moisture Content	2	IS:2720 (PART-2)	Plates B-1 thru B-6
Bulk & Dry Density	2	IS:2720 (PART-10)	Plates B-1 thru B-6
Unconfined Compressive Strength Test	2	IS:2720 (PART-10)	Plates D-1 to D-2
Consolidation Test	2	IS:2720 (PART-15)	Plates E-1 thru E-2
Uniaxial Compressive Strength of	18	IS 9143	Plates B-7 thru B-8
Point load strength index test on	3	IS 8764	Plates B-7 thru B-8
Porosity, unit weight and water	21	IS 13013	Plates B-7 thru B-8

Table 4: List of IS. Standards and related Tests on Soil & Rock Samples

The samples were tested and the test parameters were selected as per the contract and project requirement. The following tests were performed:

3.1. Laboratory Tests on Soil Samples

3.1.1. Moisture Content & Density

Moisture content, bulk and dry densities were determined for a total of two (2) soil samples, in accordance with the procedures of IS: 2720.

3.1.2. Particle Size Distribution

The particle size distribution was determined for a total of forty seven (47) soil samples in accordance with the method described in IS:2720 (Part 4). Compliance with the Standard, with respect to minimum sample quantity is dependent on the maximum sample available from the field test.

In particular, for downhole hammer/ SPT samples, the quantity of soil available for testing is typically about 100g. This sample quantity is considered representative where grain sizes range up to 4.75mm (i.e. to coarse sand size). Where significant quantities of coarser particles are present, the particle size distribution obtained from such samples should be regarded as indicative only.

3.1.3. Sedimentation/Hydrometer Analysis

Sedimentation analyses have been performed for a total of thirty one (31) 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 (<75µm) of a soil sample. The analysis is 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 theoretically related to the size of particles setting out of suspension.

3.1.4. Atterberg Limits

The Atterberg Limits comprising liquid limit, plastic limit and plasticity index were determined for a total of twenty seven (27) 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. The soil sample preparation, in accordance with the code of practice, included removal of soil particles retained on the 425µm sieve. Accordingly, where a significant quantity of coarser particles was 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.

3.1.5. Particle Density/Specific Gravity

The particle density was determined for a total of thirty one (31) samples in accordance with the small pycknometer method described in IS: 2720 (Part 3/Sec 1). Prior to testing, samples were ground down, if necessary, so as to pass the 2mm sieve.

3.1.6. Consolidation Test

The Consolidation properties of soil were determined by vertical drainage both to top and bottom surfaces. Volume change after every stress application is recorded at intervals of 0, ½, 1, 4, 9, 16, 25, 36, 49, 64min; 1½, 2, 4, 8 and 24 hours. The consolidation test was conducted on two (2) soil sample in accordance with the method of IS:2720 (PART-15.

3.1.7. Unconfined Compressive Strength Test:

Unconfined Compressive strength tests were carried out on two (2) samples as per IS 2720 Part 10.

3.2. Laboratory Tests on Rock Samples

3.2.1. Unit Weight & Specific Gravity of Rock

Unit Weight & Specific Gravity of Rock specimen were determined for a total of twenty one (21) rock samples by using saturation and buoyancy technique, in accordance with the methods of IS: 13030.

3.2.2. Uniaxial Compressive Strength Test

Uniaxial compressive strength for a total of eighteen (18) cylindrical rock specimens was determined, in accordance with the methods of ISRM. 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 (corrected) = (q_c 0.889)/(0.778+(0.222D/H))

Where q_c = Uncorrected Uniaxial Compressive Strength

D = Diameter of the specimen tested

APPENDIX-A - ENGINEERING ILLUSTRATIONS

Project : **Geological Survey for the Preparatory Survey on the Project for Construction of Mumbai Trans Harbour Link**

Job No. : IGPL/028/015

BOREHOLE LOCATION

IDEAL GEOSERVICES PVT. LTD.

BOREHOLE NO. : BH-01

Geotech Contractor : IDEAL GEOSERVICES PVT. LTD.	Job No. : IDEAL/028/015	CLIENT : ORIENTAL CONSULTANTS (ORICONSUL) Global Consulting for Sustainable Development
Project : Geological Survey for the Preparatory Survey on the Project for Construction of Mumbai Trans Harbour Link		SHEET 01 of 03

T.D. (m)	: -28.82 CD	SBL (m)	: -3.32 CD	Equipment Record	: AQUA STAR - JACKUP BARGE
Date Commenced	: 06-07-2015	Circulation Fluid	: Sea Water	Type of Rig	: Hydraulic Rig
Date Completed	: 10-07-2015	Drilling Orientation	: Vertical	Details of Casing (mm)	: SX / HX / NX
				Core-Diameter (mm)	: 54.10

Co- Ordinates E : 284389.00 N : 2101122.00

WATER TABLE

Date	Time	Mtrs.
06-07-2015	03.45 PM	8.00

Sampling Details				Standard Penetration Test (SPT)				Details of Rock core					Symbol	Depth in (m)	Details of Stratum	Soil Clasiification (USC)	Grain Size Analysis (%)				Consistency Limits (%)			Strength Test (kPa)			Consolidation Test			Remarks
	TYPE	From (m)	To (m)	150	300	450	"N" VALUE	TCR %	SCR %	RQD %	W.G	F.I.			Strata Description		GRAVEL	SAND	SILT	CLAY	LIQUID (w_L)	PLASTIC (w_P)	PLASTICITY INDEX (I_P)	UCS C_u	UU c,ϕ	CU c',ϕ'	PreConsolidation Pressure (kPa)	Commpression Index (Cc)	Initial Void Ratio (e^0)	
0		-3.32	-3.82											-3.32	Very soft, dark grey CLAY	CH	0	8	48	44	66	27	39							
1																														
2		-4.82	-5.27	0	0	0	0									CH	0	1	52	47	71	16	55							
3		-6.32	-6.77													CH	0	2	46	52	87	38	49	16			130	0.62	1.699	
4																														
5		-7.82	-8.27	7	11	15	26							-7.82	Very stiff, light yellowish grey CLAY	CH	0	4	72	24	78	32	46							
6		-9.32	-9.77	8	10	17	27									CH	12	2	29	57	79	32	47							
7																														
8		-10.82	-11.27	8	16	24	40									CH	8	6	34	52	82	28	54							
9																														
10		-12.32	-12.67	17	28	50 blows/ 5cm	>100							9.00	Hard, yellowish grey, CLAY with sand and gravels	CH	25	15	27	33	79	32	47							

Abbreviations & Symbols :

□ - SPT ■ - UDS ◪ - DS

W_L - Liquid Limit I_P - Plasticity Index MC - Moisture Content

▥ - Rock Recovery ▨ - No Recovery

TCR - Total Core Recovery SCR - Solid Core Recovery RQD - Rock Quality Designation

⊗ - Field Vane Shear ● - Sample Slipped

W.I. - Weathering Grade F.I. Fractural Index

C.D. Chart Datum, T.D. : Termination Depth, MSL : Mean Sea Level
SBL : Sea Bed Level, EGL : Existing Ground Level, R.L. : Reduced Level

Prepared By : V.N.
Checked By : S.D.
Approved By : S.T.

Plate-A1

付録3-18

付録3-19

BOREHOLE NO. : BH-01

Geotech Contractor : IDEAL GEOSERVICES PVT. LTD.	Job No. : IDEAL/028/015	CLIENT : ORIENTAL CONSULTANTS Global Consulting for Sustainable Development	SHEET 02 of 03
Project : Geological Survey for the Preparatory Survey on the Project for Construction of Mumbai Trans Harbour Link			

T.D. (m)	: -28.82 CD	SBL (m)	: -3.32 CD	Equipment Record	: AQUA STAR - JACKUP BARGE
Date Commenced	: 06-07-2015	Circulation Fluid	: Sea Water	Type of Rig	: Hydraulic Rig
Date Completed	: 10-07-2015	Drilling Orientation	: Vertical	Details of Casing (mm)	: SX / HX / NX
				Core-Diameter (mm)	: 54.10
Co- Ordinates E :	284389.00	N :	2101122.00		

WATER TABLE

Date	Time	Mtrs.
06-07-2015	03.45 PM	8.00

Depth scale	TYPE	From (m)	To (m)	SPT 150	SPT 300	SPT 450	"N" VALUE	TCR %	SCR %	RQD %	W.G	F.I.	Depth in (m)	Strata Description	Soil Clasiification (USC)	GRAVEL	SAND	SILT	CLAY	LIQUID (w_L)	PLASTIC (w_P)	PLASTICITY INDEX (I_P)	UCS C_u	UU c,ϕ	CU c',ϕ'	PreConsolidation Pressure (kPa)	Compression Index (Cc)	Initial Void Ratio (e^0)	Remarks
10														Hard, yellowish grey, CLAY with sand and gravels															
	SPT	-13.82	-14.22	16	40	50 blows/ 10cm	>100								CH	12	14	61	13	66	32	34							
11																													
12	SPT	-15.32	-15.82	10	25	38	63								CL	12	14	42	32	43	22	21							
13	SPT	-16.82	-17.07	40	52 blows/ 10cm	-	>100																						
14																													
15	SPT	-18.32	-18.37	65 blows/ 5cm	-	-	>100																						
16	Rock Recovery	-18.32	-19.82					20	15	-	IV	3.3	-18.32	Very weak, highly weathered, highly fractured, light brownish BASALT															
17	Rock Recovery	-19.82	-21.32					19	3	-	IV	6.7																	
18	Rock Recovery	-21.32	-22.82					70	60	- -	IV	>10																	
19	Rock Recovery	-22.82	-24.32					81	70	-	IV	>10																	
20																													

Abbreviations & Symbols :

- SPT - UDS - DS
- Rock Recovery - No Recovery
- Field Vane Shear - Sample Slipped

W_L - Liquid Limit I_P - Plasticity Index MC - Moisture Content

TCR - Total Core Recovery SCR - Solid Core Recovery RQD - Rock Quality Designation

C.D. Chart Datum, T.D. : Termination Depth, MSL : Mean Sea Level
SBL : Sea Bed Level, EGL : Existing Ground Level, R.L. : Reduced Level

W.I. - Weathering Grade F.I. Fractural Index

Prepared By : V.N.
Checked By : S.D.
Approved By : S.T.

IDEAL GEOSERVICES PVT. LTD.

BOREHOLE NO. : BH-01

Geotech Contractor : IDEAL GEOSERVICES PVT. LTD. | Job No. : IDEAL/028/015 | CLIENT : ORIENTAL CONSULTANTS Global Consulting for Sustainable Development | SHEET 03 of 03

Project : Geological Survey for the Preparatory Survey on the Project for Construction of Mumbai Trans Harbour Link

T.D. (m)	: -28.82 CD	SBL (m)	: -3.32 CD	Equipment Record	: AQUA STAR - JACKUP BARGE	
Date Commenced	: 06-07-2015	Circulation Fluid	: Sea Water	Type of Rig	: Hydraulic Rig	
Date Completed	: 10-07-2015	Drilling Orientation	: Vertical	Details of Casing (mm)	: SX / HX / NX	
				Core-Diameter (mm)	: 54.10	

Co- Ordinates E : 284389.00 N : 2101122.00

WATER TABLE

Date	Time	Mtrs.
06-07-2015	03.45 PM	8.00

Sampling Details				Standard Penetration Test (SPT)				Details of Rock core					Symbol	Depth in (m)	Details of Stratum	Soil Clasification (USC)	Grain Size Analysis (%)				Consistency Limits (%)			Strength Test (kPa)			Consolidation Test			Remarks
	TYPE	From (m)	To (m)	150	300	450	"N" VALUE	TCR %	SCR %	RQD %	W.G	F.I.			Strata Description		GRAVEL	SAND	SILT	CLAY	LIQUID (w_L)	PLASTIC (w_P)	PLASTICITY INDEX (I_P)	UCS C_u	UU c,ϕ	CU c',ϕ'	PreConsolidation Pressure (kPa)	Commpression Index (Cc)	Initial Void Ratio (e_0)	
20															Very weak, highly weathered, highly fractured, light brownish BASALT															
21		-24.32	-25.82					100	100	95	II	4		-24.32	Moderately strong to strong, fresh, bluish grey, BASALT															
22																														
23		-25.82	-27.32					100	100	100	II	27																		
24		-27.32	-28.82					100	100	100	III	3.3																		
25																														
26															BOREHOLE TERMINATED DEPTH AT -28.82 (m)														
27																														
28																														
29																														
30																														

Abbreviations & Symbols :

□ - SPT ■ - UDS ◥ - DS | W_L - Liquid Limit I_P - Plasticity Index MC - Moisture Content

▥ - Rock Recovery ▨ - No Recovery | TCR - Total Core Recovery SCR - Solid Core Recovery RQD - Rock Quality Designation

⊗ - Field Vane Shear ● - Sample Slipped | W.I. - Weathering Grade F.I. Fractural Index

C.D. Chart Datum, T.D. : Termination Depth, MSL : Mean Sea Level
SBL : Sea Bed Level, EGL : Existing Ground Level, R.L. : Reduced Level

Prepared By : V.N.
Checked By : S.D.
Approved By : S.T.

Plate-A3

IDEAL GEOSERVICES PVT. LTD.

BOREHOLE NO. : BH-02

Geotech Contractor : IDEAL GEOSERVICES PVT. LTD. | Job No. : IDEAL/028/015 | CLIENT : ORIENTAL CONSULTANTS Global Consulting for Sustainable Development | SHEET 01 of 03

Project : Geological Survey for the Preparatory Survey on the Project for Construction of Mumbai Trans Harbour Link

T.D. (m)	: -28.54 CD	SBL (m)	: -3.04 CD	Equipment Record	: AQUA STAR - JACKUP BARGE	
Date Commenced	: 02-07-2015	Circulation Fluid	: Sea Water	Type of Rig	: Hydraulic Rig	
Date Completed	: 06-07-2015	Drilling Orientation	: Vertical	Details of Casing (mm)	: SX / HX / NX	
				Core-Diameter (mm)	: 54.10	

Co- Ordinates E : 281555.00 N : 2100932.00

WATER TABLE

Date	Time	Mtrs.
02-07-2015	12.01 PM	7.50

Sampling Details				Standard Penetration Test (SPT)				Details of Rock core					Symbol	Depth in (m)	Details of Stratum	Soil Clasification (USC)	Grain Size Analysis (%)				Consistency Limits (%)			Strength Test (kPa)			Consolidation Test			Remarks
	TYPE	From (m)	To (m)	150	300	450	"N" VALUE	TCR %	SCR %	RQD %	W.G	F.I.			Strata Description		GRAVEL	SAND	SILT	CLAY	LIQUID (w_L)	PLASTIC (w_P)	PLASTICITY INDEX (I_P)	UCS C_u	UU c,ϕ	CU c',ϕ'	PreConsolidation Pressure (kPa)	Commpression Index (Cc)	Initial Void Ratio (e_0)	
0		-3.04	-3.54											-3.04	Very soft, dark grey CLAY	CH	0	0	55	45	58	33	25							
1																														
2		-4.54	-4.99	0	0	0	0									CH	0	1	50	49	65	32	33							
3		-6.04	-6.49	0	0	0	0									CH	0	1	52	47	63	29	34							
4																														
5		-7.54	-7.99													CH	0	1	59	40	80	36	44	4			46	0.85	2.308	
6		-9.04	-9.49	0	0	1	1									CH	0	1	79	20	59	25	24							
7																														
8		-10.54	-10.99	0	0	1	1									CH	0	1	50	49	59	29	30							
9																														
10		-12.04	-12.49	0	1	1	2									CH	0	2	52	46	62	29	33							

小樽3-21

Abbreviations & Symbols :

□ - SPT ■ - UDS ◥ - DS | W_L - Liquid Limit | I_P - Plasticity Index | MC - Moisture Content

C.D. Chart Datum, T.D. : Termination Depth, MSL : Mean Sea Level
SBL : Sea Bed Level, EGL : Existing Ground Level, R.L. : Reduced Level

▥ - Rock Recovery ▨ - No Recovery | TCR - Total Core Recovery | SCR - Solid Core Recovery | RQD - Rock Quality Designation | W.I. - Weathering Grade F.I. Fractural Index

⊗ - Field Vane Shear ● - Sample Slipped

Prepared By : V.N.
Checked By : S.D.
Approved By : S.T.

Plate-A4

IDEAL GEOSERVICES PVT. LTD.

BOREHOLE NO. : BH-02

Geotech Contractor : IDEAL GEOSERVICES PVT. LTD.	Job No. : IDEAL/028/015	CLIENT : ORIENTAL CONSULTANTS Global Consulting for Sustainable Development

SHEET 02 of 03

Project : Geological Survey for the Preparatory Survey on the Project for Construction of Mumbai Trans Harbour Link

T.D. (m)	: -28.54 CD	SBL (m)	: -3.04 CD	Equipment Record	: AQUA STAR - JACKUP BARGE
Date Commenced	: 02-07-2015	Circulation Fluid	: Sea Water	Type of Rig	: Hydraulic Rig
Date Completed	: 06-07-2015	Drilling Orientation	: Vertical	Details of Casing (mm)	: SX / HX / NX
				Core-Diameter (mm)	: 54.10

Co- Ordinates E : 281555.00 N : 2100932.00

WATER TABLE

Date	Time	Mtrs.
02-07-2015	12.01 PM	7.50

Sampling Details				Standard Penetration Test (SPT)				Details of Rock core					Symbol	Depth in (m)	Details of Stratum	Soil Clasification (USC)	Grain Size Analysis (%)				Consistency Limits (%)			Strength Test (kPa)			Consolidation Test			Remarks
	TYPE	From (m)	To (m)	150	300	450	"N" VALUE	TCR %	SCR %	RQD %	W.G	F.I.			Strata Description		GRAVEL	SAND	SILT	CLAY	LIQUID (w_L)	PLASTIC (w_P)	PLASTICITY INDEX (I_P)	UCS C_u	UU c,ϕ	CU c',ϕ'	PreConsolidation Pressure (kPa)	Commpression Index (Cc)	Initial Void Ratio (e_0)	
10															Very soft, dark grey CLAY															
		-13.54	-13.99	7	11	13	24							-13.54	Very stiff, greyish brown sandy CLAY with gravels	CH	15	31	26	28	54	23	31							
11																														
12		-15.04	-15.54	27	31	38	69							-15.04	Very dense, brownish, SAND with gravels	SP	6	94		0	-	NP	-							
13		-16.54	-16.86	30	35	50 blows/ 20cm	>100									SP	12	87		1	-	NP	-							
14																														
15																														
		-18.04	-18.49	18	24	28	52									SP	10	88		2	-	NP	-							
16																														
		-19.54	-19.99	17	24	34	58								- gravels not found below -19.45 m CD	SP	0	99		1	-	NP	-							
17																														
18		-21.04	-21.24	28	54 blows/ 5cm	-	>100									SP	0	99		1	-	NP	-							
19																														
20		-22.54	-22.79	35	54 blows/ 10cm	-	>100									SP	0	99		1	-	NP	-							

Abbreviations & Symbols :

- SPT - UDS - DS
- Rock Recovery - No Recovery
- Field Vane Shear - Sample Slipped

W_L - Liquid Limit I_P - Plasticity Index MC - Moisture Content

TCR - Total Core Recovery SCR - Solid Core Recovery RQD - Rock Quality Designation

C.D. Chart Datum, T.D. : Termination Depth, MSL : Mean Sea Level
SBL : Sea Bed Level, EGL : Existing Ground Level, R.L. : Reduced Level

W.I. - Weathering Grade F.I. Fractural Index

Prepared By : V.N.
Checked By : S.D.
Approved By : S.T.

IDEAL GEOSERVICES PVT. LTD.

BOREHOLE NO. : BH-02

Geotech Contractor : IDEAL GEOSERVICES PVT. LTD. | Job No. : IDEAL/028/015 | CLIENT : ORIENTAL CONSULTANTS Global Consulting for Sustainable Development | SHEET 03 of 03

Project : Geological Survey for the Preparatory Survey on the Project for Construction of Mumbai Trans Harbour Link

T.D. (m)	: -28.54 CD	SBL (m)	: -3.04 CD	Equipment Record	: AQUA STAR - JACKUP BARGE	
Date Commenced	: 02-07-2015	Circulation Fluid	: Sea Water	Type of Rig	: Hydraulic Rig	
Date Completed	: 06-07-2015	Drilling Orientation	: Vertical	Details of Casing (mm)	: SX / HX / NX	
				Core-Diameter (mm)	: 54.10	

Co- Ordinates E : 281555.00 N : 2100932.00

WATER TABLE

Date	Time	Mtrs.
02-07-2015	12.01 PM	7.50

Sampling Details				Standard Penetration Test (SPT)				Details of Rock core					Symbol	Depth in (m)	Details of Stratum	Soil Clasification (USC)	Grain Size Analysis (%)				Consistency Limits (%)			Strength Test (kPa)			Consolidation Test			Remarks
	TYPE	From (m)	To (m)	150	300	450	"N" VALUE	TCR %	SCR %	RQD %	W.G	F.I.			Strata Description		GRAVEL	SAND	SILT	CLAY	LIQUID (w_L)	PLASTIC (w_P)	PLASTICITY INDEX (I_P)	UCS C_u	UU c, ϕ	CU c', ϕ'	PreConsolidation Pressure (kPa)	Commpression Index (Cc)	Initial Void Ratio (e_0)	
20															Very dense, brownish, SAND with gravels															
21		-24.04	-24.12	52 blows/ 10cm	-	-	>100									SM	0	85		15	-	NP	-							
22		-24.04	-25.54					97	91	55	III	>10		-24.04	Moderately strong, moderately weathered, moderately fractured light greyish amygdaloidal BASALT															
23		-25.54	-27.04					99	98	79	III	>10																		
24		-27.04	-28.54					93	92	66	II	5.3																		
25																														
26															BOREHOLE TERMINATED DEPTH AT -28.54 (m)															
27																														
28																														
29																														
30																														

Abbreviations & Symbols :

□ - SPT ■ - UDS ▨ - DS | W_L - Liquid Limit | I_P - Plasticity Index | MC - Moisture Content

C.D. Chart Datum, T.D. : Termination Depth, MSL : Mean Sea Level
SBL : Sea Bed Level, EGL : Existing Ground Level, R.L. : Reduced Level

▥ - Rock Recovery ▨ - No Recovery | TCR - Total Core Recovery | SCR - Solid Core Recovery | RQD - Rock Quality Designation | W.I. - Weathering Grade F.I. Fractural Index

⊗ - Field Vane Shear ● - Sample Slipped

Prepared By : V.N.
Checked By : S.D.
Approved By : S.T.

小樽3-23

Plate-A6

IDEAL GEOSERVICES PVT. LTD.

BOREHOLE NO. : BH-03

Geotech Contractor : IDEAL GEOSERVICES PVT. LTD.	Job No. : IDEAL/028/015	CLIENT : ORIENTAL CONSULTANTS (Global Consulting for Sustainable Development)
Project : Geological Survey for the Preparatory Survey on the Project for Construction of Mumbai Trans Harbour Link		SHEET 01 of 03

T.D. (m)	: -28.40 CD	SBL (m)	: -2.90 CD	Equipment Record	: AQUA STAR - JACKUP BARGE
Date Commenced	: 11-07-2015	Circulation Fluid	: Sea Water	Type of Rig	: Hydraulic Rig
Date Completed	: 16-07-2015	Drilling Orientation	: Vertical	Details of Casing (mm)	: SX / HX / NX
				Core-Diameter (mm)	: 54.10

Co- Ordinates E : 286953.00 N : 2100893.00

WATER TABLE

Date	Time	Mtrs.
11-07-2015	10.35 AM	6.00

Sampling Details				Standard Penetration Test (SPT)				Details of Rock core					Symbol	Depth in (m) w.r.t.(CD)	Details of Stratum	Soil Clasification (USC)	Grain Size Analysis (%)				Consistency Limits (%)			Strength Test (kPa)			Consolidation Test			Remarks
	TYPE	From (m)	To (m)	150	300	450	"N" VALUE	TCR %	SCR %	RQD %	W.G	F.I.			Strata Description		GRAVEL	SAND	SILT	CLAY	LIQUID (w_L)	PLASTIC (w_P)	PLASTICITY INDEX (I_P)	UCS C_u	UU c, ϕ	CU c', ϕ'	PreConsolidation Pressure (kPa)	Commpression Index (Cc)	Initial Void Ratio (e_0)	
0		-2.90	-3.40											-2.90	Very soft, dark grey, CLAY	CH	0	2	57	41	62	26	36							
1																														
2		-4.40	-4.85	0	0	0	0									CH	0	1	57	42	62	43	19							
3		-5.90	-6.35																											
4																														UDS Slipped
5		-7.40	-7.52	54 blows/ 12cm	-	-	>100																							
		-7.40	-8.90					37	11	Nil	II	4		-7.40	Weak, moderately weathered, highly fractured light greyish amygdaloidal BASALT															
6																														
		-8.90	-10.40					43	13	Nil	II	3.3																		
7																														
		-10.40	-11.90					33	11	Nil	II	4.7																		
8																														
9		-11.90	-13.40					27	15	Nil	II	3.3			- colour changes to reddish grey below -11.90m CD															
10																														

Abbreviations & Symbols :

□ - SPT ■ - UDS ▨ - DS | W_L - Liquid Limit | I_P - Plasticity Index | MC - Moisture Content

C.D. Chart Datum, T.D. : Termination Depth, MSL : Mean Sea Level
SBL : Sea Bed Level, EGL : Existing Ground Level, R.L. : Reduced Level

▥ - Rock Recovery ▨ - No Recovery | TCR - Total Core Recovery | SCR - Solid Core Recovery | RQD - Rock Quality Designation | W.I. - Weathering Grade F.I. Fractural Index

⊗ - Field Vane Shear ● - Sample Slipped

Prepared By : V.N.
Checked By : S.D.
Approved By : S.T.

小橋3-24

Plate-A7

IDEAL GEOSERVICES PVT. LTD.

BOREHOLE NO. : BH-03

Geotech Contractor : IDEAL GEOSERVICES PVT. LTD.	Job No. : IDEAL/028/015	CLIENT : ORIENTAL CONSULTANTS Global Consulting for Sustainable Development	SHEET 02 of 03

Project : Geological Survey for the Preparatory Survey on the Project for Construction of Mumbai Trans Harbour Link

T.D. (m)	: -28.40 CD	SBL (m)	: -2.90 CD	Equipment Record	: AQUA STAR - JACKUP BARGE
Date Commenced	: 11-07-2015	Circulation Fluid	: Sea Water	Type of Rig	: Hydraulic Rig
Date Completed	: 16-07-2015	Drilling Orientation	: Vertical	Details of Casing (mm)	: SX / HX / NX
				Core-Diameter (mm)	: 54.10

Co- Ordinates E : 286953.00 N : 2100893.00

WATER TABLE

Date	Time	Mtrs.
11-07-2015	10.35 AM	6.00

Sampling Details				Standard Penetration Test (SPT)				Details of Rock core					Symbol	Depth in (m) w.r.t.(CD)	Details of Stratum	Soil Clasification (USC)	Grain Size Analysis (%)				Consistency Limits (%)			Strength Test (kPa)			Consolidation Test			Remarks
	TYPE	From (m)	To (m)	150	300	450	"N" VALUE	TCR %	SCR %	RQD %	W.G	F.I.			Strata Description		GRAVEL	SAND	SILT	CLAY	LIQUID (w_L)	PLASTIC (w_P)	PLASTICITY INDEX (I_P)	UCS C_u	UU c,ϕ	CU c',ϕ'	PreConsolidation Pressure (kPa)	Commpression Index (Cc)	Initial Void Ratio (e_0)	
10															Weak, moderately weathered, highly fractured light greyish amygdaloidal BASALT															
11		-13.40	-14.90					19	7	Nil	III	2.7																		
12		-14.90	-16.40					17	Nil	Nil	III	0.7																		
13																														
14		-16.40	-17.90					21	3	Nil	IV	2																		
15		-17.90	-19.40					39	28	8	IV	4.7																		
16																														
17		-19.40	-20.90					36	2	Nil	IV	>10																		
18		-20.90	-22.40					49	42	17	II	4.7		-20.90	Moderately strong, moderately weathered, moderately fractured reddish amygdloidal BASALT															
19																														
20		-22.40	-23.90					47	32	19	III	6																		

Abbreviations & Symbols :

□ - SPT ■ - UDS ▨ - DS

W_L - Liquid Limit I_P - Plasticity Index MC - Moisture Content

▥ - Rock Recovery ▨ - No Recovery

⊗ - Field Vane Shear ● - Sample Slipped

TCR - Total Core Recovery SCR - Solid Core Recovery RQD - Rock Quality Designation

C.D. Chart Datum, T.D. : Termination Depth, MSL : Mean Sea Level
SBL : Sea Bed Level, EGL : Existing Ground Level, R.L. : Reduced Level

W.I. - Weathering Grade F.I. Fractural Index

Prepared By : V.N.
Checked By : S.D.
Approved By : S.T.

IDEAL GEOSERVICES PVT. LTD.

BOREHOLE NO. : BH-03

Geotech Contractor : IDEAL GEOSERVICES PVT. LTD.	Job No. : IDEAL/028/015	CLIENT : ORIENTAL CONSULTANTS Global Consulting for Sustainable Development	SHEET 03 of 03

Project : Geological Survey for the Preparatory Survey on the Project for Construction of Mumbai Trans Harbour Link

T.D. (m)	: -28.40 CD	SBL (m)	: -2.90 CD	Equipment Record	: AQUA STAR - JACKUP BARGE
Date Commenced	: 11-07-2015	Circulation Fluid	: Sea Water	Type of Rig	: Hydraulic Rig
Date Completed	: 16-07-2015	Drilling Orientation	: Vertical	Details of Casing (mm)	: SX / HX / NX
				Core-Diameter (mm)	: 54.10

Co- Ordinates E : 286953.00 N : 2100893.00

WATER TABLE

Date	Time	Mtrs.
11-07-2015	10.35 AM	6.00

Sampling Details				Standard Penetration Test (SPT)				Details of Rock core					Symbol	Depth in (m) w.r.t.(CD)	Details of Stratum	Soil Clasification (USC)	Grain Size Analysis (%)				Consistency Limits (%)			Strength Test (kPa)			Consolidation Test			Remarks
	TYPE	From (m)	To (m)	150	300	450	"N" VALUE	TCR %	SCR %	RQD %	W.G	F.I.			Strata Description		GRAVEL	SAND	SILT	CLAY	LIQUID (w_L)	PLASTIC (w_P)	PLASTICITY INDEX (I_P)	UCS C_u	UU c, ϕ	CU c', ϕ'	PreConsolidation Pressure (kPa)	Commpression Index (Cc)	Initial Void Ratio (e^0)	
20															Moderately strong, moderately weathered, moderately fractured reddish amygdloidal BASALT															
21																														
22		-23.90	-25.40					94	94	80	II	4.7		-23.90	Strong, fresh, slightly fractured greyish BASALT															
23		-25.40	-26.90					83	80	59	II	6.7																		
24		-26.90	-28.40					100	100	86	III	4.7																		
25																														
26															BOREHOLE TERMINATED AT -28.40 (m) BELOW CD														
27																														
28																														
29																														
30																														

Abbreviations & Symbols :

□ - SPT ■ - UDS ▨ - DS

W_L - Liquid Limit I_P - Plasticity Index MC - Moisture Content

▥ - Rock Recovery ▨ - No Recovery

⊗ - Field Vane Shear ● - Sample Slipped

TCR - Total Core Recovery SCR - Solid Core Recovery RQD - Rock Quality Designation

C.D. Chart Datum, T.D. : Termination Depth, MSL : Mean Sea Level
SBL : Sea Bed Level, EGL : Existing Ground Level, R.L. : Reduced Level

W.I. - Weathering Grade F.I. Fractural Index

Prepared By : V.N.
Checked By : S.D.
Approved By : S.T.

IDEAL GEOSERVICES PVT. LTD.

BOREHOLE NO. : BH-04

Geotech Contractor : IDEAL GEOSERVICES PVT. LTD.	Job No. : IDEAL/028/015	CLIENT : ORIENTAL CONSULTANTS (DIGCONSUL) Global Consulting for Sustainable Development
Project : Geological Survey for the Preparatory Survey on the Project for Construction of Mumbai Trans Harbour Link		SHEET 01 of 03

T.D. (m)	: -31.85 CD	SBL (m)	: -5.60 CD	Equipment Record	: AQUA STAR - JACKUP BARGE
Date Commenced	: 22-06-2015	Circulation Fluid	: Sea Water	Type of Rig	: Hydraulic Rig
Date Completed	: 27-06-2015	Drilling Orientation	: Vertical	Details of Casing (mm)	: SX / HX / NX
				Core-Diameter (mm)	: 54.10

Co- Ordinates E : 286846.00 N : 2100932.00

WATER TABLE

Date	Time	Mtrs.
26-06-2015	10.20 AM	7.50

Sampling Details				Standard Penetration Test (SPT)				Details of Rock core					Symbol	Depth in (m)	Details of Stratum	Soil Clasification (USC)	Grain Size Analysis (%)				Consistency Limits (%)			Strength Test (kPa)			Consolidation Test			Remarks
	TYPE	From (m)	To (m)	150	300	450	"N" VALUE	TCR %	SCR %	RQD %	W.G	F.I.			Strata Description		GRAVEL	SAND	SILT	CLAY	LIQUID (w_L)	PLASTIC (w_P)	PLASTICITY INDEX (I_P)	UCS C_u	UU c,ϕ	CU c',ϕ'	PreConsolidation Pressure (kPa)	Commpression Index (Cc)	Initial Void Ratio (e_0)	
0		-5.60	-6.10											-5.60	Very loose, dark grey, clayey SAND	SC	5	53	25	17	36	24	12							
1																														
2		-7.10	-7.55	0	0	1	1							-7.10	Very soft, dark grey CLAY with sand	CL	0	23	38	39	47	26	21							
3		-8.60	-9.05																											UDS Slipped
4																														
5		-10.10	-10.55	5	11	18	29							-10.10	Medium dense, yellowish grey, clayey SAND with gravel	SC	11	52	20	17	49	27	22							
6		-11.60	-12.05	8	13	19	32							-11.60	Hard, yellowish grey CLAY with sand and gravels	CH	13	15	22	50	58	27	31							
7																														
8		-13.10	-13.55	23	24	34	58							-13.10	Very dense, yellowish brown, silty SAND	SM	3	76	14	7	-	NP	-							
9																														
10		-14.60	-14.87	18	55 blows/ 12cm	-	>100							-14.60	Very dense, yellowish brown,gravelly SAND with silt	SP	39	51	10		-	NP	-							

Abbreviations & Symbols :

□ - SPT ■ - UDS ◥ - DS

W_L - Liquid Limit I_P - Plasticity Index MC - Moisture Content

▥ - Rock Recovery ▨ - No Recovery

⊗ - Field Vane Shear ● - Sample Slipped

TCR - Total Core Recovery SCR - Solid Core Recovery RQD - Rock Quality Designation

C.D. Chart Datum, T.D. : Termination Depth, MSL : Mean Sea Level
SBL : Sea Bed Level, EGL : Existing Ground Level, R.L. : Reduced Level

W.I. - Weathering Grade F.I. Fractural Index

Prepared By : V.N.
Checked By : S.D.
Approved By : S.T.

IDEAL GEOSERVICES PVT. LTD.

BOREHOLE NO. : BH-04

Geotech Contractor : IDEAL GEOSERVICES PVT. LTD. | Job No. : IDEAL/028/015 | CLIENT : ORIENTAL CONSULTANTS Global Consulting for Sustainable Development | SHEET 02 of 03

Project : Geological Survey for the Preparatory Survey on the Project for Construction of Mumbai Trans Harbour Link

T.D. (m)	: -31.85 CD	SBL (m)	: -5.60 CD	Equipment Record	: AQUA STAR - JACKUP BARGE	
Date Commenced	: 22-06-2015	Circulation Fluid	: Sea Water	Type of Rig	: Hydraulic Rig	
Date Completed	: 27-06-2015	Drilling Orientation	: Vertical	Details of Casing (mm)	: SX / HX / NX	
				Core-Diameter (mm)	: 54.10	

Co- Ordinates E : 286846.00 N : 2100932.00

WATER TABLE

Date	Time	Mtrs.
26-06-2015	10.20 AM	7.50

Sampling Details				Standard Penetration Test (SPT)				Details of Rock core					Symbol	Depth in (m)	Details of Stratum	Soil Clasiffication (USC)	Grain Size Analysis (%)				Consistency Limits (%)			Strength Test (kPa)			Consolidation Test			Remarks
	TYPE	From (m)	To (m)	150	300	450	"N" VALUE	TCR %	SCR %	RQD %	W.G	F.I.			Strata Description		GRAVEL	SAND	SILT	CLAY	LIQUID (w_L)	PLASTIC (w_P)	PLASTICITY INDEX (I_P)	UCS C_u	UU c,ϕ	CU c',ϕ'	PreConsolidation Pressure (kPa)	Commpression Index (Cc)	Initial Void Ratio (e^0)	
10															Very dense, yellowish brown,gravelly SAND with silt															
		-16.10	-16.45	25	28	55 blows/ 5cm	>100									SP	37	55		8	-	NP	-							
11		-16.10	-17.60					25	12	-	V	>10		-16.10	Very weak, highly weathered, highly fractured, greyish BASALT															
12		-17.60	-18.10					19	12	-	V	>10																		
		-18.10	-19.60					45	32	8	IV	>10																		
13																														
14		-19.60	-21.10					55	30	8	IV	>10																		
15																														
16		-21.10	-22.60					67	57	7	IV	>10																		
17																														
		-22.60	-24.10					90	60	29	IV	>10		-22.60	Moderately strong, moderately weathered, moderately fractured reddish amygdaloidal BASALT															
18																														
19		-24.10	-25.60					77	52	-	V	>10																		
20																														

Abbreviations & Symbols :

□ - SPT ■ - UDS ▨ - DS | W_L - Liquid Limit I_P - Plasticity Index MC - Moisture Content

▥ - Rock Recovery ▧ - No Recovery | TCR - Total Core Recovery SCR - Solid Core Recovery RQD - Rock Quality Designation

⊗ - Field Vane Shear ● - Sample Slipped | W.I. - Weathering Grade F.I. Fractural Index

C.D. Chart Datum, T.D. : Termination Depth, MSL : Mean Sea Level
SBL : Sea Bed Level, EGL : Existing Ground Level, R.L. : Reduced Level

Prepared By : V.N.
Checked By : S.D.
Approved By : S.T.

