付録-2

Topographic Survey Report



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Annexure 1

MOBILISATION REPORT

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Chart No.	Scale	Description
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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



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				

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

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
	A	284033.6	2104918
Route 2	В	291903	2100254
	С	274629.6	2100246
Route 3	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 Interchange1,040,000 sq.m.Navi Mumbai road1,100,000sq.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: I,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-S	Sheva Side		
code	Easting	Northing	RL
GPS3	290717.0470	2098124.4430	6.256
A-25	290533.2421	2098031.9197	4.161
Sewri Sid	e		
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 barcheck 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.



SOWIL Limited











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



<u>11.</u> FIELD PHOTOGRAPHS















Figure 11:-topographic survey work at JNPT site NH4B













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





Bathymetric Survey Photo



Figure 16 Exposed headland at KP3.35











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

ltem	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



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4 Vessel Offsets

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







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.





Page | **39**

-		1	_				From No.		Sv328
		0.000					Resiston	-	302
			DGPS	POSITIO	COMPARISON		Date	-	1.365-2018
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-		-					Coldmonth of a		114
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Client		INPT	_	_	Vessel	ML Ana	h.		
Lucation		Landing Jetty (INIP)	Manibai	0	Date	[6-Apr-]	5		_
FOURME	ST	1	PRIMAR	v	1		FCONDAR	v	
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2	16:41	283158.34	1	095896.64	283158.37	-0.03	205	5896.67	+0.03
3	16:42	283158.34	1	095896.64	783158.38	-0.04	209	5896.64	0.00
4	16:43	283158.34	1	095896.64	283158.40	-0.06	209	3896.63	0.01
5	16:44	283158.34	2	095896.64	283158.36	-0.02	209	5896.66	-0.02
6	16:45	283158.34	2	093896.64	283158,36	-0.02	209	5896.65	-0.01
7	16:46	283158.34	2	095895.64	283158,38	-0.04	209	5896.69	-0.05
8	16:47	283158.34	2	095896.64	283158.38	-0.04	209	5896.69	-0.05
ŋ	16:48	283158,34	2	095896,64	283158.36	-0.02	209	5896.71	+0,07
10	16:49	283155.34	2	095896.64	283158,35	-0.01	209	5896.68	-0.04
Comments				Mean C-O		-0.03	Mean C-O		-0.03
					5.0.	0.01	5.0.		0.02
SECONDA	RY DGPS	CHECK	-						
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1-1-1-1	2					1	-		
2									
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10	-			-					
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Position		Name		Signature	-			Date	
				3	Sinch	_			10 41/10
Engineer	_	Alinder Singh, Sur-I	ngmar	3	TI the				15-Api-15
Party Chief	-	Praveen Kannar, Sr. 5	Surveyor						16-Apr-15



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.

1						Fahm No	Sy371
		GYRO CALIBRATION				Revision:	
		(to be filled in Exce) format only)				Date	1-Jan-201
a		1.			Approved By:	PK	
			-			Tables and the	
Vessel		Gyra		Location	1000	Date	
ML Afrah		Me	ridian	Landing Jetty (.	INPT Mumbal)	16-Ap	r-15
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218	1.472		6			Por	rt.
	Observ	vations		Calculations			C-0
		1.1		and the second	Calculated	2	
Time	Gy(o (true)	Bow	Stern	Calc angle	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
16:01:06	221.6	2.84	2.55	2.77	218.83	218.472	-0.36
16:03:00	222.2	2.81	2.62	277	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-0	-0.78
	<		Dertit Ho. Car			Fore and A	ft line
	218.472"	Step re	dg. (6 m) mtrs Baseline	Bpw rdg	Quay side	Fore and A	ft line
GENERAL INFO	218.472"	Step n	dg. (6 m) mtrs Baseline g rot on scale	Bow rdg	Quay side led showing	Fore and A	ft line
GENERAL INFO	218.472"	Stern ro	dg. (6 m) mtrs Baseline g not on scale	Bpw rdg	Quay side led showing	Fore and A	ft line
GENERAL INFO Project Name &	218.472" DRMATION No.	Stern ro Note Drawing P19215	dg. (6 m) mtrs Baseline g not on scale	Bow rdg	Quay side led showing	Fore and A	ft line
GENERAL INFO Project Name & Client:	218.472" DRMATION No.	Step no Note Drawing P19215 JNPT	dg. (6 m) mtrs Baseline g not on scale	Bow rdg	Quay side led showing	Fore and A	ft line
GENERAL INFO Projoci Name & Client: Date of Survey	218.472" DRMATION	Step re Note Drawing P19215 JNPT 16-Apr-15	dg. (6 m) mtrs Baseline g riot on scale	Bow rdg	Quay side led showing	Fore and A	ft line
GENERAL INF(Project Name & Client: Date of Survey Vessel:	218.472° DRMATION No.	Stem re Note Drawing P19215 JNPT 16-Apr-15 ML Afran	dg. (6 m) mtrs Baseline g not on scale	Bpw rdg	Quay side led showing	Fore and A	ft line
GENERAL INFO Project Name & Client Date of Survey Vessel: Owner:	218.472 ² DRMATION No.	Stem ro Stem ro Note Drawing P19215 JNPT 16-Apr-15 ML Afran Mr Altaf	dg. (6 m) mtrs Baseline g riot on scale	Bpw rdg	Quay side.	Fore and A	ft line
GENERAL INFO Project Name & Client: Date of Survey Vessel: Owner Projection	218.472°	Stem ro Stem ro Note Drawing P19215 JNPT 16-Apr-15 ML Adrah Mr Altaf UTM	dg. (6 m) mtrs Baseline g not on scale	Bow rdg	Quay side led showing	Fore and A	ft line
GENERAL INFO Project Name & Client Date of Survey Veasel: Owner Projection Datum	218.472°	Stem ro Stem ro Note Drawing P19215 JNPT 16-Apr-15 ML Adrah Mr Altaf UTM WG5 84	dg. (6 m) mtrs Baseline g not on scale	Bow rdg	Quay side led showing	Fore and A	ft line

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





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.





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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.

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







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.



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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.

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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.



Site Location:	MTHL – Proposed Alignment
Investigation Date:	Commenced from 3 rd 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	Reason for low	Image
	CD(m)	strength	
BH-04	-29.54	Because of secondary infillings of the vugs. Secondary infillings are of minerals like calcite, chlorite etc	
ВН-04	-30.80	Because weathering extends through out the rock. In some part of the core the rock material is friable	est-100

EVECUTIVE SUMMADY



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 **'DEAL-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	То			
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.

Sr.	B.H.	Proj	posed	Ac	tual	Remarks
NO.	NO	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	

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

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		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 LS. 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 425 m 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, $\frac{1}{2}$, 1, 4, 9, 16, 25, 36, 49, 64min; 1 $\frac{1}{2}$, 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







															BOREHOLE NO. : BH-01														
C	Geote	ech Co	ntract	or: II	DEAL	GEC	SER	VICES	S PVT	LTD			Job	No. :	DEAL/028/015 CLIENT :	ICAIT		C	DAL	CII	TA	AITO	•	L		SHEET	Г 01	of 03	
F	Proje	ct : Ge	ologi	cal Su	urvey	for t	he Pi	repar	atory	Surv	ey or	n the	Proje	ect for	Construction of Mumbai Trans Harbour Link	IEN IA	AL ing f	or St	JN	JU nable	Deve	lopme	nt	┝	,	WATE		IF	
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0	ate Co	ompleted	d :	10-07	-2015	Drillin	g Oriei	ntation	:	Verti	cal				Details of Casing (mm) : SX / HX / NX											_			
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_	5	-7 <u>.</u> 82	-8.27	7	11	15	26							-7.82	Very stiff, light yellowish grey CLAY	CH	1 0	4	72	24	78	32 46	6						
_	6	-9.32	-9.77	8	10	17	27									CH	1 12	2 2	29	57	79	32 47	7						
	8	-10.82	-11.27	8	16	24	40									CH	48	6	34	52	82	28 54	1						
	9	-12.32	-12.67	17	28	50 blows/ 5cm	>100						424	9.00	Hard, yellowish grey, CLAY with sand and gravels	CH	1 25	5 15	27	33	79	32 4	7						
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Project : Geologica	al Survey for the Preparatory Survey on the Pr	oject for Construction of Mumbai Trans Harbour Link	bal Consulting for Sustainable Development	WATER TABLE
T.D. (m) : -2	28.82 CD SBL (m) : -3.32 CD	Equipment Record : AQUA STAR - JACKUP BARGE		Date Time Mtrs.
Date Commenced : 00	06-07-2015 Circulation Fluid : Sea Water	Type of Rig		06-07-2015 03.45 PM 8.00
Date Completed : 10	0-07-2015 Drilling Orientation : Vertical	Details of Casing (mm) : SX / HX / NX		
	-	Core-Diameter (mm) : 54.10		
Co-Ordinates E: 2	284389.00 N : 2101122.00	-		
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H From ├ (m) To (m)	150 300 450 450 TCR % SCR % W.G F.I.	Strata Description	Soil Clasi GRAVE SAND SAND SILT CLAY CLAY PLASTICI PLASTICI NDEX ([c,¢ c,ý PreConsoli n Presu n Presu (kPa) (kPa) (kPa) ndex (C Index (C Index (C Index (C Index (C Index (C Index (C Index (C Index (C Index (C)) (k) (k) (k) (k) (k) (k) (k) (k) (k) (
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- 18 -21.32 -22.82	70 60 - IV >10			
19				
- 13 -22.82 -24.32	81 70 - IV >10			
- 20				
Abbreviations & Symbols :	N Liquid Limit I Plasticity Index MC	C.D. Chart Datum, T.D. : Termination Depth, MSL : Mean	n Sea Level	Prenared By : V N
		SBL : Sea Bed Level, EGL : Existing Ground Level, R.L. : R		Checked By : S.D.
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15												•									
	-18.04	-18.49	18	24	28	52						•		SP 10 88 2	- NP	-					
17	-19.54	-19.99	17	24	34	58								gravels not found below - 19.45 m CD SP 0 99 1	- NP	-					
_ 18	-21.04	-21.24	28	54		>100								SP 0 99 1	- NP						
_ 19			20	blows/ 5cm 54																	
- 20	-22.54	-22.79	35	blows/ 10cm	/ -	>100								SP 0 99 1							
Abbrev	/iations &	Symbols	WL	- Liq	uid Lin	nit	I _P	- Pla	sticity	Index	Ň	ис -	Moist	C.D. Chart Datum, T.D. : Termination Depth, MSL : Mean Sea Level SBL : Sea Bed Level, EGL : Existing Ground Level, R.L. : Reduced Level		· •	[Prepa	ared By	: VN]
- Roc	ck Recovery	- No	Recover	у Т	CR -	Total	Core F	ecove	ry	SCR	- So	id Cor	e Recc	ry RQD - Rock Quality Designation W.I Weathering Grade F.I. Fractural Index				Appr	oved By	/:S.T.	
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ТҮРЕ	From (m)	To (m)	150	300	450	"N" VALL	TCR %	SCR %	RQD %	W.G	F.I.	S	Dep	Strata Description Strata Description Strata Description	ບື	¢.,9	PreConsoli n Pressu (kPa) Commpres	Initial Vo Ratio (e Re
20														rry dense, brownish, SAND with gravels				
- 21	-24.04	-24.12	52 blows/	/ <u>-</u>	-	>100								SM 0 85 15 - NP -				
- 22	-24.04	-25.54	10cm				97	91	55	111	>10		-24.0	oderately strong, moderately weathered, moderately fractured light greyish amygdaloidal BASALT				
_ 23	-25.54	-27.04					99	98	79	Ш	>10							
_ 24	27.04	28 54									5.0							
_ 25	-27,04	-20,04					93	92	00		5.3							
_ 26																		
_ 27														BOREHOLE TERMINATED DEPTH AT -28.54 (m)				
_ 28																		
_ 29																		
- 30																		
(bbrevi	ations &	Symbols	: W _L	- Liqu	ıid Lin	nit	I _P	- Pla	sticity	Index	M	ic -	Mois	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		Prepa	red By : V.N. cked By : S.D.]
- Rock	Recovery Vane Shea	No r ● - Sar	Recover	ped TC	CR -	Total	Core R	ecover	y	SCR	- Soli	d Core	e Rec	y RQD - Rock Quality Designation W.I Weathering Grade F.I. Fractural Index		Appro	ved By : S.T.	