Plate-A11

小樽3-28

IDEAL GEOSERVICES PVT. LTD.

BOREHOLE NO. : BH-04

Geotech Contractor : IDEAL GEOSERVICES PVT. LTD.	Job No. : IDEAL/028/015	CLIENT : ORIENTAL CONSULTANTS Global Consulting for Sustainable Development	SHEET 03 of 03

Project : Geological Survey for the Preparatory Survey on the Project for Construction of Mumbai Trans Harbour Link

T.D. (m)	: -31.85 CD	SBL (m)	: -5.60 CD	Equipment Record	: AQUA STAR - JACKUP BARGE
Date Commenced	: 22-06-2015	Circulation Fluid	: Sea Water	Type of Rig	: Hydraulic Rig
Date Completed	: 27-06-2015	Drilling Orientation	: Vertical	Details of Casing (mm)	: SX / HX / NX
				Core-Diameter (mm)	: 54.10

Co- Ordinates E : 286846.00 N : 2100932.00

WATER TABLE

Date	Time	Mtrs.
26-06-2015	10.20 AM	7.50

Sampling Details				Standard Penetration Test (SPT)				Details of Rock core					Symbol	Depth in (m)	Details of Stratum	Soil Clasification (USC)	Grain Size Analysis (%)				Consistency Limits (%)			Strength Test (kPa)			Consolidation Test			Remarks
	TYPE	From (m)	To (m)	150	300	450	"N" VALUE	TCR %	SCR %	RQD %	W.G	F.I.			Strata Description		GRAVEL	SAND	SILT	CLAY	LIQUID (w_L)	PLASTIC (w_P)	PLASTICITY INDEX (I_P)	UCS C_u	UU c, ϕ	CU c', ϕ'	PreConsolidation Pressure (kPa)	Commpression Index (Cc)	Initial Void Ratio (e^0)	
20		-25.60	-27.10					82	39	21	IV	>10		-25.60	Moderately strong, moderately weathered, moderately fractured reddish amygdaloidal BASALT															
21		-27.10	-28.60					98	97	81	III	4.7		-27.10	Weak to moderately strong, slightly weathered, greyish BASALT															
22																														
23		-28.60	-30.10					93	90	60	III	5.3			- secondary infilling of the vugs are noticed and some part of the rock materials is friable															
24																														
25		-30.10	-31.60					97	96	60	III	>10																		
26		-31.60	-31.80					100	100	60	III	1.3																		
27															BOREHOLE TERMINATED DEPTH AT -31.80 (m)														
28																														
29																														
30																														

Abbreviations & Symbols :

□ - SPT ■ - UDS ◥ - DS | W_L - Liquid Limit I_P - Plasticity Index MC - Moisture Content

C.D. Chart Datum, T.D. : Termination Depth, MSL : Mean Sea Level
SBL : Sea Bed Level, EGL : Existing Ground Level, R.L. : Reduced Level

▥ - Rock Recovery ▨ - No Recovery | TCR - Total Core Recovery SCR - Solid Core Recovery RQD - Rock Quality Designation | W.I. - Weathering Grade F.I. Fractural Index

⊗ - Field Vane Shear ● - Sample Slipped

Prepared By : V.N.
Checked By : S.D.
Approved By : S.T.

IDEAL GEOSERVICES PVT. LTD.

BOREHOLE NO. : BH-05

Geotech Contractor : IDEAL GEOSERVICES PVT. LTD.	Job No. : IDEAL/028/015	CLIENT : ORIENTAL CONSULTANTS (Global Consulting for Sustainable Development)
Project : Geological Survey for the Preparatory Survey on the Project for Construction of Mumbai Trans Harbour Link		SHEET 01 of 03

T.D. (m)	: -25.34 CD	SBL (m)	: -3.10 CD	Equipment Record	: AQUA STAR - JACKUP BARGE
Date Commenced	: 13-06-2015	Circulation Fluid	: Sea Water	Type of Rig	: Hydraulic Rig
Date Completed	: 16-06-2015	Drilling Orientation	: Vertical	Details of Casing (mm)	: SX / HX / NX
				Core-Diameter (mm)	: 54.10

Co- Ordinates E : 287282.00 N : 2100749.00

WATER TABLE

Date	Time	Mtrs.
13-06-2015	10.30 AM	7.00

Sampling Details				Standard Penetration Test (SPT)				Details of Rock core					Symbol	Depth in (m) w.r.t.(CD)	Details of Stratum	Soil Clasification (USC)	Grain Size Analysis (%)				Consistency Limits (%)			Strength Test (kPa)			Consolidation Test			Remarks
	TYPE	From (m)	To (m)	150	300	450	"N" VALUE	TCR %	SCR %	RQD %	W.G	F.I.			Strata Description		GRAVEL	SAND	SILT	CLAY	LIQUID (w_L)	PLASTIC (w_P)	PLASTICITY INDEX (I_P)	UCS C_u	UU c, ϕ	CU c', ϕ'	PreConsolidation Pressure (kPa)	Commpression Index (Cc)	Initial Void Ratio (e_0)	
0		-3.10	-3.60											-3.10	Very soft, greyish sandy CLAY with gravels	CL	7	43	28	22	42	22	20							
1																														
2		-4.60	-5.05																											
3		-6.10	-6.20	50 blows/ 10cm	-	-	>100							-6.10	Very dense, greyish silty SAND with gravels	SM	6	67	22	5	-	NP	-							
4																														
5		-7.60	-8.05													SM	6	68	21	5	-	NP	-							
6		-9.10	-9.35	45	50 blows/ 10cm	-	>100									SP	19	73	8		-	NP	-							
7																														
8		-10.60	-10.83	35	50 blows/ 8cm	-	>100							-10.60	Very dense, brownish sandy GRAVELS	GP	56	43	1		-	NP	-							
9		-12.10	-12.55	42	50	52	>100								- with silt	GC	40	27	28	5	32	20	12							
10																														

Abbreviations & Symbols :

- SPT - UDS - DS
- Rock Recovery - No Recovery
- Field Vane Shear - Sample Slipped

W_L - Liquid Limit I_P - Plasticity Index MC - Moisture Content

TCR - Total Core Recovery SCR - Solid Core Recovery RQD - Rock Quality Designation

C.D. Chart Datum, T.D. : Termination Depth, MSL : Mean Sea Level
SBL : Sea Bed Level, EGL : Existing Ground Level, R.L. : Reduced Level

W.I. - Weathering Grade F.I. Fractural Index

Prepared By : V.N.
Checked By : S.D.
Approved By : S.T.

Plate-A13

IDEAL GEOSERVICES PVT. LTD.

BOREHOLE NO. : BH-05

Geotech Contractor : IDEAL GEOSERVICES PVT. LTD. | Job No. : IDEAL/028/015 | CLIENT : ORIENTAL CONSULTANTS Global Consulting for Sustainable Development | SHEET 02 of 03

Project : Geological Survey for the Preparatory Survey on the Project for Construction of Mumbai Trans Harbour Link

T.D. (m)	: -25.34 CD	SBL (m)	: -3.10 CD	Equipment Record	: AQUA STAR - JACKUP BARGE	
Date Commenced	: 13-06-2015	Circulation Fluid	: Sea Water	Type of Rig	: Hydraulic Rig	
Date Completed	: 16-06-2015	Drilling Orientation	: Vertical	Details of Casing (mm)	: SX / HX / NX	
				Core-Diameter (mm)	: 54.10	

Co- Ordinates E : 287282.00 N : 2100749.00

WATER TABLE

Date	Time	Mtrs.
13-06-2015	10.30 AM	7.00

Sampling Details				Standard Penetration Test (SPT)				Details of Rock core					Symbol	Depth in (m) w.r.t.(CD)	Details of Stratum	Soil Clasification (USC)	Grain Size Analysis (%)				Consistency Limits (%)			Strength Test (kPa)			Consolidation Test			Remarks
	TYPE	From (m)	To (m)	150	300	450	"N" VALUE	TCR %	SCR %	RQD %	W.G	F.I.			Strata Description		GRAVEL	SAND	SILT	CLAY	LIQUID (w_L)	PLASTIC (w_P)	PLASTICITY INDEX (I_P)	UCS C_u	UU c, ϕ	CU c', ϕ'	PreConsolidation Pressure (kPa)	Commpression Index (Cc)	Initial Void Ratio (e_0)	
10															Very dense, brownish sandy GRAVELS															
11		-13.60	-14.05	35	38	43	81							-13.60	Hard, brownish sandy, CLAY with gravels	CL	5	35	53	7	41	22	19							
12		-15.10	-15.22	56 blows/ 12cm	-	-	>100							-15.10	Very dense, brownish, fine to medium SAND	SP	0	90	10		-	NP	-							
13																														
14		-16.60	-16.68	60 blows/ 8cm	-	-	>100									SM	2	78	14	6	-	NP	-							
		-16.60	-18.10					67	53	7	IV	>10		-16.60	Very weak to weak, highly to completely weathered, reddish to greyish BASALT															
15																														
16		-18.10	-19.60					67	54	8	IV	>10																		
17		-19.60	-21.10					100	100	53	IV	>10		-19.60	Weak to moderately strong moderately weathered, horizontal fractured, greyish amygdaloidal BASALT															
18																														
19		-21.10	-22.60					100	95	52	III	>10																		
20		-22.60	-24.10					100	100	55	III	6.7																		

Abbreviations & Symbols :

- SPT - UDS - DS
- Rock Recovery - No Recovery
- Field Vane Shear - Sample Slipped

W_L - Liquid Limit I_P - Plasticity Index MC - Moisture Content

TCR - Total Core Recovery SCR - Solid Core Recovery RQD - Rock Quality Designation

C.D. Chart Datum, T.D. : Termination Depth, MSL : Mean Sea Level
SBL : Sea Bed Level, EGL : Existing Ground Level, R.L. : Reduced Level

W.I. - Weathering Grade F.I. Fractural Index

Prepared By : V.N.
Checked By : S.D.
Approved By : S.T.

Plate-A14

小樽3-31

IDEAL GEOSERVICES PVT. LTD.

BOREHOLE NO. : BH-05

Geotech Contractor : IDEAL GEOSERVICES PVT. LTD.	Job No. : IDEAL/028/015	CLIENT : ORIENTAL CONSULTANTS Global Consulting for Sustainable Development	SHEET 03 of 03

Project : Geological Survey for the Preparatory Survey on the Project for Construction of Mumbai Trans Harbour Link

T.D. (m)	: -25.34 CD	SBL (m)	: -3.10 CD	Equipment Record	: AQUA STAR - JACKUP BARGE
Date Commenced	: 13-06-2015	Circulation Fluid	: Sea Water	Type of Rig	: Hydraulic Rig
Date Completed	: 16-06-2015	Drilling Orientation	: Vertical	Details of Casing (mm)	: SX / HX / NX
				Core-Diameter (mm)	: 54.10

Co- Ordinates E : 287282.00 N : 2100749.00

WATER TABLE

Date	Time	Mtrs.
13-06-2015	10.30 AM	7.00

Sampling Details				Standard Penetration Test (SPT)				Details of Rock core					Symbol	Depth in (m) w.r.t.(CD)	Details of Stratum	Soil Clasification (USC)	Grain Size Analysis (%)				Consistency Limits (%)			Strength Test (kPa)			Consolidation Test			Remarks
	TYPE	From (m)	To (m)	150	300	450	"N" VALUE	TCR %	SCR %	RQD %	W.G	F.I.			Strata Description		GRAVEL	SAND	SILT	CLAY	LIQUID (w_L)	PLASTIC (w_P)	PLASTICITY INDEX (I_P)	UCS C_u	UU c, ϕ	CU c', ϕ'	PreConsolidation Pressure (kPa)	Commpression Index (Cc)	Initial Void Ratio (e_0)	
20															Weak to moderately strong moderately weathered, horizontal fractured, greyish amygdaloidal BASALT															
21		-24.10	-25.30					96	88	23	III	>10		-24.10	Moderately strong, slightly weathered, greyish BASALT															
22																														
23															BOREHOLE TERMINATED AT -25.30 (m) BELOW CD															
24																														
25																														
26																														
27																														
28																														
29																														
30																														

Abbreviations & Symbols :

- SPT - UDS - DS
- Rock Recovery - No Recovery
- Field Vane Shear - Sample Slipped

W_L - Liquid Limit I_P - Plasticity Index MC - Moisture Content

TCR - Total Core Recovery SCR - Solid Core Recovery RQD - Rock Quality Designation

C.D. Chart Datum, T.D. : Termination Depth, MSL : Mean Sea Level
SBL : Sea Bed Level, EGL : Existing Ground Level, R.L. : Reduced Level

W.I. - Weathering Grade F.I. Fractural Index

Prepared By : V.N.
Checked By : S.D.
Approved By : S.T.

IDEAL GEOSERVICES PVT. LTD.

BOREHOLE NO. : BH-06

Geotech Contractor : IDEAL GEOSERVICES PVT. LTD.	Job No. : IDEAL/028/015	CLIENT : ORIENTAL CONSULTANTS (Global Consulting for Sustainable Development)
Project : Geological Survey for the Preparatory Survey on the Project for Construction of Mumbai Trans Harbour Link		SHEET 01 of 03

T.D. (m)	: -22.11 CD	SBL (m)	: 0.09 CD	Equipment Record	: AQUA STAR - JACKUP BARGE
Date Commenced	: 11-06-2015	Circulation Fluid	: Sea Water	Type of Rig	: Hydraulic Rig
Date Completed	: 12-06-2015	Drilling Orientation	: Vertical	Details of Casing (mm)	: SX / HX / NX
				Core-Diameter (mm)	: 54.10

Co- Ordinates E : 288918.00 N : 2099540.00

WATER TABLE

Date	Time	Mtrs.
11-06-2015	9.30 AM	3.00

Sampling Details				Standard Penetration Test (SPT)				Details of Rock core					Symbol	Depth in (m) w.r.t.(CD)	Details of Stratum	Soil Clasification (USC)	Grain Size Analysis (%)				Consistency Limits (%)			Strength Test (kPa)			Consolidation Test			Remarks
	TYPE	From (m)	To (m)	150	300	450	"N" VALUE	TCR %	SCR %	RQD %	W.G	F.I.			Strata Description		GRAVEL	SAND	SILT	CLAY	LIQUID (w_L)	PLASTIC (w_P)	PLASTICITY INDEX (I_P)	UCS C_u	UU c, ϕ	CU c', ϕ'	PreConsolidation Pressure (kPa)	Commpression Index (Cc)	Initial Void Ratio (e_0)	
0		0.09	-0.41											0.09	Loose, greyish SAND with shells	SP	2	98	0		-	NP	0							
1																														
2		-1.41	-1.86																											UDS Slipped
3		-2.91	-3.36	14	24	32	56							-2.91	Very dense, greenish grey silty SAND	SM	0	65	30	5	44	27	17							
4																														
5		-4.41	-4.86	7	24	52 blows/ 8cm	>100									SP	0	97	3		-	NP	-							
6		-5.91	-6.30	12	45	54 blows/ 9cm	>100																							
7																SM	0	85	15		-	NP	-							
		-7.41	-7.51	50 blows/ 10cm	-	-	>100								-with gravels															
8		-7.41	-8.91					20	Nil	Nil	V	>10		-7.41	Very weak, highly weathered, light brownish BASALT	SM	14	71	15		-	NP	-							
9		-8.91	-10.41					11	Nil	Nil	IV	4																		
10																														

Abbreviations & Symbols :

- SPT - UDS - DS
- Rock Recovery - No Recovery
- Field Vane Shear - Sample Slipped

W_L - Liquid Limit I_P - Plasticity Index MC - Moisture Content

TCR - Total Core Recovery SCR - Solid Core Recovery RQD - Rock Quality Designation

C.D. Chart Datum, T.D. : Termination Depth, MSL : Mean Sea Level
SBL : Sea Bed Level, EGL : Existing Ground Level, R.L. : Reduced Level

W.I. - Weathering Grade F.I. Fractural Index

Prepared By : V.N.
Checked By : S.D.
Approved By : S.T.

IDEAL GEOSERVICES PVT. LTD.

BOREHOLE NO. : BH-06

Geotech Contractor : IDEAL GEOSERVICES PVT. LTD. | Job No. : IDEAL/028/015 | CLIENT : ORIENTAL CONSULTANTS Global Consulting for Sustainable Development | SHEET 02 of 03

Project : Geological Survey for the Preparatory Survey on the Project for Construction of Mumbai Trans Harbour Link

T.D. (m)	: -22.11 CD	SBL (m)	: 0.09 CD	Equipment Record	: AQUA STAR - JACKUP BARGE	
Date Commenced	: 11-06-2015	Circulation Fluid	: Sea Water	Type of Rig	: Hydraulic Rig	
Date Completed	: 12-06-2015	Drilling Orientation	: Vertical	Details of Casing (mm)	: SX / HX / NX	
				Core-Diameter (mm)	: 54.10	

WATER TABLE

Date	Time	Mtrs.
11-06-2015	9.30 AM	3.00

Co- Ordinates E : 288918.00 N : 2099540.00

Sampling Details				Standard Penetration Test (SPT)				Details of Rock core					Symbol	Depth in (m) w.r.t.(CD)	Details of Stratum	Soil Clasification (USC)	Grain Size Analysis (%)				Consistency Limits (%)			Strength Test (kPa)			Consolidation Test			Remarks
	TYPE	From (m)	To (m)	150	300	450	"N" VALUE	TCR %	SCR %	RQD %	W.G	F.I.			Strata Description		GRAVEL	SAND	SILT	CLAY	LIQUID (w_L)	PLASTIC (w_P)	PLASTICITY INDEX (I_P)	UCS C_u	UU c, ϕ	CU c', ϕ'	PreConsolidation Pressure (kPa)	Commpression Index (Cc)	Initial Void Ratio (e_0)	
10															Very weak, highly weathered, light brownish BASALT															
		-10.41	-11.91					23	Nil	Nil	IV	>10																		
11																														
12		-11.91	-13.41					40	Nil	Nil	IV	>10																		
13																														
		-13.41	-14.91					51	33	20	III	>10		-13.41	Weak to moderately strong, highly to moderately weathered, highly fractured, brownish grey BASALT															
14																														
15		-14.91	-16.41					100	67	44	III	>10																		
16																														
		-16.41	-17.91					100	100	71	III	6.7		-16.41	Moderately strong, moderately weathered, reddish brown, amygdaloidal BASALT															
17																														
18		-17.91	-19.41					97	84	47	IV	>10																		
19																														
20		-19.41	-20.91					100	100	76	III	5.3																		

Abbreviations & Symbols :

- SPT, UDS, DS
- W_L - Liquid Limit
- I_P - Plasticity Index
- MC - Moisture Content
- Rock Recovery, No Recovery
- TCR - Total Core Recovery
- SCR - Solid Core Recovery
- RQD - Rock Quality Designation
- Field Vane Shear, Sample Slipped
- W.I. - Weathering Grade F.I. Fractural Index

C.D. Chart Datum, T.D. : Termination Depth, MSL : Mean Sea Level
SBL : Sea Bed Level, EGL : Existing Ground Level, R.L. : Reduced Level

Prepared By : V.N.
Checked By : S.D.
Approved By : S.T.

IDEAL GEOSERVICES PVT. LTD.

BOREHOLE NO. : BH-06

Geotech Contractor : IDEAL GEOSERVICES PVT. LTD.	Job No. : IDEAL/028/015	CLIENT : ORIENTAL CONSULTANTS Global Consulting for Sustainable Development	SHEET 03 of 03

Project : Geological Survey for the Preparatory Survey on the Project for Construction of Mumbai Trans Harbour Link

T.D. (m)	: -22.11 CD	SBL (m)	: 0.09 CD	Equipment Record	: AQUA STAR - JACKUP BARGE
Date Commenced	: 11-06-2015	Circulation Fluid	: Sea Water	Type of Rig	: Hydraulic Rig
Date Completed	: 12-06-2015	Drilling Orientation	: Vertical	Details of Casing (mm)	: SX / HX / NX
				Core-Diameter (mm)	: 54.10

Co- Ordinates E : 288918.00 N : 2099540.00

WATER TABLE

Date	Time	Mtrs.
11-06-2015	9.30 AM	3.00

Sampling Details				Standard Penetration Test (SPT)				Details of Rock core					Symbol	Depth in (m) w.r.t.(CD)	Details of Stratum	Soil Clasification (USC)	Grain Size Analysis (%)				Consistency Limits (%)			Strength Test (kPa)			Consolidation Test			Remarks
	TYPE	From (m)	To (m)	150	300	450	"N" VALUE	TCR %	SCR %	RQD %	W.G	F.I.			Strata Description		GRAVEL	SAND	SILT	CLAY	LIQUID (w_L)	PLASTIC (w_P)	PLASTICITY INDEX (I_P)	UCS C_u	UU c, ϕ	CU c', ϕ'	PreConsolidation Pressure (kPa)	Commpression Index (Cc)	Initial Void Ratio (e_0)	
20															Moderately strong, moderately weathered, reddish brown, amygdaloidal BASALT															
21		-20.91	-22.11					100	100	96	III	4																		
22																														
23															BOREHOLE TERMINATED AT -22.11 (m) BELOW CD														
24																														
25																														
26																														
27																														
28																														
29																														
30																														

Abbreviations & Symbols :

- SPT - UDS - DS
- Rock Recovery - No Recovery
- Field Vane Shear - Sample Slipped

W_L - Liquid Limit I_P - Plasticity Index MC - Moisture Content

TCR - Total Core Recovery SCR - Solid Core Recovery RQD - Rock Quality Designation

C.D. Chart Datum, T.D. : Termination Depth, MSL : Mean Sea Level
SBL : Sea Bed Level, EGL : Existing Ground Level, R.L. : Reduced Level

W.I. - Weathering Grade F.I. Fractural Index

Prepared By : V.N.
Checked By : S.D.
Approved By : S.T.

Plate-A18

Project: Geological Survey for the Preparatory Survey on the Project for Construction of Mumbai Trans Harbour Link

Job No. : IDEAL/028/015

SPT v/s DEPTH [Corrected]

DATE : 06/07/15 to 10/07/15	CLIENT : Oriental Consultants	Location : BH-01

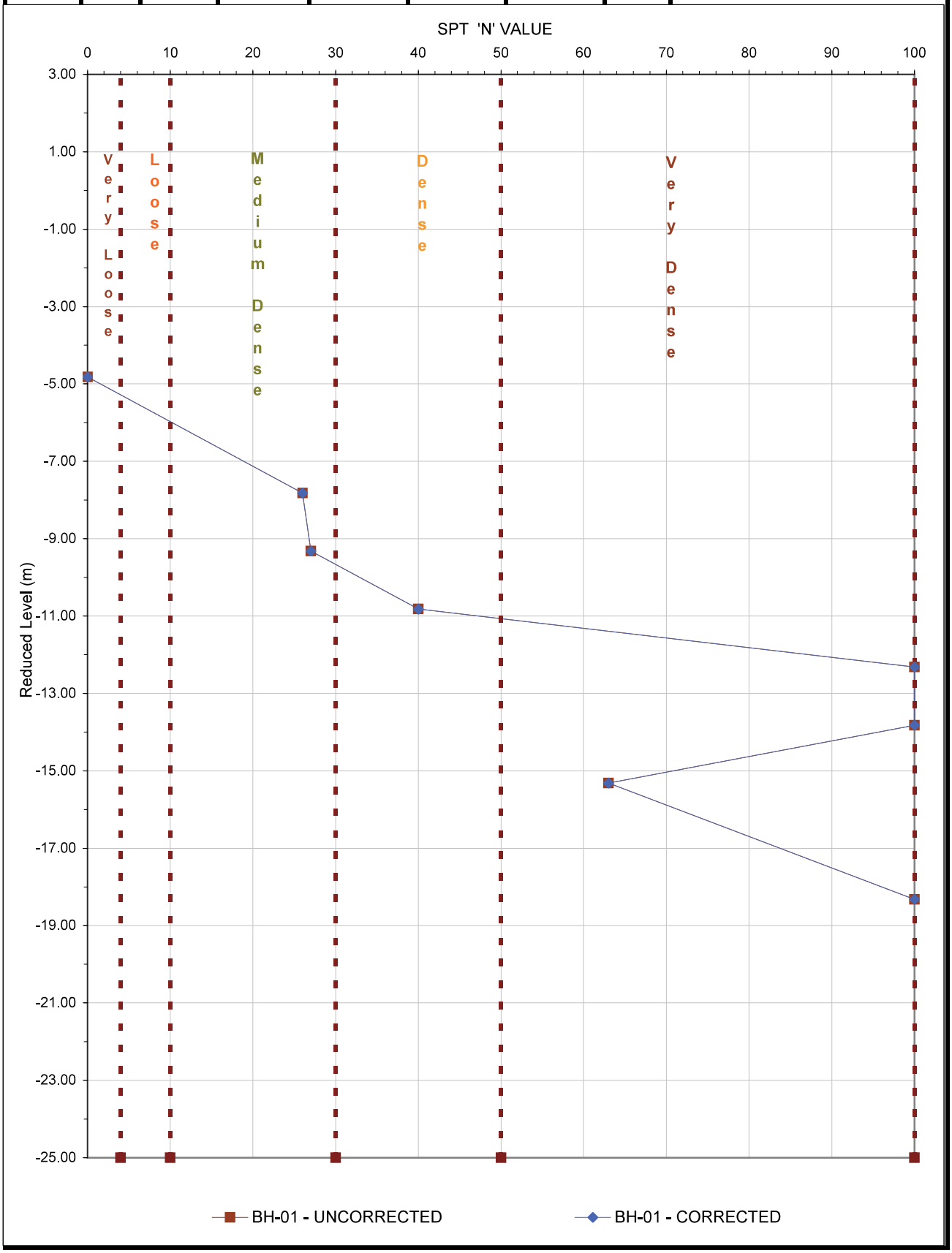


Plate-A19

Project: Geological Survey for the Preparatory Survey on the Project for Construction of Mumbai Trans Harbour Link

Job No. : IDEAL/028/015

SPT v/s DEPTH [Corrected]

DATE : 02/07/15 to 06/07/15	CLIENT : Oriental Consultants	Location : BH-02

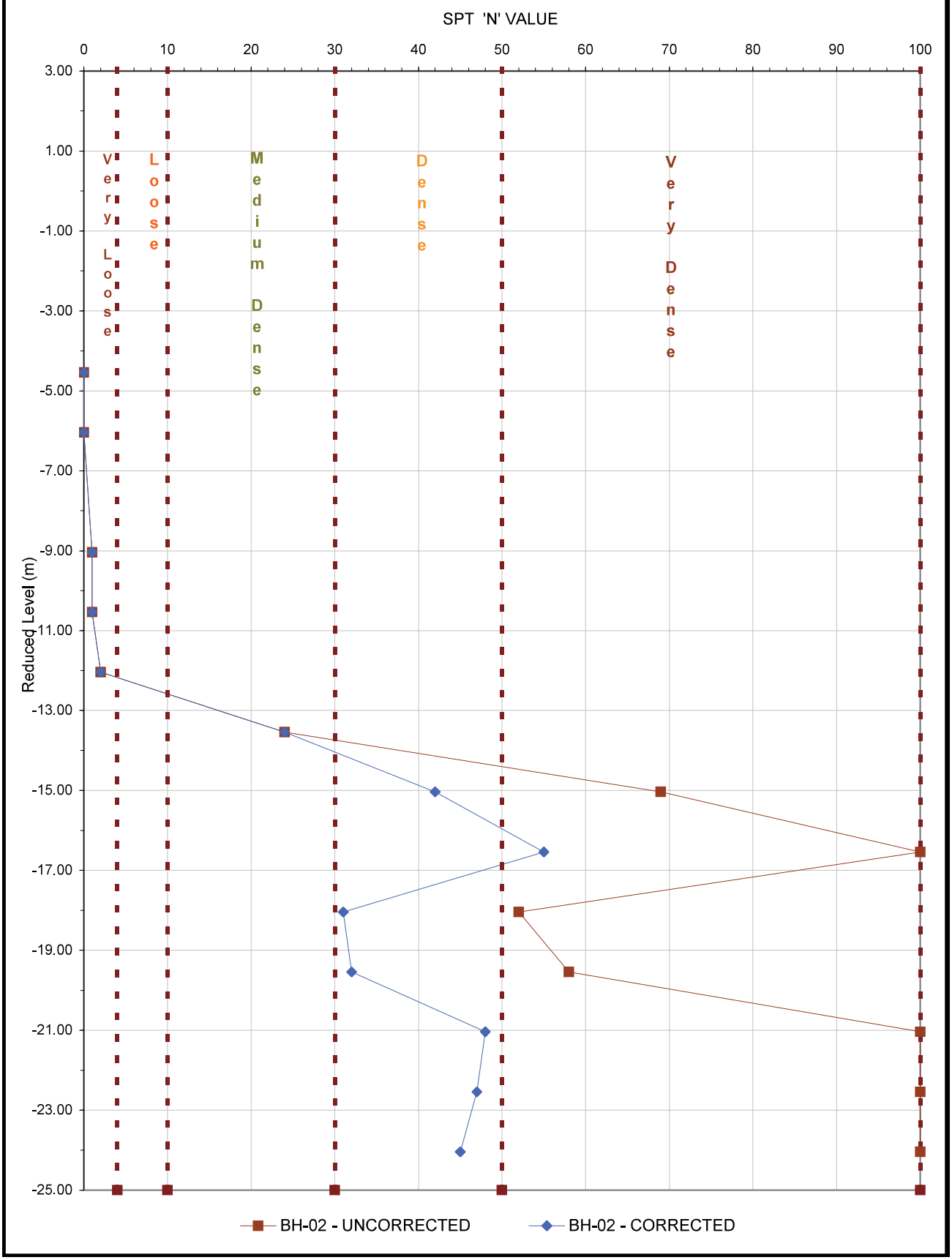


Plate-A20

Project: Geological Survey for the Preparatory Survey on the Project for Construction of Mumbai Trans Harbour Link

Job No. : IDEAL/028/015

SPT v/s DEPTH [Corrected]

DATE : 11/07/15 to 16/07/15	CLIENT : Oriental Consultants	Location : BH-03

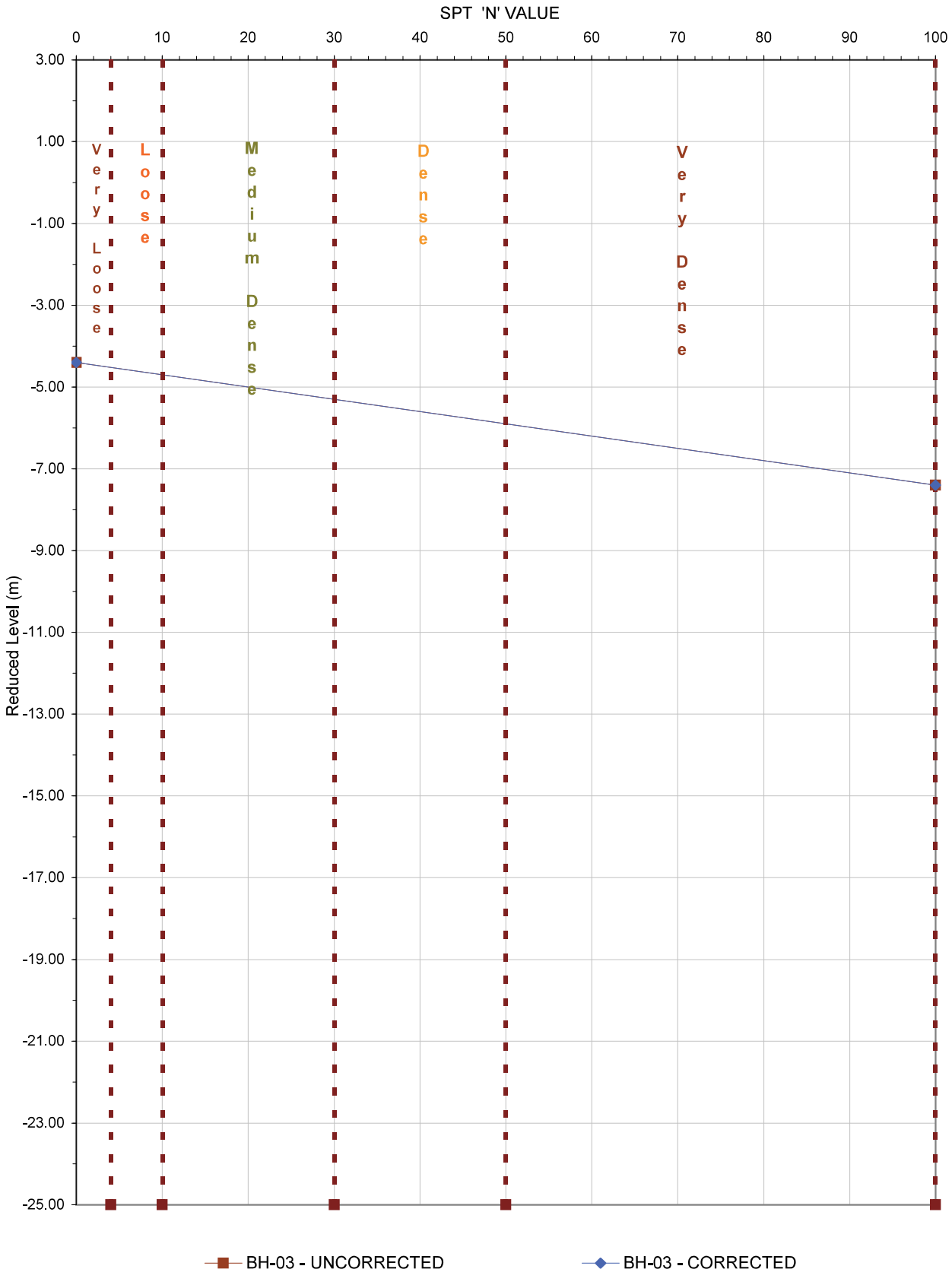


Plate-A21

Project: Geological Survey for the Preparatory Survey on the Project for Construction of Mumbai Trans Harbour Link

Job No. : IDEAL/028/015

SPT v/s DEPTH [Corrected]

DATE : 22/06/15 to 27/06/15	CLIENT : Oriental Consultants	Location : BH-04

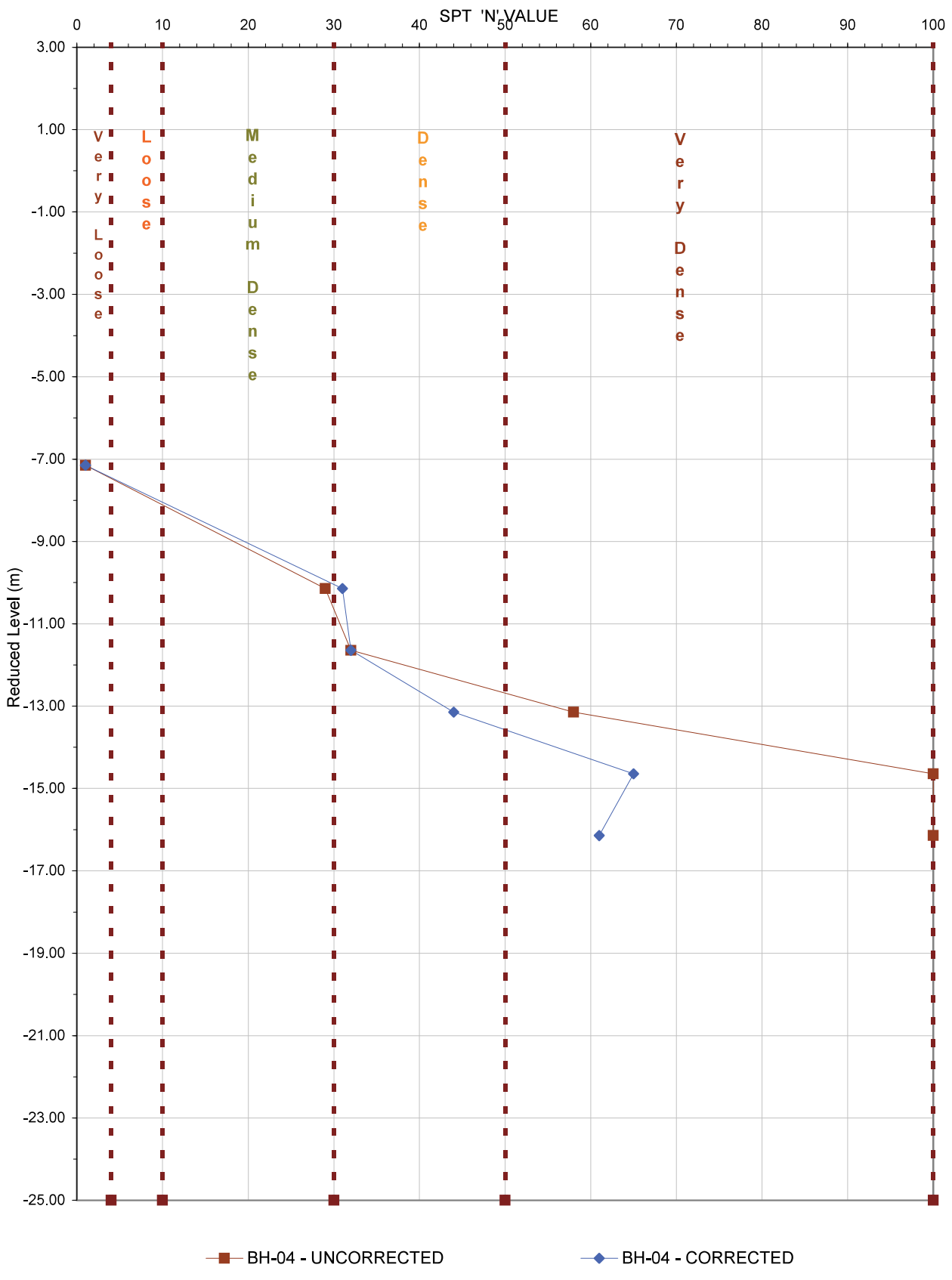


Plate-A22

Project: Geological Survey for the Preparatory Survey on the Project for Construction of Mumbai Trans Harbour Link

Job No. : IDEAL/028/015

SPT v/s DEPTH [Corrected]

DATE : 13/06/15 to 16/06/15	CLIENT : Oriental Consultants	Location : BH-05

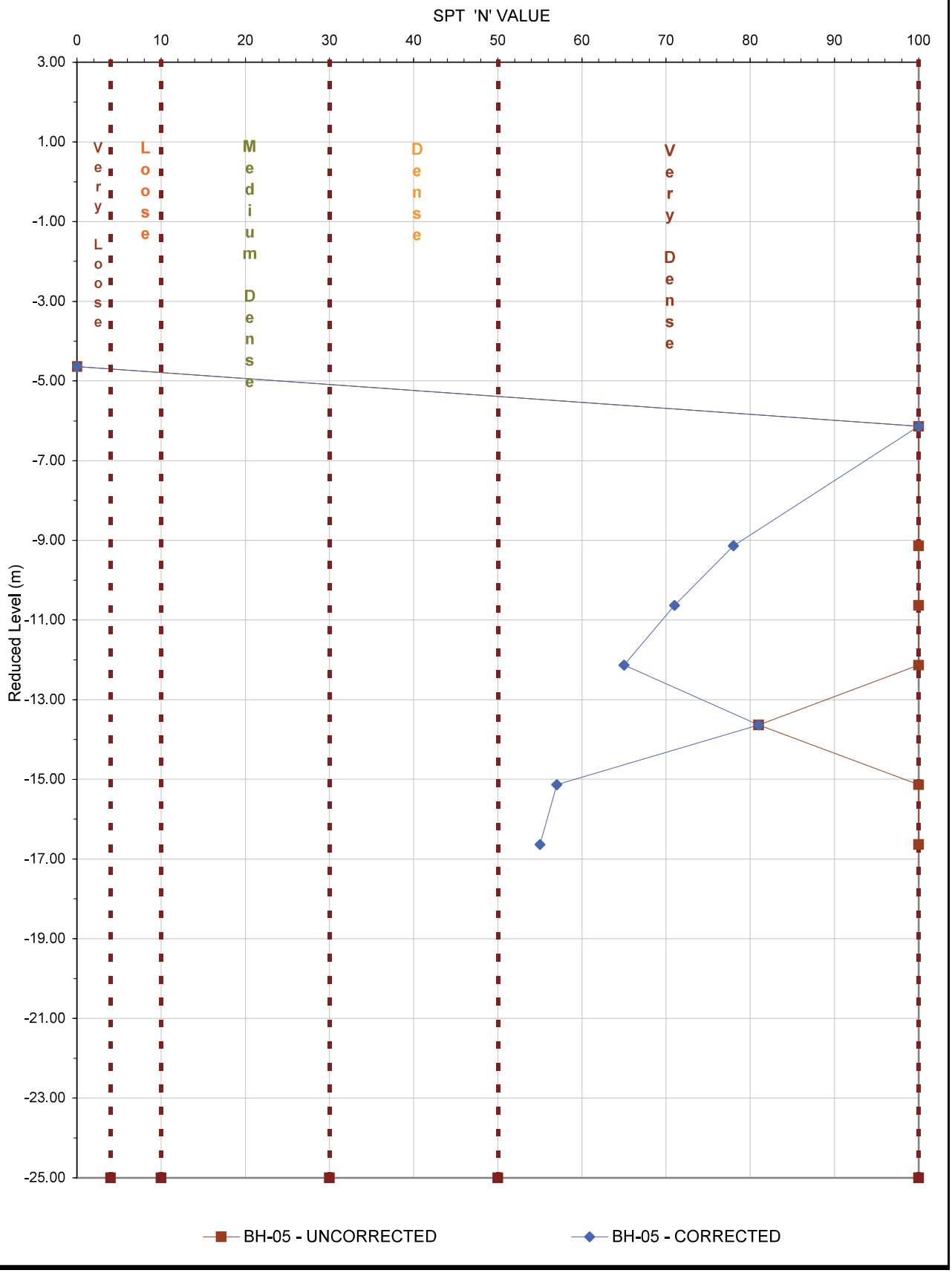


Plate-A23

Project: Geological Survey for the Preparatory Survey on the Project for Construction of Mumbai Trans Harbour Link

Job No. : IDEAL/028/015

SPT v/s DEPTH [Corrected]

DATE : 11/06/15 to 12/06/15	CLIENT : Oriental Consultants	Location : BH-06

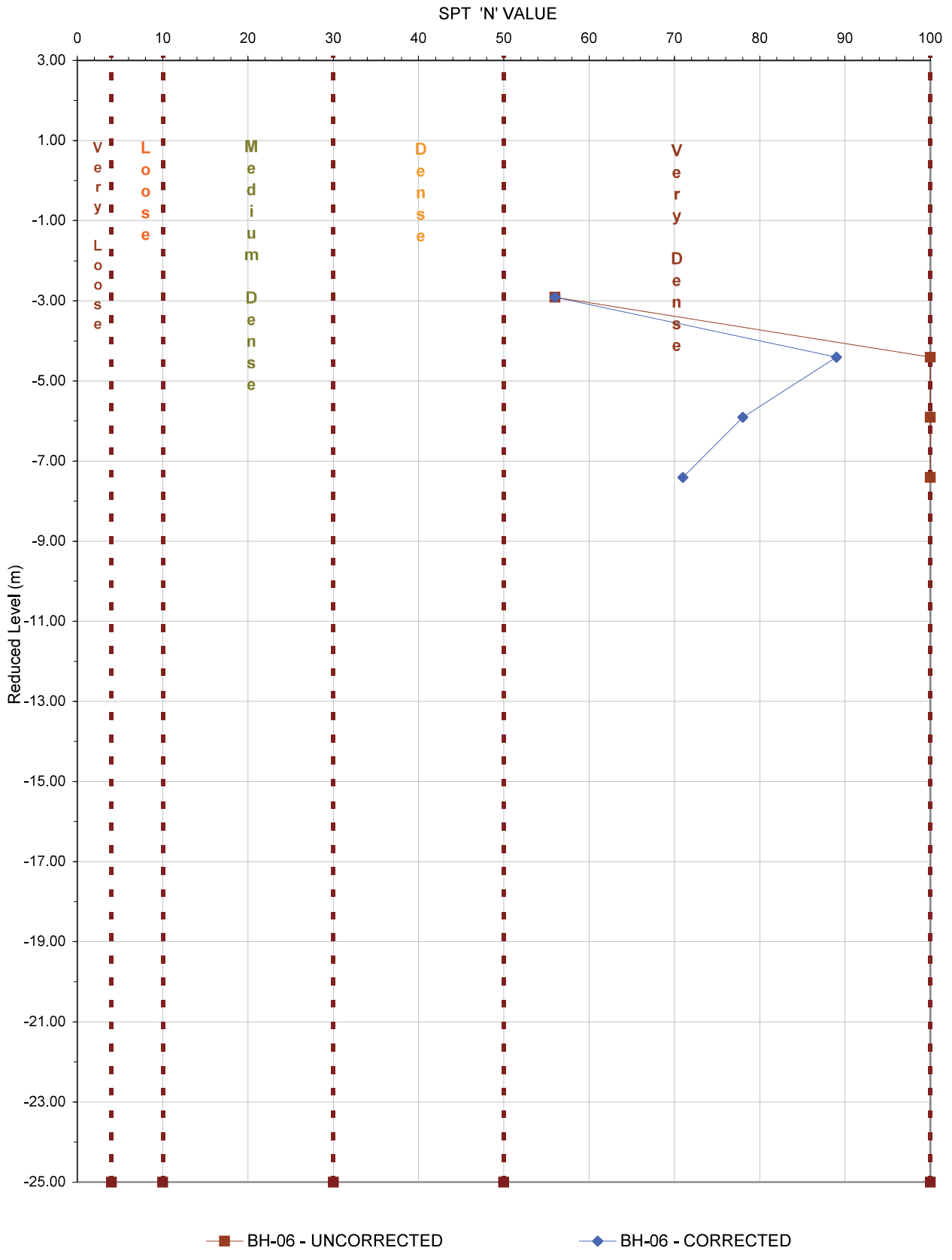


Plate-A24

APPENDIX-B - SUMMARY OF LABORATORY TEST RESULTS

SUMMARY OF LABORATORY TEST RESULTS ON SOIL SAMPLES

Project : Geological Survey for the Preparatory Survey on the Project for Construction of Mumbai Trans Harbour Link

Client: ORIENTAL CONSULTANTS — Global Consulting for Sustainable Development

Job Number : IDEAL/028/015

BOREHOLE - NO.	TestDepth (m)		Sample Type (D/S/SPT/UDS)	DENSITY & MOISTURE CONTENT			Soil Clasification (USC)	CLASSIFICATION TESTS								STRENGTH TESTS (kPa)							CONSOLIDATION TEST			CHEMICAL TEST						
				Moisture Content (%)	Density (Kg/cm^3)			Sp. Gravity	Atterberg Limits(%)			Particle Size Distribution(%)				UCS	UU		CU		Lab Shear Vane		Pre-Consolidation Pressure (kPa)	Commpression Index (Cc)	Initial Void Ratio (e^0)	Soil (%)				Water (mg/l)		
	From	To			Wet	Dry			W_L	W_P	I_P	Gravel	Sand	Silt	Clay	C_u	c	ϕ	c'	ϕ'	τ_v	τ_{vr}				SO_3	SO_4	CL	pH	SO_4	CL	pH
BH-01	-3.32	-3.82	D/S				CH	2.61	66	27	39	0	8	48	44																	
	-4.82	-5.27	SPT				CH	2.60	71	16	55	0	1	52	47																	
	-6.32	-6.77	UDS	67	1.60	0.96	CH	2.58	87	38	49	0	2	46	52	16							130	0.619	1.699							
	-7.82	-8.27	SPT				CH	2.61	78	32	46	0	4	72	24																	
	-9.32	-9.77	SPT				CH	2.59	79	32	47	12	2	29	57																	
	-10.82	-11.27	SPT				CH	2.61	82	28	54	8	6	34	52																	
	-12.32	-12.67	SPT				CH	2.59	79	32	47	25	15	27	33																	
	-13.82	-14.22	SPT				CH	2.60	66	32	34	12	14	61	13																	
	-15.32	-15.77	SPT				CL	2.61	43	22	21	12	14	42	32																	

PREPARED BY : **V.N.** CHECKED BY : **S.D** APPROVED BY : **S.T.**

付録3-43

Plate-B1

SUMMARY OF LABORATORY TEST RESULTS ON SOIL SAMPLES

Project : Geological Survey for the Preparatory Survey on the Project for Construction of Mumbai Trans Harbour Link

Client: ORIENTAL CONSULTANTS — Global Consulting for Sustainable Development

Job Number : IDEAL/028/015

BOREHOLE - NO.	TestDepth (m)		Sample Type (D/S/SPT/UDS)	DENSITY & MOISTURE CONTENT			Soil Clasification (USC)	CLASSIFICATION TESTS								STRENGTH TESTS (kPa)							CONSOLIDATION TEST			CHEMICAL TEST						
				Moisture Content (%)	Density (Kg/cm^3)			Sp. Gravity	Atterberg Limits(%)			Particle Size Distribution(%)				UCS	UU		CU		Lab Shear Vane		Pre-Consolidation Pressure (kPa)	Commpression Index (Cc)	Initial Void Ratio (e^0)	Soil (%)				Water (mg/l)		
	From	To			Wet	Dry			W_L	W_P	I_P	Gravel	Sand	Silt	Clay	C_u	c	ϕ	c'	ϕ'	τ_v	τ_{vr}				SO_3	SO_4	CL	pH	SO_4	CL	pH
BH-02	-3.04	-3.54	D/S				CH	2.60	58	33	25	0	0	55	45																
	-4.54	-4.99	SPT				CH	2.61	65	32	33	0	1	50	49																
	-6.04	-6.49	SPT				CH	2.59	63	29	34	0	1	52	47																
	-7.54	-7.99	UDS	122	1.60	0.72	CH	2.54	80	36	44	0	1	59	40	4							46	0.851	2.308							
	-9.04	-9.49	SPT				CH	2.57	59	25	24	0	1	79	20																
	-10.54	-10.99	SPT				CH	2.59	59	29	30	0	1	50	49																
	-12.04	-12.49	SPT				CH	2.60	62	29	33	0	2	52	46																
	-13.54	-13.99	SPT				CH	2.58	54	23	31	15	31	26	28																
	-15.04	-15.49	SPT				SP	-	-	NP	-	6	94	0																	
	-16.54	-16.86	SPT				SP	-	-	NP	-	12	87	1																	
	-18.04	-18.49	SPT				SP	-	-	NP	-	10	88	2																	
	-19.54	-19.99	SPT				SP	-	-	NP	-	0	99	1																	
	-21.04	-21.24	SPT				SP	-	-	NP	-	0	99	1																	
	-22.54	-22.79	SPT				SP	-	-	NP	-	0	99	1																	
	-24.04	-24.12	SPT				SM	-	-	NP	-	0	85	15																	

PREPARED BY : **V.N.** CHECKED BY : **S.D** APPROVED BY : **S.T.**

付録3−44

Plate-B2

SUMMARY OF LABORATORY TEST RESULTS ON SOIL SAMPLES

Project : Geological Survey for the Preparatory Survey on the Project for Construction of Mumbai Trans Harbour Link

Client: ORIENTAL CONSULTANTS — Global Consulting for Sustainable Development

Job Number : IDEAL/028/015

BOREHOLE - NO.	TestDepth (m)		Sample Type (D/S/SPT/ UDS)	DENSITY & MOISTURE CONTENT			Soil Clasiification (USC)	CLASSIFICATION TESTS								STRENGTH TESTS (kPa)							CONSOLIDATION TEST			CHEMICAL TEST							
				Moisture Content (%)	Density (Kg/cm^3)			Sp. Gravity	Atterberg Limits(%)			Particle Size Distribution(%)				UCS	UU		CU		Lab Shear Vane		Pre-Consolidation Pressure (kPa)	Commpression Index (Cc)	Initial Void Ratio (e^0)	Soil (%)				Water (mg/l)		
	From	To			Wet	Dry			W_L	W_P	I_P	Gravel	Sand	Silt	Clay	C_u	c	ϕ	c'	ϕ'	τ_v	τ_{vr}				SO_3	SO_4	CL	pH	SO_4	CL	pH
BH-03	-2.90	-3.40	D/S				CH	2.60	62	26	36	0	2	57	41																	
	-4.40	-4.85	SPT				CH	2.60	62	43	19	0	1	57	42																	

PREPARED BY : V.N. CHECKED BY : S.D APPROVED BY : S.T.

付録3-45

Plate-B3

SUMMARY OF LABORATORY TEST RESULTS ON SOIL SAMPLES

Project : Geological Survey for the Preparatory Survey on the Project for Construction of Mumbai Trans Harbour Link

Client: ORIENTAL CONSULTANTS — Global Consulting for Sustainable Development

Job Number : IDEAL/028/015

BOREHOLE - NO.	TestDepth (m)		Sample Type (D/S/SPT/ UDS)	DENSITY & MOISTURE CONTENT			Soil Clasification (USC)	CLASSIFICATION TESTS									STRENGTH TESTS (kPa)							CONSOLIDATION TEST			CHEMICAL TEST							
				Moisture Content (%)	Density (Kg/cm^3)			Sp. Gravity	Atterberg Limits(%)			Particle Size Distribution(%)					UCS	UU		CU		Lab Shear Vane		Pre-Consolidation Pressure (kPa)	Commpression Index (Cc)	Initial Void Ratio (e^0)	Soil (%)				Water (mg/l)			
	From	To			Wet	Dry			W_L	W_P	I_P	Gravel	Sand	Silt	Clay	C_u	c	ϕ	c'	ϕ'	τ_v	τ_{vr}				SO_3	SO_4	CL	pH	SO_4	CL	pH
BH-04	-5.60	-6.10	D/S				SC	2.52	36	24	12	5	53	25	17																		
	-7.10	-7.55	SPT				CL	2.54	47	26	21	0	23	38	39																		
	-10.10	-10.55	SPT				SC	2.50	49	27	22	11	52	20	17																		
	-11.60	-12.05	SPT				CH	2.52	58	27	31	13	15	22	50																		
	-13.10	-13.55	SPT				SM	2.52	-	NP	-	3	76	14	7																		
	-14.60	-14.87	SPT				SP	-	-	NP	-	39	51	10																			
	-16.10	-16.55	SPT				SP	-	-	NP	-	37	55	8																			

PREPARED BY : **V.N.** CHECKED BY : **S.D** APPROVED BY : **S.T.**

SUMMARY OF LABORATORY TEST RESULTS ON SOIL SAMPLES

Project : Geological Survey for the Preparatory Survey on the Project for Construction of Mumbai Trans Harbour Link

Client: ORIENTAL CONSULTANTS — Global Consulting for Sustainable Development

Job Number : IDEAL/028/015

BOREHOLE - NO.	TestDepth (m)		Sample Type (D/S/SPT/UDS)	DENSITY & MOISTURE CONTENT			Soil Clasification (USC)	CLASSIFICATION TESTS									STRENGTH TESTS (kPa)							CONSOLIDATION TEST			CHEMICAL TEST						
									Atterberg Limits(%)			Particle Size Distribution(%)					UCS	UU		CU		Lab Shear Vane						Soil (%)				Water (mg/l)		
	From	To		Moisture Content (%)	Density (Kg/cm^3) Wet	Density (Kg/cm^3) Dry		Sp. Gravity	W_L	W_P	I_P	Gravel	Sand	Silt	Clay	C_u	c	ϕ	c'	ϕ'	τ_v	τ_{vr}	Pre-Consolidation Pressure (kPa)	Commpression Index (Cc)	Initial Void Ratio (e^0)	SO_3	SO_4	CL	pH	SO_4	CL	pH
BH-05	-3.10	-3.60	D/S				CL	2.53	42	22	20	7	43	28	22																	
	-6.10	-6.20	SPT				SM	2.48	-	NP	-	6	67	22	5																	
	-7.60	-8.05	UDS				SM	2.53	-	NP	-	6	68	21	5																	
	-9.10	-9.35	SPT				SP	-	-	NP	-	19	73	8																		
	-10.60	-10.83	SPT				GP	-	-	NP	-	56	43	1																		
	-12.10	-12.55	SPT				GC	2.52	30	20	10	40	27	28	5																	
	-13.60	-14.05	SPT				CL	2.54	41	22	19	5	35	53	7																	
	-15.10	-15.22	SPT				SP	-	-	NP	-	0	90	10																		
	-16.60	-16.68	SPT				SM	2.49	-	NP	-	2	78	14	6																	

PREPARED BY : **V.N.** CHECKED BY : **S.D** APPROVED BY : **S.T.**

付録3-47

Plate-B5

SUMMARY OF LABORATORY TEST RESULTS ON SOIL SAMPLES

Project : Geological Survey for the Preparatory Survey on the Project for Construction of Mumbai Trans Harbour Link

Client: ORIENTAL CONSULTANTS — Global Consulting for Sustainable Development

Job Number : IDEAL/028/015

BOREHOLE - NO.	TestDepth (m)		Sample Type (D/S/SPT/ UDS)	DENSITY & MOISTURE CONTENT			Soil Clasification (USC)	CLASSIFICATION TESTS								STRENGTH TESTS (kPa)						CONSOLIDATION TEST			CHEMICAL TEST							
				Moisture Content (%)	Density (Kg/cm^3)			Sp. Gravity	Atterberg Limits(%)			Particle Size Distribution(%)				UCS	UU		CU		Lab Shear Vane		Pre-Consolidation Pressure (kPa)	Commpression Index (Cc)	Initial Void Ratio (e^0)	Soil (%)				Water (mg/l)		
	From	To			Wet	Dry			W_L	W_P	I_P	Gravel	Sand	Silt	Clay	C_u	c	ϕ	c'	ϕ'	τ_v	τ_{vr}				SO_3	SO_4	CL	pH	SO_4	CL	pH
BH-06	0.09	-0.41	D/S				SP	-	-	NP	-	2	98	0																		
	-2.91	-3.36	SPT				SM	2.54	44	27	17	0	65	30	5																	
	-4.41	-4.79	SPT				SP	-	-	NP	-	0	97	3																		
	-5.91	-6.30	SPT				SM	-	-	NP	-	0	85	15																		
	-7.41	-7.51	SPT				SM	-	-	NP	-	14	71	15																		

PREPARED BY : **V.N.** CHECKED BY : **S.D** APPROVED BY : **S.T.**

付録3-48

Plate-B6

SUMMARY OF LABORATORY TEST RESULTS ON ROCK SAMPLES

Project : Geological Survey for the Preparatory Survey on the Project for Construction of Mumbai Trans Harbour Link

Job No. IDEAL/028/015

Client : ORIENTAL CONSULTANTS Global Consulting for Sustainable Development

DATE : 26-06-2015

BH No.	Depth(m)	Length (cm)	Diameter (cm)	Test Condition	Moisture Absorption (%)	Porosity (%)	Unit Weight (g/cm^3)	Specific Gravity	Point Load Index Strength(Mpa)	Uniaxial Compressive Strength (MPa)	Corrected Uniaxial Compressive Strength (MPa)	Modulus of Elasticity	Brazilian Test	Remarks
BH-01	-25.63 - -25.82	10.20	5.40	SOAKED	1.01	2.65	2.63	2.46	-	25.85	25.66	-	-	
	-26.84 - -26.95	10.00	5.40	SOAKED	0.84	2.27	2.70	2.57	-	18.86	18.68	-	-	
	-28.32 - -28.55	10.30	5.40	SOAKED	0.56	1.53	2.72	2.68	-	52.00	51.69	-	-	
BH-02	-24.46 - -24.58	10.00	5.40	SOAKED	1.34	3.49	2.60	2.49	-	32.75	32.42	-	-	
	-26.87 - -27.04	10.10	5.40	SOAKED	0.92	2.51	2.74	2.64	-	46.07	45.67	-	-	
	-27.43 - -27.60	10.00	5.40	SOAKED	0.91	2.53	2.78	2.65	-	25.33	25.07	-	-	
BH-03	-22.63 - -22.74	9.50	5.40	SOAKED	0.68	1.93	2.85	2.69	-	43.84	43.10	-	-	
	-25.03 - -25.24	10.00	5.40	SOAKED	0.40	1.14	2.84	2.71		60.47	59.88	-	-	
	-26.07 - -26.24	10.10	5.40	SOAKED	0.22	0.65	2.88	2.78	-	113.09	112.12	-	-	
	-27.85 - -28.04	10.00	5.40	SOAKED	0.61	1.66	2.72	2.59	-	61.44	60.83	-	-	

SUMMARY OF LABORATORY TEST RESULTS ON ROCK SAMPLES

Project : Geological Survey for the Preparatory Survey on the Project for Construction of Mumbai Trans Harbour Link

Job No. IDEAL/028/015

Client : ORIENTAL CONSULTANTS Global Consulting for Sustainable Development

DATE : 26-06-2015

BH No.	Depth(m)	Length (cm)	Diameter (cm)	Test Condition	Moisture Absorption (%)	Porosity (%)	Unit Weight (g/cm^3)	Specific Gravity	Point Load Index Strength(Mpa)	Uniaxial Compressive Strength (MPa)	Corrected Uniaxial Compressive Strength (MPa)	Modulus of Elasticity	Brazilian Test	Remarks
BH-04	-22.67 - -22.81	10.00	5.40	SOAKED	1.33	3.49	2.63	2.51	-	38.29	37.91	-	-	
	-26.38 - -26.58	10.00	5.40	SOAKED	0.70	1.88	2.70	2.58	-	43.36	42.93	-	-	
	-29.40 - -29.60	10.20	5.40	SOAKED	0.60	1.67	2.79	2.71	0.39	-	8.59	-	-	
	-30.75 - -30.93	7.10	5.40	SOAKED	0.38	1.05	2.75	2.79	0.25	-	5.47	-	-	
BH-05	-21.60 - -21.73	10.10	5.40	SOAKED	1.16	3.07	2.65	2.45	-	17.55	17.40	-	-	
	-22.95 - -23.05	10.20	5.40	SOAKED	1.21	3.08	2.55	2.48	-	17.12	16.99	-	-	
	-24.60 - -25.75	10.20	5.40	SOAKED	0.85	2.23	2.63	2.67	-	34.19	33.94	-	-	
BH-06	-13.41 - -13.54	10.20	5.40	SOAKED	0.46	1.28	2.81	2.74	-	69.21	68.70	-	-	
	-17.29 - -17.41	10.20	5.40	SOAKED	1.45	3.64	2.52	2.45	-	14.32	14.22	-	-	
	-22.23 - -22.41	10.10	5.40	SOAKED	1.06	2.68	2.53	2.44	-	11.61	11.51	-	-	

Prepared By : V.N. **Checked By: S.D** **Approved by : ST**

APPENDIX-C - CLASSIFICATION TEST RESULTS

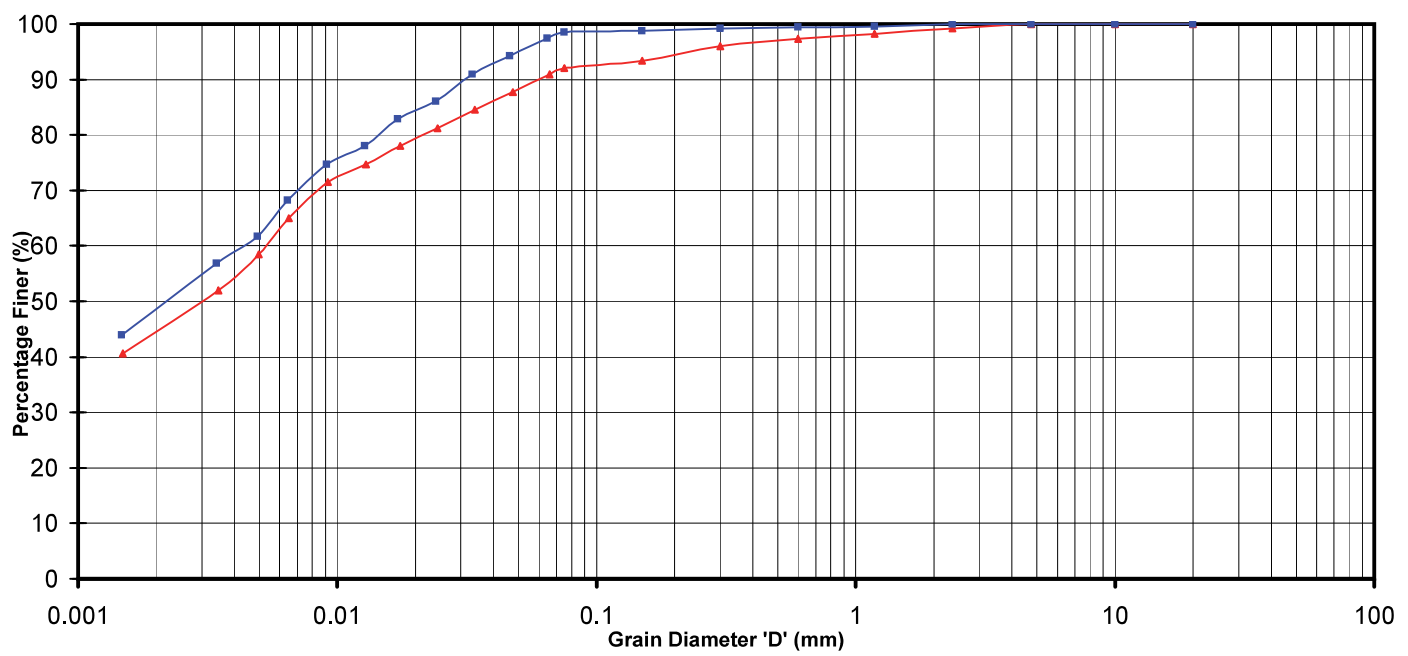
PARTICLE SIZE DISTRIBUTION

Project : Geological Survey for the Preparatory Survey on the Project for Construction of Mumbai Trans Harbour Link
Job No. : IDEAL/028/015

As Per IS:2720

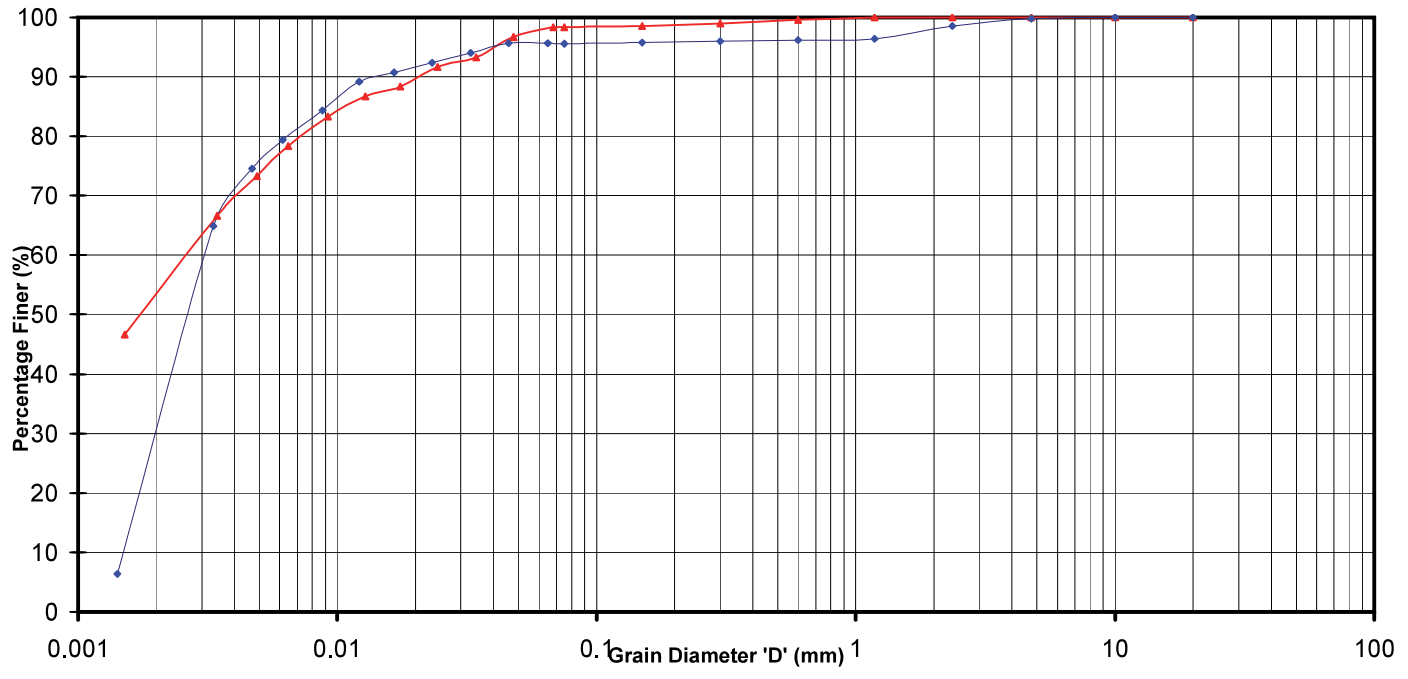
BH NO.: **BH-01** Depth (m) : **-3.32 - -3.82** ▲ **-4.82 - -5.27** ■

	CLAY	SILT	SAND			GRAVEL
			FINE	MEDIUM	COARSE	
▲	44	48	5	2	1	0
■	47	52	0	1	0	0



BH NO.: **BH-01** Depth (m) : **-6.32 - -6.77** ▲ **-7.82 - -8.27** ■

	CLAY	SILT	SAND			GRAVEL
			FINE	MEDIUM	COARSE	
▲	52	46	1	1	0	0
■	24	72	0	2	2	0



Tested By : **P.M.** Prepared By :**V.N.** Checked By :**S.D.** Approved By :**S.T.**

IDEAL

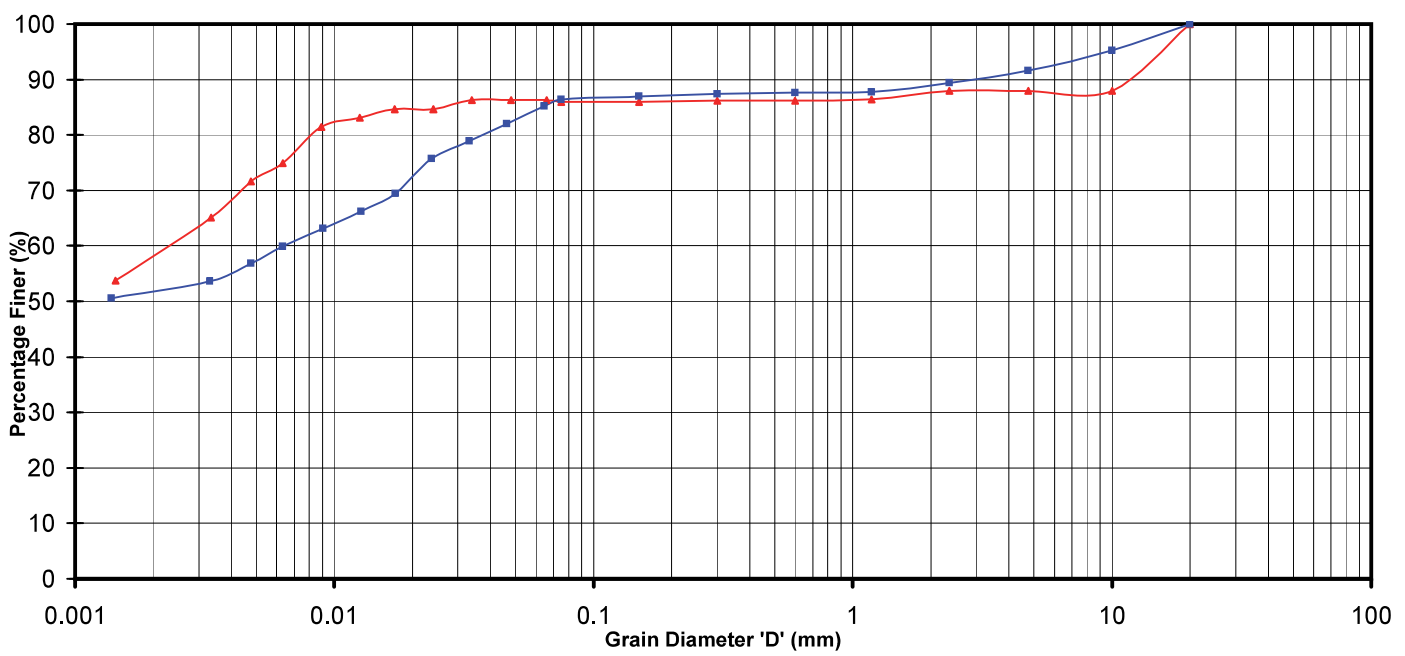
PARTICLE SIZE DISTRIBUTION

Project : Geological Survey for the Preparatory Survey on the Project for Construction of Mumbai Trans Harbour Link
Job No. : IDEAL/028/015

As Per IS:2720

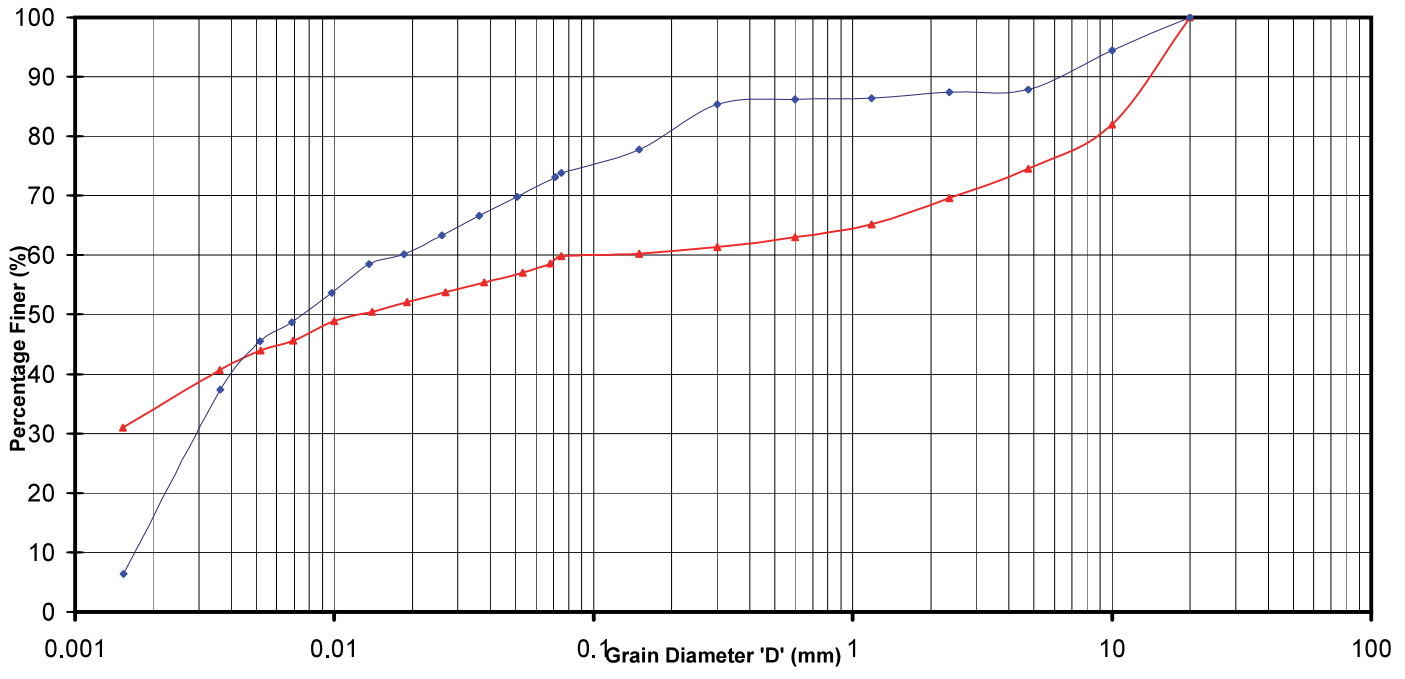
BH NO.: **BH-01** Depth (m) : **-9.32 - -9.77** ▲ **-10.82 - -11.27** ■