															BOREHOLE NO. : BH-03					
C	Geote	ech Co	ontract	or: II	DEAL	. GEC	SER	VICES	S PVT	LTD	-		Job	No. :	DEAL/028/015 CLIENT : CONSULTANTS		SH	EET	01 of 03	_
F	Proje	ct : Ge	eologi	cal Su	urvey	/ for t	he P	repar	atory	Surv	ey or	n the	Proj	ect fo	r Construction of Mumbai Trans Harbour Link Global Consulting for Sustainable Development		WA	TER T/	ABLE	
т	.D. (m	I)	:	-28.40	D CD	SBL (n)		:	-2.90	CD				Equipment Record : AQUA STAR - JACKUP BARGE	Date	,	Time	Mtrs	ş.
C	ate C	ommenc	ed :	11-07	-2015	Circul	ation F	luid	:	Sea V	Vater				Type of Rig : Hydraulic Rig	11-07-20	15	10.35 AM	6.00	
C	ate C	omplete	d:	16-07	-2015	Drillin	g Orier	ntation	:	Vertic	al				Details of Casing (mm) : SX / HX / NX					
															Core-Diameter (mm) : 54.10		\rightarrow			
C	Co- OI	dinates	5 E:	2869	53.00			N :	2100	893.00)		1	r			——		<u> </u>	
	Sam	pling D	etails	Stand	dard F Test	Penetra (SPT)	ation		Details	of Roc	k core)		v.r.t.(CD)	Details of Stratum	ength Tes (kPa)	^{it} C	onsolida	tion Test	ks
			1			1	<u> </u>		<u> </u>	1	<u> </u>	1	ymbo	Ű.		<u>s uu c</u>	dati U	sion) e i e	emar
	ТҮРЕ	From (m)	To (m)	150	300	450	N"' VALL	TCR %	SCR %	RQD %	N.G	F.I.	S	Depth in	Strata Description	- 8 - 5-	reConsoli	n Pressu (kPa) commpres	Index (C Initial Vo Ratio (e	ž
	0	-2.90	-3.40				•							-2.90	Very soft, dark grey, CLAY CH 0 2 57 41 62 26 36		-			
付级3-24	1 2 3 4 6	-4.40 -5.90 -7.40 -7.40	-4.85 -6.35 -7.52 -8.90	0 54 blows/ 12cm	0 -	-	0	37	11	Nil	11	4		-7.40	Weak, moderately weathered, highly fractured light greyish amygdaloidal BASALT CH 0 1 57 42 62 43 19				1	UDS Slipj ed
	7	-8.90	-10.40					43	13	Nil	II	3.3								
-	8	-10.40	-11.90	-				33	11	Nil	11	4.7								
-	9 10	-11.90	-13.40	-				27	15	Nil	11	3.3			- colour changes to reddish grey below -11.90m CD					
	bbrevi - SPT - Roci	ations &	Symbols DS DS No	Recovery	- Liqı / T	uid Lin CR	nit Total	I _P Core R	- Pla: ecover	sticity ry	Index SCR	N - Sol	IC -	Moist e Reco	C.D. Chart Datum, T.D. : Termination Depth, MSL : Mean Sea Level Ire Content SBL : Sea Bed Level, EGL : Existing Ground Level, R.L. : Reduced Level /ery RQD - Rock Quality Designation W.I Weathering Grade F.I. Fractural Index	Pre Cł Ap	pared tecked proved	By: V.I IBy:S.I IBy:S.	N. D. T.	





															BORE	HOLE NO	0.:	BH-03	_																
Geo	tech C	ontract	or: I	DEAL	_ GEO	DSER	VICES	S PVT	LTD	-		Job	No. :	IDEAL/028/	015			CLIEN	NT :	Ø	ORIE	NTA	1	201	ISI	ШТ		21	Ţ		5	SHEET	Г 02	2 of)3
Proj	ect : (Geologi	cal Su	urvey	y for	the P	repar	atory	Surv	ey oi	n the	Proj	ect fo	or Construc	ction of Mu	umbai Trans	s Harb	our Link		ORICONSUL	Global Co	nsultir	ng for	Sust	ainab	le De	velopi	ment	╞		w	VATEF		LE	
T.D. (m)	:	-28.40	0 CD	SBL ((m)		:	-2.90	CD				Equipment R	Record	:	А	QUA STAR -	JACKI	UP BARG	=									Date	е	Tir	ne	N	ltrs.
Date	Comme	nced :	11-07	-2015	Circu	lation F	luid	:	Sea V	Vater				Type of Rig		:	н	ydraulic Rig												11-07-20	015	10.35	AM		6.00
Date	Comple	ted :	16-07	-2015	Drillin	g Orie	ntation	:	Vertic	al				Details of Ca	ising (mm)	:	s	X / HX / NX																	
														Core-Diamet	ter (mm)	:	5	4.10																	
Co- (Ordinat	es E:	2869	53.00			N :	2100	893.00)																									
Sa	mpling	Details	Stan	dard F Test	Penetr (SPT)	ation		Details	of Roc	k core	9	.	w.r.t.(CD)			Deta	ails of S	Stratum				tion (USC)	A	Grain S nalysi	Size s (%)	Ca	onsiste .imits (ency (%)	Stren (gth Te≋ kPa)	st	Consc	lidatio	n Test	
	T			I	1	<u><u></u></u>			1	1	1	dmy	Ē									lificat				(Jw	(wp)	<u>}</u>	JCS		CU	idatio	sion	o id	-
	From (m)	¹ To (m)	150	300	450	"N" VALI	TCR %	SCR %	RQD %	0.0 V.G	F.I.	0,	Depth in			Stra	ata Desc	cription				Soil Clas	GRAVE	SAND) ainain	PLASTIC	PLASTIC INDEX (ບື	.	. ө '0	reConsol n Pressu (kPa)	Commpres	Initial Vo	Katio
10						-								Weak, modera	itely weathered,	highly fractured I	light grey	ish amygda l oida	al BASAI	LT												<u> </u>			╈
	-13,4	0 -14.90					19	7	Nil		27																								
11																																			
12																																			
	Ⅲ -14.9	0 -16.40					17	Nil	Ni		0.7																								
13																																			
		0 _17.90					21	3	Nil	īV	2																								
14							21	Ũ			2																								
15																																			
	-17.9	0 -19.40					39	28	8	IV	4.7																								
16																																			
n	-19.4	0 -20.90					36	2	Nil	N	>10												1												
17	₩																						1												
																							1												
18																							1												
	-20.9	0 -22.40					49	42	17		4.7		-20.90	Moderately stro	ong, moderately	weathered, mod	derately fr	actured reddish	n amygdi	loidal BASA	_T														
19	1																						1												
	-22.4	0 -23.90	1				47	32	19	ш	6												1												
20 bbre	viations	& Symbol																																	
]- s	PT - U	DS N - DS	WL	- Liq	uid Lir	nit	I _P	- Pla	sticity	Index	N	IC -	Moist	ure Content	SBI	C.D. Chart Dat L : Sea Bed Le	tum, T.D evel, EG).:Terminati GL:Existing(ion Dep Ground	pth, MSL : d Level, R	Mean Sea .L. : Reduce	Level ed Lev	vel							Pre	epare	ed By :	V.N.		
	ck Recove	<u>гу</u> [] - N	Recovery	y T	CR -	Total	Core R	ecove	ry	SCR	- Soli	d Cor	e Reco	very RQD) - Rock Qua	ality Designation	ion	 	Weathe	ering Grad	e F.I. Frac	tural I	ndex		ī					Cł An	heck	ed By	: S.D.		
2) - Fi	eld Vane SI	near 🌒 - Sa	mple Slipp	ped	· · ·		•		-											U										LAP	100	сч Бу 			





											BOREHOLE NO. : BH-03														
Geotech C	ontract	or: IDE	AL GEOSE	RVICES	S PVT	LTD			Job	No. :	DEAL/028/015 CLIENT :	NT/		Co	NCII	17/	NI	21			Sł	HEET	03	of 0	3
Project : G	ieologi	al Surv	ey for the	Prepar	atory	Surv	ey or	n the	Proj	ect fo	Construction of Mumbai Trans Harbour Link	onsult	ing f	or Sust	ainable	Dev	elopr	ment	┟		W	ATER 1	TABL	E	—
T.D. (m)	:	-28.40 C	D SBL (m)		:	-2.90	CD				Equipment Record : AQUA STAR - JACKUP BARGE									Date	Т	Time	э 🛛	M	trs.
Date Commer	nced :	11-07-20	15 Circulation	Fluid	:	Sea W	later				Type of Rig : Hydraulic Rig								ľ	11-07-201/	5	10,35 AI	м	6	.00
Date Complet	ed :	16-07-20	15 Drilling Orie	entation	:	Vertic	al				Details of Casing (mm) : SX / HX / NX								Ī						
											Core-Diameter (mm) : 54.10														
Co- Ordinate	s E:	286953.	00	N :	2100	893.00)		1	T						1					\perp				
Sampling	Details	Standar Te	d Penetration st (SPT)		Details	of Roc	k core	•	<u> </u>	w.r.t.(CD)	Details of Stratum	ion (USC)		Grain S Analysi	Size is (%)	Con Li	isiste mits (ncy (%)	Stren (ıgth Test [kPa)	t c	Consolic	lation	Test	ks
			<u> </u>		1			1	ymbe	í m		lificat				(]w	(wp)	<u>}</u>	ucs		idatio	lre	sion (c)	bid	emar
ଅଧିFrom ≿ (m)	To (m)	150	450	TCR %	SCR %	RQD %	W.G	F.I.	S	Depth in	Strata Description	Soil Clasi	GRAVE	SAND	SILT CLAY	LIQUID (PLASTIC	PLASTIC	ບັ	ຸອຸ ອີ່ນ ເ	× * PreConsoli	n Pressu (kPa)	Commpres Index (C	Initial Vo Ratio (e	- W
20											Moderately strong, moderately weathered, moderately fractured reddish amygdloidal BASALT														
- 21	-25.40			94	94	80	п	4.7		-23.90	Strong, fresh, slightly fractured greyish BASALT														
22																									
_ 23	-26.90			83	80	59		6.7																	
_ 24																									
-26,90	-28.40			100	100	86	Ш	4.7																	
_ 25																									
																				_	-				-
_ 26											BOREHOLE TERMINATED AT -28.40 (m) BELOW CD														
27																									
28																									
				1																					
_ 29				1																					
– 30 Abbreviations 3	& Symbols	∎ :		1	1						C.D. Chart Datum T.D Termination Donth MCL - Mean Sec							ш							<u> </u>
- SPT - UD	s 💽 - DS	W _L - L	iquid Limit.	I _P	- Pla	sticity	Index	N	IC -	Moist	re Content SBL : Sea Bed Level, EGL : Existing Ground Level, R.L. : Reduc	ed Le	evel							Prep	parec	ן By: ۱	V.N.		
- Rock Recover	y 🚺 - No	Recovery	TCR - Tota	I Core R	ecover	ry	SCR	- Soli	d Cor	e Reco	ery RQD - Rock Quality Designation W.I Weathering Grade F.I. Frac	tural	Inde	ex						App	prove	ч ву:s ed By::	э.р. S.T.		
🔕 - Field Vane Sh	ear 🌒 - Sa	nple Slipped																						1	




															BOREHOLE NO. : BH-04			_		
Ģ	eote	ech C	ontract	or:I	DEAL	_ GEO	DSER	VICES	S PVT	LTC).		Job	No. :	DEAL/028/015 CLIENT :	CONCULTAN	-		SHEET 01	l of 03
F	roje	ect : G	ieologi	cal S	urvey	for	the P	repar	atory	Surv	vey o	n the	e Proj	ject fo	r Construction of Mumbai Trans Harbour Link	for Sustainable Developr	13 nent			
т	D. (n	n)	:	-31.8	5 CD	SBL (m)		:	-5.60	CD				Equipment Record : AQUA STAR - JACKUP BARGE			Date	Time	Mtrs
D	ate C	ommen	iced :	22-06	6-2015	Circu	lation F	luid	:	Sea \	Nater				Type of Rig Hydraulic Rig			26-06-2015	10.20 AM	7.50
D	ate C	complete	ed :	27-06	6-2015	Drillin	g Orie	ntation	:	Verti	cal				Details of Casing (mm) : SX / HX / NX				<u> </u>	
	n- 0	rdinate	s F·	2868	346.00			N·	2100	932.0	0				Core-Diameter (mm) : 54.10					
		Taniato	<u> </u>								-				ତା <i>।</i>	Grain Siza Consistor	an Str	nath Tost		<u> </u>
	San	npling (Details	Stan	ndard F Test	Penetra (SPT)	ation		Details	of Ro	ck cor	е	_	Ê	Details of Stratum	Analysis (%) Limits (%	%)	(kPa)	Consolidation	n Test
		1			1	1	<u><u> </u></u>				1	1	ymbo	oth in		(LC:	UU CU	idatio ire ire sion Cc)	i i o
	ТҮРЕ	From (m)	To (m)	150	300	450	"N" VALL	TCR %	SCR %	RQD %	N.G	E.I.	S	Dep	Strata Description	SAND SILT SILT CLAY CLAY PLASTIC		ຸ ສຸ ອີ່ນ	PreConsoli n Pressu (kPa) Commpres	Initial Vo Ratio (6
	0	-5.60	-6.10				_							-5.60	Very loose, dark grey, clayey SAND SC 5	53 25 17 36 24	12			
(1)	1																			
2-97 -	2	-8.60	-7.55	U	U	1	1							-7.10		23 38 39 47 26	21			L
	5	-10.10	-10.55	5	11	18	29							-10.10	Medium dense, yellowish grey, clayey SAND with gravel SC 11	1 52 20 17 49 27	22			5
-	6 	-11.60	-12.05	8	13	19	32							-11.60	Hard, yellowish grey CLAY with sand and gravels CH 13	3 15 22 50 58 27	31			
_	В	-13.10	-13.55	23	24	34	58							-13.10	Very dense, yellowish brown, silty SAND SM 3	76 14 7 - NP	-			
$\left \right $	9	-14.60	-14.87	18	55 blows/ 12cm		>100						•••	-14.60	Very dense, yellowish brown,gravelly SAND with silt SP 39	9 51 10 - NP	-			
	bbrev - SP1 - Roc	tiations &	& Symbol s	B : WL Recover	- Liqu	uid Lir CR	nit Total	I _P Core R	- Pla:	sticity ry	Index SCR	N - Sol	MC - lid Cor	- Moist re Recc	C.D. Chart Datum, T.D. : Termination Depth, MSL : Mean Sea Level SBL : Sea Bed Level, EGL : Existing Ground Level, R.L. : Reduced Level rery RQD - Rock Quality Designation W.I Weathering Grade F.I. Fractural Index	×x		Prep Che Appr	ared By: V.N. cked By:S.D. oved By:S.T.	