	CLAY	SILT	SAND			GRAVEL
			FINE	MEDIUM	COARSE	
▲	57	29	0	2	0	12
■	52	34	1	2	3	8



BH NO.: **BH-01** Depth (m) : **-12.32 - -12.67** ▲ **-13.82 - -14.22** ■

	CLAY	SILT	SAND			GRAVEL
			FINE	MEDIUM	COARSE	
▲	33	27	2	6	7	25
■	13	61	12	1	1	12



Tested By : **P.M.** Prepared By :**V.N.** Checked By :**S.D.** Approved By :**S.T.**

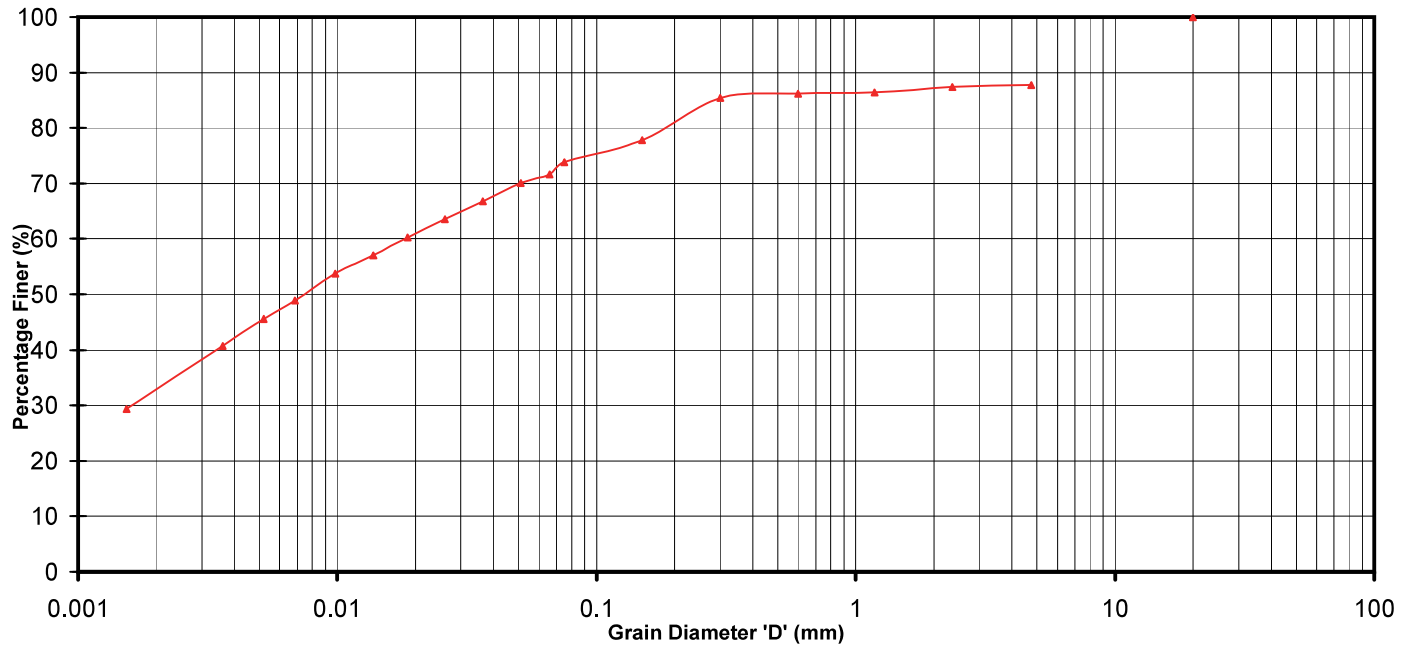
PARTICLE SIZE DISTRIBUTION

Project : Geological Survey for the Preparatory Survey on the Project for Construction of Mumbai Trans Harbour Link
Job No. : IDEAL/028/015

As Per IS:2720

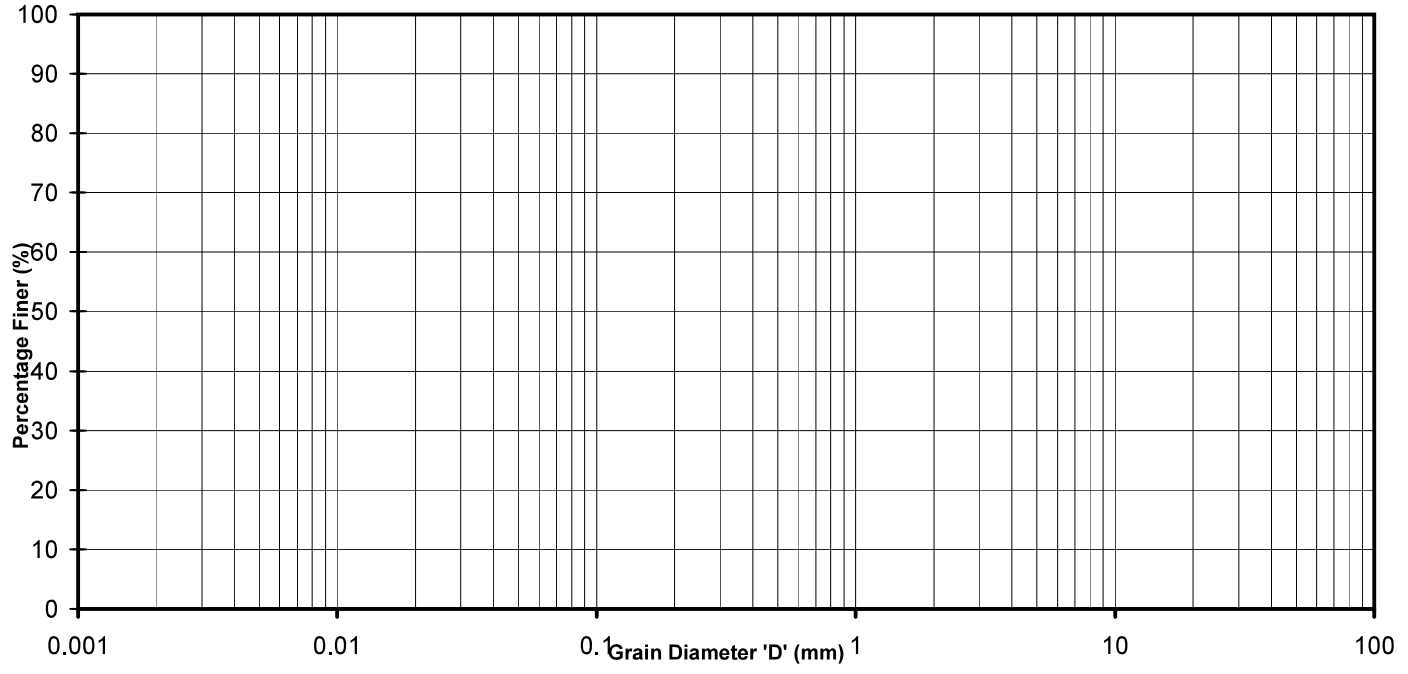
BH NO.: **BH-01** Depth (m) : **-13.82 - -14.22**

	CLAY	SILT	SAND			GRAVEL
			FINE	MEDIUM	COARSE	
▲	32	42	12	1	1	12
■						



BH NO.: Depth (m) :

	CLAY	SILT	SAND			GRAVEL
			FINE	MEDIUM	COARSE	
▲						
■						



Tested By : **P.M.** Prepared By :**V.N.** Checked By :**S.D.** Approved By :**S.T.**

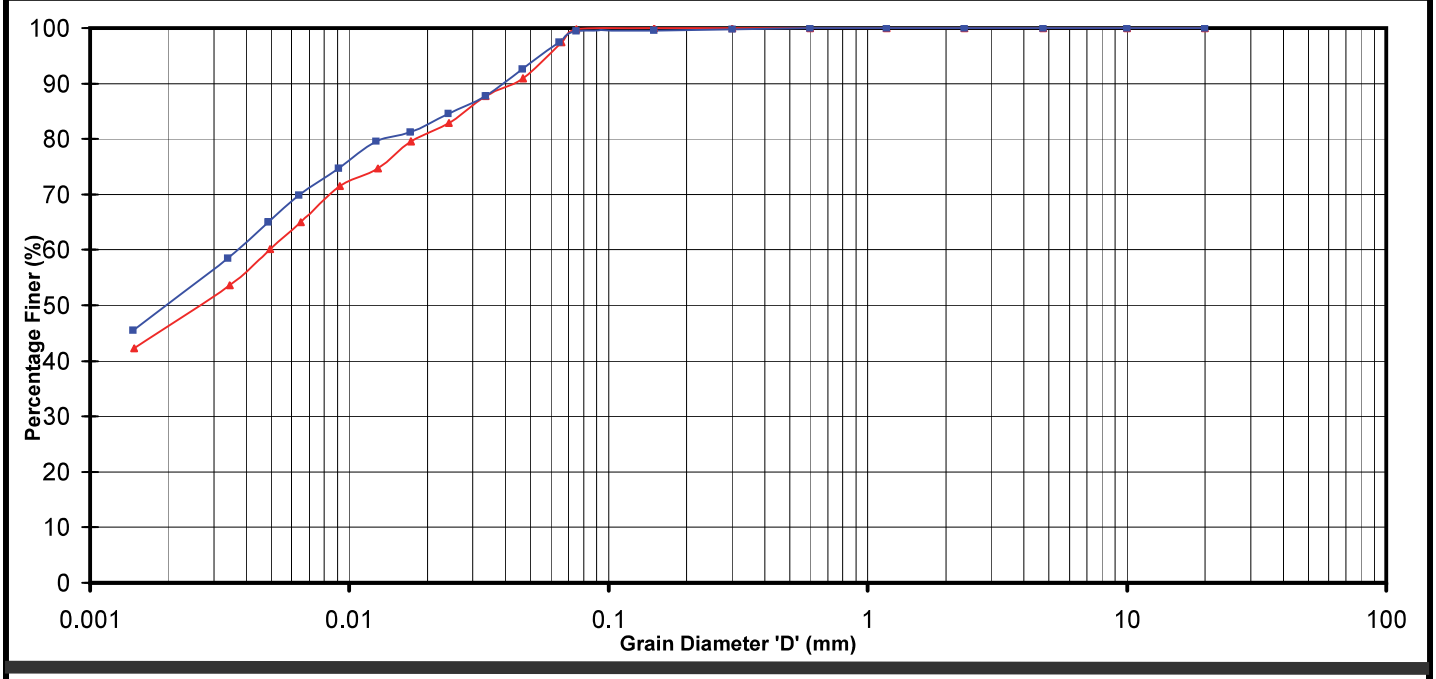
PARTICLE SIZE DISTRIBUTION

Project : Geological Survey for the Preparatory Survey on the Project for Construction of Mumbai Trans Harbour Link
Job No. : IDEAL/028/015

As Per IS:2720

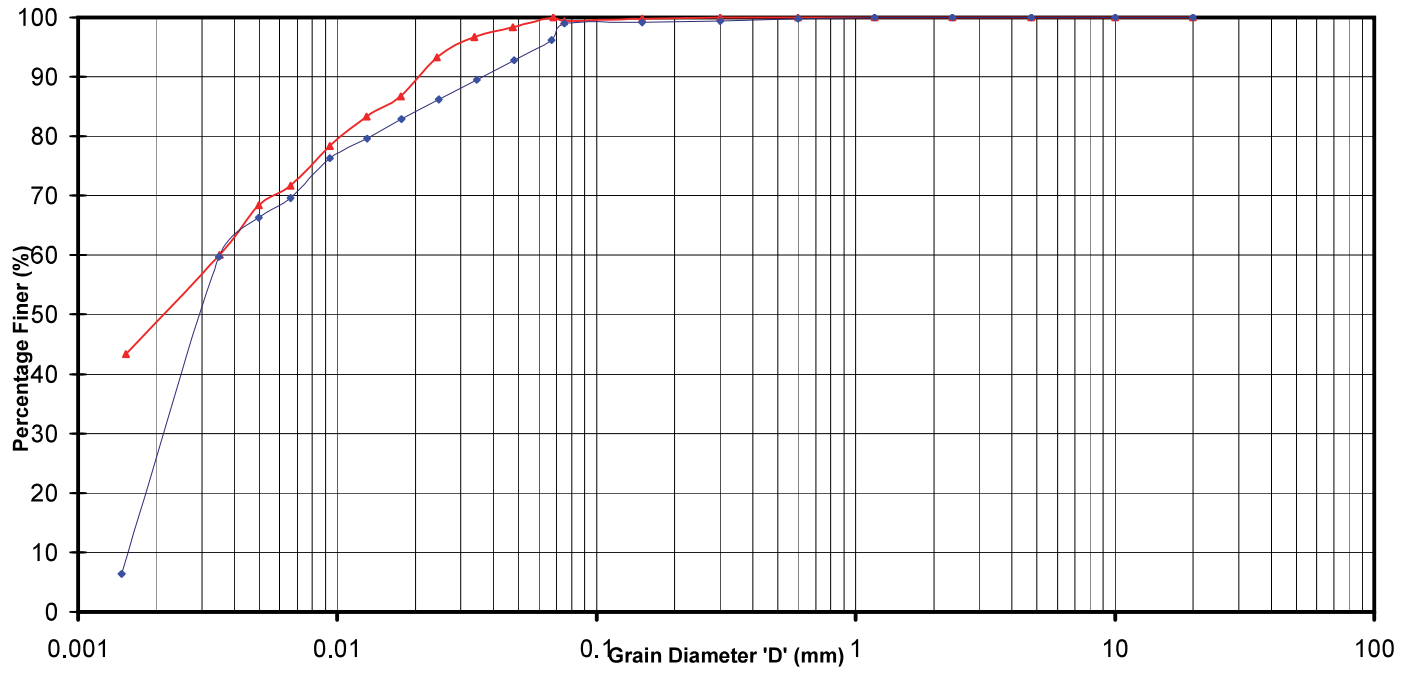
BH NO.: **BH-02** Depth (m) : **-3.04 - -3.54** **-4.54 - -4.99**

	CLAY	SILT	SAND			GRAVEL
			FINE	MEDIUM	COARSE	
▲	45	55	0	0	0	0
■	49	50	1	0	0	0



BH NO.: **BH-02** Depth (m) : **-6.04 - -6.49** **-9.04 - -9.49**

	CLAY	SILT	SAND			GRAVEL
			FINE	MEDIUM	COARSE	
▲	47	52	1	0	0	0
■	20	79	1	0	0	0



Tested By : **P.M.** Prepared By :**V.N.** Checked By :**S.D.** Approved By :**S.T.**

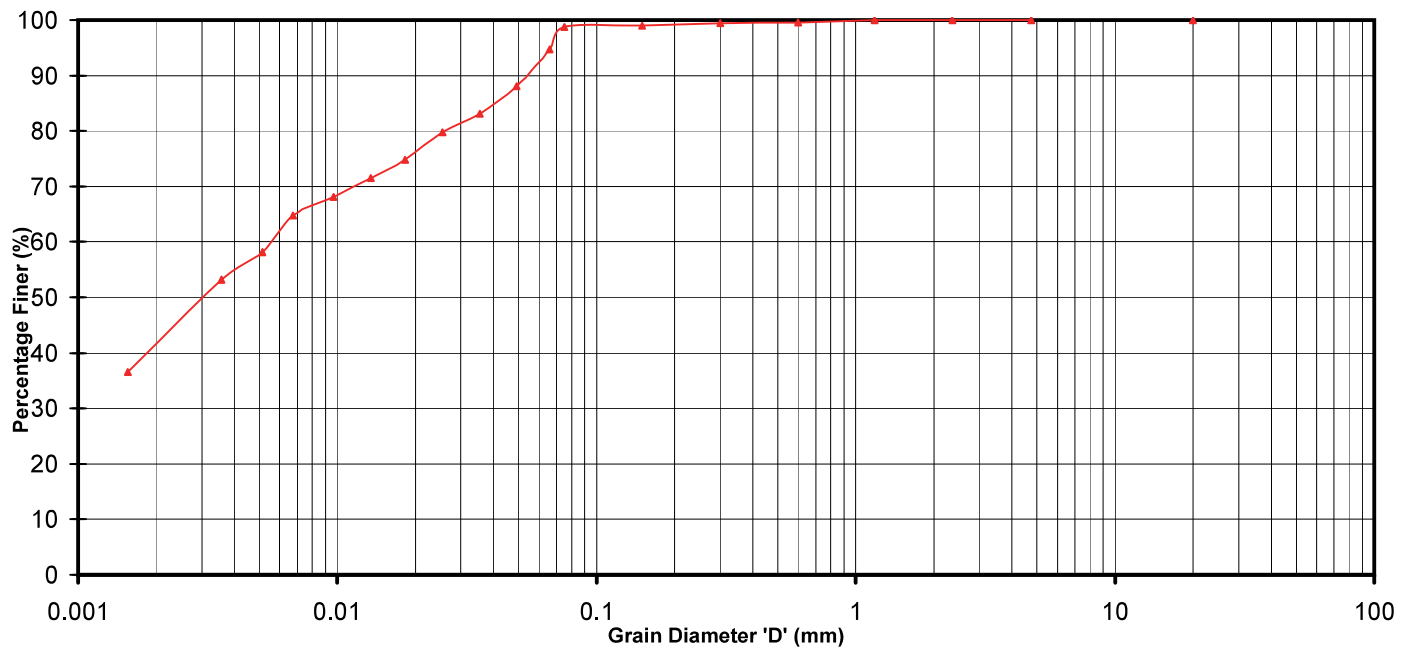
PARTICLE SIZE DISTRIBUTION

Project : Geological Survey for the Preparatory Survey on the Project for Construction of Mumbai Trans Harbour Link
Job No. : IDEAL/028/015

As Per IS:2720

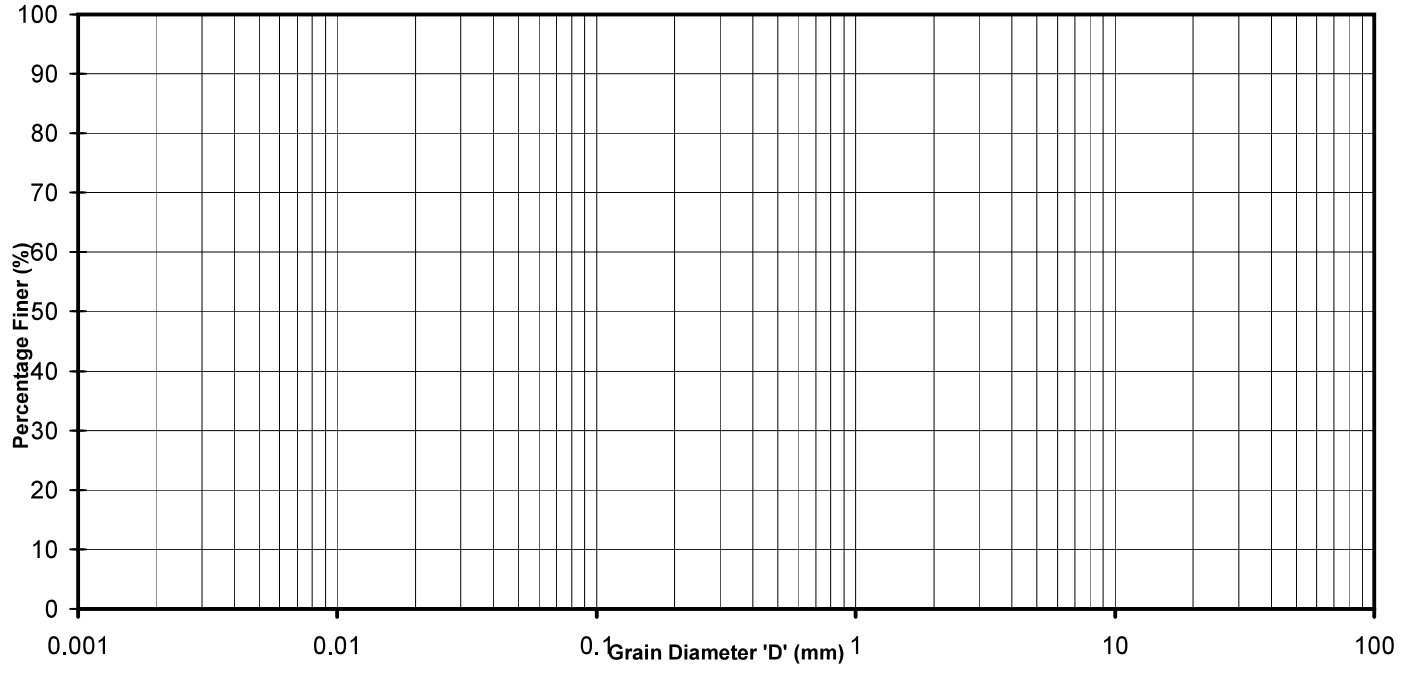
BH NO.: **BH-02** Depth (m) : **-7.54 - -7.99** **-4.54 - -4.99**

	CLAY	SILT	SAND			GRAVEL
			FINE	MEDIUM	COARSE	
▲	40	59	0	1	0	0
■						



BH NO.: Depth (m) :

	CLAY	SILT	SAND			GRAVEL
			FINE	MEDIUM	COARSE	
▲						
■						



Tested By : **P.M.** Prepared By :**V.N.** Checked By :**S.D.** Approved By :**S.T.**

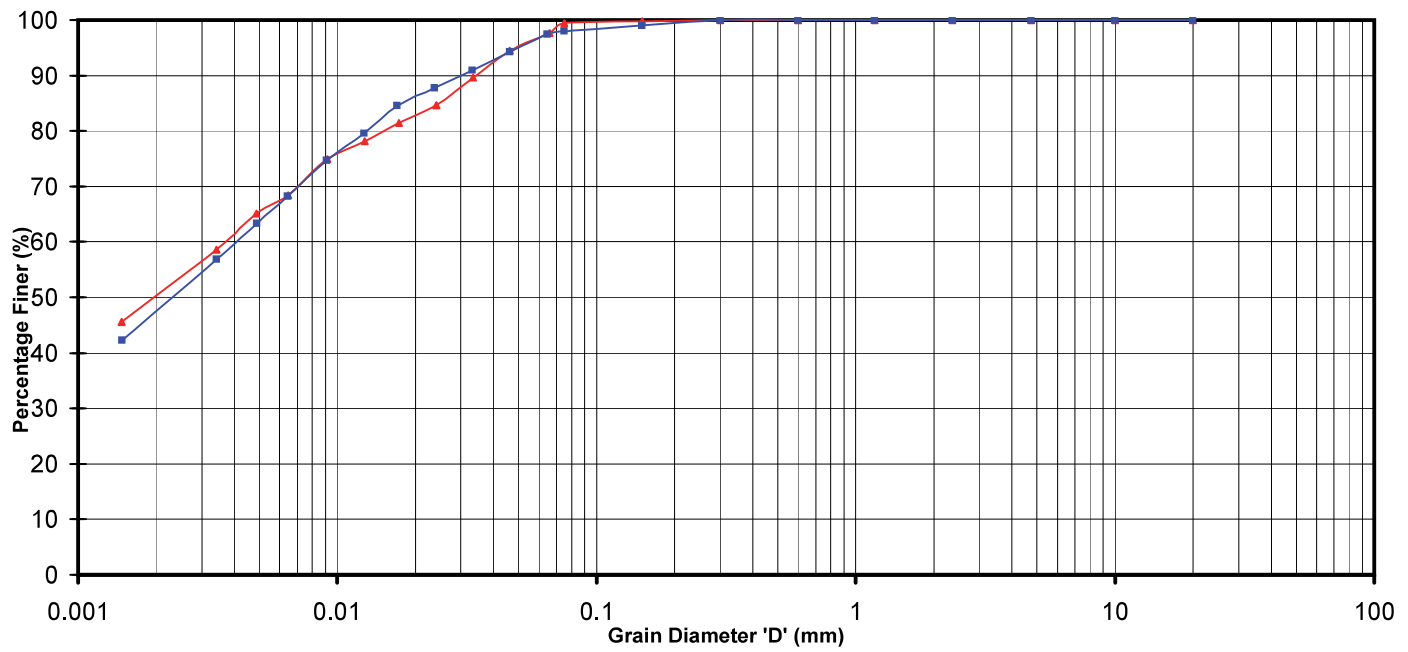
PARTICLE SIZE DISTRIBUTION

Project : Geological Survey for the Preparatory Survey on the Project for Construction of Mumbai Trans Harbour Link
Job No. : IDEAL/028/015

As Per IS:2720

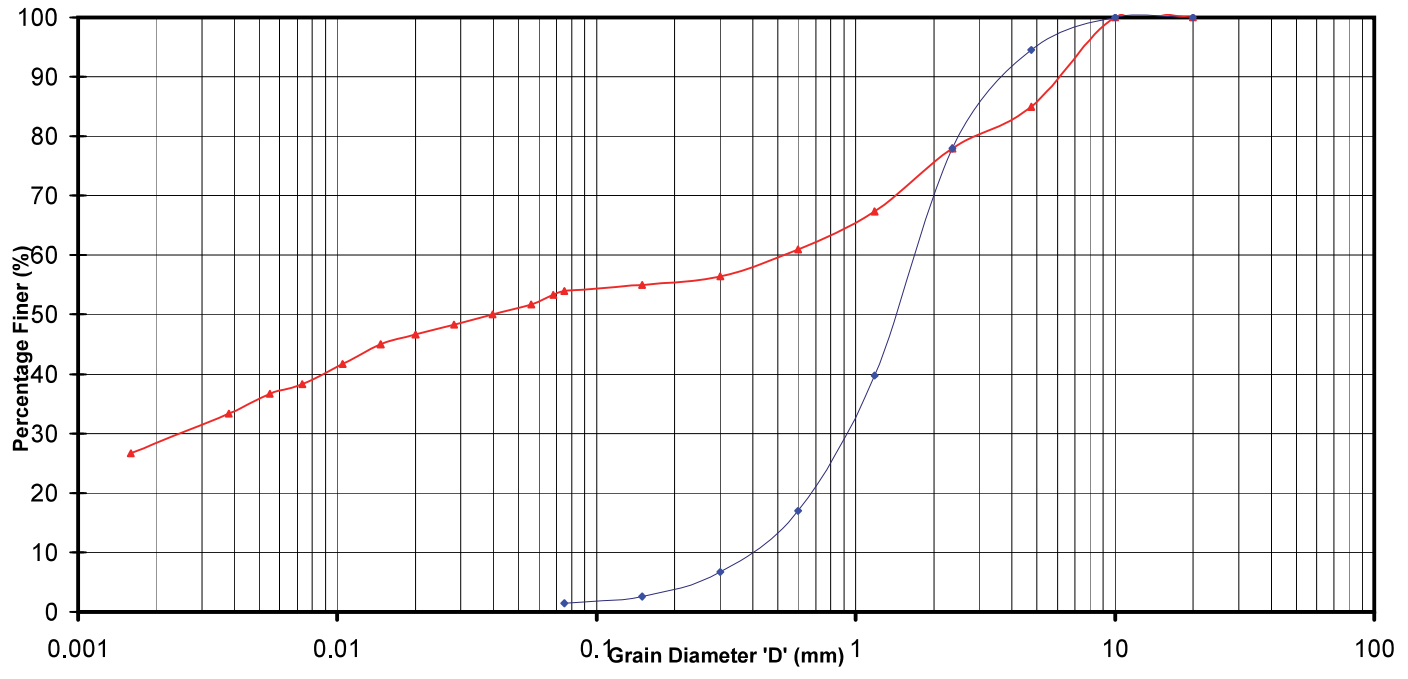
BH NO.: **BH-02** Depth (m) : **-10.54 - -10.99** ▲ **-12.04 - -12.49** ■

	CLAY	SILT	SAND			GRAVEL
			FINE	MEDIUM	COARSE	
▲	49	50	1	0	0	0
■	46	52	2	0	0	0



BH NO.: **BH-02** Depth (m) : **-13.54 - -13.99** ▲ **-15.04 - -15.49** ■

	CLAY	SILT	SAND			GRAVEL
			FINE	MEDIUM	COARSE	
▲	28	26	4	17	10	15
■	0		10	55	29	6



Tested By : **P.M.** Prepared By :**V.N.** Checked By :**S.D.** Approved By :**S.T.**

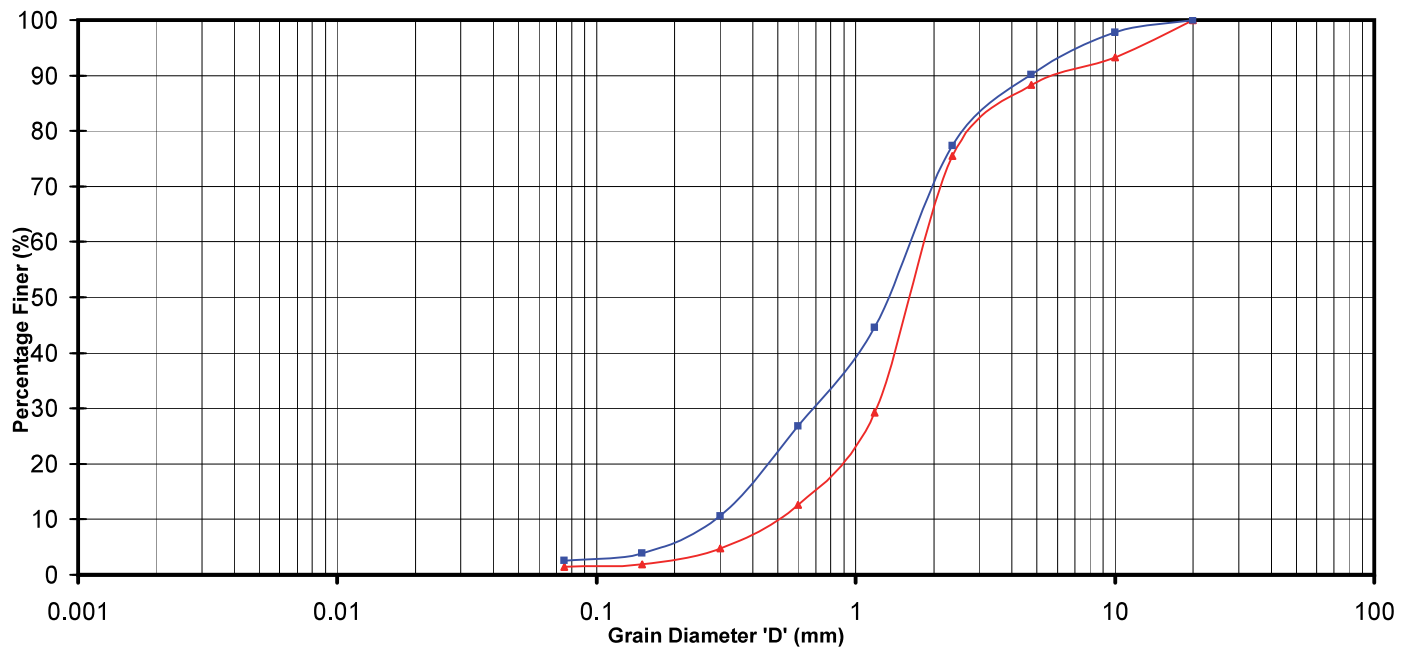
PARTICLE SIZE DISTRIBUTION

Project : Geological Survey for the Preparatory Survey on the Project for Construction of Mumbai Trans Harbour Link
Job No. : IDEAL/028/015

As Per IS:2720

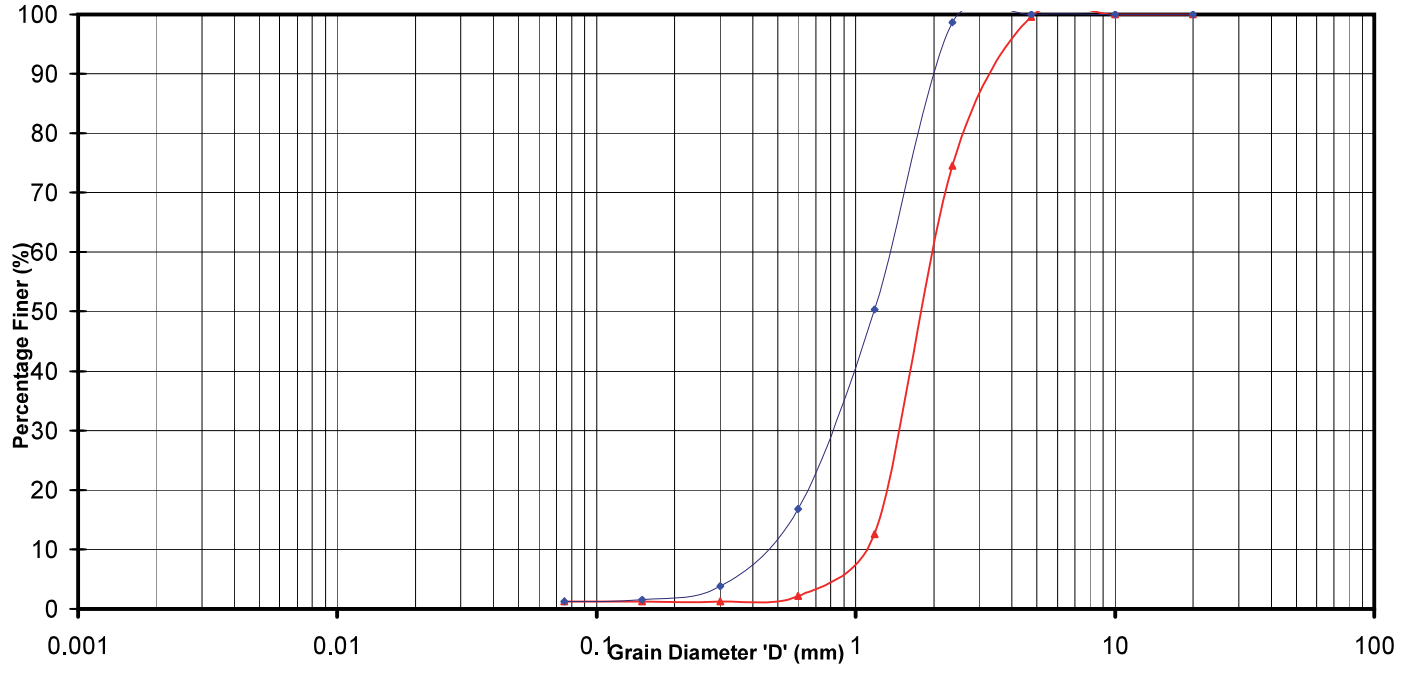
BH NO.: **BH-02** Depth (m) : **-16.54 - -16.86** **-18.04 - -18.49**

	CLAY & SILT	SAND			GRAVEL
		FINE	MEDIUM	COARSE	
▲	1	7	53	27	12
■	2	15	50	23	10



BH NO.: **BH-02** Depth (m) : **-19.54 - -19.99** **-21.04 - -21.24**

	CLAY & SILT	SAND			GRAVEL
		FINE	MEDIUM	COARSE	
▲	1	1	54	44	0
■	1	8	75	16	0



Tested By : **P.M.** Prepared By :**V.N.** Checked By :**S.D.** Approved By :**S.T.**

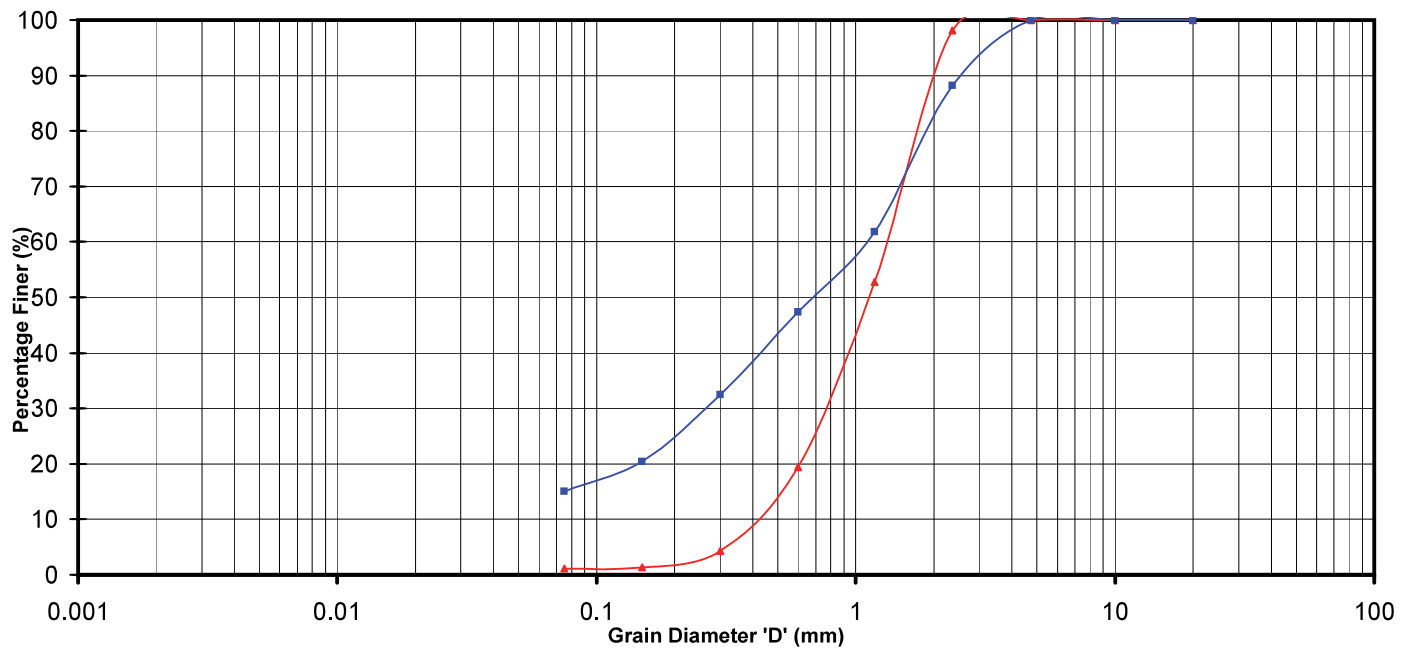
PARTICLE SIZE DISTRIBUTION

Project : Geological Survey for the Preparatory Survey on the Project for Construction of Mumbai Trans Harbour Link
Job No. : IDEAL/028/015