																BOREF	HOLE NO	О.:В	H-04															
	Geot	ech Co	ntract	or:IC	EAL	GEC	SER	VICES	S PVT	. LTD	-		Job	No. :	IDEAL/028/0)15			CLIENT	· Ø		ΤΔΙ	C	ON	SIII	TAN	ZTI				SHEET	02 (of 03	
	Proje	ect : Ge	ologi	ca l Su	rvey	for t	he P	repar	atory	Surv	ey o	n the	Proj	ect fo	or Construct	tion of Mu	mbai Trans	s Harbo	ur Link	ORICONSUL	Global Con	sulting	for S	ustair	able D	levelo	pment	i				TADI	_	
	T.D. (r	n)		-31.85	СD	SBL (r	m)			-5.60	CD				Equipment Re		:	AQI											Dat	te	Tim	IABL	Mtr	s.
) Date (Commenc	ed ·	22-06-	2015	Circula	tion F	luid		Sea V	Vater				Type of Rig	,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	:	Hyd	raulic Rig									ŀ	26-06-2	2015	10.20	AM	7.50	0
	Date 0	Completed	d :	27-06-	2015	Drilling	g Orier	ntation		Vertic	al				Details of Cas	sing (mm)	:	SX	/ HX / NX									ļ						
															Core-Diamete	ər (mm)	:	54.1	10															
	Co- C	Ordinates	Ε:	28684	6.00			N :	2100	932.00)		r	1																$ \rightarrow$				
	Sar	npling D	etails	Stand	lard P Test (enetra (SPT)	ation		Details	of Roc	k core	9	-	(m)			Deta	ails of Str	atum			ion (USC)	Gra Ana	in Siz lysis (e (%)	Consis Limit	tency ≩ (%)	Strer	ıgth Te (kPa)	əst	Consol	idation	Test	ks
		1					<u><u></u></u>		1	1	1	1	symbo	oth in								iificat				([¬] M	È ĵª			CU	idatio ure	ssion Sc)	oid ()	emar
	ТҮРЕ	From (m)	To (m)	150	300	450	"N" VALI	TCR %	SCR %	RQD %	N.G	E.I.	0	Der			Stra	ata Descrij	ption			Soil Clasi	GRAVE	SILT	CLAY		PLASTIC INDEX (ບື	¢,	c', ¢ '	PreConsoli n Pressu (kPa)	Commpres Index (C	Initial Vo Ratio (E	Å
	10					55									Very dense, ye	lowish brown,gr	avelly SAND wit	th si l t									-					-		
\uparrow		-16.10	-16.45	25	28	5cm	>100															SP	37 5	5	8	- NF	· _							
寸録3-	- 11	-16.10	-17.60					25	12	-	V	>10		-16.10	0 Very weak, high	ily weathered, hi	ighly fractured, g	greyish BAS	SALT															
28	- 12	-17.60	-18.10					19	12	_	v	>10																						
	_ 13	-18.10	-19.60					45	32	8	IV	>10																						
	_ 14	Π																																
	_ 15	-19.60	-21,10					55	30	8	IV	>10																						
	_ 16	-21.10	-22.60					67	57	7	IV	>10																						
	17																																	
	18	-22.60	-24.10					90	60	29	IV	>10		-22.60	0 Moderately stro	ng, moderately v	weathered, mode	lerately fract	tured reddish am	nygdaloidal BASAL	.T													
	_ 19	-24.10	-25.60					77	52	-	V	>10																						
	Abbrev	viations &	Symbols									I	M3030303	3		c	.D. Chart Dat	um, T.D. :	Termination	Depth, MSL : N	/lean Sea Le	evel			<u> </u>			<u>ı </u>						4
	<u> </u>	T J- UDS	- DS	W _L .	• Liqu	id Lin	nit	I _P	- Plas	sticity	Index	N	IC -	Moist	ture Content	SBL	. : Sea Bed Le	evel, EGL	: Existing Gro	ound Level, R.L	. : Reduced	Leve							Pr C	epare Sheck	ed By : ked By :	V.N. S.D.		
	- Roc	ck Recovery	No - No	Recovery		CR -	Total	Core R	ecover	У	SCR	- Sol	id Cor	e Reco	overy RQD	- Rock Qual	ity Designatio	on	W.I Wea	athering Grade	F.I. Fractu	ral Inc	lex						Aŗ	prov	/ed By :	S.T.		
	W-Fiel	iu vane Shea	r ♥ - Sa	mpie Slippe	ed																											_		





Geotech Contractor : IDEAL GEOSERVICES PVT. LTD. Job No. : IDEAL/028/015 CLIENT : State Construction of Numbai Trans Harbour Link State 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 Image: Consulting for Sustainable Development WATER TABLE T.D. (m) : 34.85 CD SBL (m) : 4.560 CD Equipment Record : AQUA STAR - JACKUP BARGE Time Date Time Mit Date Completed : 22.06-2015 Circulation Fluid : Sea Water Equipment Record : AQUA STAR - JACKUP BARGE Time Time Time Mit Date Completed : 22.06-2015 Drilling Orientation : Vertical Details of Casing (mm) : SX / HX / NX Tom Tom <td< th=""></td<>
Project : Geological Survey for the Preparatory Survey on the Project for Construction of Mumbai Trans Harbour Link Coldad Consulting for Sustainable Development WATER TABLE T.D. (m) : -31.85 CD SBL (m) : -5.60 CD Equipment Record : AQUA STAR - JACKUP BARGE Date Date Time Mit Date Commenced : 22.06-2015 Circulation Fluid : Sea Water Type of Rig : Hydraulic Rig Details of Casing (mm) : SX / HX / NX : 10:00 Mit : 20:00-000 : : 0:000-000 : : 0:000-000 : : 0:000-000 : : 0:000-000 : : 0:000-000 : : : 0:000-000 : : 0:000-000 : : : : : : </td
T.D. (m) : -31.85 CD SBL (m) : -5.60 CD Equipment Record : AQUA STAR - JACKUP BARGE Date Date Date Date Completed : 22.06-2015 Circulation Fluid : Sea Water Equipment Record : AQUA STAR - JACKUP BARGE Date Date Time Mit Mit Date Completed : 22.06-2015 Circulation Fluid : Sea Water Equipment Record : AQUA STAR - JACKUP BARGE Date Mit Mit 20.00000000000000000000000000000000000
Date Commenced: 22.06.2015 Circulation Fluid: : Sea Water The of Rig : Hydraullc Rig Date Completed: : 27.06.2015 Dirilling Orientation: Vertical Details of Casing (mm) : SX / HX / NX :
Date Completed 2 7-06-2016 Drilling Orientation : Vertical Details of Casing (mm) : SX / HX / NX
Co- Ordinates E: 286846.00 N: 2100932.00 Consolidation Consolidation<
Sampling Details Standard Penetration Test (SPT) Details of Rock core peretration Standard Penetration S
V V
H From (m) To (m) Q <
20 -27.10 -27.10 -28.60 -27.10 -28.60 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
-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 1
30.10 -31.60 III >10 III >10
_26
27 BOREHOLE TERMINATED DEPTH AT -31.80 (m)
29
C.D. Chart Datum, T.D. : Termination Depth, MSL : Mean Sea Level Sea Sea Level Sea Sea Level, SEL : Sea Bed Level, EGL : Existing Ground Level, R.L. : Reduced Level Sea Sea Level Sea Sea Level, SEL : Sea Bed Level, Sea Sea Level Sea Sea Sea Level Sea Sea Sea Level Sea Sea Sea Sea Sea Level Sea Sea Sea Sea Sea Sea Sea Sea Sea
Approved By : S.T.





													BOREHOLE NO. : BH-05		_				
Geote	ech Co	ntracto	or: IC	DEAL	GEOSE	RVIC	ES PV	T. LTI).		Job	No. :	EAL/028/015 CLIENT :	C			SHEET	01 of	03
Proje	ct : Ge	ologio	al Su	ırvey	for the	Prepa	arator	y Sur	vey o	n the	Proj	ect fo	Construction of Mumbai Trans Harbour Link	ant					
T.D. (m	1)		-25.34	CD	SBL (m)			-3 10							Dat	e	Time		Mtrs.
Date C	ommenc	ed ·	13-06-	2015	Circulatio	n Fluid		Seal	Water				vne of Rig		13-06-20	015	10 30 AM	-	7.00
Date C	ompleted	d :	16-06-	2015	Drilling O	rientatio	n :	Verti	cal				etails of Casing (mm) : SX / HX / NX		13-00-20	10	10.00 AM		1.00
													ore-Diameter (mm) : 54.10						
Co- O	rdinates	Ε:	28728	32.00		Ν	: 210	0749.0	0										
Sam	pling D	etails	Stand	dard Po Test (enetratio SPT)	n	Detail	s of Ro	ck core	e		v.r.t.(CD)	Details of Stratum	y Stre	ingth Te⊧ (kPa)	⊭st	Consolidat	tion Te:	st
					<u> </u>	_					ymbo	^ (L)	۲۵ او	<u>_</u> ucs		<u> </u>	datio re sion	id C)	°) mar
ТҮРЕ	From (m)	To (m)	150	300	450 "N" VALL	TCR %	SCR %	RQD %	N.G	E.I.	s	Depth in	Strata Description Strata Description Strata Description	C	¢ C	а, с. а	PreConsoli n Pressu (kPa) Commpres	Index (C Initial Vo	Ratio (e Re
0	-3.10	-3.60			-							-3.10	ery soft, greyish sandy CLAY with gravels CL 7 43 28 22 42 22 2	D		-+'			
- 1 - 2 - 3	-4.60	-5.05	50																
_ 4	-6.10	-6.20	10cm	-	- >1	00						-6.10	ery dense, greyish silty SAND with gravels SM 6 67 22 5 - NP ·						
_ 5	-7.60	-8.05											SM 6 68 21 5 - NP .						
6 7	-9.10	-9.35	45	50 blows/ 10cm	- >1	00							SP 19 73 8 - NP -						
_ 8	-10.60	-10.83	35	50 blows/ 8cm	- >1	00					;; ;;	-10.60	ery dense, brownish sandy GRAVELS GP 56 43 1 - NP						
_ 9 _ 10	-12.10	-12.55	42	50	52 >1	00							with silt GC 40 27 28 5 32 20 1	2					
Abbrev	ations &	Symbols	:		1		•					-	C.D. Chart Datum, T.D. : Termination Depth, MSL : Mean Sea Level				<u>`</u>		
SPT	UDS	- DS	WL	- Liqu	id Limit	I _P	- P	asticity	/ Index	N	IC -	Moist	Content SBL : Sea Bed Level, EGL : Existing Ground Level, R.L. : Reduced Level		Pre Ci	epare heck	∋d By: V.N (ed By:S.I	ч. D.	
	Recovery	<u> </u>	Recovery		R - Tol	al Core	Recov	ery	SCR	- Sol	d Cor	e Recc	y ROCK Quality Designation W.I Weathering Grade F.I. Fractural Index		Ар	prov	ed By : S.T	г.	
🛛 - Field	l Vane Shea	r 🛡 - Sai	nple Slipp	ed															





				BOREHOLE NO. : BH-05					
Geotech Contract	or: IDEAL GEOSE	RVICES PVT. LTD.	Job No. :	DEAL/028/015 CLIENT :	ENTAL CONSI	TANTS		SHEET 02	of 03
Project : Geologi	cal Survey for the I	Preparatory Survey on th	he Project fo	r Construction of Mumbai Trans Harbour Link	Consulting for Sustainab	le Development			IF
T.D. (m) :	-25.34 CD SBL (m)	: -3.10 CD		Equipment Record : AQUA STAR - JACKUP BARGE			Date	Time	Mtrs.
Date Commenced	13-06-2015 Circulation	Fluid : Sea Water		Type of Rig : Hydraulic Rig			13-06-2015	10,30 AM	7.00
Date Completed :	16-06-2015 Drilling Orie	entation : Vertical		Details of Casing (mm) : SX / HX / NX					
				Core-Diameter (mm) : 54.10					
Co- Ordinates E :	287282.00	N: 2100749.00			- T - T				
Sampling Details	Standard Penetration Test (SPT)	Details of Rock core	ol wr.t.(CD)	Details of Stratum	ວິ ດີ ດີ ດາalysis (%)	Consistency Limits (%)	Strength Test (kPa)	Consolidation	n Test
			- my (m)			(⁻ ⁻ ⁻ / ₋		idatio ire ire sion	oid emar
₩ From (m) To (m)	150 300 450 "N" VALL	TCR % SCR % RQD % W.G	Depth in S	Strata Description	Soil Clasi GRAVE SAND SILT	LIQUID (PLASTIC PLASTIC INDEX (ບ ຈີ -ຈີ	PreConsol n Pressu (kPa) Commpres Index (C	Initial Vo Ratio (6 Re
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	7 41 22 19			
_ 12	56								
15.10 -15.22 13	blows/ >100 12cm		-15.10	Very dense, brownish, fine to medium SAND	SP 0 90 10	- NP -			
-16.60 -16.68	60 >100		10 000000 10 00	Vacuusak ta waak hisblu ta asmalatah waatharad raddiah ta araviah RASALT	SM 2 78 14 6	6 - NP -			
_ 14	8cm		-16.60						
_ 15		67 54 8 IV >1	10						
_ 16									
_ 17		100 100 53 IV >1	10 -19.60	Weak to moderately strong moderately weathered, horizontal fractured, greyish amygdaloidal BASALT					
- 18 -21.10 -22.60		100 95 52 III >1	10						
_ 19			-						
- 20		100 100 55 6.	./						
Abbreviations & Symbol	s: W Liquid Limit	I - Plasticity Index	MC - Moist	C.D. Chart Datum, T.D. : Termination Depth, MSL : Mean Se	a Level		Prepa	ared By : VN]
- Rock Recovery	o Recovery	I Core Recovery SCR - S	Solid Core Reco	rerv RQD - Rock Quality Designation W.I Weathering Grade FI Fra	actural Index		Chec	ked By : S.D.	
- Field Vane Shear 🌒 - Sa	ample Slipped						Appro	ууец Ву : S.T.	





														BOREHOLE NO. : BH-05						
Geo	otech C	ontract	or:IC	DEAL	GEC	DSER	VICES	S PVT	LTD).		Job	No. :	AL/028/015 CLIENT : ORIENTAL CONSULTANT	2			SHEET	03 of	f 03
Pro	ject : G	ieologi	cal Su	urvey	/ for t	the P	repar	atory	Surv	vey o	n the	Proj	ect f	onstruction of Mumbai Trans Harbour Link Global Consulting for Sustainable Developm	nent	\vdash	v	NATER T	ABLE	
T.D.	(m)	:	-25.34	CD	SBL (m)		:	-3.10	CD				uipment Record AQUA STAR - JACKUP BARGE		D	ate	Time	;	Mtrs.
Date	Commer	iced :	13-06-	2015	Circul	ation F	luid	:	Sea V	Vater				pe of Rig : Hydraulic Rig		13-0	6-2015	10.30 AN	4	7.00
Date	Complet	ed :	16-06-	-2015	Drillin	g Orier	ntation	:	Vertic	al				tails of Casing (mm) : SX / HX / NX						
														re-Diameter (mm) : 54.10						
Co-	Ordinate	s E:	28728	82.00			N :	2100	749.00	0		<u> </u>	1							<u> </u>
s	ampling	Details	Stand	dard F Test	Penetra (SPT)	ation	C	Details	of Roc	ck core	9	<u>-</u>	w.r.t.(CD)	Details of Stratum	ıcy St %)	trength (kPa	Test)	Consolid	ation Te	est v
			+			۳		1		1	1	ymb	Ű.		≟≘	<u>s uu</u>	CU	idatio	ssion Sc) Sc)	emar
	Harrom Lapha (m)	To (m)	150	300	450	"N" VALI	TCR %	SCR %	RQD %	N.G	E.	0,	Depth in	Strata Description		ງ ວິ	с',ф	PreConsol n Press (kPa)	Commpres Index (C Initial Vo	Ratio (6
20														ak to moderately strong moderately weathered, horizontal fractured, greyish amygdaloidal BASALT					-	
- 21		05.00	-																	
ル ン レ ン – 22	-24.10	-25.30					96	88	23		>10		-24.1	terately strong, signuy weathered, greyish bASAL1						
_ 23													3	BOREHOLE TERMINATED AT -25.30 (m) BELOW CD						
_ 25																				
_ 26																				
_ 27																				
_ 28																				
_ 29																				
- 30																				
Abbr	eviations SPT - UC Rock Recover	8. Symbol: s N- Ds v N - N	S : W _L Recovery	- Liqu	uid Lin CR -	nit Total	I _P Core R	- Pla: ecover	sticity ry	Index SCR	1 - Sol	/IC - id Cor	Mois e Rec	C.D. Chart Datum, T.D. : Termination Depth, MSL : Mean Sea Level SBL : Sea Bed Level, EGL : Existing Ground Level, R.L. : Reduced Level RQD - Rock Quality Designation W.I Weathering Grade F.I. Fractural Index		I	Prepar Chec	red By: V ked By: S	/.N. 3.D.	
8-1	ield Vane Sh	ear 🌒 - Sa	mple Slipp	ped																





Geotech Contract	or: IDEAL GEOSER	VICES PVT. LTD.	BOREHOLE NO. : BH-00 Job No. : IDEAL/028/015 CL	5 JENT :	SHEET 01 of 03
Project : Geologi	cal Survey for the P	reparatory Survey on the	Project for Construction of Mumbai Trans Harbour Li		
	22.44.CD			Global Consulting for Sustainable Development	WATER TABLE
D. (III)	14 06 2015 Circulation E	: 0.09 CD	Equipment Record AQUA ST	AR - JACKUP BARGE Rig	
Date Completed :	12-06-2015 Drilling Orier	ntation : Vertical	Details of Casing (mm) SX/HX/I	NX	11-06-2015 9.30 AM 3.00
			Core-Diameter (mm) : 54.10		
o- Ordinates E:	288918.00	N: 2099540.00			
Sampling Details	Standard Penetration Test (SPT)	Details of Rock core	Details of Stratum	S Grain Size Consistency S O Analysis (%) Limits (%)	trength Test (kPa) Consolidation Test
			(u) / (u)		CS UD UD UD UD CO
H From ├ (m) To (m)	150 300 450 "N" VALL	TCR % SCR % RQD % W.G	の デ デ の の の の の の の の の の の の の	Soil Clasi Soil Clasi GRAVE SAND SAND SAND CLAY CLAY CLAY CLAY CLAY	Cu c,+ c,+ c,+ c,+ c,+ c,+ c,+ c,+ c,+ c,+
0 0.09 -0.41			0.09 Loose, greyish SAND with shells	SP 2 98 0 - NP 0	
1 -1.41 -1.86 2 -2.91 -3.36 4 -4.41 -4.86	14 24 32 56 7 24 $\frac{52}{8 cm}$ >100		-2,91 Very dense, greenish grey silty SAND	SM 0 65 30 5 44 27 17 SP 0 97 3 - NP -	UD Slij ec
65.916.30 7	12 45 ⁵⁴ 9cm >100			SM 0 85 15 - NP -	
8 -7.41 -7.51 8 -7.41 -8.91	50 blows/ - >100 10cm	20 Nil Nil V >10	-with gravels -7.41 Very weak, highly weathered, light brownish BASALT	SM 14 71 15 - NP -	
9 -8.91 -10.41		11 Nil Nil IV 4			
	PRECOVERY	I _P - Plasticity Index M Core Recovery SCR - Soli	C - Moisture Content C - Moist	ination Depth, MSL : Mean Sea Level ing Ground Level, R.L. : Reduced Level I Weathering Grade F.I. Fractural Index	Prepared By : V.N. Checked By : S.D. Approved By : S.T.
- Field Vane Shear 🌒 - Sa	mpie Supped				Plate A1