As Per IS:2720

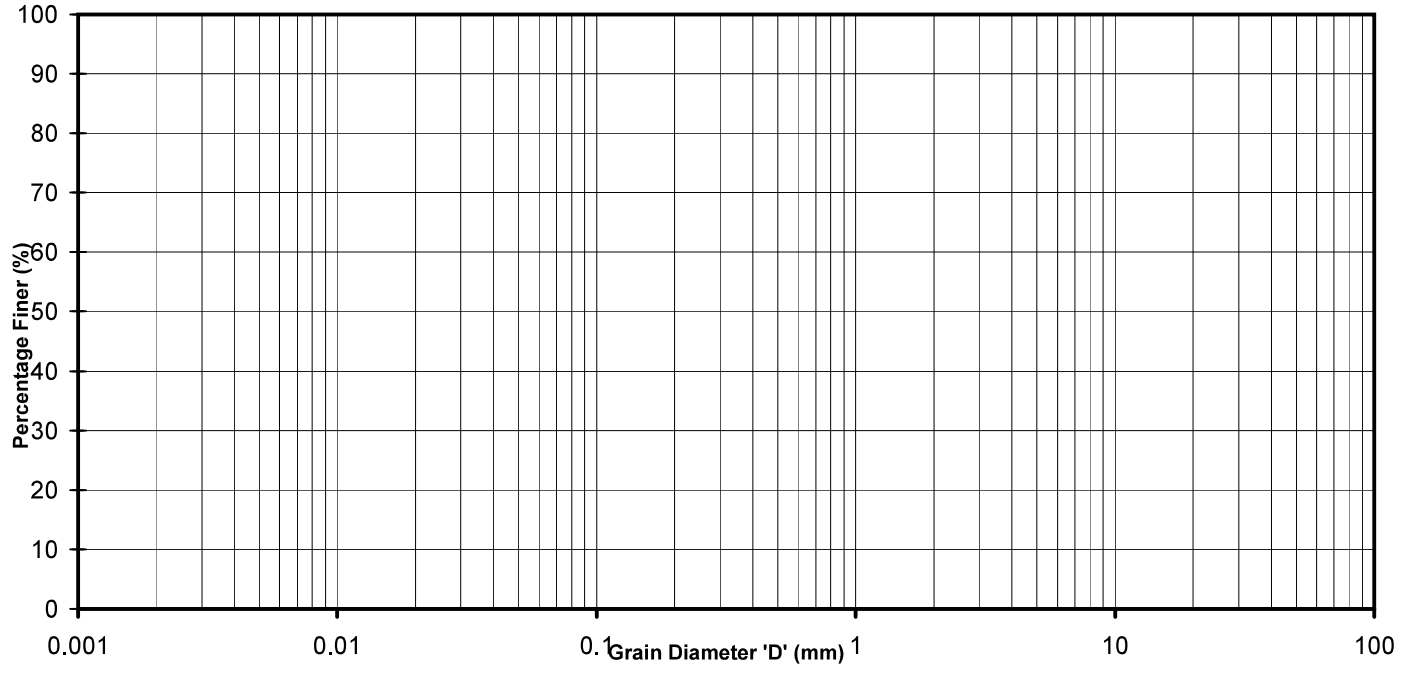
BH NO.: **BH-02** Depth (m) : **-22.54- -22.79** **-24.04 - -24.12**

	CLAY & SILT	SAND			GRAVEL
		FINE	MEDIUM	COARSE	
▲	1	10	73	16	0
■	15	24	41	20	0



BH NO.: Depth (m) :

	CLAY	SILT	SAND			GRAVEL
			FINE	MEDIUM	COARSE	
▲						
■						



Tested By : **P.M.** Prepared By :**V.N.** Checked By :**S.D.** Approved By :**S.T.**

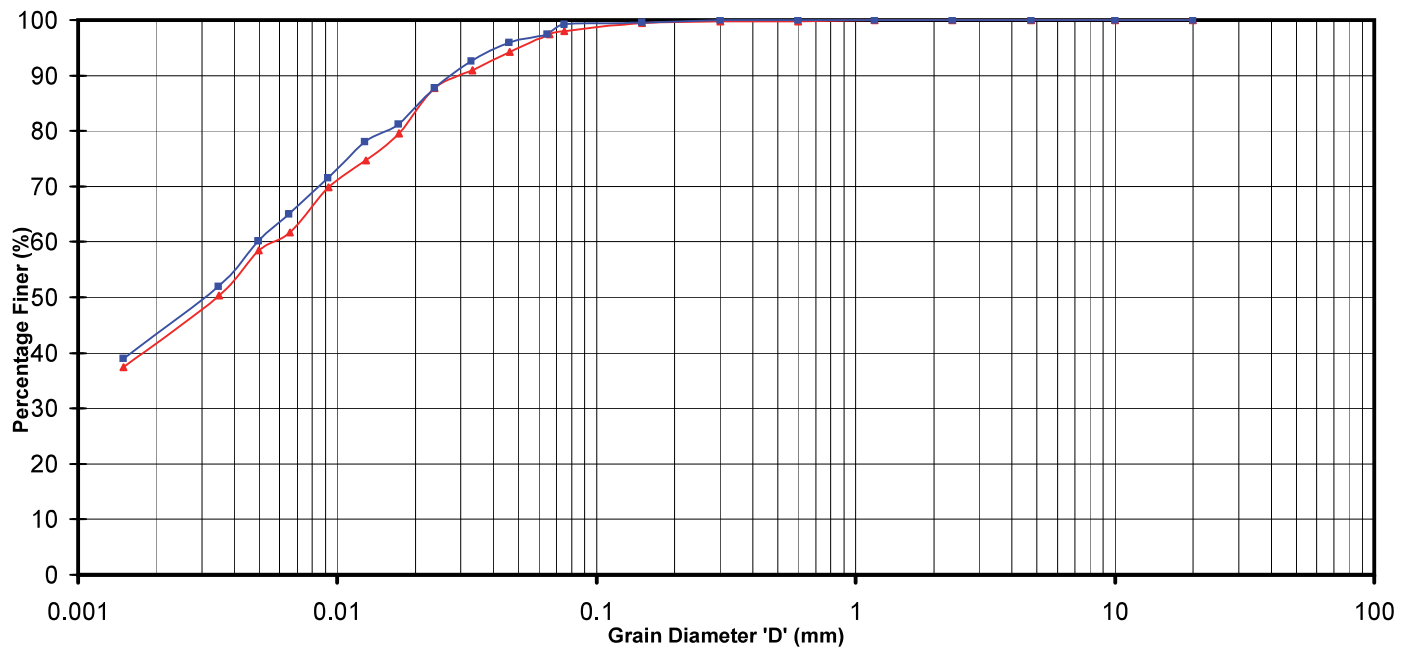
PARTICLE SIZE DISTRIBUTION

Project : Geological Survey for the Preparatory Survey on the Project for Construction of Mumbai Trans Harbour Link
Job No. : IDEAL/028/015

As Per IS:2720

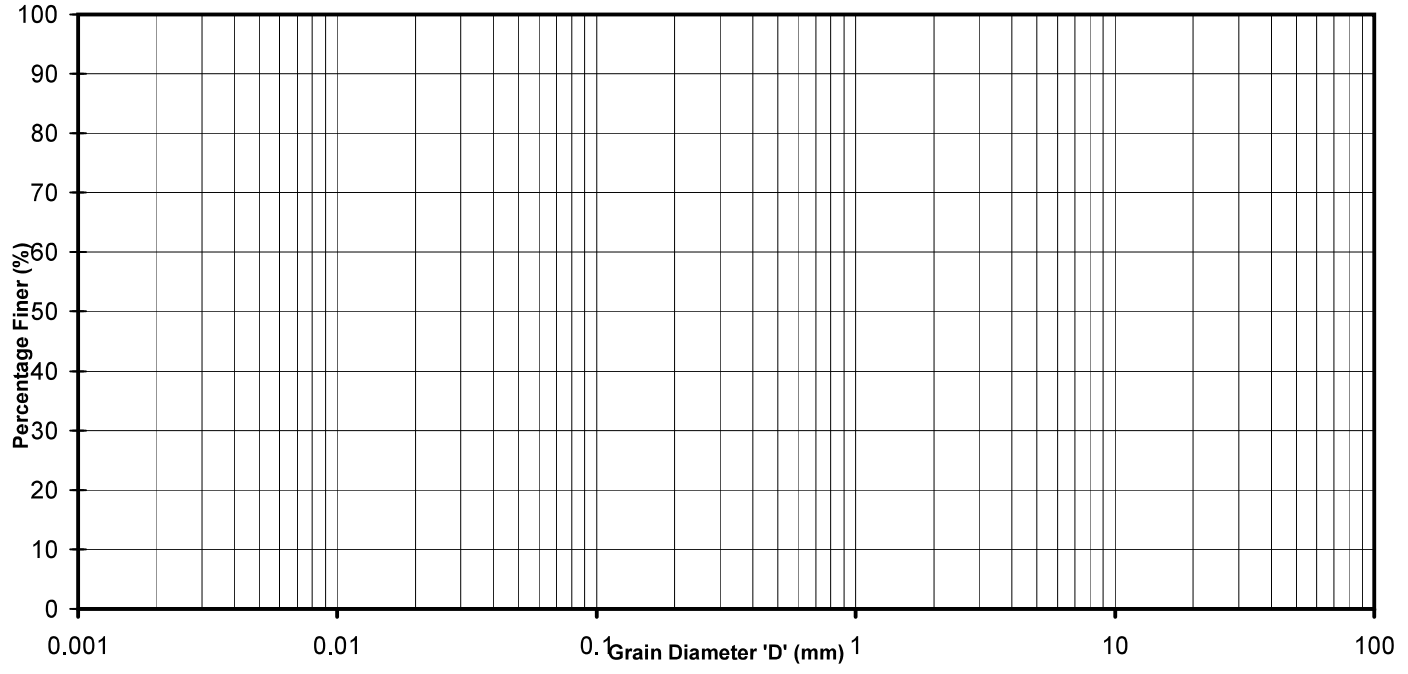
BH NO.: **BH-03** Depth (m) : **-2.90 - -3.40** **-4.40 - -4.85**

	CLAY	SILT	SAND			GRAVEL
			FINE	MEDIUM	COARSE	
▲	41	57	2	0	0	0
■	42	57	1	0	0	0



BH NO.: Depth (m) :

	CLAY	SILT	SAND			GRAVEL
			FINE	MEDIUM	COARSE	
▲						
■						



Tested By : **P.M.** Prepared By :**V.N.** Checked By :**S.D.** Approved By :**S.T.**

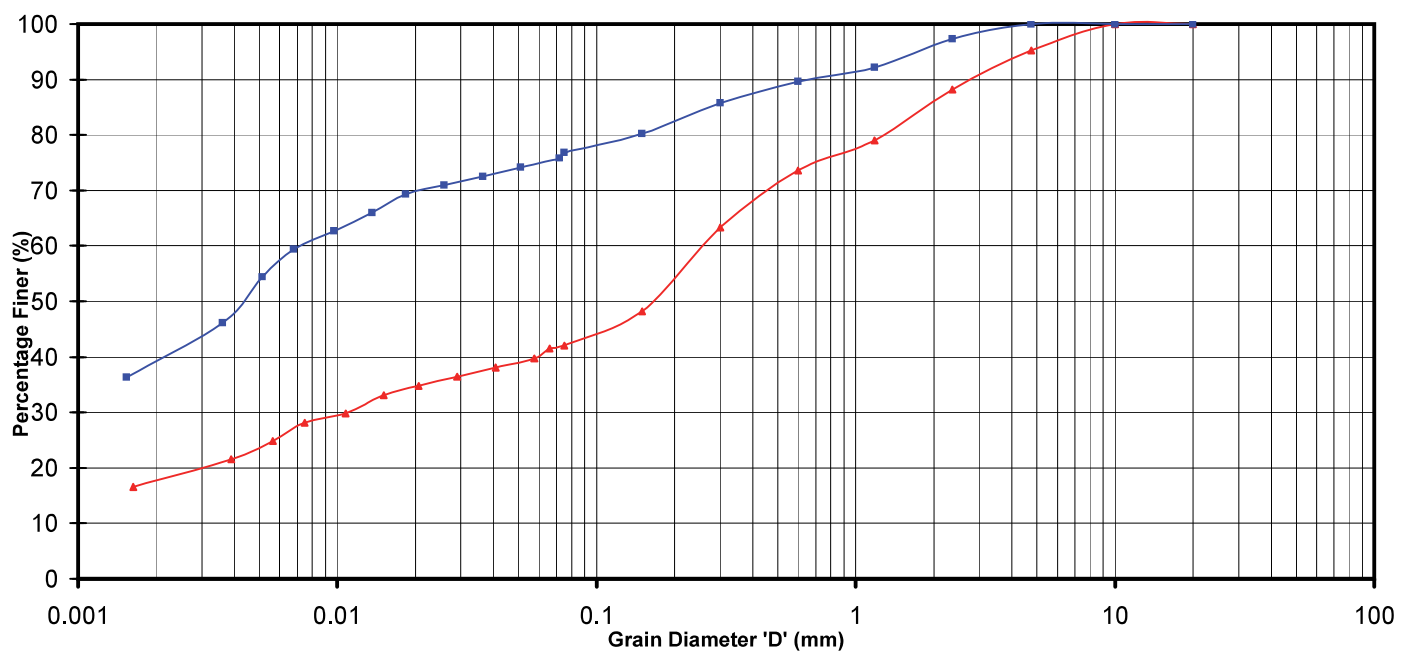
PARTICLE SIZE DISTRIBUTION

Project : Geological Survey for the Preparatory Survey on the Project for Construction of Mumbai Trans Harbour Link
Job No. : IDEAL/028/015

As Per IS:2720

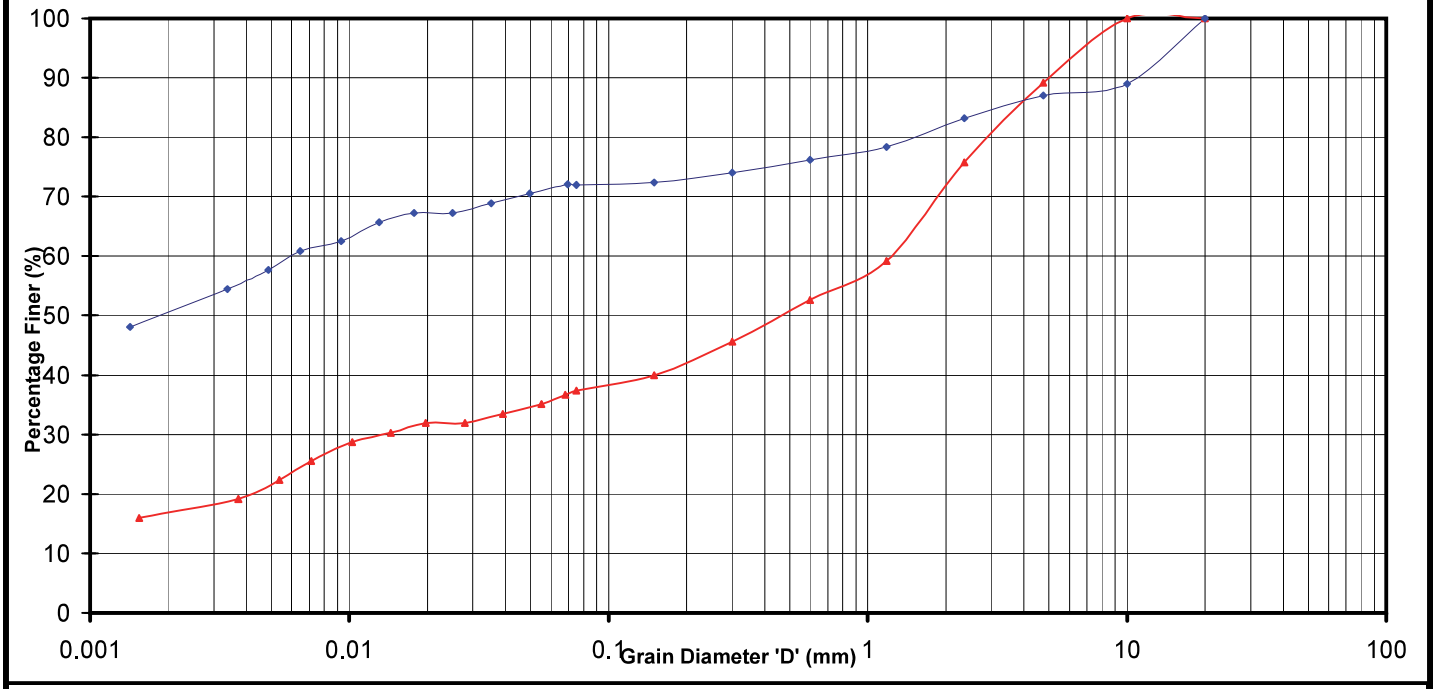
BH NO.: **BH-04** Depth (m) : **-5.60 - -6.10** ▲ **-7.10 - -7.55** ■

	CLAY	SILT	SAND			GRAVEL
			FINE	MEDIUM	COARSE	
▲	17	25	26	17	10	5
■	39	38	10	9	4	0



BH NO.: **BH-04** Depth (m) : **-10.10 - -10.55** ▲ **-11.60 - -12.05** ■

	CLAY	SILT	SAND			GRAVEL
			FINE	MEDIUM	COARSE	
▲	17	20	12	22	18	11
■	50	22	3	7	5	13



Tested By : **P.M.** Prepared By :**V.N.** Checked By :**S.D.** Approved By :**S.T.**

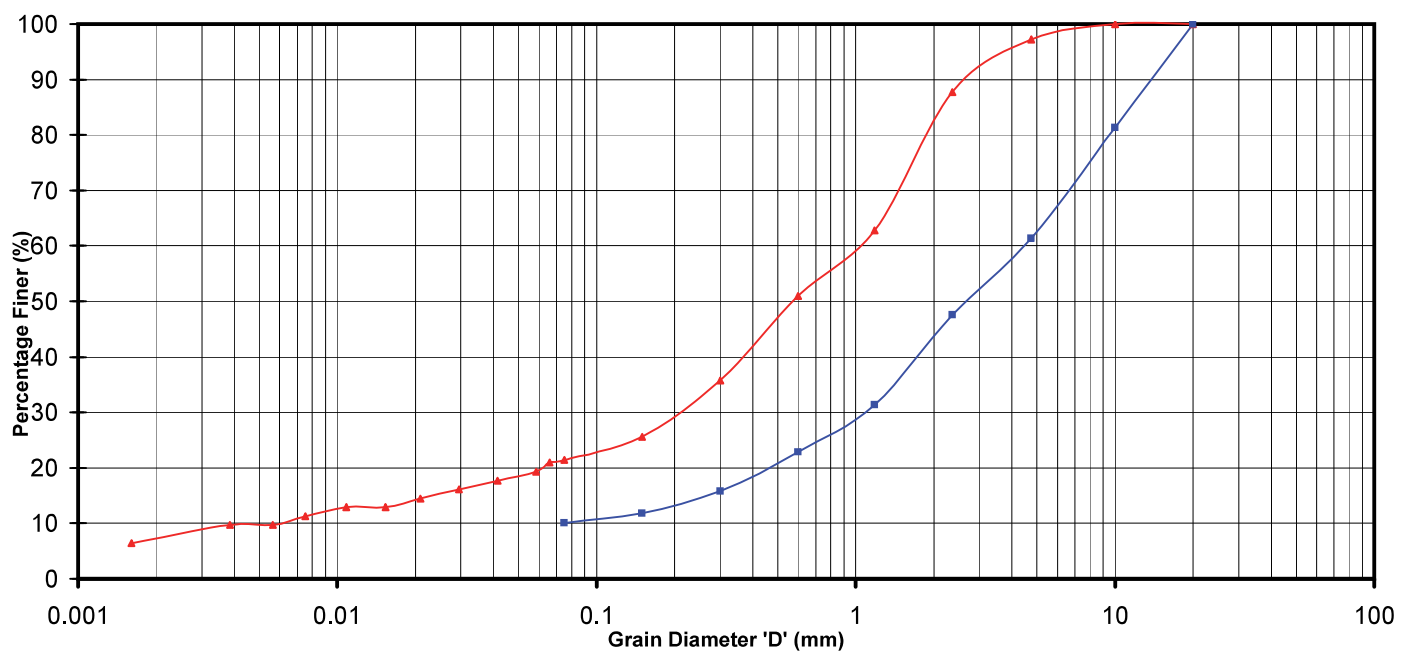
PARTICLE SIZE DISTRIBUTION

Project : Geological Survey for the Preparatory Survey on the Project for Construction of Mumbai Trans Harbour Link
Job No. : IDEAL/028/015

As Per IS:2720

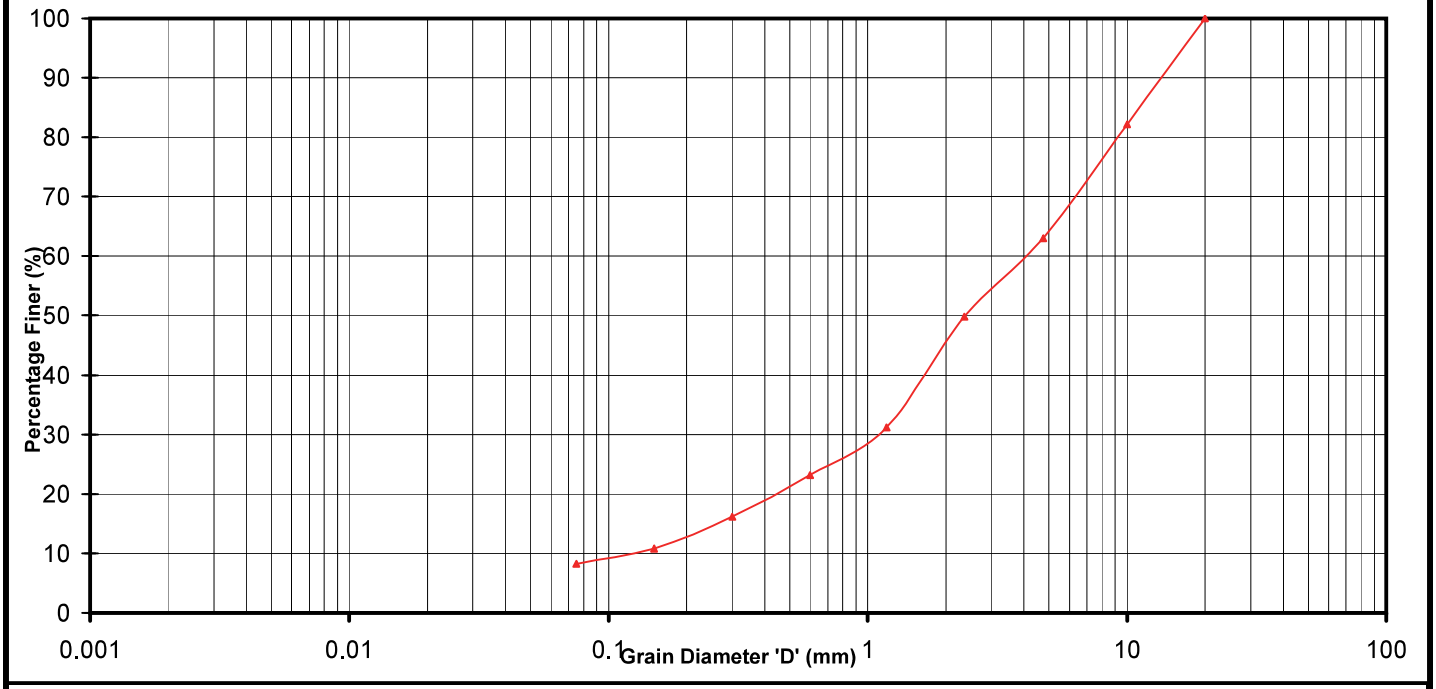
BH NO.: **BH-04** Depth (m) : **-13.10 - -13.55** **-14.60 - -14.87**

	CLAY	SILT	SAND FINE	SAND MEDIUM	SAND COARSE	GRAVEL
▲	7	14	21	38	17	3
■	10		9	24	18	39



BH NO.: **BH-04** Depth (m) : **-16.10 - -16.55**

	CLAY & SILT	SAND FINE	SAND MEDIUM	SAND COARSE	GRAVEL
▲	8	11	25	19	37
■					



Tested By : **P.M.** Prepared By :**V.N.** Checked By :**S.D.** Approved By :**S.T.**

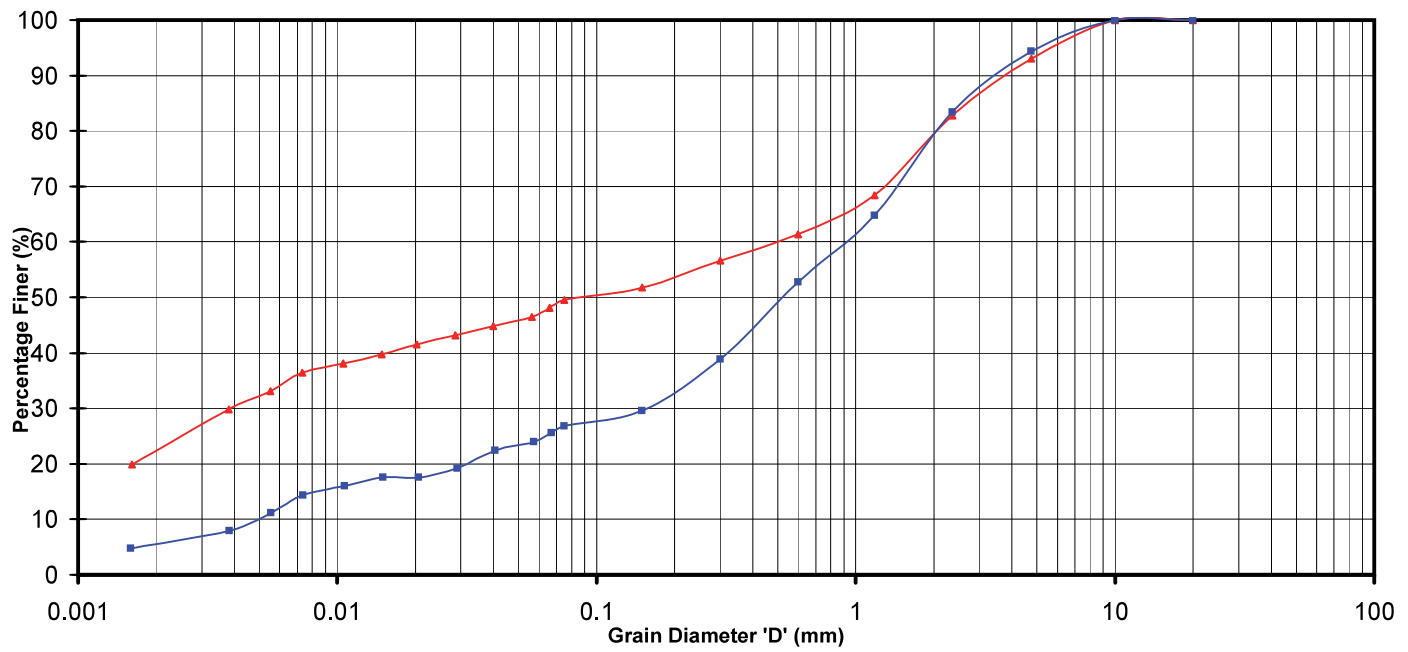
PARTICLE SIZE DISTRIBUTION

Project : Geological Survey for the Preparatory Survey on the Project for Construction of Mumbai Trans Harbour Link
Job No. : IDEAL/028/015

As Per IS:2720

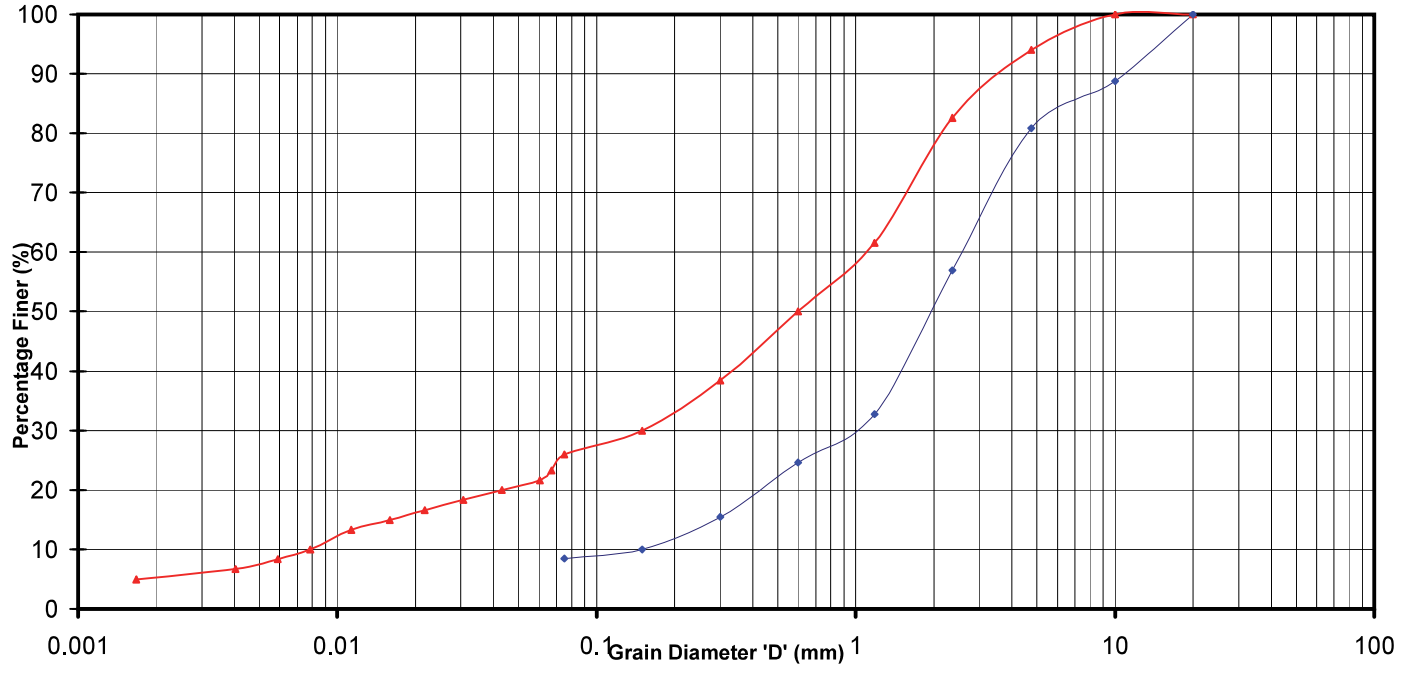
BH NO.: **BH-05** Depth (m) : **-3.10 - -3.60** ▲ **-6.10 - -6.20** ■

	CLAY	SILT	SAND			GRAVEL
			FINE	MEDIUM	COARSE	
▲	22	28	9	19	15	7
■	5	22	18	33	16	6



BH NO.: **BH-05** Depth (m) : **-7.60 - 8.05** ▲ **-9.10 - -9.35** ■

	CLAY	SILT	SAND			GRAVEL
			FINE	MEDIUM	COARSE	
▲	5	21	17	33	18	6
■	8		11	31	31	19



Tested By : **P.M.** Prepared By :**V.N.** Checked By :**S.D.** Approved By :**S.T.**

Plate-C12

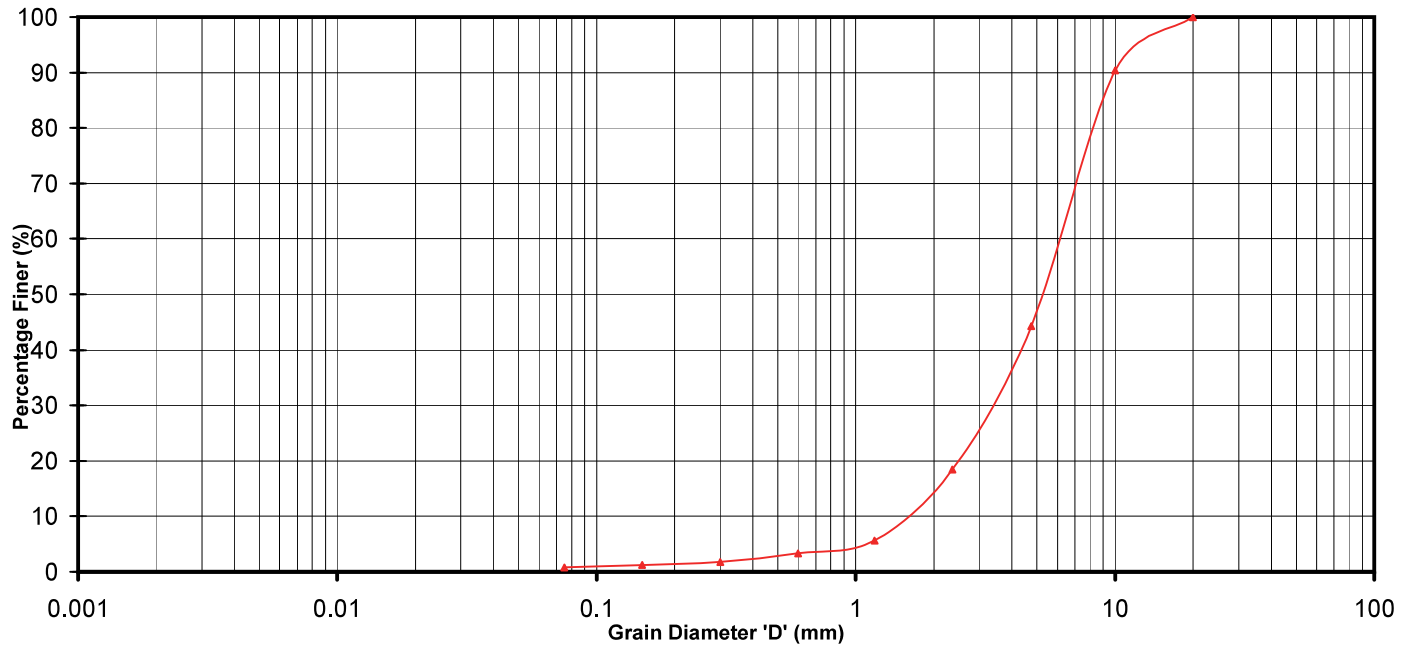
PARTICLE SIZE DISTRIBUTION

Project : Geological Survey for the Preparatory Survey on the Project for Construction of Mumbai Trans Harbour Link
Job No. : IDEAL/028/015

As Per IS:2720

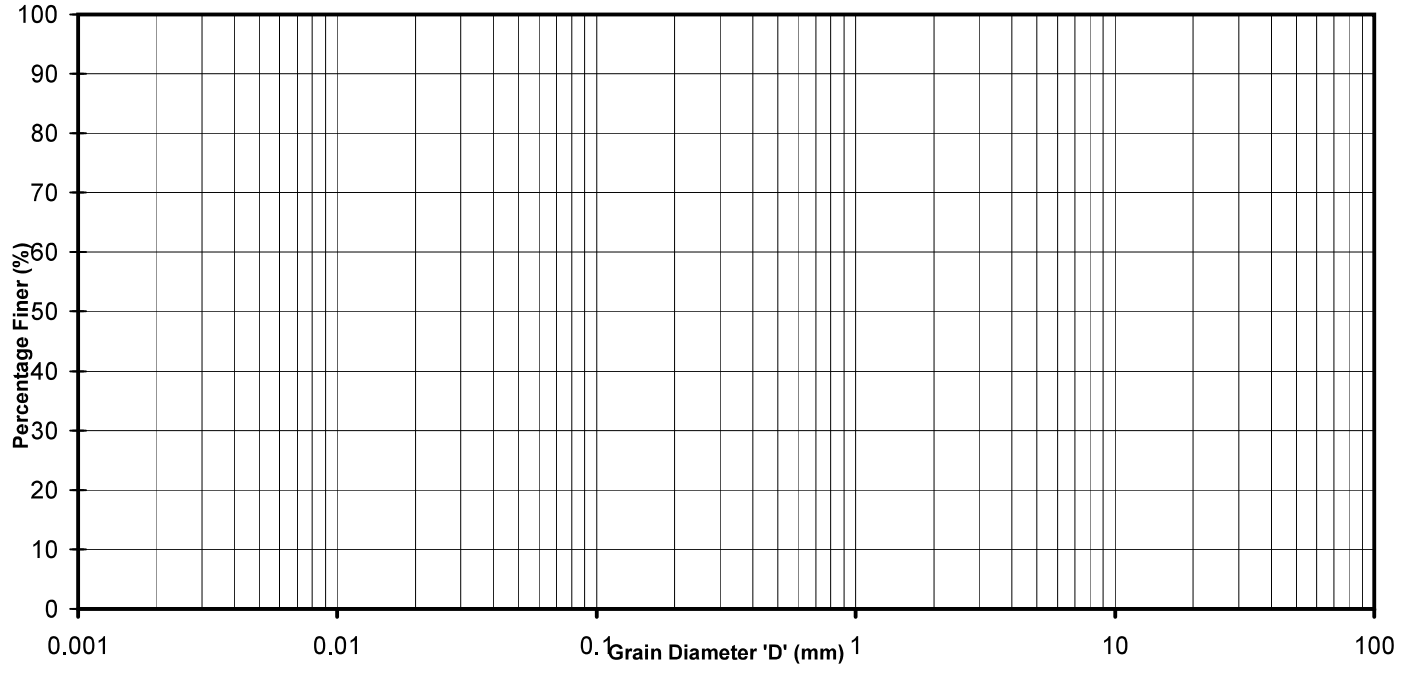
BH NO.: **BH-05** Depth (m) : **-10.60 - -10.83**

	CLAY & SILT	SAND			GRAVEL
		FINE	MEDIUM	COARSE	
▲	1	1	12	30	56
■					



BH NO.: Depth (m) :

	CLAY	SILT	SAND			GRAVEL
			FINE	MEDIUM	COARSE	
▲						
■						



Tested By : **P.M.** Prepared By :**V.N.** Checked By :**S.D.** Approved By :**S.T.**

Plate-C13

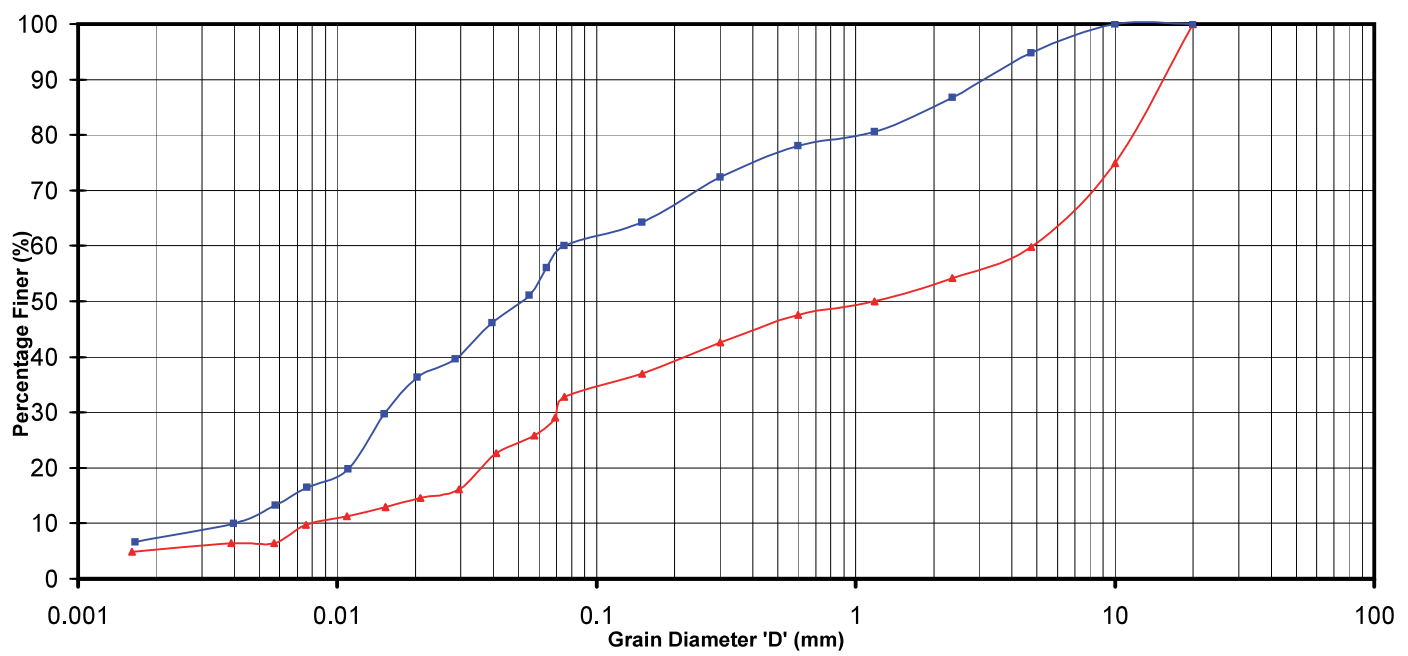
PARTICLE SIZE DISTRIBUTION

Project : Geological Survey for the Preparatory Survey on the Project for Construction of Mumbai Trans Harbour Link
Job No. : IDEAL/028/015

As Per IS:2720

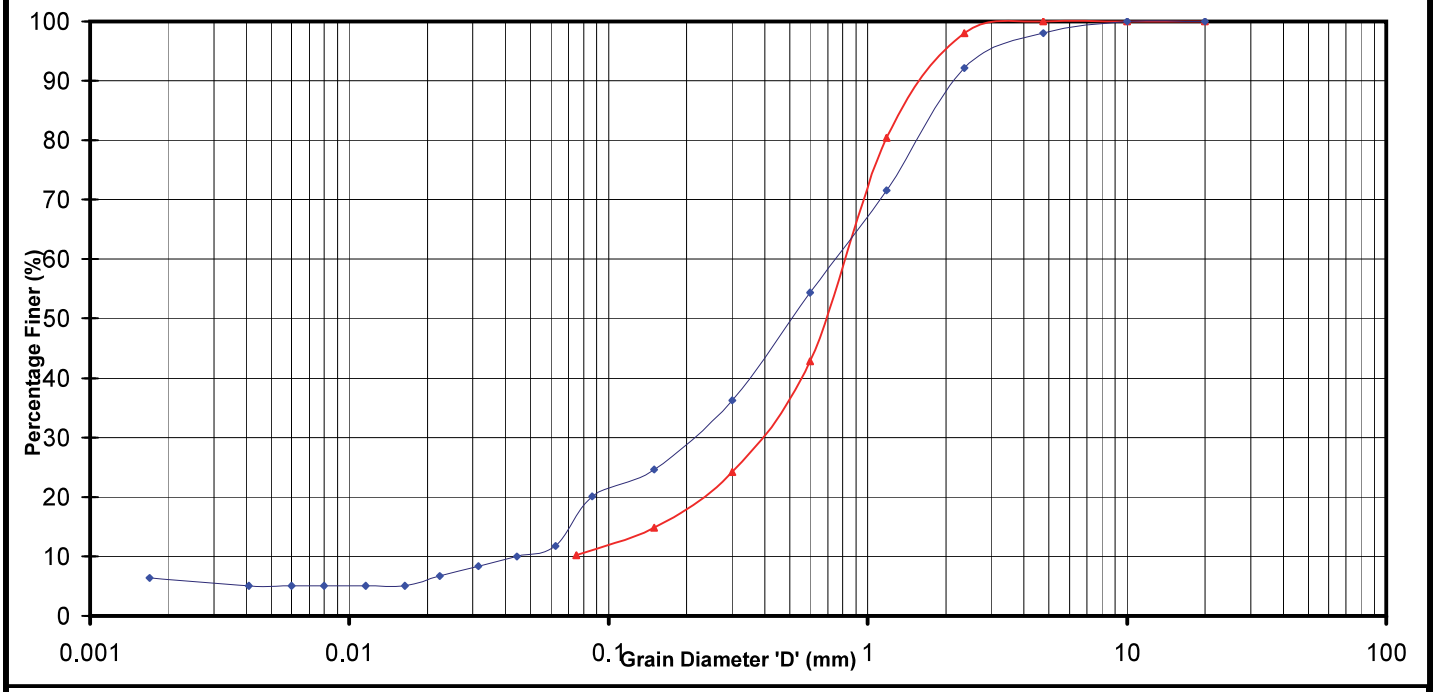
BH NO.: **BH-05** Depth (m) : **-12.10 - -12.55** **-13.60 - -14.05**

	CLAY	SILT	SAND			GRAVEL
			FINE	MEDIUM	COARSE	
▲	5	28	12	8	7	40
■	7	53	15	10	10	5



BH NO.: **BH-05** Depth (m) : **-15.10 - -15.22** **-16.60 - -16.68**

	CLAY	SILT	SAND			GRAVEL
			FINE	MEDIUM	COARSE	
▲	10		22	61	7	0
■	6	14	24	42	12	2



Tested By : **P.M.** Prepared By :**V.N.** Checked By :**S.D.** Approved By :**S.T.**

Plate-C14

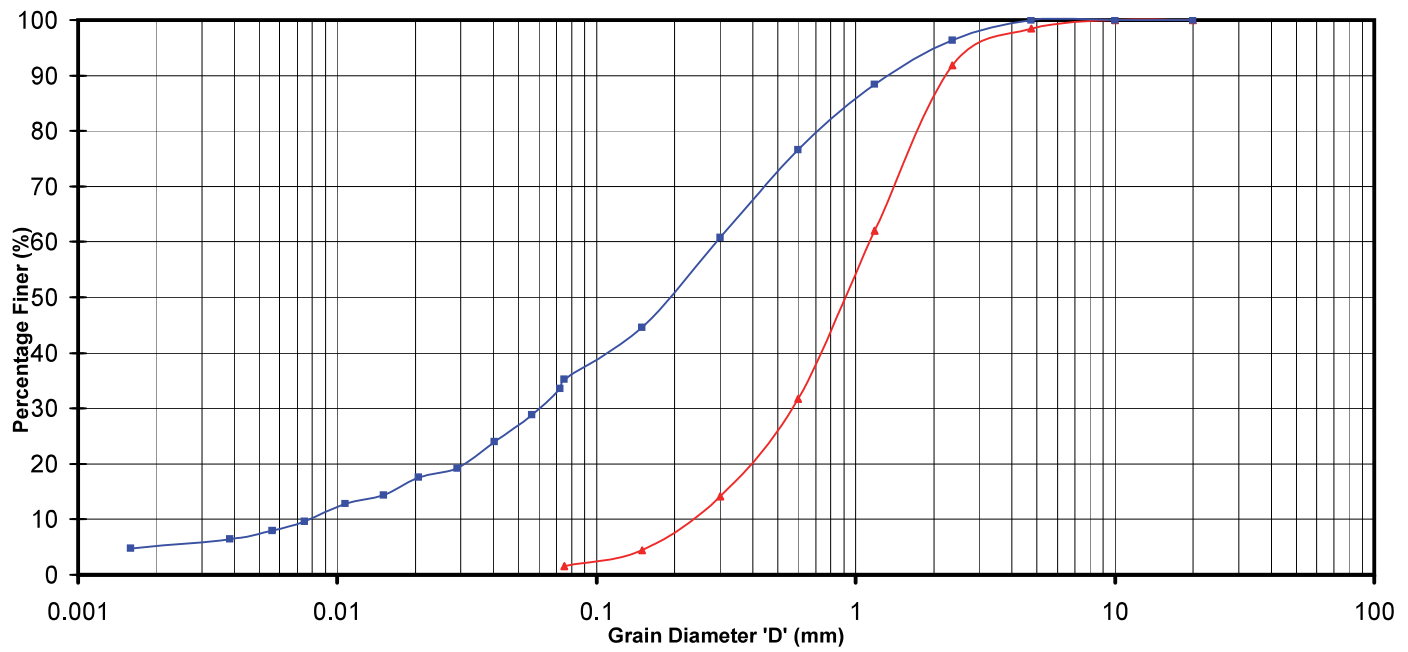
PARTICLE SIZE DISTRIBUTION

Project : Geological Survey for the Preparatory Survey on the Project for Construction of Mumbai Trans Harbour Link
Job No. : IDEAL/028/015

As Per IS:2720

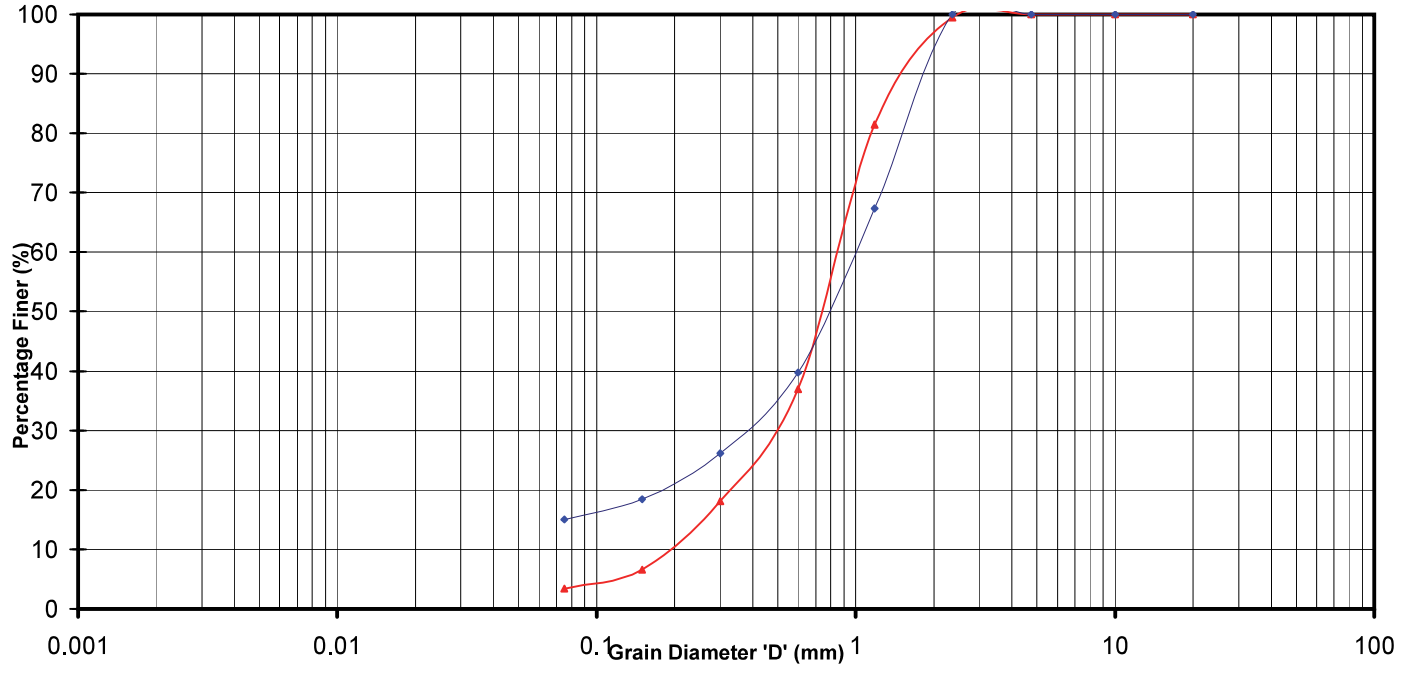
BH NO.: **BH-06** Depth (m) : **0.09 - -0.41** **-2.91 - -3.36**

	CLAY	SILT	SAND			GRAVEL
			FINE	MEDIUM	COARSE	
▲		0	20	62	16	2
■	5	30	32	27	6	0



BH NO.: **BH-06** Depth (m) : **-4.41 - -4.79** **-5.91 - -6.30**

	CLAY & SILT	SAND			GRAVEL
		FINE	MEDIUM	COARSE	
▲	3	23	68	6	0
■	15	17	58	10	0



Tested By : **P.M.** Prepared By :**V.N.** Checked By :**S.D.** Approved By :**S.T.**

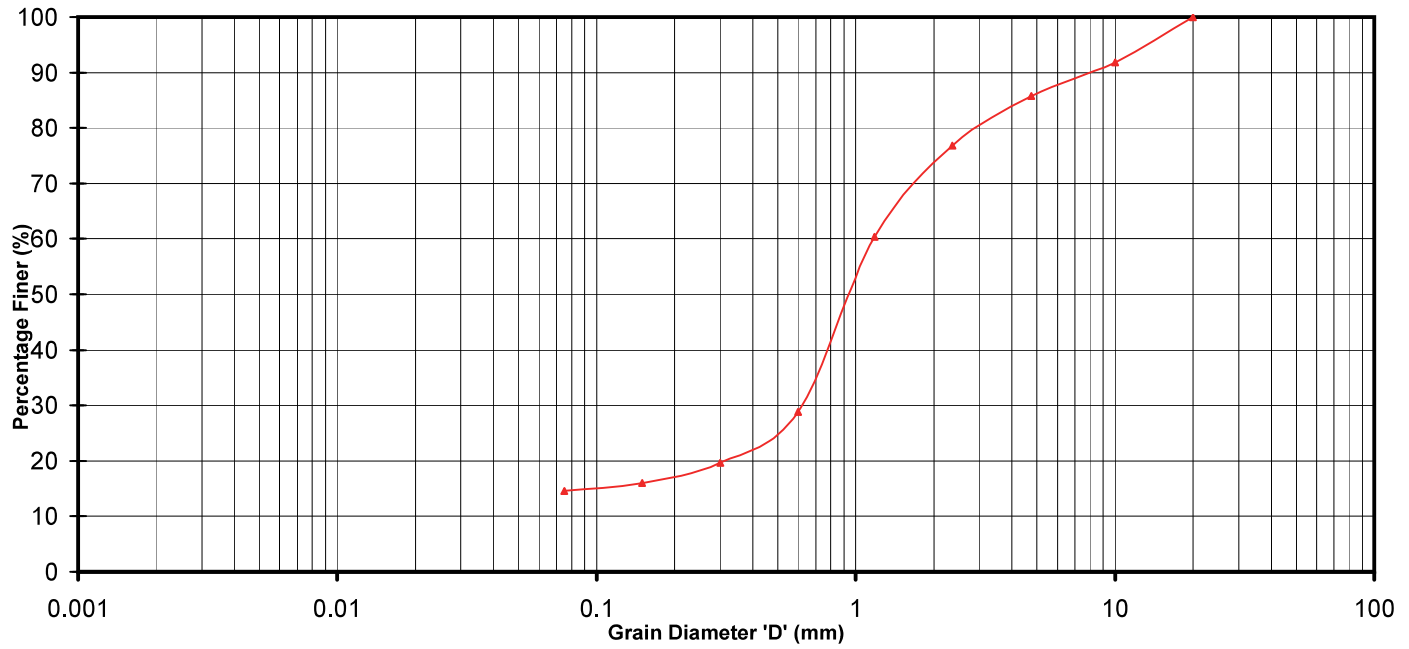
PARTICLE SIZE DISTRIBUTION

Project : Geological Survey for the Preparatory Survey on the Project for Construction of Mumbai Trans Harbour Link
Job No. : IDEAL/028/015

As Per IS:2720

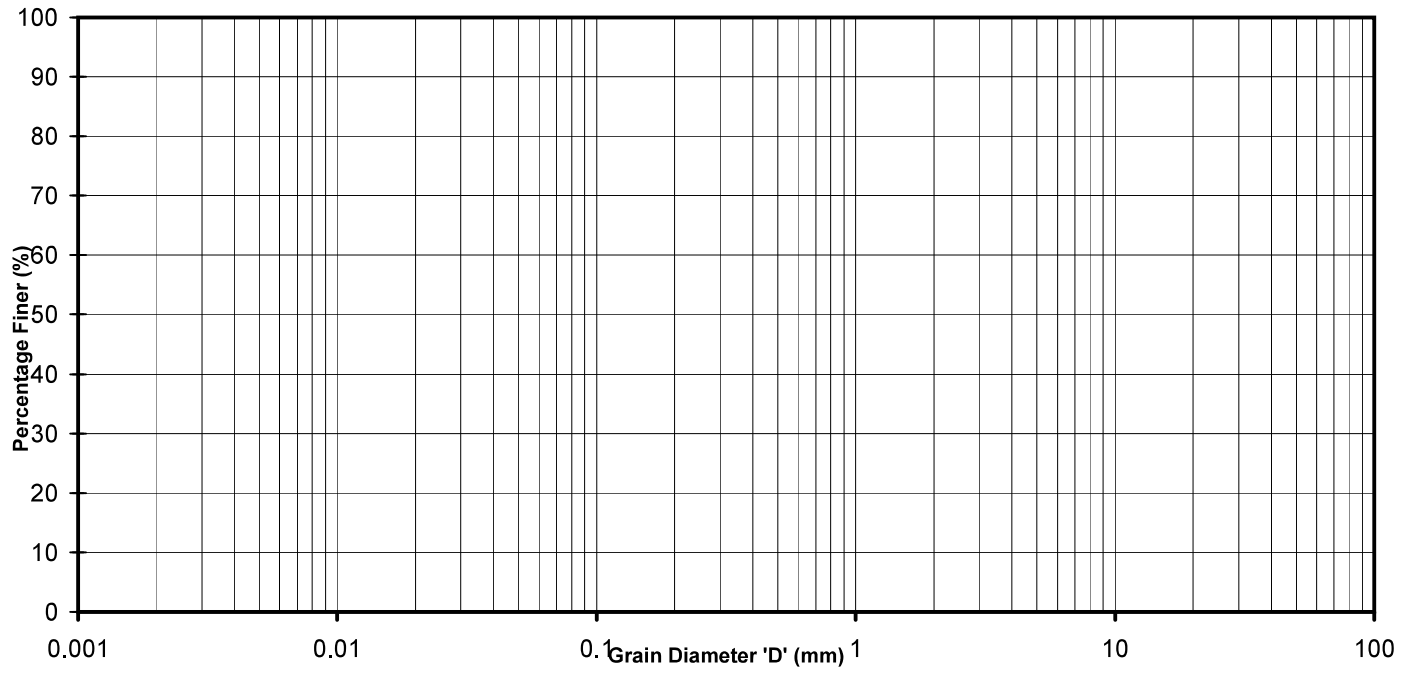
BH NO.: **BH-06** Depth (m) : **-7.41 - -7.51**

	CLAY & SILT	SAND			GRAVEL
		FINE	MEDIUM	COARSE	
▲	15	8	49	14	14
■					



BH NO.: **BH-06** Depth (m) :

	CLAY	SILT	SAND			GRAVEL
			FINE	MEDIUM	COARSE	
▲						
■						



Tested By : **P.M.** Prepared By :**V.N.** Checked By :**S.D.** Approved By :**S.T.**

Plate-C16

Liquid Limit *(Casagrande method)* and Plastic Limit

Project : Geological Survey for the Preparatory Survey on the Project for Construction of Mumbai Trans Harbour Link

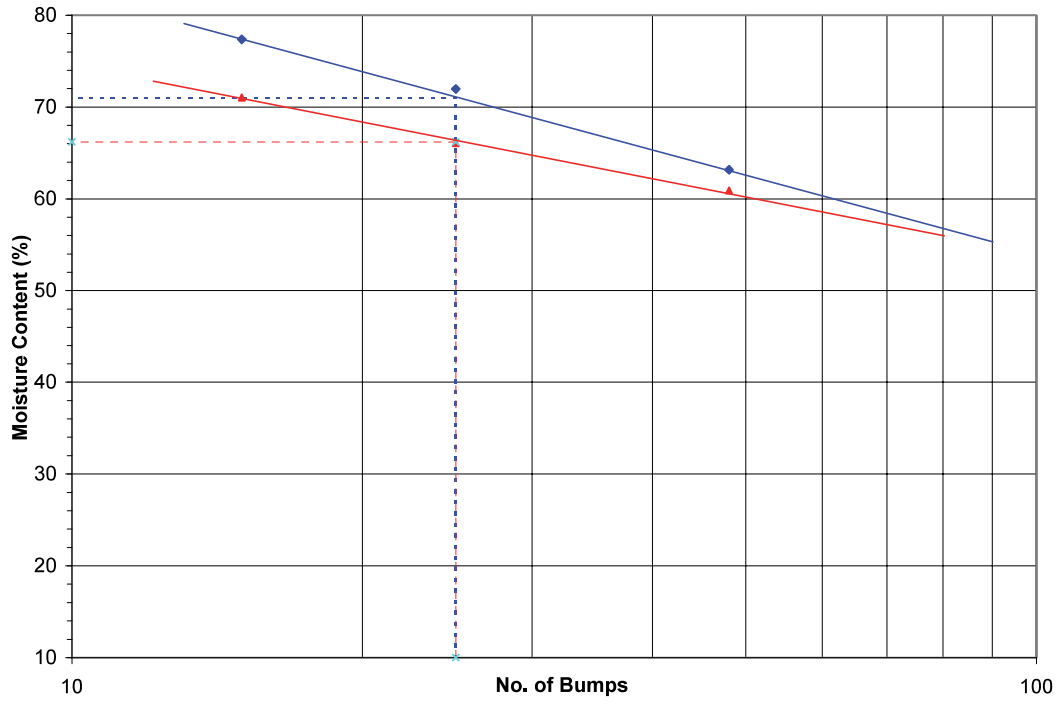
Job No. IDEAL/028/015

BH NO. :	Sample Depth(m) :		Sample No. :		Date :	
BH-01	-3.32 - -3.82		ID-M-BH-01-D0000		21-07-2015	
BH-01	-4.82 - -5.27		ID-M-BH-01-S1500		21-07-2015	

Test method : **IS 2720 : Part 5**

PLASTIC LIMIT	Test no.	1	2	Average	1	2	Average
Container no.		A44	A61		A38	A57	
Mass of wet soil + container	g	24.20	22.40		23.50	27.70	
Mass of dry soil + container	g	23.20	21.40		22.20	25.50	
Mass of container	g	19.44	17.81		18.28	18.97	
Mass of moisture	g	1.00	1.00		1.30	2.20	
Mass of dry soil	g	3.76	3.59		3.92	6.53	
Moisture Content	%	**26.60**	**27.86**	**27.23**	**33.16**	**33.69**	**33.43**

LIQUID LIMIT	Test no.	1	2	3	1	2	3
Number of bumps		15	25	48	15	25	48
Container no.		A19	A36	A29	A28	A2	A17
Mass of wet soil + container (m_3)	g	37.20	37.50	36.70	42.40	31.80	34.40
Mass of dry soil + container (m_2)	g	32.00	33.90	32.70	35.50	26.90	30.10
Mass of container (m_1)	g	24.68	28.45	26.13	26.58	20.09	23.29
Mass of moisture ($m_3 - m_2$)	g	5.20	3.60	4.00	6.90	4.90	4.30
Mass of dry soil ($m_2 - m_1$)	g	7.32	5.45	6.57	8.92	6.81	6.81
Water Content	%	**71.04**	**66.06**	**60.88**	**77.35**	**71.95**	**63.14**



Sample preparation	
washed on 425 μ m sieve oven dried at	105 °C
Liquid limit	66 %
Plastic limit	27 %
Plasticity index	39 %
Liquid limit	71 %
Plastic limit	33 %
Plasticity index	38 %

Operator	Checked	Approved
P.M.	K.B.	S.T.

Liquid Limit *(Casagrande method)* and Plastic Limit

Project : Geological Survey for the Preparatory Survey on the Project for Construction of Mumbai Trans Harbour Link

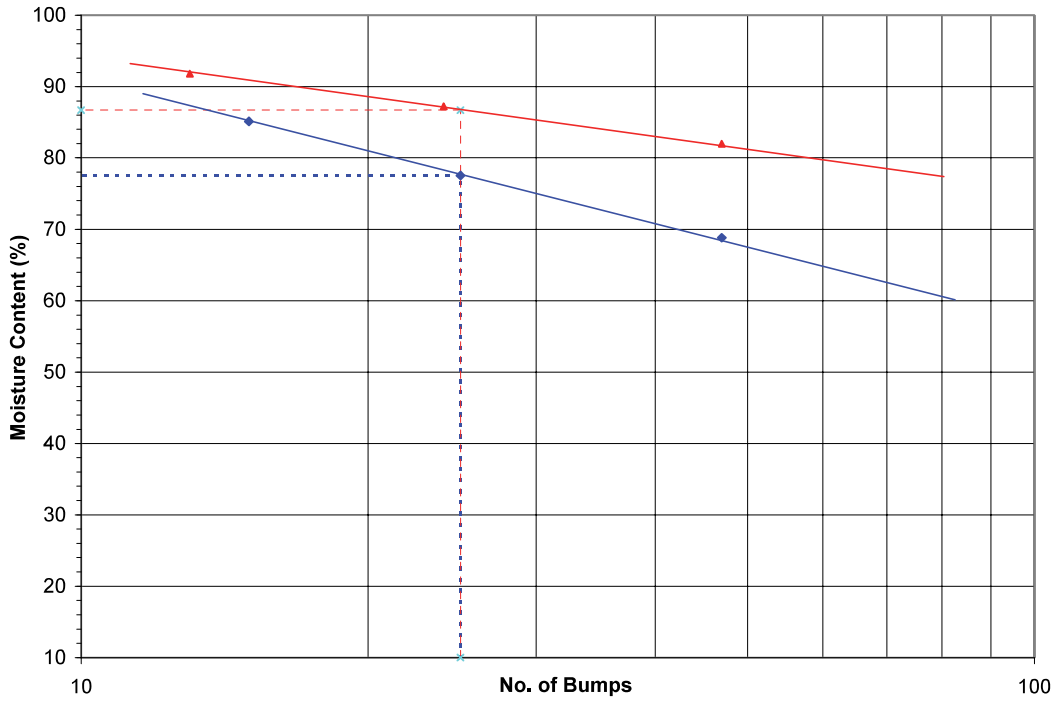
Job No. IDEAL/028/015

BH NO. :	Sample Depth(m) :		Sample No. :		Date :	
BH-01	-6.32 - -6.77		ID-M-BH-01-S3000		21-07-2015	
BH-01	-7.82 - -8.27		ID-M-BH-01-S4500		21-07-2015	

Test method : **IS 2720 : Part 5**

PLASTIC LIMIT	Test no.	1	2	Average	1	2	Average
Container no.		A38	A51		A51	A55	
Mass of wet soil + container	g	27.50	29.60		21.80	22.30	
Mass of dry soil + container	g	25.00	26.40		20.90	21.50	
Mass of container	g	18.28	18.03		18.03	18.98	
Mass of moisture	g	2.50	3.20		0.90	0.80	
Mass of dry soil	g	6.72	8.37		2.87	2.52	
Moisture Content	%	37.20	38.23	37.72	31.36	31.75	31.55

LIQUID LIMIT	Test no.	1	2	3	1	2	3
Number of bumps		13	24	47	15	25	47
Container no.		A42	A64	A39	A25	A10	A5
Mass of wet soil + container (m_3)	g	35.60	32.90	32.00	37.60	36.20	34.40
Mass of dry soil + container (m_2)	g	29.20	26.00	25.90	32.10	30.40	29.50
Mass of container (m_1)	g	22.23	18.09	18.46	25.64	22.92	22.38
Mass of moisture ($m_3 - m_2$)	g	6.40	6.90	6.10	5.50	5.80	4.90
Mass of dry soil ($m_2 - m_1$)	g	6.97	7.91	7.44	6.46	7.48	7.12
Water Content	%	91.82	87.23	81.99	85.14	77.54	68.82



Sample preparation		
washed on 425 μ m sieve oven dried at	105 °C	
Liquid limit	87	%
Plastic limit	38	%
Plasticity index	49	%
Liquid limit	78	%
Plastic limit	32	%
Plasticity index	46	%

Operator	Checked	Approved
P.M.	K.B.	S.T.

Liquid Limit *(Casagrande method)* and Plastic Limit

Project : Geological Survey for the Preparatory Survey on the Project for Construction of Mumbai Trans Harbour Link

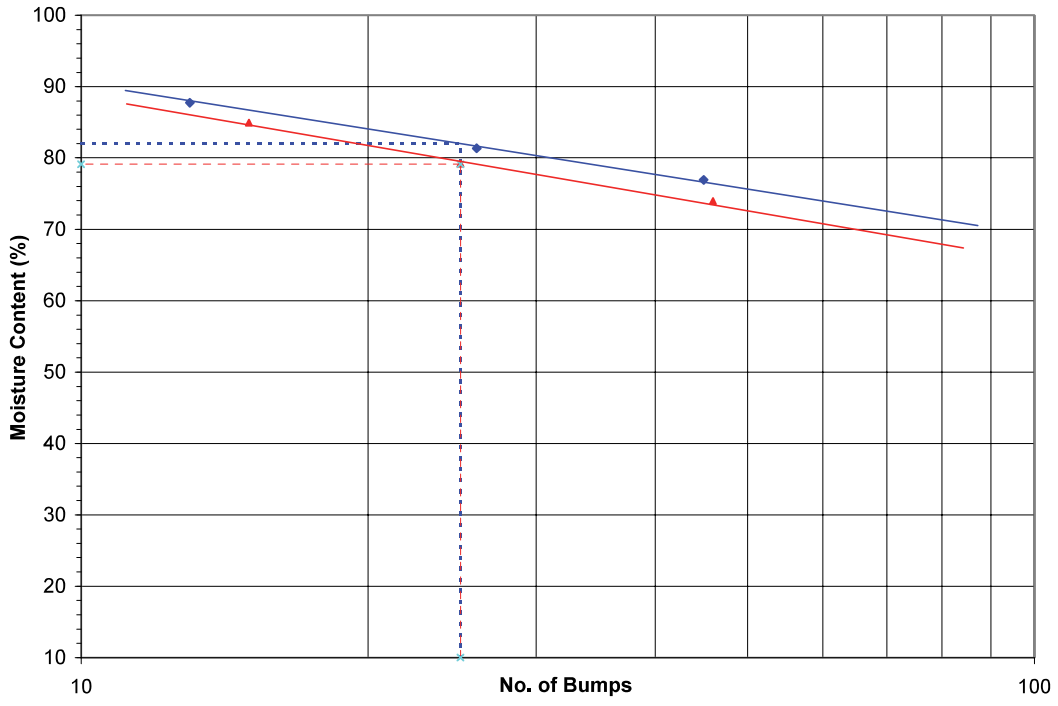
Job No. IDEAL/028/015

BH NO. :		Sample Depth(m) :					
	BH-01		-9.32 - -9.77	Sample No. :	ID-M-BH-01-S6000	Date :	22-07-2015
	BH-01		-10.82 - -11.27	Sample No. :	ID-M-BH-01-S7500	Date :	22-07-2015

Test method : **IS 2720 : Part 5**

PLASTIC LIMIT	Test no.	1	2	Average	1	2	Average
Container no.		A4	A18		A48	A42	
Mass of wet soil + container	g	28.20	28.40		24.50	26.40	
Mass of dry soil + container	g	27.00	27.30		23.00	25.50	
Mass of container	g	23.29	23.78		17.70	22.23	
Mass of moisture	g	1.20	1.10		1.50	0.90	
Mass of dry soil	g	3.71	3.52		5.30	3.27	
Moisture Content	%	**32.35**	**31.25**	**31.80**	**28.30**	**27.52**	**27.91**

LIQUID LIMIT	Test no.	1	2	3	1	2	3
Number of bumps		15	25	46	13	26	45
Container no.		A8	A1	A32	A12	A22	A33
Mass of wet soil + container (m_3)	g	39.50	29.90	41.80	34.30	37.00	41.10
Mass of dry soil + container (m_2)	g	31.20	25.40	35.20	28.80	31.90	34.90
Mass of container (m_1)	g	21.43	19.72	26.28	22.53	25.63	26.84
Mass of moisture ($m_3 - m_2$)	g	8.30	4.50	6.60	5.50	5.10	6.20
Mass of dry soil ($m_2 - m_1$)	g	9.77	5.68	8.92	6.27	6.27	8.06
Water Content	%	**84.95**	**79.23**	**73.99**	**87.72**	**81.34**	**76.92**



Sample preparation	
washed on 425 μ m sieve oven dried at	105 °C
Liquid limit	79 %
Plastic limit	32 %
Plasticity index	47 %
Liquid limit	82 %
Plastic limit	28 %
Plasticity index	54 %

Operator	Checked	Approved
P.M.	K.B.	S.T.

Liquid Limit *(Casagrande method)* and Plastic Limit

Project : Geological Survey for the Preparatory Survey on the Project for Construction of Mumbai Trans Harbour Link

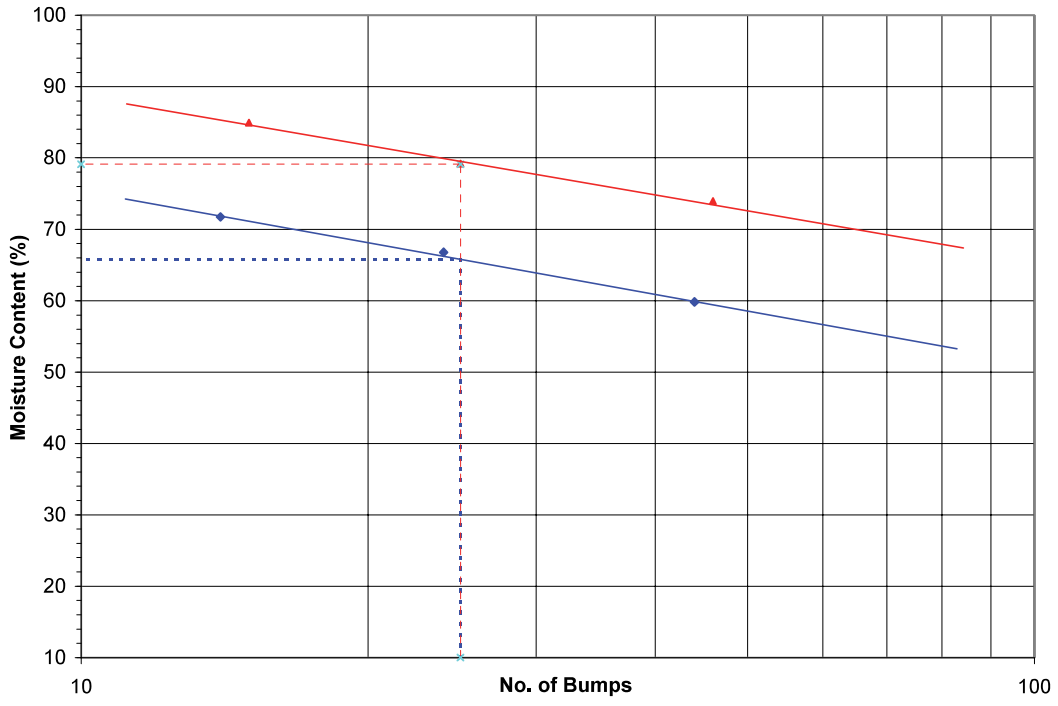
Job No. IDEAL/028/015

BH NO. :	Sample Depth(m) :		Sample No. :		Date :	
BH-01	-12.32 - -12.67		ID-M-BH-01-S9000		22-07-2015	
BH-01	-13.82 - -14.22		ID-M-BH-01-S1050		22-07-2015	

Test method : **IS 2720 : Part 5**

PLASTIC LIMIT	Test no.	1	2	Average	1	2	Average
Container no.		A4	A18		A47	A64	
Mass of wet soil + container	g	28.20	28.40		21.80	22.60	
Mass of dry soil + container	g	27.00	27.30		20.60	21.50	
Mass of container	g	23.29	23.78		16.87	18.09	
Mass of moisture	g	1.20	1.10		1.20	1.10	
Mass of dry soil	g	3.71	3.52		3.73	3.41	
Moisture Content	%	32.35	31.25	31.80	32.17	32.26	32.21

LIQUID LIMIT	Test no.	1	2	3	1	2	3
Number of bumps		15	25	46	14	24	44
Container no.		A8	A1	A32	A45	A49	A43
Mass of wet soil + container (m_3)	g	39.50	29.90	41.80	29.80	32.20	30.70
Mass of dry soil + container (m_2)	g	31.20	25.40	35.20	24.80	26.80	26.10
Mass of container (m_1)	g	21.43	19.72	26.28	17.83	18.71	18.41
Mass of moisture ($m_3 - m_2$)	g	8.30	4.50	6.60	5.00	5.40	4.60
Mass of dry soil ($m_2 - m_1$)	g	9.77	5.68	8.92	6.97	8.09	7.69
Water Content	%	84.95	79.23	73.99	71.74	66.75	59.82



Sample preparation		
washed on 425 μ m sieve oven dried at 105 °C		
Liquid limit	79	%
Plastic limit	32	%
Plasticity index	47	%
Liquid limit	66	%
Plastic limit	32	%
Plasticity index	34	%

Operator	Checked	Approved
P.M.	K.B.	S.T.