Geodes Contractor: J: DEAL GEOSERVICES PVT, LTD. Job No. : DEAL/GEOSITIO CLEINT: CONTRACTOR: : DEAL/GEOSITIO SPEET 0.0 of 0.3 Project: : Geodogical Survey for the Preparatory Survey on the Project for Construction of Mumbal Tana Harbour Link CPEET 0.0 of 0.3 SPEET 0.0 of 0.3 Date Contractor: : 1.004.0000 Giobalcon Fuid : Source Vertex Sectory Survey on the Project for Construction of Mumbal Tana Harbour Link CPEET 0.0 of 0.3 Date Contractor: : 1.004.0000 Giobalcon Fuid : Source Vertex The project for 0.000000 Structure Fig Model Structure Fig Mode											BOREHOLE NO. : BH-06														
Project: Goological Survey for the Project for Construction of Mumbal Trans Harbour Link Project for Goological Survey for the Project for Construction of Mumbal Trans Harbour Link Project for Goological Survey for the Project for Construction of Mumbal Trans Harbour Link Project for Goological Survey for the Project for Construction of Mumbal Trans Harbour Link Project for Goological Survey for the Project for Construction of Mumbal Trans Harbour Link Project for Goological Survey for the Project for Construction of Mumbal Trans Harbour Link Project for Goological Survey for the Project for Construction of Mumbal Trans Harbour Link Project for Goological Survey for the Project for Construction of Mumbal Trans Harbour Link Project for Goological Survey for the Project for Construction of Mumbal Trans Harbour Link Project for Goological Survey for the Project for Construction of Mumbal Trans Harbour Link Project for Goological Survey for the Project for Construction of Mumbal Trans Harbour Link Project for Goological Survey for Harbour Link Project for Construction For Harbour L	Geotech Contrac	tor : IDEAL	GEOSE	RVICES	S PVT.	LTD.			Job	No. :	DEAL/028/015 CLIENT :	MT		Co	DNC		AN	PTI				SHEET	. 02	of 0:	3
Dur(h) : 242100 Status Date Time Mus. Date Comments : 1106.0016 Scalaborn FLid : 8ea Water Scalaborn FLid : 9ea Water : 9ea Water <td>Project : Geolog</td> <td>ical Survey</td> <td>for the F</td> <td>Prepara</td> <td>atory</td> <td>Surve</td> <td>ey or</td> <td>the</td> <td>Proje</td> <td>ect fo</td> <td>Construction of Mumbai Trans Harbour Link</td> <td>onsult</td> <td>ing f</td> <td>or Su</td> <td>Istainat</td> <td>ole De</td> <td>evelo</td> <td>pment</td> <td>£</td> <td>┣—</td> <td><u> </u></td> <td>NATER</td> <td></td> <td>LE</td> <td></td>	Project : Geolog	ica l Survey	for the F	Prepara	atory	Surve	ey or	the	Proje	ect fo	Construction of Mumbai Trans Harbour Link	onsult	ing f	or Su	Istainat	ole De	evelo	pment	£	┣—	<u> </u>	NATER		LE	
Date Comparison 11.146.010 Stratubor Fuki is service Very et Pip Migraf Pip Mig	T.D. (m) :	-22.11 CD	SBL (m)		:	0.09	CD				Equipment Record : AQUA STAR - JACKUP BARGE									Da	ite	Tin	ne	Mt	rs.
Date Complexit 1 204-2015 Disting Orientation Y Windle Date Complexit Y Windle Y W	Date Commenced :	11-06-2015	Circulation	Fluid	:	Sea W	ater				Type of Rig : Hydraulic Rig									11-06	2015	9.30	АМ	3.0	00
Verte Verte <th< td=""><td>Date Completed :</td><td>12-06-2015</td><td>Drilling Orie</td><td>entation</td><td>:</td><td>Vertica</td><td>al</td><td></td><td></td><td></td><td>Details of Casing (mm) : SX / HX / NX</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></th<>	Date Completed :	12-06-2015	Drilling Orie	entation	:	Vertica	al				Details of Casing (mm) : SX / HX / NX														
Co-D Carlination E: 28881400 N: 288944.00 N: 288944.00 N: 288944.00 N: 288944.00 N: Co-D Carlination Text Operation Text Operatif text Operatif text											Core-Diameter (mm) : 54.10														
	Co- Ordinates E:	288918.00		N :	20995	540.00							-								\rightarrow				—
V V	Sampling Details	Standard P Test (enetration (SPT)		Details o	of Roci	k core		0	w.r.t.(CD)	Details of Stratum	(JISC)		Grai Analy	n Size /sis (%)	с	onsis Limit	stency s (%)	Stre	ngth T (kPa)	'est	Conso	lidation	n Test	ks
# From To (m) 9 9 9 1			<u> </u>		1	I			Symb	(m) r		lifica				3	(dw)	: L:@	ucs	UU	CU	lidatic ure	ssion Cc)	e ^o)	emai
10 -1	≝ From È (m) To (m	300 150 (450 "N" VAL	TCR %	SCR %	RQD %	W.G	F.I.		Depth i	Strata Description	Soil Clas	CERAVI	SAN	SILT		PLASTIC	PLASTIC	ບື	¢,5	. е .0	PreConsol n Press (kPa	Commpre Index (Initial V Ratio (L C
-14 -	10										Very weak, highly weathered, light brownish BASALT											.=			
- 14 - 14 - 13 - 14 -	-10.41 -11.9			23	Nil	Nil	IV	>10																	
12 1.13 1.34 1.44 1.34 1.44 1.34 1.44 <	- 11																								
12 11.91 13.41 13.41 13.41 14.34 14.4																									
13 13.41 14.91 14.91 14.91 14.91 16.41 14.91 16.41 17.91 100 07 44 11 >10 13.44 Weak to moderately strong, highly to moderately weathered, highly fractured, brownish grey BASALT 100 100 100 11 10.0 100 11 10.0 10.0 11 11.0 10.0 16.41 11.0 100 100 11 10.0 100 11 10.0 10.0 11.0 10.0 11.0 10.0 11.0 10.0 11.0 10.0 11.0 10.0 10.0 11.0 10.0 <t< td=""><td>- 12 -11.91 -13.4⁻</td><td></td><td></td><td>40</td><td>Nil</td><td>Nil</td><td>IV</td><td>>10</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></t<>	- 12 -11.91 -13.4 ⁻			40	Nil	Nil	IV	>10																	
0 0 <td< td=""><td>13</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></td<>	13																								
-14 -13.41 -13.41 -13.41 -13.41 -13.41 -13.41 -13.41 -13.41 -13.41 Weak to moderately strong, highly to moderately weathered, highly fractured, brownish grey BASALT		_																							
Interview weighting is symbol: Interview weightis symbol: Interview weightin the symbol: Interview we	_ 14			51	33	20	Ш	>10		-13.41	Weak to moderately strong, highly to moderately weathered, highly fractured, brownish grey BASALT														
- 14.91 - 16.41 - 17.91 - 19.41 - 20.91 - 20.41 - 20.91																									
-14.91 -16.41 -16.41 -17.91 -16.41 -17.91 -16.41 -17.91 -16.41 -17.91 -16.41 -17.91 -17.91 -19.41 -19.41 -20.91 -19.41 -20.91 -10.41	_ 15																								
- 16 - 17.91 - 19.41 - 17.91 - 19.41 - 17.91 - 19.41 - 17.91 - 19.41 - 19.41 - 100 71 - 11 - 16.41 Moderately strong, moderately weathered, reddish brown, amygdaloidal BASALT - 17.91 - 19.41	-14.91 -16.4			100	67	44	Ш	>10																	
In the state of the sta	_ 16																								
- 17 - 18 - 17.91 - 19.41 - 19 - 19 - 19.41 - 20.91 - 100 100 76 III 5.3 - 20 - 20 - 19.41 - 20.91 - 100 100 76 III 5.3 - 20 - 20 - 19.41 - 20.91 - 100 100 76 III 5.3 - 20 - 20 - 20 - 19.41 - 20.91 - 100 100 76 III 5.3 - 20 - 20 - 20 - 20 - 20 - 19.41 - 20.91 - 100 100 76 III 5.3 - 20 - 2	-16.41 -17.9 [.]	_		100	100	71	Ш	6.7		-16.41	Moderately strong, moderately weathered, reddish brown, amygdaloidal BASALT														
- 18 - 17.91 - 19.41 - 19 - 19.41 - 20.91 - 19.41 - 20.91 - 19.41 - 20.91 - 100 100 76 III 5.3 - 100 - 100 - 100 76 III 5.3 - 100 - 100 - 100 76 III 5.3 - 100 - 100 - 100 - 100 76 III 5.3 - 100 - 10	_ 17																								
-18 -17.91 -19.41 -19.41 -19.41 -20.91 IV >10 100 100 76 III 5.3 -19 -19.41 -20.91 IV >100 100 76 III 5.3 IIII 5.3 IIIII 5.3 IIII 5.3 IIII 5.3 IIIII 5.3 IIIIII 5.3 IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII																									
- 19 - 19,41 - 20,91 - 19,41 - 20,91 - 100 100 76 III 5.3 - 100 IIII 5.3 - 100 IIII 5.3 - 100 IIII 5.3 - 100 III 5.3 - 100 III 5	- ¹⁸ -17.91 -19.4 ⁴	-		97	84	47	IV	>10																	
- 20 -19.41 -20.91 -20.91 100 100 76 III 5.3 Abbreviations & Symbols : - 0.9 No Recovery - 0.9 No Recovery - 0.9 No Recovery 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. 0 Field Vane Shear	19																								
- 20 - 20.01	- 19 41 - 20 9	-		100	100	76	ш	5.3																	
Abbreviations & symbols :	- 20																		\square		\square				
Image: Control Contenter Control Control Control Control Contro	Abbreviations & Symbo	w, - Liau	uid Limit	I.	- Plas	ticity I	ndex	M	с -	Moist	C.D. Chart Datum, T.D. : Termination Depth, MSL : Mean Sea	Leve	l vel							F	'repar	red By :	V.N.]	
k → Field Vane Shear ↓ - Sample Slipped	- Rock Recovery	lo Recovery	CR - Tota	I Core Re	ecover	y :	SCR	- Solid	d Core	Reco	ery RQD - Rock Quality Designation W.I Weathering Grade F.I. Frac	tural	Inde	€X							Check	ked By	S.D.		
	🔊 - Field Vane Shear 🌒 - S	ample Slipped												-]										