Liquid Limit *(Casagrande method)* and Plastic Limit

Project : Geological Survey for the Preparatory Survey on the Project for Construction of Mumbai Trans Harbour Link

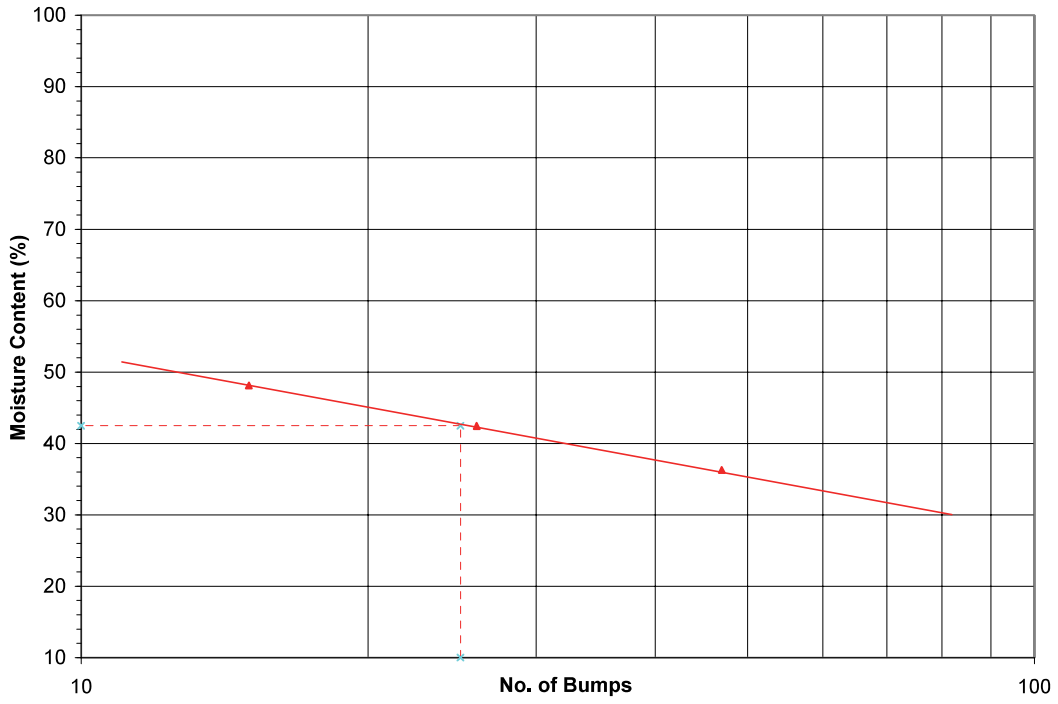
Job No. IDEAL/028/015

BH NO. :	BH-01	Sample Depth(m) :	-15.32 - -15.77	Sample No. :	ID-M-BH-01-S1200	Date :	22-07-2015

Test method : **IS 2720 : Part 5**

PLASTIC LIMIT	Test no.	1	2	Average	1	2	Average
Container no.		A39	A54				
Mass of wet soil + container	g	23.00	27.70				
Mass of dry soil + container	g	22.20	26.70				
Mass of container	g	18.46	22.16				
Mass of moisture	g	0.80	1.00				
Mass of dry soil	g	3.74	4.54				
Moisture Content	%	**21.39**	**22.03**	**21.71**			

LIQUID LIMIT	Test no.	1	2	3	1	2	3
Number of bumps		15	26	47			
Container no.		A63	A58	A59			
Mass of wet soil + container (m_3)	g	36.60	30.80	36.20			
Mass of dry soil + container (m_2)	g	30.70	26.60	32.40			
Mass of container (m_1)	g	18.44	16.71	21.93			
Mass of moisture ($m_3 - m_2$)	g	5.90	4.20	3.80			
Mass of dry soil ($m_2 - m_1$)	g	12.26	9.89	10.47			
Water Content	%	**48.12**	**42.47**	**36.29**			



Sample preparation	
washed on 425 μ m sieve oven dried at	105 °C
Liquid limit	43 %
Plastic limit	22 %
Plasticity index	21 %
Liquid limit	%
Plastic limit	%
Plasticity index	%

Operator	Checked	Approved
P.M.	K.B.	S.T.

Liquid Limit *(Casagrande method)* and Plastic Limit

Project : Geological Survey for the Preparatory Survey on the Project for Construction of Mumbai Trans Harbour Link

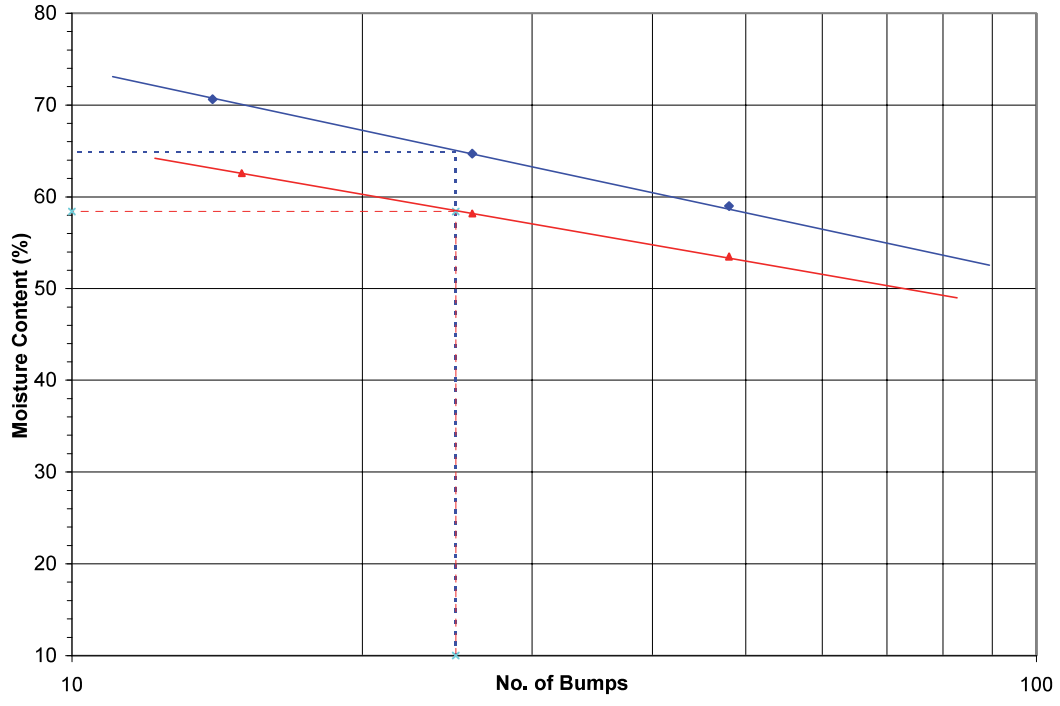
Job No. IDEAL/028/015

BH NO. :	Sample Depth(m) :		Sample No. :		Date :	
BH-02	-3.04 - -3.54		Sample No. :	ID-M-BH-02-D0000	Date :	08-07-2015
BH-02	-4.54 - -4.99		Sample No. :	ID-M-BH-02-S1500	Date :	08-07-2015

Test method : **IS 2720 : Part 5**

PLASTIC LIMIT	Test no.	1	2	Average	1	2	Average
Container no.		A50	A37		A62	A64	
Mass of wet soil + container	g	27.30	28.63		30.21	28.20	
Mass of dry soil + container	g	24.64	25.68		27.38	25.74	
Mass of container	g	16.60	16.72		18.57	18.09	
Mass of moisture	g	2.66	2.95		2.83	2.46	
Mass of dry soil	g	8.04	8.96		8.81	7.65	
Moisture Content	%	**33.08**	**32.92**	**33.00**	**32.12**	**32.16**	**32.14**

LIQUID LIMIT	Test no.	1	2	3	1	2	3
Number of bumps		15	26	48	14	26	48
Container no.		A20	A35	A26	A60	A44	A48
Mass of wet soil + container (m_3)	g	38.21	39.59	35.83	29.22	30.64	28.67
Mass of dry soil + container (m_2)	g	33.13	35.08	32.37	24.07	26.24	24.60
Mass of container (m_1)	g	25.01	27.33	25.90	16.78	19.44	17.70
Mass of moisture ($m_3 - m_2$)	g	5.08	4.51	3.46	5.15	4.40	4.07
Mass of dry soil ($m_2 - m_1$)	g	8.12	7.75	6.47	7.29	6.80	6.90
Water Content	%	**62.56**	**58.19**	**53.48**	**70.64**	**64.71**	**58.99**



Sample preparation	
washed on 425 μ m sieve oven dried at	105 °C
Liquid limit	58 %
Plastic limit	33 %
Plasticity index	25 %
Liquid limit	65 %
Plastic limit	32 %
Plasticity index	33 %

Operator	Checked	Approved
P.M.	K.B.	S.T.

Liquid Limit *(Casagrande method)* and Plastic Limit

Project : Geological Survey for the Preparatory Survey on the Project for Construction of Mumbai Trans Harbour Link

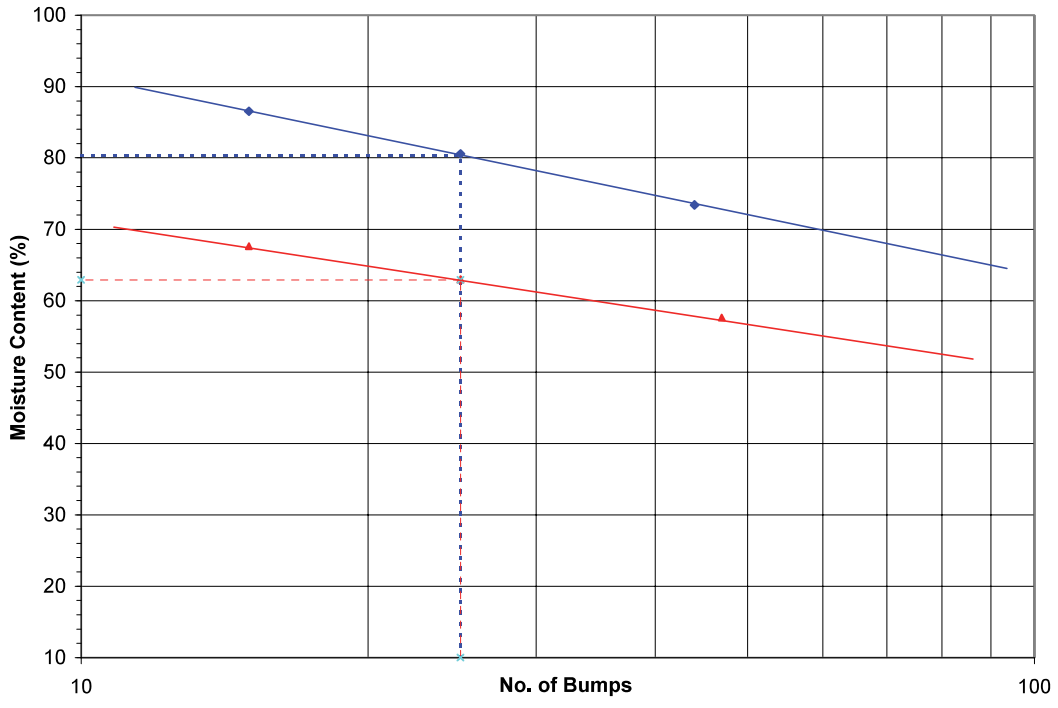
Job No. IDEAL/028/015

BH NO. :	BH-02	Sample Depth(m) :	-6.04 - -6.49	Sample No. :	ID-M-BH-02-S3000	Date :	08-07-2015
	BH-02		-7.54 - -7.99	Sample No. :	ID-M-BH-02-U4500	Date :	22-07-2015

Test method : **IS 2720 : Part 5**

PLASTIC LIMIT Test no.		1	2	Average	1	2	Average
Container no.		A55	A54		A57	A44	
Mass of wet soil + container	g	32.51	35.29		33.00	30.40	
Mass of dry soil + container	g	29.43	32.32		29.30	27.50	
Mass of container	g	18.98	22.16		18.97	19.44	
Mass of moisture	g	3.08	2.97		3.70	2.90	
Mass of dry soil	g	10.45	10.16		10.33	8.06	
Moisture Content	%	**29.47**	**29.23**	**29.35**	**35.82**	**35.98**	**35.90**

LIQUID LIMIT Test no.		1	2	3	1	2	3
Number of bumps		15	25	47	15	25	44
Container no.		A16	A10	A3	A47	A48	A50
Mass of wet soil + container (m_3)	g	37.30	36.01	33.43	33.90	30.70	35.50
Mass of dry soil + container (m_2)	g	31.58	30.95	29.46	26.00	24.90	27.50
Mass of container (m_1)	g	23.12	22.92	22.57	16.87	17.70	16.60
Mass of moisture ($m_3 - m_2$)	g	5.72	5.06	3.97	7.90	5.80	8.00
Mass of dry soil ($m_2 - m_1$)	g	8.46	8.03	6.89	9.13	7.20	10.90
Water Content	%	**67.61**	**63.01**	**57.62**	**86.53**	**80.56**	**73.39**



Sample preparation	
washed on 425 μ m sieve oven dried at	105 °C
Liquid limit	63 %
Plastic limit	29 %
Plasticity index	34 %
Liquid limit	80 %
Plastic limit	36 %
Plasticity index	44 %

Operator	Checked	Approved
P.M.	K.B.	S.T.

Liquid Limit *(Casagrande method)* and Plastic Limit

Project : Geological Survey for the Preparatory Survey on the Project for Construction of Mumbai Trans Harbour Link

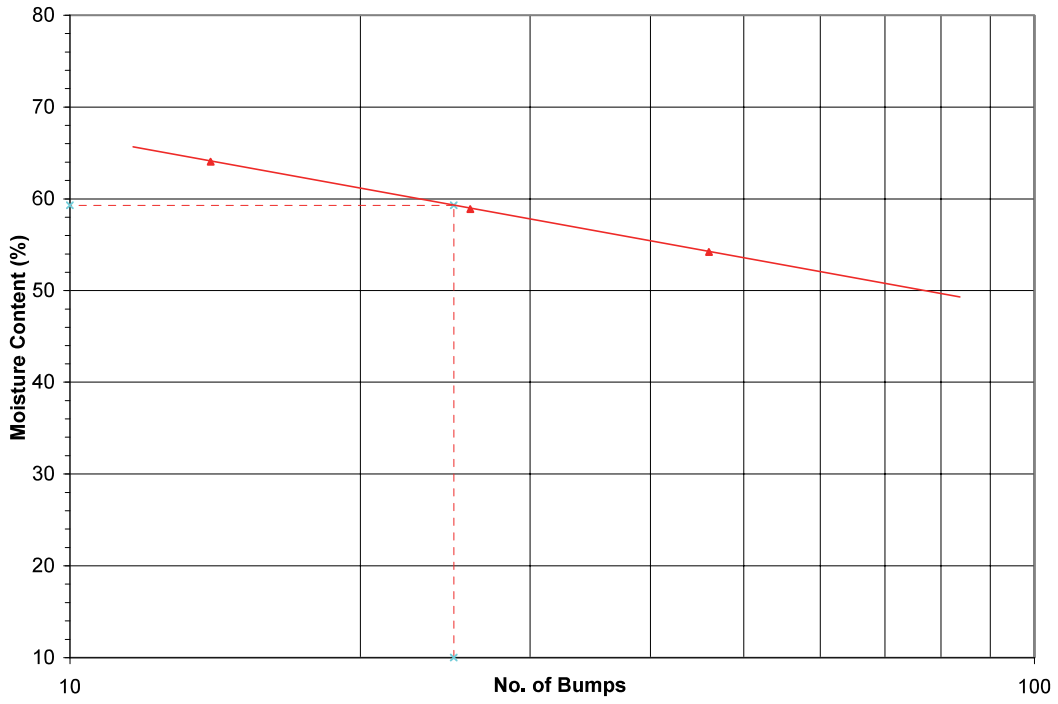
Job No. IDEAL/028/015

BH NO. :	BH-02	Sample Depth(m) :	-9.04 - -9.49	Sample No. :	ID-M-BH-02-S6000	Date :	08-07-2015

Test method : **IS 2720 : Part 5**

PLASTIC LIMIT	Test no.	1	2	Average	1	2	Average
Container no.		A47	A52				
Mass of wet soil + container	g	28.77	30.21				
Mass of dry soil + container	g	26.44	27.93				
Mass of container	g	16.87	19.14				
Mass of moisture	g	2.33	2.28				
Mass of dry soil	g	9.57	8.79				
Moisture Content	%	**24.35**	**25.94**	**25.14**			

LIQUID LIMIT	Test no.	1	2	3	1	2	3
Number of bumps		46	26	14			
Container no.		A11	A36	A4			
Mass of wet soil + container (m_3)	g	33.40	39.19	35.51			
Mass of dry soil + container (m_2)	g	29.79	35.21	30.74			
Mass of container (m_1)	g	23.13	28.45	23.29			
Mass of moisture ($m_3 - m_2$)	g	3.61	3.98	4.77			
Mass of dry soil ($m_2 - m_1$)	g	6.66	6.76	7.45			
Water Content	%	**54.20**	**58.88**	**64.03**			



Sample preparation	
washed on 425 μ m sieve oven dried at	105 °C
Liquid limit	59 %
Plastic limit	25 %
Plasticity index	34 %
Liquid limit	%
Plastic limit	%
Plasticity index	%

Operator	Checked	Approved
P.M.	K.B.	S.T.

Liquid Limit *(Casagrande method)* and Plastic Limit

Project : Geological Survey for the Preparatory Survey on the Project for Construction of Mumbai Trans Harbour Link

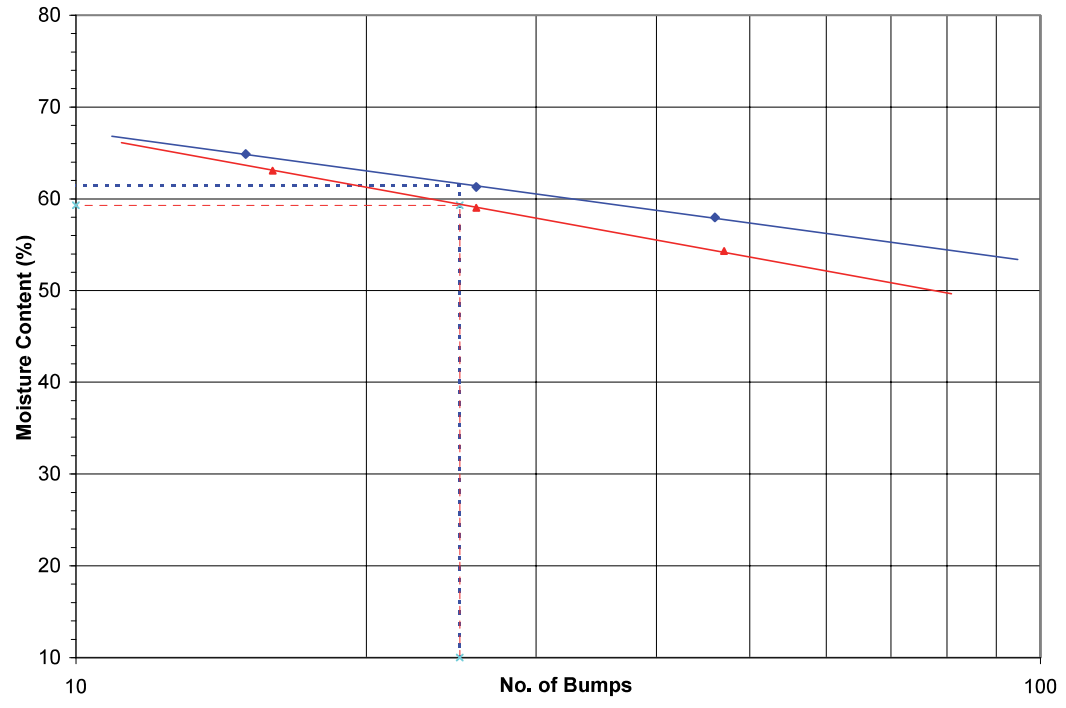
Job No. IDEAL/028/015

BH NO. :	Sample Depth(m) :		Sample No. :		Date :	
BH-02	-10.54 - -10.99		ID-M-BH-02-S7500		08-07-2015	
BH-02	-12.04 - -12.49		ID-M-BH-02-S9000		08-07-2015	

Test method : **IS 2720 : Part 5**

PLASTIC LIMIT	Test no.	1	2	Average	1	2	Average
Container no.		A42	A53		A39	A41	
Mass of wet soil + container	g	34.41	28.88		29.62	29.40	
Mass of dry soil + container	g	31.64	26.35		27.15	26.73	
Mass of container	g	22.23	17.55		18.46	17.55	
Mass of moisture	g	2.77	2.53		2.47	2.67	
Mass of dry soil	g	9.41	8.80		8.69	9.18	
Moisture Content	%	29.44	28.75	29.09	28.42	29.08	28.75

LIQUID LIMIT	Test no.	1	2	3	1	2	3
Number of bumps		26	47	16	15	26	46
Container no.		A5	A27	A19	A51	A61	A45
Mass of wet soil + container (m_3)	g	34.10	37.98	37.17	32.29	30.10	31.70
Mass of dry soil + container (m_2)	g	29.75	33.72	32.34	26.68	25.43	26.61
Mass of container (m_1)	g	22.38	25.88	24.68	18.03	17.81	17.83
Mass of moisture ($m_3 - m_2$)	g	4.35	4.26	4.83	5.61	4.67	5.09
Mass of dry soil ($m_2 - m_1$)	g	7.37	7.84	7.66	8.65	7.62	8.78
Water Content	%	59.02	54.34	63.05	64.86	61.29	57.97



Sample preparation		
washed on 425 μ m sieve oven dried at 105 °C		
Liquid limit	59	%
Plastic limit	29	%
Plasticity index	30	%
Liquid limit	62	%
Plastic limit	29	%
Plasticity index	33	%

Operator	Checked	Approved
P.M.	K.B.	S.T.

Liquid Limit *(Casagrande method)* and Plastic Limit

Project : Geological Survey for the Preparatory Survey on the Project for Construction of Mumbai Trans Harbour Link

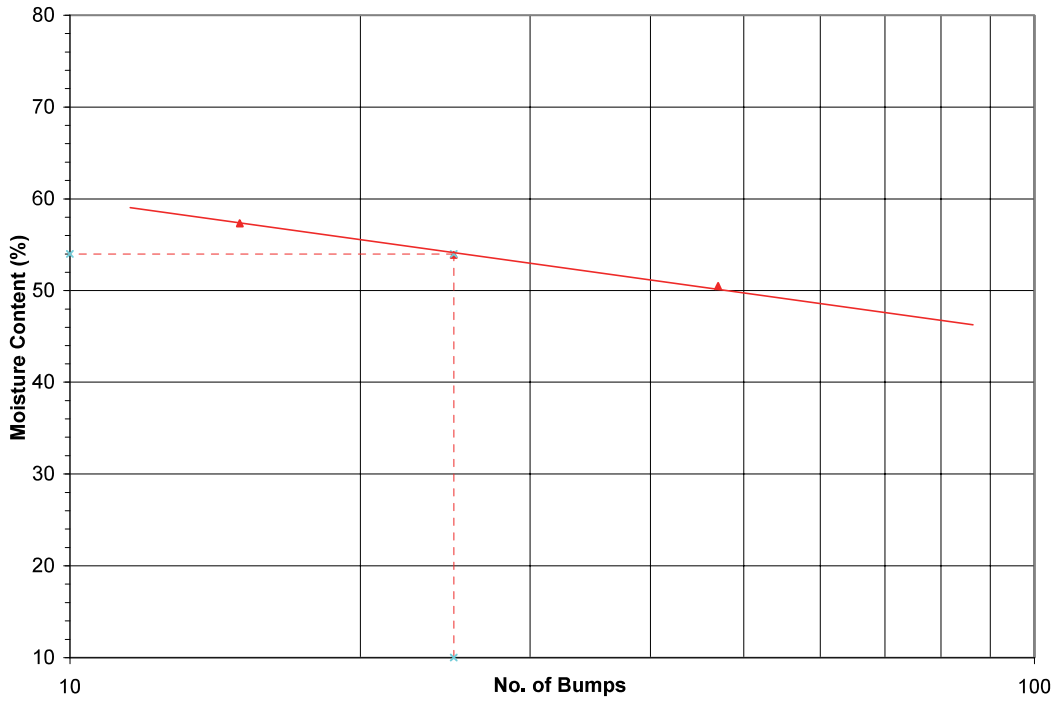
Job No. IDEAL/028/015

BH NO. :	BH-02	Sample Depth(m) :	-13.54 - -13.99	Sample No. :	ID-M-BH-02-S1050	Date :	08-07-2015

Test method : **IS 2720 : Part 5**

PLASTIC LIMIT	Test no.	1	2	Average	1	2	Average
Container no.		A49	A38				
Mass of wet soil + container	g	29.58	29.38				
Mass of dry soil + container	g	27.53	27.29				
Mass of container	g	18.71	18.28				
Mass of moisture	g	2.05	2.09				
Mass of dry soil	g	8.82	9.01				
Moisture Content	%	**23.24**	**23.20**	**23.22**			

LIQUID LIMIT	Test no.	1	2	3	1	2	3
Number of bumps		15	25	47			
Container no.		A7	A30	A28			
Mass of wet soil + container (m_3)	g	34.90	38.87	35.70			
Mass of dry soil + container (m_2)	g	30.20	34.44	32.64			
Mass of container (m_1)	g	22.00	26.22	26.58			
Mass of moisture ($m_3 - m_2$)	g	4.70	4.43	3.06			
Mass of dry soil ($m_2 - m_1$)	g	8.20	8.22	6.06			
Water Content	%	**57.32**	**53.89**	**50.50**			



Sample preparation	
washed on 425 μ m sieve oven dried at	105 °C
Liquid limit	54 %
Plastic limit	23 %
Plasticity index	31 %
Liquid limit	%
Plastic limit	%
Plasticity index	%

Operator	Checked	Approved
P.M.	K.B.	S.T.

Liquid Limit *(Casagrande method)* and Plastic Limit

Project : Geological Survey for the Preparatory Survey on the Project for Construction of Mumbai Trans Harbour Link

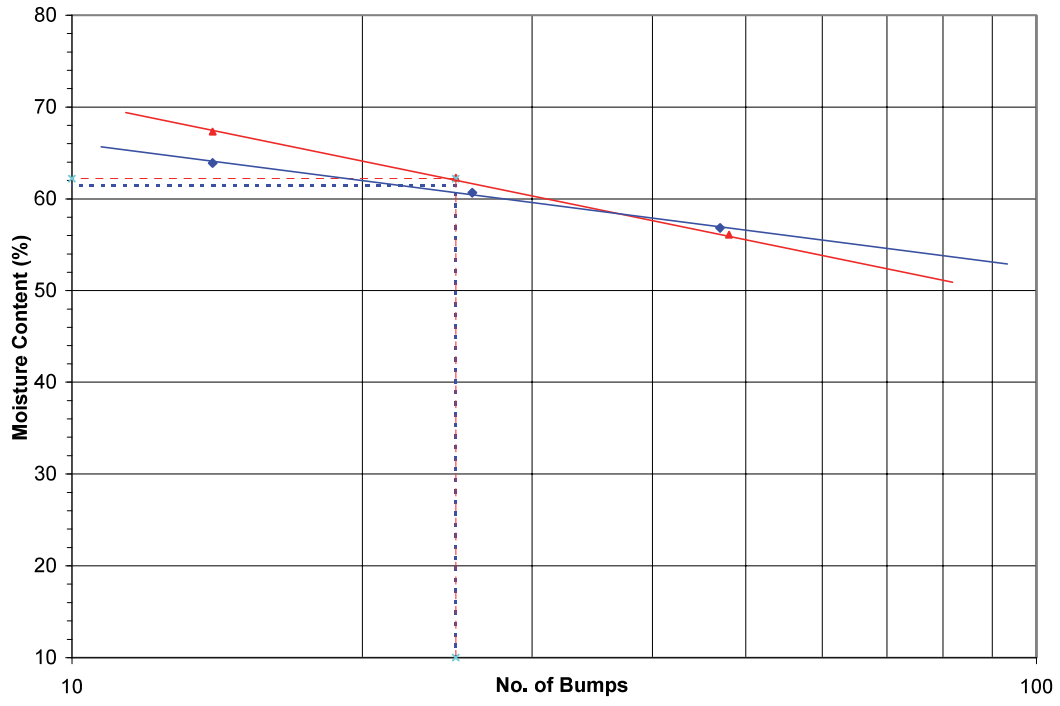
Job No. IDEAL/028/015

BH NO. :	Sample Depth(m) :		Sample No. :		Date :	
BH-03		-2.90 - -3.40		ID-M-BH-01-S0000		22-07-2015
BH-03		-4.40 - -4.85		ID-M-BH-01-D1500		22-07-2015

Test method : **IS 2720 : Part 5**

PLASTIC LIMIT	Test no.	1	2	Average	1	2	Average
Container no.		A62	A52		A41	A65	
Mass of wet soil + container	g	27.70	26.90		23.50	23.60	
Mass of dry soil + container	g	25.80	25.30		21.70	21.80	
Mass of container	g	18.57	19.14		17.55	17.53	
Mass of moisture	g	1.90	1.60		1.80	1.80	
Mass of dry soil	g	7.23	6.16		4.15	4.27	
Moisture Content	%	26.28	25.97	26.13	43.37	42.15	42.76

LIQUID LIMIT	Test no.	1	2	3	1	2	3
Number of bumps		14	25	48	14	26	47
Container no.		A11	A27	A9	A35	A14	A24
Mass of wet soil + container (m_3)	g	36.80	35.00	33.50	39.90	31.60	33.20
Mass of dry soil + container (m_2)	g	31.30	31.50	29.40	35.00	27.70	30.00
Mass of container (m_1)	g	23.13	25.88	22.09	27.33	21.27	24.37
Mass of moisture ($m_3 - m_2$)	g	5.50	3.50	4.10	4.90	3.90	3.20
Mass of dry soil ($m_2 - m_1$)	g	8.17	5.62	7.31	7.67	6.43	5.63
Water Content	%	67.32	62.28	56.09	63.89	60.65	56.84



Sample preparation		
washed on 425 μ m sieve oven dried at 105 °C		
Liquid limit	62	%
Plastic limit	26	%
Plasticity index	36	%
Liquid limit	62	%
Plastic limit	43	%
Plasticity index	19	%

Operator	Checked	Approved
P.M.	K.B.	S.T.

Liquid Limit *(Casagrande method)* and Plastic Limit

Project : Geological Survey for the Preparatory Survey on the Project for Construction of Mumbai Trans Harbour Link

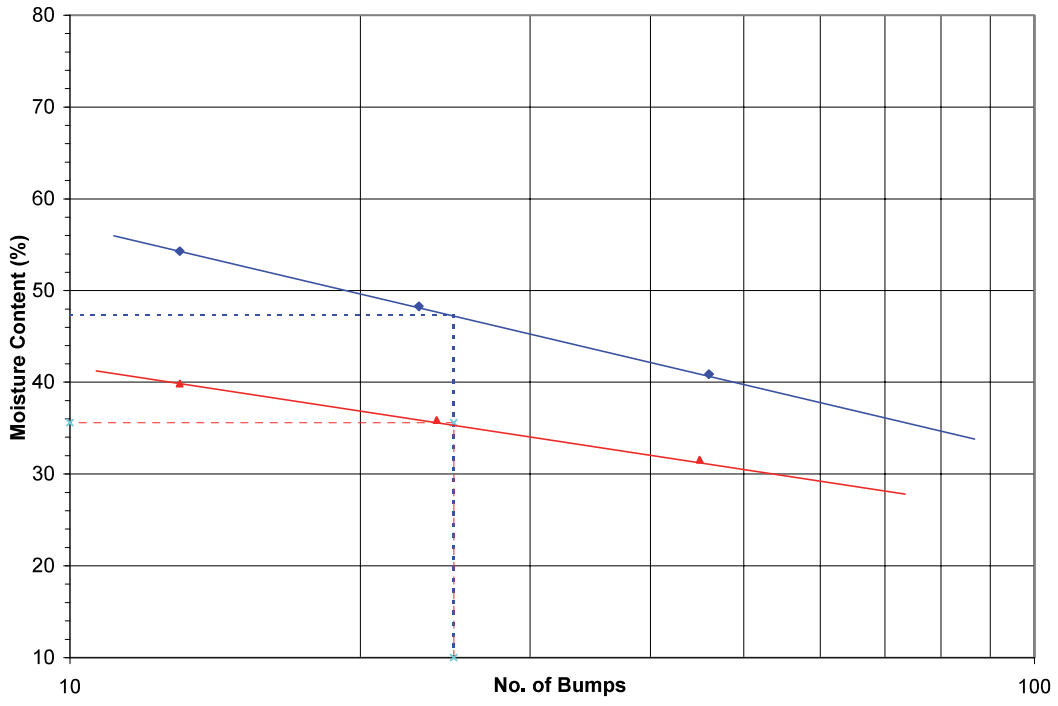
Job No. IDEAL/028/015

BH NO. :	Sample Depth(m) :		Sample No. :		Date :	
BH-04		-5.60 - -6.10		ID-M-BH-04-D0000		02-07-2015
BH-04		-7.10 - -7.55		ID-M-BH-04-S1500		02-07-2015

Test method : **IS 2720 : Part 5**

PLASTIC LIMIT	Test no.	1	2	Average	1	2	Average
Container no.		A37	A60		A56	A50	
Mass of wet soil + container	g	27.00	27.00		29.44	26.57	
Mass of dry soil + container	g	25.03	25.01		27.31	24.51	
Mass of container	g	16.72	16.78		19.07	16.60	
Mass of moisture	g	1.97	1.99		2.13	2.06	
Mass of dry soil	g	8.31	8.23		8.24	7.91	
Moisture Content	%	23.71	24.18	23.94	25.85	26.04	25.95

LIQUID LIMIT	Test no.	1	2	3	1	2	3
Number of bumps		45	24	13	46	23	13
Container no.		A55	A61	A48	A65	A45	A41
Mass of wet soil + container (m_3)	g	27.90	25.46	32.47	24.18	26.49	27.10
Mass of dry soil + container (m_2)	g	25.76	23.44	28.26	22.25	23.67	23.74
Mass of container (m_1)	g	18.98	17.81	17.70	17.53	17.83	17.55
Mass of moisture ($m_3 - m_2$)	g	2.14	2.02	4.21	1.93	2.82	3.36
Mass of dry soil ($m_2 - m_1$)	g	6.78	5.63	10.56	4.72	5.84	6.19
Water Content	%	31.56	35.88	39.87	40.89	48.29	54.28



Sample preparation	
washed on 425 μ m sieve oven dried at	105 °C
Liquid limit	36 %
Plastic limit	24 %
Plasticity index	12 %
Liquid limit	47 %
Plastic limit	26 %
Plasticity index	21 %

Operator	Checked	Approved
P.M.	K.B.	S.T.