																BOREHOLE NO. : BH-06															
	Geot	ech Co	ntract	or:ID	EAL	GEOS	ERVIC	ES F	PVT. I	LTD.			Job	No. :	: ID	./028/015 CLIENT :		TAI	1	Co	NS	ULT	AN	TS			s	SHEET	03	of 0	3
	Proje	ect : Ge	ologi	cal Su	rvey	for the	e Prep	arat	ory S	Surv	ey oi	n the	Proj	ect f	for	struction of Mumbai Trans Harbour Link	Global Const	ulting	g for	Sust	tainat	le De	velop	oment			w	ATER	TABL	E	
	T.D. (n Date C Date C	n) Commenc Completer	: ed : 1 ·	-22.11 11-06-: 12-06-:	CD 2015 2015	SBL (m) Circulatio Drilling (on Fluid Drientatio	วท	: 0 : S).09 Sea W /ertic:	CD /ater al				T	ment Record : AQUA STAR - JAC of Rig : Hydraulic Rig s of Casing (mm) : SX / HX / NX	KUP BARGE									Date 11-06-201	<u>)</u> 115	9.30 A	е м	Мt з.	7 S. 20
	Co- 0	rdinates	F ·	28891	8 00		N	• 2	09954	10 00					0	Diameter (mm) : 54.10											+				
ľ	San	npling De	etails	Stand	ard P Test (enetratic SPT)	on	Det	ails of	f Roc	k core)	-	v.r.t.(CD)		Details of Stratum		ion (USC)	C A	Grain : nalys	Size is (%)	Co	onsist .imits	tency 5 (%)	Stre	ngth Tes (kPa)	st	Consoli	idation	Test	\$ S
-	ТҮРЕ	From (m)	To (m)	150	300	450		% 422	SCR %	RQD %	N.G	Ë	Symbo	Depth in (m) v		Strata Description		Soil Clasiificat	GRAVEL	SAND	SILT	LIQUID (ML)	PLASTIC (w _P)	PLASTICITY INDEX (Ip)	UCS ບື	UU C	<u>, U</u>	reConsolidatio n Pressure (kPa)	ommpression Index (Cc)	Initial Void Ratio (e ⁰)	Remar
रे र	20						:								N	ately strong, moderately weathered, reddish brown, amygdaloidal BAS	ALT											<u>e</u>	0		
-録3-35	- 21	-20.91	-22.11				10	00	100	96	111	4																			
-	_ 23													3		BOREHOLE TERMINATED AT -22,11 (m) BELO	W CD														
	_ 24 _ 25																														
-	_ 26																														
-	27																														
	_ 29																														
	- 30 Abbrev	iations & a T - UDS k Recovery d Vane Shear	Symbols	S : W _L -	Liqu TC	id Limit CR - To	I P otal Core	e Rec	Plasti overy	icity I	ndex SCR	- So	IC - id Cor	Mois re Reco	sture	C.D. Chart Datum, T.D. : Termination i SBL : Sea Bed Level, EGL : Existing Gro RQD - Rock Quality Designation W.I Wea	Depth, MSL : Mean Sea Lev und Level, R.L. : Reduced I thering Grade F.I. Fractur	vel Leve ral In	el ndex							Pre Ch App	∋pare heck prov	ed By : (ed By : /ed By :	V.N. S.D. S.T.		











Projec	t: Ge	ological	Survey f	or the Pr	eparatory Trans H Job No. : I	Survey arbour L DEAL/02	on the Pro .ink 28/015	oject for (Construc	tion of M	umbai
				SP	T v/s DEF	РТН [Со	rrected]				
DAT	ΓE : 02/	07/15 to 0	6/07/15		CLIENT: O	riental Co	onsultants		Locati	on : BH-02	
					SF	PT 'N' VAL	UE				
3.00	0	10	20	30	40	50	60	70	80	90	100
		-									
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-23.00											
-25.00		-		H-02 - UNC	CORRECTE	D -	◆ BH-02 -	CORRECT	ED		





Project	: Ge	ological	Survey f	or the Pr	eparatory Trans H lob No. : I	^v Survey arbour L DEAL/02	on the Pro ink 8/015	oject for	Construc	tion of M	umbai			
				SP	Γv/s DEF		rrected]							
DATI	E : 11/0	07/15 to 10	6/07/15		CLIENT : C	riental Co	nsultants		Locat	ion : BH-03				
					SP	T 'N' VALU	JE							
(C	10	20	30	40	50	60	70	80	90	100			
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IDEAL GEOSERVICES PRIVATE LIMITED



APPENDIX-B - SUMMARY OF LABORATORY TEST RESULTS





Project	: Geolo	ogical S	Survey	/ for the Pr	eparato	ry Surv	ey on tł	ne Proje	ect fo	or Co	onst	ruct	ion	of M	umb	oai Tra	ns ⊦	larl	bour	Link	Clien	ıt:	Ø 0	RIENT	TAL (CON	SUL	TANT	S		
Job N	umber	: IDE/	AL/02	8/015																		9	Gic	bal Consu	ulting for	Sustair	nable D	evelopn	nent		
ġ	T (D .		/SPT/		' & MOIST ONTENT	TURE	uo		CLA	SSIFI	CATI	ON 1	EST	s		5	STRE	NG	ТН ТЕ	STS (kPa)	CONS	OLIDATIO	ON TEST			CHE	MICAL	TEST		
OLE - N	TestDe	ptn (m)	pe (D/S DS)	Moisture	Density	(Kg/cm³)	siificati ISC)	vity	At Li	terbe mits(erg %)	P Di	articl stribi	le Siz ution	:e (%)	UCS	υι	J	CU	La	b Shear Vane	ation (kPa)	ssion Cc)	Ratio		Soi	l (%)	-	Wa	iter (m	g/l)
BOREH	From	То	Sample Ty U	Content (%)	Wet	Dry	(L Soil Cla	Sp. Gra	ML	۹W	<u> </u>	Grave	Sand	Silt	Clay	Cu	С	¢	c'	τ _v	τ _{vr}	Pre- Consolid	Commpre Index (Initial Void (e ⁰)	SO3	SO₄	CL	рН	SO4	CL	рН
BH-01	-3.32	-3.82	D/S				СН	2.61	66	27	39	0	8	48	44																
	-4.82	-5.27	SPT				СН	2.60	71	16	55	0	1	52	47																
	-6.32	-6.77	UDS	67	1.60	0.96	СН	2.58	87	38	49	0	2	46	52	16						130	0.619	1.699							
	-7.82	-8.27	SPT				СН	2.61	78	32	46	0	4	72	24					-										·	
	-9.32	-9.77	SPT				СН	2.59	79	32	47	12	2	29	57					-										·	
	-10.82	-11.27	SPT				СН	2.61	82	28	54	8	6	34	52		+-								 						
	-12.32	-12.67	SPT				СН	2.59	79	32	47	25	15	27	33					-		-			†						
	-13.82	-14.22	SPT				СН	2.60	66	32	34	12	14	61	13					-		-			†						
	-15.32	-15.77	SPT				CL	2.61	43	22	21	12	14	42	32		+-								†			<u> </u>		 	
																															
																													 	 	
													 	 						<u> </u>			 	 	 				 		
			PRE	PARED BY :	V.N.							С	HEC	KED	BY :	S.D								APF	PROVE	D BY :	S.T.				





Project	: Geolo	ogical S	urvey	for the Pr	eparato	ry Surv	ey on tl	ne Proje	ect fo	or Co	onst	ruct	ion	of M	umt	oai Tra	ns H	larb	our	Lin	k	Client	: 🤰	0	RIENT	TAL (CON	SUL	TANT	S		
Job N	umber	: IDE/	AL/02	8/015																			0	GIO	bal Consu	liting for	r Sustair	able D	evelopm	ient		
O			SPT/	DENSITY CC	& MOIST	TURE	uo		CLA	SSIFI	CATI	ON 1	EST	s		5	STRE	NGT	гн те	STS	6 (kPa	a)	CONSC	LIDATIC	ON TEST			CHEI	MICAL	TEST		
OLE - N	TestDe	pth (m)	pe (D/S/ DS)	Moisture	Density	(Kg/cm³)	siificati JSC)	vity	At Li	terbe mits(rg %)	P Di	artic strib	le Siz ution	:e (%)	ucs	UU	'	си	ľ	Lab S Va	Shear Ine	ation (kPa)	ssion Cc)	Ratio		Soil	(%)		Wa	ter (m	g/l)
BOREH	From	То	Sample Ty U	Content (%)	Wet	Dry	Cla Soil Cla	Sp. Gra	ML	WP	<u> </u>	Gravel	Sand	Silt	Clay	Cu	C	ф (с' ф	1	τν	τ _{vr}	Pre- Consolid Pressure	Commpre Index (Initial Void (e ⁰)	SO3	SO₄	CL	рН	SO₄	CL	рН
BH-02	-3.04	-3.54	D/S				СН	2.60	58	33	25	0	0	55	45																	
	-4.54	-4.99	SPT				СН	2.61	65	32	33	0	1	50	49																	
	-6.04	-6.49	SPT				СН	2.59	63	29	34	0	1	52	47																	
	-7.54	-7.99	UDS	122	1.60	0.72	СН	2.54	80	36	44	0	1	59	40	4							46	0.851	2.308							
	-9.04	-9.49	SPT				СН	2.57	59	25	24	0	1	79	79 20																	
	-10.54	-10.99	SPT				СН	2.59	59	29	30	0	1	50	49																	
	-12.04	-12.49	SPT				СН	2.60	62	29	33	0	2	52	46																	
	-13.54	-13.99	SPT				СН	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	<u>,</u>	15			1														
			PRE	PARED BY :	V.N.	•						С	HEC	KED	BY :	S.D	· · · ·								APF	ROVE	D BY :	S.T.	·			