Liquid Limit *(Casagrande method)* and Plastic Limit

Project : Geological Survey for the Preparatory Survey on the Project for Construction of Mumbai Trans Harbour Link

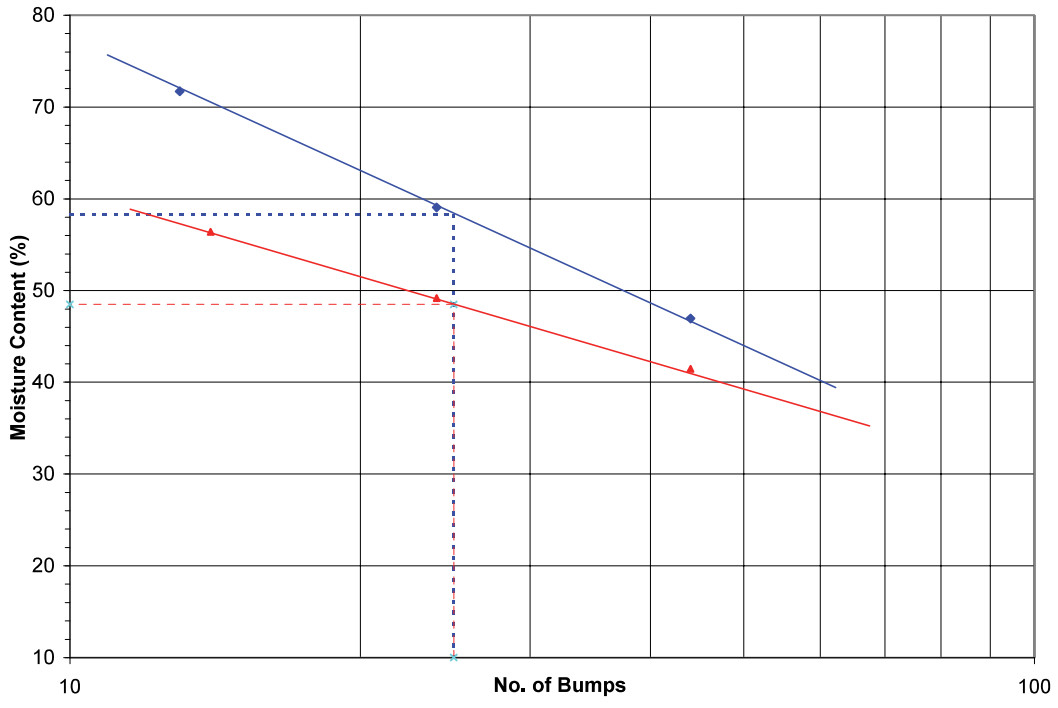
Job No. IDEAL/028/015

BH NO. :		Sample Depth(m) :					
	BH-04		-10.10 - -10.55	Sample No. :	ID-M-BH-04-S4500	Date :	02-07-2015
	BH-04		-11.60 - -12.05	Sample No. :	ID-M-BH-04-S6000	Date :	02-07-2015

Test method : **IS 2720 : Part 5**

PLASTIC LIMIT	Test no.	1	2	Average	1	2	Average
Container no.		A42	A53		A38	A47	
Mass of wet soil + container	g	32.60	26.93		27.77	25.61	
Mass of dry soil + container	g	30.38	24.91		25.72	23.75	
Mass of container	g	22.23	17.55		18.28	16.87	
Mass of moisture	g	2.22	2.02		2.05	1.86	
Mass of dry soil	g	8.15	7.36		7.44	6.88	
Moisture Content	%	**27.24**	**27.45**	**27.34**	**27.55**	**27.03**	**27.29**

LIQUID LIMIT	Test no.	1	2	3	1	2	3
Number of bumps		44	24	14	24	44	13
Container no.		A28	A15	A27	A26	A7	A34
Mass of wet soil + container (m_3)	g	34.80	34.42	38.14	35.22	30.20	35.93
Mass of dry soil + container (m_2)	g	32.39	31.06	33.72	31.76	27.58	32.03
Mass of container (m_1)	g	26.58	24.23	25.88	25.90	22.00	26.59
Mass of moisture ($m_3 - m_2$)	g	2.41	3.36	4.42	3.46	2.62	3.90
Mass of dry soil ($m_2 - m_1$)	g	5.81	6.83	7.84	5.86	5.58	5.44
Water Content	%	**41.48**	**49.19**	**56.38**	**59.04**	**46.95**	**71.69**



Sample preparation	
washed on 425 μ m sieve oven dried at	105 °C
Liquid limit	49 %
Plastic limit	27 %
Plasticity index	22 %
Liquid limit	58 %
Plastic limit	27 %
Plasticity index	31 %

Operator	Checked	Approved
P.M.	K.B.	S.T.

Liquid Limit *(Casagrande method)* and Plastic Limit

Project : Geological Survey for the Preparatory Survey on the Project for Construction of Mumbai Trans Harbour Link

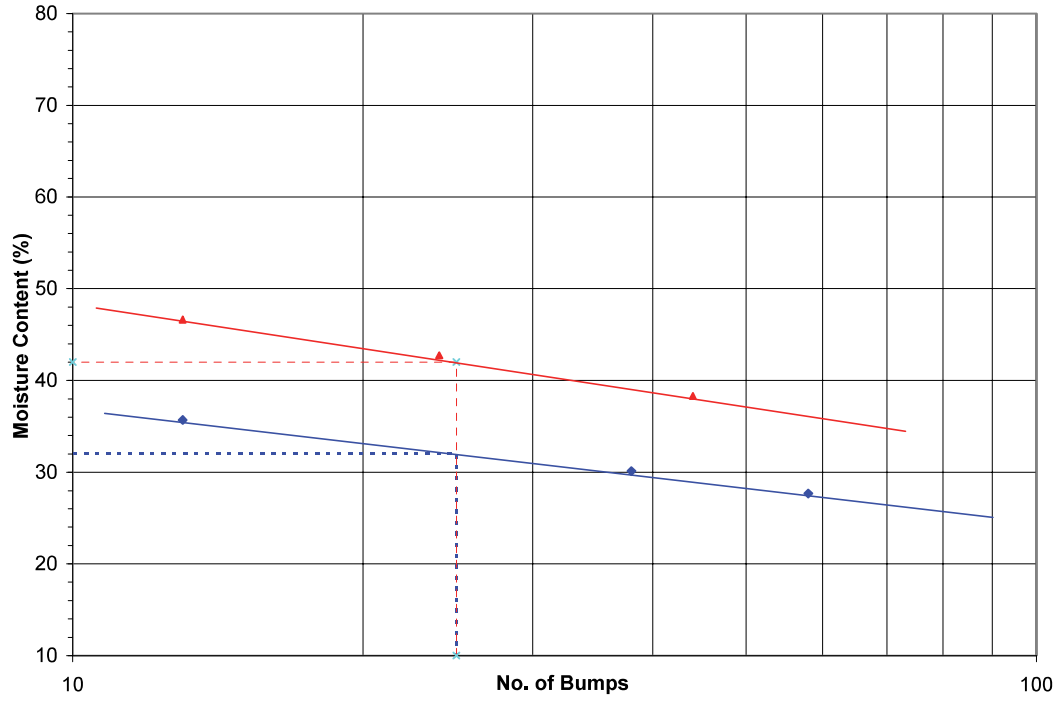
Job No. IDEAL/028/015

BH NO. :	Sample Depth(m) :		Sample No. :		Date :	
BH-05	-3.10 - -3.60		Sample No. :	ID-M-BH-05-D0000	Date :	02-07-2015
BH-05	-12.10 - -12.55		Sample No. :	ID-M-BH-05-S9000	Date :	02-07-2015

Test method : **IS 2720 : Part 5**

PLASTIC LIMIT	Test no.	1	2	Average	1	2	Average
Container no.		A39	A51		A59	A52	
Mass of wet soil + container	g	27.32	27.25		34.12	29.93	
Mass of dry soil + container	g	25.69	25.57		32.05	28.12	
Mass of container	g	18.46	18.03		21.93	19.14	
Mass of moisture	g	1.63	1.68		2.07	1.81	
Mass of dry soil	g	7.23	7.54		10.12	8.98	
Moisture Content	%	**22.54**	**22.28**	**22.41**	**20.45**	**20.16**	**20.31**

LIQUID LIMIT	Test no.	1	2	3	1	2	3
Number of bumps		13	24	44	13	38	58
Container no.		A16	A20	A9	A11	A19	A40
Mass of wet soil + container (m_3)	g	37.11	35.10	31.40	34.50	38.03	34.50
Mass of dry soil + container (m_2)	g	32.66	32.08	28.82	31.51	34.94	31.00
Mass of container (m_1)	g	23.12	25.01	22.09	23.13	24.68	18.36
Mass of moisture ($m_3 - m_2$)	g	4.45	3.02	2.58	2.99	3.09	3.50
Mass of dry soil ($m_2 - m_1$)	g	9.54	7.07	6.73	8.38	10.26	12.64
Water Content	%	**46.65**	**42.72**	**38.34**	**35.68**	**30.12**	**27.69**



Sample preparation	
washed on 425 μ m sieve oven dried at	105 °C
Liquid limit	42 %
Plastic limit	22 %
Plasticity index	20 %
Liquid limit	32 %
Plastic limit	20 %
Plasticity index	12 %

Operator	Checked	Approved
P.M.	K.B.	S.T.

Liquid Limit *(Casagrande method)* and Plastic Limit

Project : Geological Survey for the Preparatory Survey on the Project for Construction of Mumbai Trans Harbour Link

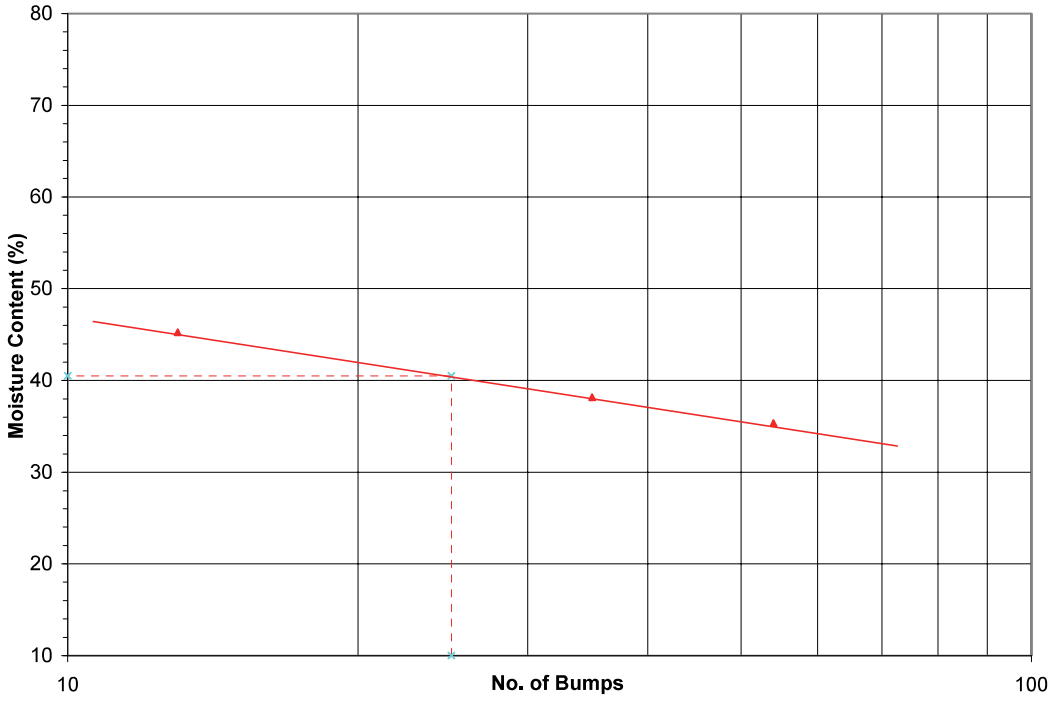
Job No. IDEAL/028/015

BH NO. :	BH-05	Sample Depth(m) :	-13.60 - -14.05	Sample No. :	ID-M-BH-05-D1050	Date :	26-06-2015

Test method : **IS 2720 : Part 5**

PLASTIC LIMIT	Test no.	1	2	Average	1	2	Average
Container no.		A44	A46				
Mass of wet soil + container	g	29.23	29.00				
Mass of dry soil + container	g	27.45	27.07				
Mass of container	g	19.44	18.37				
Mass of moisture	g	1.78	1.93				
Mass of dry soil	g	8.01	8.70				
Moisture Content	%	22.22	22.18	22.20			

LIQUID LIMIT	Test no.	1	2	3	1	2	3
Number of bumps		13	35	54			
Container no.		A6	A17	A9			
Mass of wet soil + container (m_3)	g	30.80	34.04	31.20			
Mass of dry soil + container (m_2)	g	27.89	31.07	28.82			
Mass of container (m_1)	g	21.46	23.29	22.09			
Mass of moisture ($m_3 - m_2$)	g	2.91	2.97	2.38			
Mass of dry soil ($m_2 - m_1$)	g	6.43	7.78	6.73			
Water Content	%	45.26	38.17	35.36			



Sample preparation	
washed on 425 μ m sieve oven dried at	105 °C
Liquid limit	41 %
Plastic limit	22 %
Plasticity index	19 %
Liquid limit	%
Plastic limit	%
Plasticity index	%

Operator	Checked	Approved
P.M.	K.B.	S.T.

Liquid Limit *(Casagrande method)* and Plastic Limit

Project : Geological Survey for the Preparatory Survey on the Project for Construction of Mumbai Trans Harbour Link

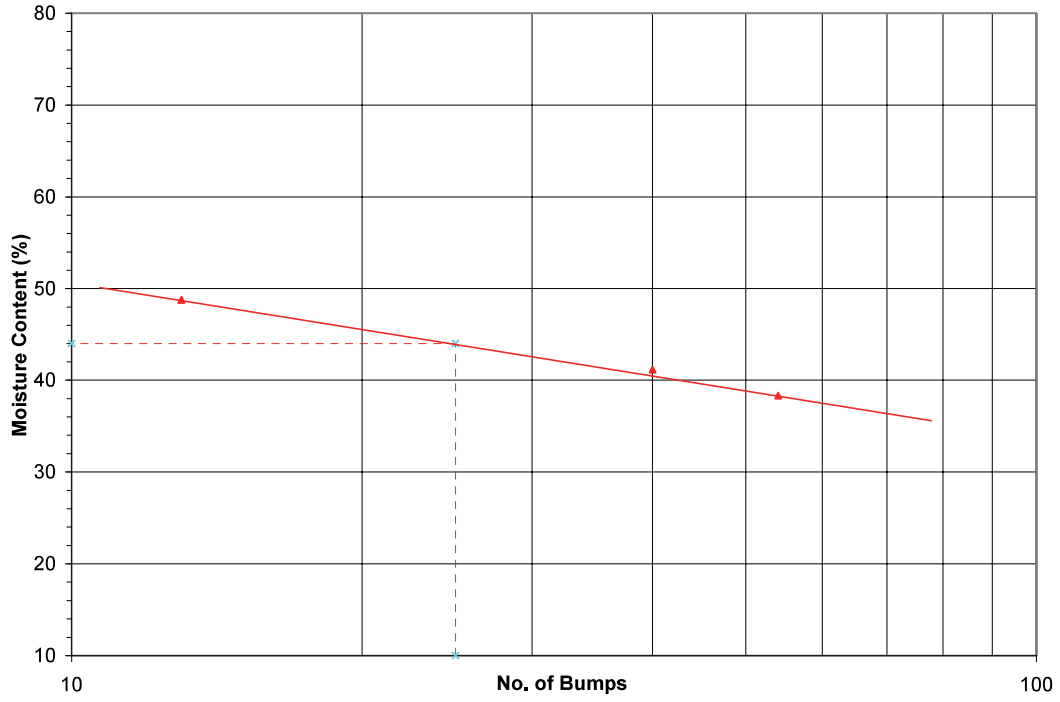
Job No. IDEAL/028/015

BH NO. :	BH-06	Sample Depth(m) :	-2.91 - -3.36	Sample No. :	ID-M-BH-06-D0000	Date :	26-06-2015

Test method : **IS 2720 : Part 5**

PLASTIC LIMIT	Test no.	1	2	Average	1	2	Average
Container no.		A49	A62				
Mass of wet soil + container	g	29.90	30.34				
Mass of dry soil + container	g	27.49	27.80				
Mass of container	g	18.71	18.57				
Mass of moisture	g	2.41	2.54				
Mass of dry soil	g	8.78	9.23				
Moisture Content	%	27.45	27.52	27.48			

LIQUID LIMIT	Test no.	1	2	3	1	2	3
Number of bumps		13	40	54			
Container no.		A29	A5	A9			
Mass of wet soil + container (m_3)	g	38.70	36.20	31.40			
Mass of dry soil + container (m_2)	g	34.58	32.17	28.82			
Mass of container (m_1)	g	26.13	22.38	22.09			
Mass of moisture ($m_3 - m_2$)	g	4.12	4.03	2.58			
Mass of dry soil ($m_2 - m_1$)	g	8.45	9.79	6.73			
Water Content	%	48.76	41.16	38.34			



Sample preparation	
washed on 425 μ m sieve oven dried at	105 °C
Liquid limit	44 %
Plastic limit	27 %
Plasticity index	17 %
Liquid limit	%
Plastic limit	%
Plasticity index	%

Operator	Checked	Approved
P.M.	K.B.	S.T.

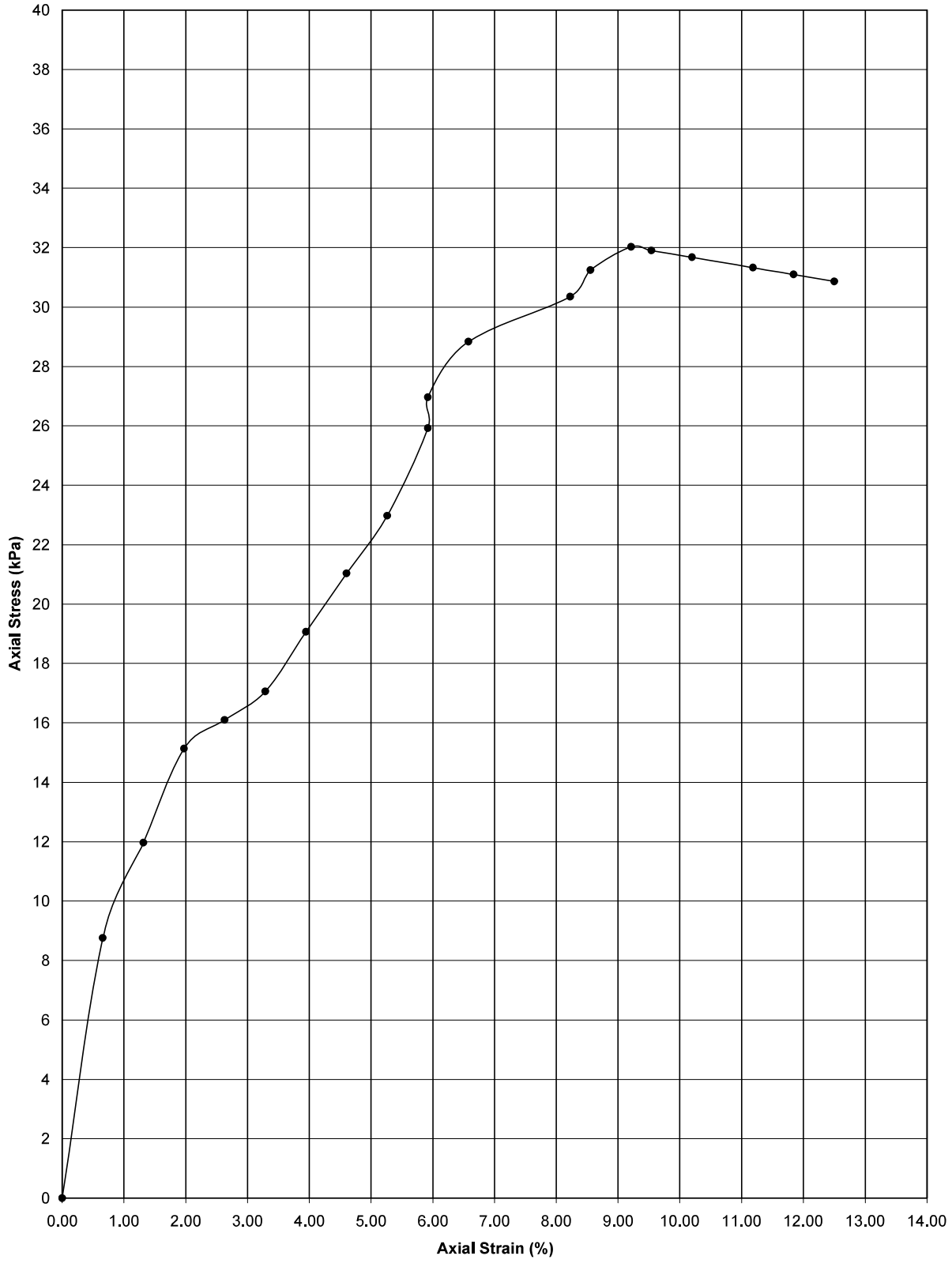
APPENDIX-D - STRENGTH TEST RESULTS

PROJECT : Geological Survey for the Preparatory Survey on the Project for Construction of Mumbai Trans Harbour Link

Job No.: IDEAL/028/015

Unconfined Compression Test

Borehole:	BH-1	Sample Diameter (mm):	38	Bulk Density(g/cm^3)	1.60	q_u :	32.0 kPa
Depth (m):	-6.32 - -6.77	Sample Height (mm):	76	Dry Density (g/cm^3)	0.96	c_u:	16.0 kPa



qu = Unconfined Compressive Strength
cu = Undrained Cohesion

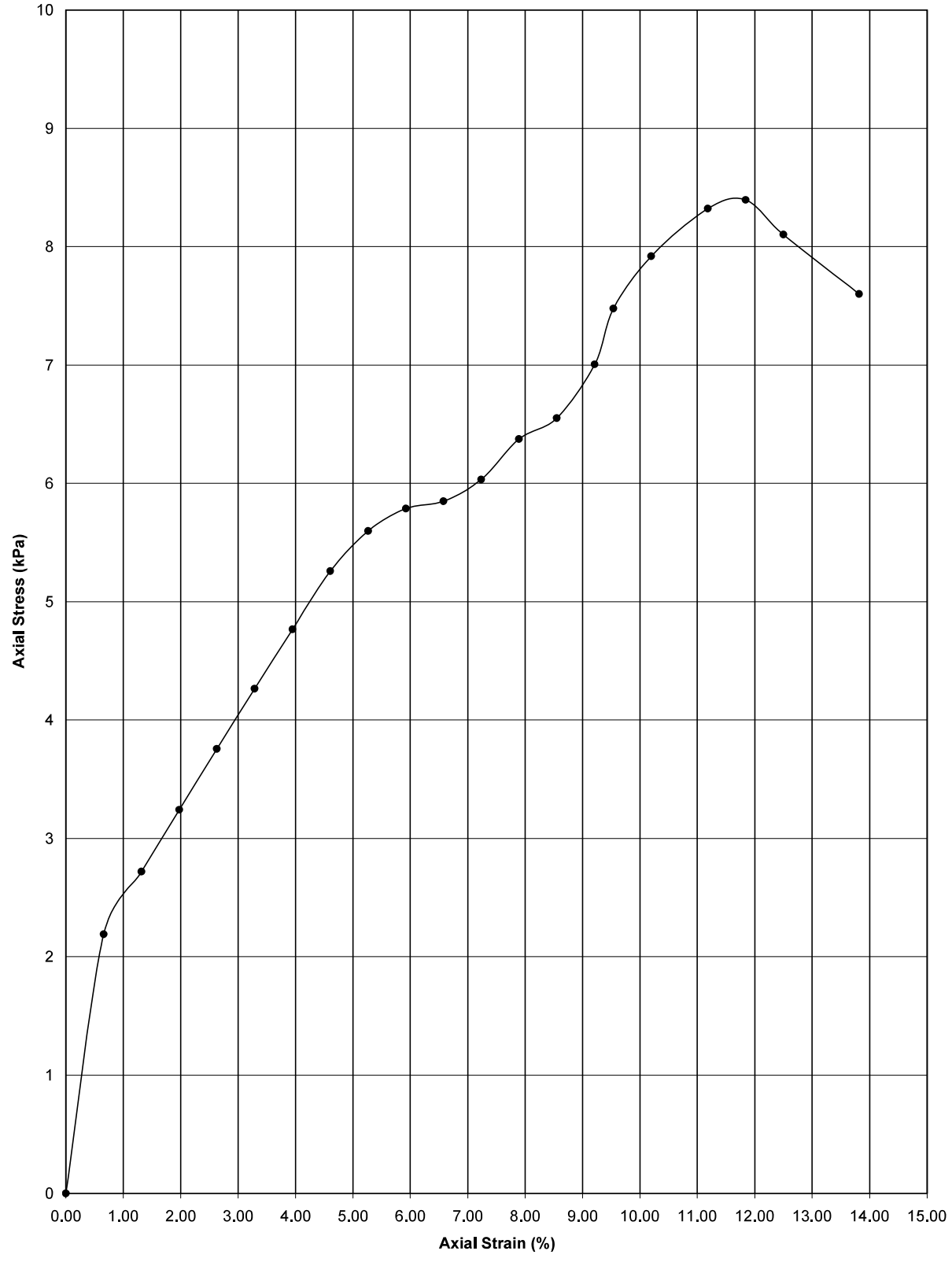
Plate-D1

PROJECT : Geological Survey for the Preparatory Survey on the Project for Construction of Mumbai Trans Harbour Link

Job No.: IDEAL/028/015

Unconfined Compression Test

Borehole: BH-2	Sample Diameter (mm): 38	Bulk Density(g/cm^3)	1.60	q_u :	8.0 kPa
Depth (m): -7.54 - -7.99	Sample Height (mm): 76	Dry Density (g/cm^3)	0.72	c_u:	4.0 kPa



qu = Unconfined Compressive Strength
cu = Undrained Cohesion

Plate-D2

APPENDIX-E - COMPRESSIBILITY TEST RESULTS

CONSOLIDATION TEST RESULTS

Project:Geological Survey for the Preparatory Survey on the Project for Construction of Mumbai Trans Harbour Link

Job No.: IDEAL/028/015

BH-No	: BH-01	Diameter of Specimen(cm)	6		
Depth (m)	: -6.32 - -6.77	Area of Specimen,A (cm^2)	27.94	σ_c	: 130 KN/m²
Wt. of Dry Soil (gm)	53.40	Specific Gravity of Sample	: 2.58	C_C	: 0.619
Dial Gauge L.C.,mm	0.002mm	Initial Height of Sample (H_o)	: 20.0	e_0	: 1.699
		Height of Solids (H_s)	: 7.41		

Applied Pressure σ (kN/m^2)	Final Dial Reading	Dial Change	Dial Change ΔH(mm)	Specimen Height ($H=H_1+\Delta H$) (mm)	Height of voids= $H-H_s$(mm)	Void Ratio $e=(H-H_s)/H_s$	Coefficient of Volume Change $M_v=(\Delta e/1+e_o)/\Delta\sigma$($m^2$/kN)
0	3500	-10	-0.02	20.000	12.59	1.699	
10	3490	-23	-0.05	19.980	12.57	1.697	1.0000E-04
20	3467	-129	-0.26	19.934	12.53	1.691	2.3023E-04
50	3338	-163	-0.33	19.676	12.27	1.656	4.3142E-04
100	3175	-319	-0.64	19.350	11.94	1.612	3.3137E-04
200	2856	-896	-1.79	18.712	11.30	1.526	3.2972E-04
400	1960	122	0.24	16.920	9.51	1.284	4.7884E-04
50	2082	123	0.25	17.164	9.76	1.317	4.1202E-05
20	2205	-185	-0.37	17.410	10.00	1.350	4.7774E-04
0	2020						

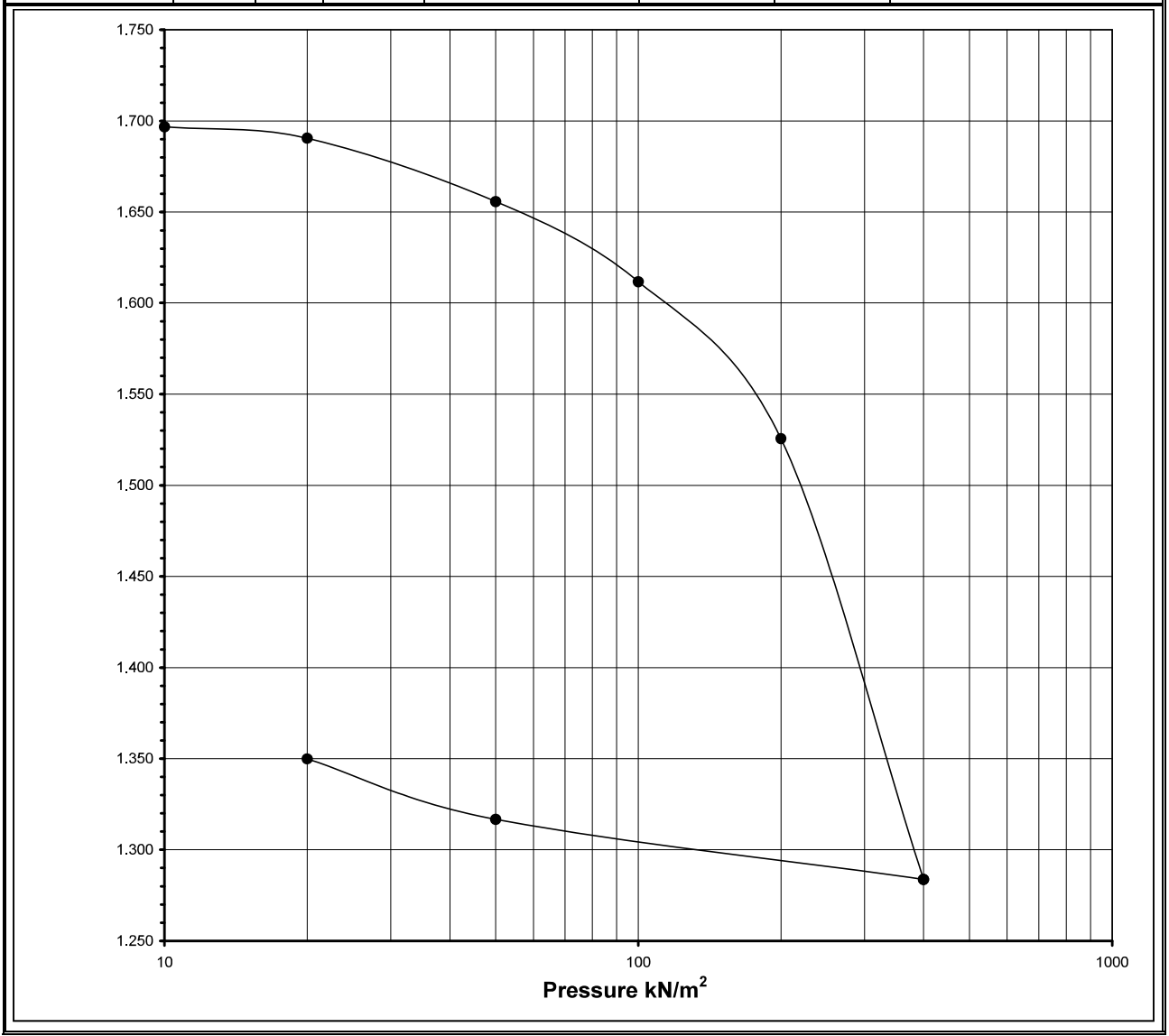


Plate-E1

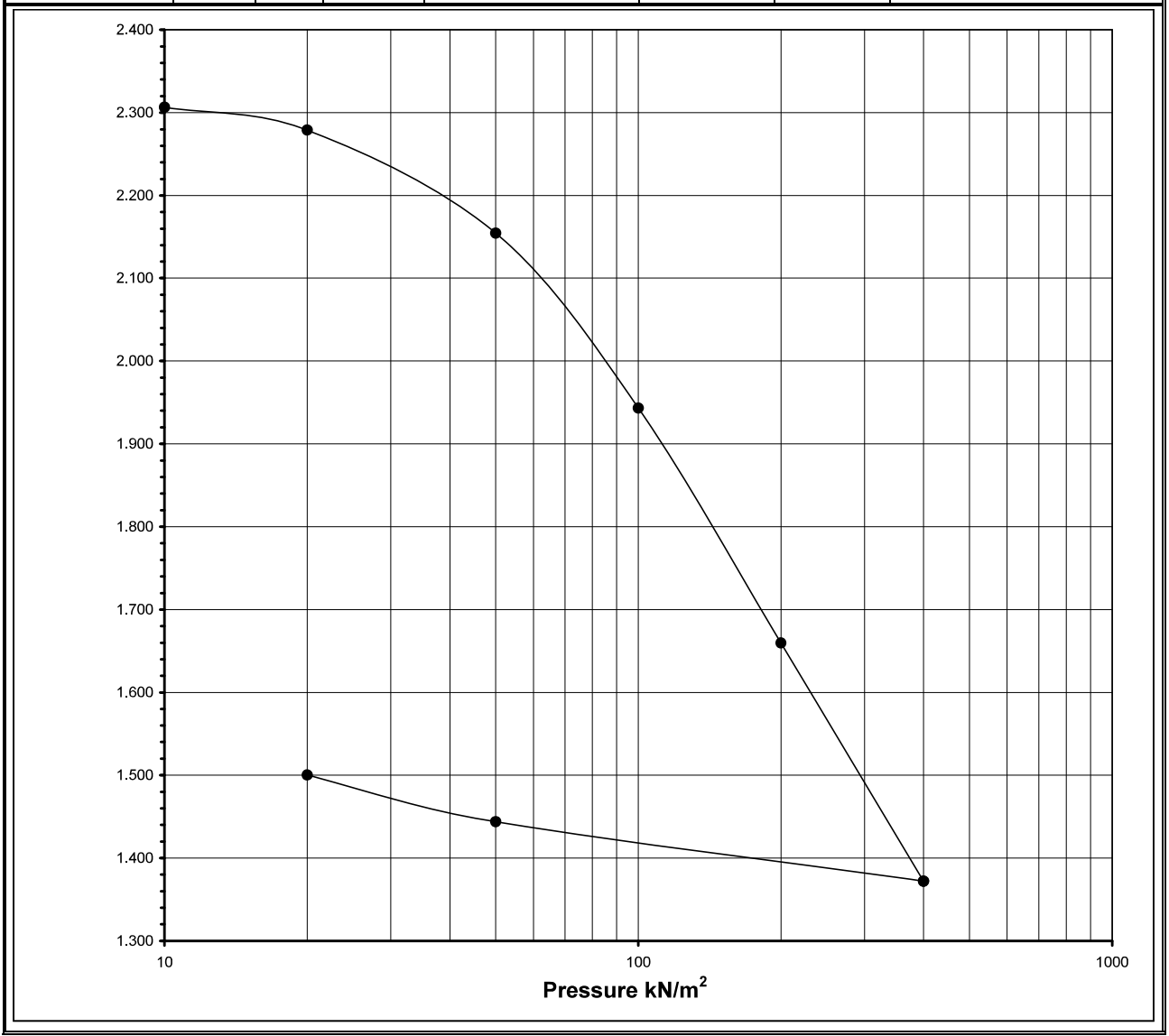
CONSOLIDATION TEST RESULTS

Project:Geological Survey for the Preparatory Survey on the Project for Construction of Mumbai Trans Harbour Link

Job No.: IDEAL/028/015

BH-No	: BH-02	Diameter of Specimen(cm)	6		
Depth (m)	: -7.54 - -7.99	Area of Specimen,A (cm^2)	27.94	σ_c	: 46 KN/m²
Wt. of Dry Soil (gm)	42.90	Specific Gravity of Sample	: 2.54	C_C	: 0.851
Dial Gauge L.C.,mm	0.002mm	Initial Height of Sample (H_o)	: 20.0	e_0	: 2.308
		Height of Solids (H_s)	: 6.05		

Applied Pressure σ (kN/m^2)	Final Dial Reading	Dial Change	Dial Change ΔH(mm)	Specimen Height ($H=H_1+\Delta H$) (mm)	Height of voids= $H-H_s$(mm)	Void Ratio $e=(H-H_s)/H_s$	Coefficient of Volume Change $M_v=(\Delta e/1+e_o)/\Delta\sigma(m^2/kN)$
0	3500	-5	-0.01	20.000	13.95	2.308	
10	3495	-83	-0.17	19.990	13.94	2.306	5.0000E-05
20	3412	-376	-0.75	19.824	13.78	2.279	8.3042E-04
50	3036	-639	-1.28	19.072	13.03	2.155	1.2645E-03
100	2397	-857	-1.71	17.794	11.75	1.943	1.3402E-03
200	1540	-869	-1.74	16.080	10.03	1.660	9.6325E-04
400	671	217	0.43	14.342	8.30	1.372	5.4042E-04
50	888	170	0.34	14.776	8.73	1.444	8.6459E-05
20	1058	146	0.29	15.116	9.07	1.500	7.6701E-04
0	1204						



APPENDIX-F - CORE BOX PHOTOGRAPHS

PROJECT : Geological Survey for the Preparatory Survey on the Project for Construction of Mumbai Trans Harbour Link

Job No. : IDEAL/028/015

CLIENT

ORIENTAL CONSULTANTS
Global Consulting for Sustainable Development

BOREHOLE NO. : BH-01

Depth (m) : -19.82 - -27.32 Core Box 01 of 02

BOREHOLE NO. : BH-01

Depth (m) : -27.32 - -28.82 Core Box 02 of 02

PROJECT : Geological Survey for the Preparatory Survey on the Project for Construction of Mumbai Trans Harbour Link

Job No. : IDEAL/028/015

CLIENT

ORIENTAL CONSULTANTS
Global Consulting for Sustainable Development

BOREHOLE NO. : BH-02

Depth (m) : -24.04 - -28.54 Core Box 01 of 01

Plate-F2

PROJECT : Geological Survey for the Preparatory Survey on the Project for Construction of Mumbai Trans Harbour Link

Job No. : IDEAL/028/015

CLIENT

ORIENTAL CONSULTANTS
Global Consulting for Sustainable Development

BOREHOLE NO. : BH-03

Depth (m) : -7.40 - -22.40 Core Box 01 of 03

BOREHOLE NO. : BH-03

Depth (m) : -23.90 - -26.90 Core Box 02 of 03

PROJECT : Geological Survey for the Preparatory Survey on the Project for Construction of Mumbai Trans Harbour Link

Job No. : IDEAL/028/015

CLIENT

ORIENTAL CONSULTANTS
Global Consulting for Sustainable Development

BOREHOLE NO. : BH-03

Depth (m) : -26.90 - -28.40 Core Box 03 of 03

PROJECT : Geological Survey for the Preparatory Survey on the Project for Construction of Mumbai Trans Harbour Link

Job No. : IDEAL/028/015

CLIENT

ORIENTAL CONSULTANTS
Global Consulting for Sustainable Development

BOREHOLE NO. : BH-04

Depth (m) : -16.10 - -25.60 Core Box 01 of 02

BOREHOLE NO. : BH-04

Depth (m) : -25.60 - -31.80 Core Box 02 of 02

PROJECT : Geological Survey for the Preparatory Survey on the Project for Construction of Mumbai Trans Harbour Link

Job No. : IDEAL/028/015

CLIENT

ORIENTAL CONSULTANTS
Global Consulting for Sustainable Development

BOREHOLE NO. : BH-05

Depth (m) : -16.60 - -22.60 Core Box 01 of 02

BOREHOLE NO. : BH-05

Depth (m) : -22.60 - -25.30 Core Box 02 of 02

PROJECT : Geological Survey for the Preparatory Survey on the Project for Construction of Mumbai Trans Harbour Link

Job No. : IDEAL/028/015

CLIENT

ORIENTAL CONSULTANTS
Global Consulting for Sustainable Development

BOREHOLE NO. : BH-06

Depth (m) : -7.41 - -17.91 Core Box 01 of 02

BOREHOLE NO. : BH-06

Depth (m) : -17.91 - - 22.11 Core Box 02 of 02