Project	: Geol	ogical S	Burvey	y for the Pi	reparato	ory Surv	vey on	the Pro	ject	for C	ons	truc	tion	of I	Mum	bai Tr	ans F	Harb	our	Link	Client		× 0	RIENT	AL (CON	SUL	TANT	S		
Job Nı	umber	: IDE/	AL/02	28/015																		OR	GIO	bal Consu	Iting for	r Sustair	able D	evelopn	ient		
<u>o.</u>			SPT/	DENSITY CC	& MOIST	TURE	uc		CLA	SSIFI	CATI	ON 1	EST	s		5	STREN	IGTH	TES	TS (kP	a)	CONSO		N TEST			CHE	MICAL	TEST		
OLE - N	TestDe	epth (m)	pe (D/S/ DS)	Moisture	Density	(Kg/cm³)	siificatic JSC)	vity	At Li	terbe mits(erg %)	P Di	artic stribi	e Siz ution	ze (%)	UCS	υυ	C	CU	Lab S Vá	Shear ane	ation (kPa)	ssion Cc)	l Ratio		Soil	(%)		Wa	ıter (m	ıg/I)
BOREH	From	То	Sample Ty U	Content (%)	Wet	Dry	ר) Soil Cla	Sp. Gra	ML	WP	4	Grave	Sand	Silt	Clay	Cu	Сф	c'	φ'	τ _v	τ _{vr}	Pre- Consolid Pressure	Commpre Index (Initial Void (e ⁰)	SO₃	SO₄	CL	рН	SO₄	CL	рН
BH-03	-2.90	-3.40	D/S				СН	2.60	62	26	36	0	2	57	41																
·	-4.40	-4.85	SPT				СН	2.60	62	43	19	0	1	57	42																
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Project	: Geolo	ogical S	urvey	for the Pr	eparato	ry Surv	ey on th	ne Proje	ect fo	or Co	onst	ruct	ion	of M	umt	oai Tra	ns H	arb	our	Link		Client	. 3	x 0	RIENT		CON	SUIT	TANT	S		
Job N	umber	: IDE/	4L/02	8/015																			01	GIO	bal Consu	Iting for	Sustair	able D	evelopm	ient		
ö			SPT/	DENSITY C(' & MOIS ⁻ ONTENT	TURE	uc		CLA	SSIFI	CATI	ON 1	EST	S		Ş	STREM	NGT	ТН ТЕ	STS	(kPa)	CONSC	LIDATIC	N TEST			CHE	MICAL	TEST		
IOLE - N	TestDe	pth (m)	pe (D/S/ IDS)	Moisture	Density	(Kg/cm³)	siificatic JSC)	wity	At Li	terbe mits(rg %)	P Di	articl stribu	e Siz ution	:e (%)	UCS	υu		CU	Lá	ab Sl Var	near 1e	ation (kPa)	ssion Cc)	l Ratio		Soil	(%)		Wa	ater (m	g/l)
BOREH	From	То	Sample Ty U	Content (%)	Wet	Dry	Soil Cla (L	Sp. Gra	ML	۸P	<u> </u>	Gravel	Sand	Silt	Clay	Cu	c ¢	,	c'	τ、	v	τ _{vr}	Pre. Consolid Pressure	Commpre Index (Initial Void (e ⁰)	SO3	SO₄	CL	рН	SO₄	CL	рН
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				СН	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	1	0																	
	-16.10	-16.55	SPT				SP	-	-	NP	-	37	55		8																	
			PRE	PARED BY :	V.N.							C	HECI	KED	BY :	S.D									APP	ROVE	D BY :	S.T.		•	•	





Project	: Geolo	ogical S	urvey	for the Pr	eparato	ry Surv	ey on tł	ne Proje	ect fo	or Co	onst	ruct	ion d	of M	umk	oai Tra	ns Ha	arb	our	Lin	k	Client	. 3	x 0	RIENT		CON	SUIT	TANT	S		
Job N	ımber	: IDE/	AL/02	8/015																		-	0	GIC	bal Consu	Iting for	r Sustair	nable D	evelopn	nent		
Ö			SPT/	DENSITY CO	& MOIST	FURE	uc		CLA	SSIFI	CATI	ΟΝ Τ	EST	S		;	STREM	NGT	Н ТЕ	STS	6 (kPa	a)	CONSC	LIDATIO	ON TEST			CHEI	MICAL	TEST		
OLE - N	TestDe	pth (m)	pe (D/S/ DS)	Moisture	Density	(Kg/cm ³)	siificatio JSC)	vity	At Li	terbe mits(erg (%)	P Dis	articl stribu	e Siz ution	:e (%)	UCS	υυ		си	ľ	Lab S Va	Shear	ation (kPa)	ssion Cc)	l Ratio		Soi	(%)		Wa	iter (m	ıg/l)
BOREH	From	То	Sample Ty U	Content (%)	Wet	Dry	Soil Cla (L	Sp. Gra	M	۸	<u> </u>	Grave	Sand	Silt	Clay	Cu	c ¢		c'		τ _v	τ _{vr}	Pre- Consolid Pressure	Commpre Index (Initial Void (e ⁰)	SO₃	SO₄	CL	рН	SO₄	CL	рН
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	1	10																	
	-16.60	-16.68	SPT				SM	2.49	-	NP	-	2	78	14	6																	
			PRE	PARED BY :	V.N.		-					C	HEC	K ED	BY :	S.D	-	-							APP	ROVE	D BY :	S.T.	•			<u> </u>





Project	: Geolo	ogical S	urvey	for the Pr	eparato	ry Surv	ey on tl	ne Proje	ect fo	or Co	onsti	ruct	ion	of M	umb	oai Tra	ns Ha	rbo	our L	.ink	Client		00	RIENT	TAL	CON	SUL	TANT	S		
Job N	umber	: IDE/	AL/02	8/015																		01	Gio	bal Consu	liting for	r Sustair	able D	evelopn	ient		
0			'SPT/	DENSITY CC	& MOIST	TURE	uc		CLA	SSIFI	CATI	ON T	EST	S		5	STREN	GTH	ITES	STS (kF	Pa)	CONSC	LIDATIO	ON TEST			CHE	MICAL	TEST		
OLE - N	TestDe	pth (m)	pe (D/S/ DS)	Moisture	Density	(Kg/cm ³)	siificatio ISC)	vity	At Li	terbe mits(erg %)	P. Dis	articl stribu	e Siz ution	:e (%)	UCS	UU	C	cu	Lab V	Shear ane	ation (kPa)	ssion Cc)	Ratio		Soil	(%)	-	Wa	iter (m	g/l)
BOREH	From	То	Sample Ty U	Content (%)	Wet	Dry	Soil Cla: (U	Sp. Gra	ML	۸	4	Gravel	Sand	Silt	Clay	Cu	сф	c'	φ'	τ _v	τ _{vr}	Pre- Consolida Pressure	Commpre: Index ((Initial Void (e ⁰)	SO3	SO₄	CL	рН	SO₄	CL	рН
BH-06	0.09	-0.41	D/S				SP	-	_	NP	-	2	98	0	D																
	-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	1	5															·	
	-7.41	-7.51	SPT				SM	-	_	NP	-	14	71	1	5																
			PRE	PARED BY :	V.N.							С	HECI	KED I	BY :	S.D								APF	PROVE	D BY :	S.T.				





		<u>SU</u>	MMAF	RY OF	LABOR	ATORY	TEST	RESU	LTS ON	ROCK	SAMPLES	<u> </u>		
	Project : Ge	ologic	al Surv	ey for th	e Prepara	atory Surv	ey on the	e Project	for Constru	uction of	Mumbai Tra	ns Harbo	our Link	
Job No.	IDEAL/028/015								Client :	Ø 0F	RIENTAL	Consi	ILTAN	rs
DAT	E : 26-06-2015									Glob	al Consulting fo	r Sustainabl	e Developr	nent
BH No.	Depth(m)	Length (cm)	Diameter (cm)	Test Condition	Moisture Absorption (%)	Porosity (%)	Unit Weight (g/cm³)	Specific Gravity	Point Load Index Strength(Mpa)	Uniaxial Compressive Strength (MPa)	Corrected Uniaxial Compressive Strength (MPa)	Modulus of Elasticity	Brazilian Test	Remarks
BH-01	-25.6325.82	10.20	5.40	SOAKED	1.01	2.65	2.63	2.46	-	25.85	25.66	-	-	
	-26.8426.95	10.00	5.40	SOAKED	0.84	2.27	2.70	2.57	-	18.86	18.68	-	-	
	-28.3228.55	10.30	5.40	SOAKED	0.56	1.53	2.72	2.68	-	52.00	51.69	-	-	
BH-02	-24.4624.58	10.00	5.40	SOAKED	1.34	3.49	2.60	2.49	-	32.75	32.42	-	-	
	-26.8727.04	10.10	5.40	SOAKED	0.92	2.51	2.74	2.64	-	46.07	45.67	-	-	
	-27.4327.60	10.00	5.40	SOAKED	0.91	2.53	2.78	2.65	-	25.33	25.07	-	-	
BH-03	-22.6322.74	9.50	5.40	SOAKED	0.68	1.93	2.85	2.69	-	43.84	43.10	-	-	
	-25.0325.24	10.00	5.40	SOAKED	0.40	1.14	2.84	2.71		60.47	59.88	-	-	
	-26.0726.24	10.10	5.40	SOAKED	0.22	0.65	2.88	2.78	-	113.09	112.12	-	-	
	-27.8528.04	10.00	5.40	SOAKED	0.61	1.66	2.72	2.59	-	61.44	60.83	-	-	





			<u>SUI</u>	MMAF	RY OF I	ABOR	ATORY	TEST	RESU	LTS ON	ROCKS	SAMPLES	<u>S</u>		
	Project	: Ge	ologic	al Surv	ey for th	e Prepara	atory Surv	ey on the	e Project	for Constru	uction of I	Mumbai Tra	ns Harbo	our Link	
Job No.	IDEAL/028	/015								Client :	Ø Or	RIENTAL	Consi	JLTAN	rs
DAT	E : 26-06-201	15			T		T	1		2	Globa	al Consulting fo	r Sustainabi	e Developr	nent
BH No.	Depth(m)	1)	Length (cm)	Diameter (cm)	Test Condition	Moisture Absorption (%)	Porosity (%)	Unit Weight (g/cm³)	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	-	-	
Prenared	BV · V N				1			becked By:	S D	1		۸۳	proved by .	ет	I

IDEAL GEOSERVICES PRIVATE LIMITED



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 -24.04 - -24.12 -BH NO.: BH-02 Depth (m) : -22.54--22.79 SAND MEDIUM GRAVEL IICLAY & SILT FINE ĊÒARSE -10 73 16 0 1 ------15 24 **4**1 20 0 100 90 80 70 <u>-</u>860 Finer 10 20 10 0 0.001 0.01 0.1 1 10 100 Grain Diameter 'D' (mm) BH NO.: Depth (m) : SAND GRAVEL CD. •: COARSE FINE MEDIUM -- -100 90 80 70 ર્જુ 60 Finer 050 Percentage F 05 05 20 10 0 0.001 0.01 10 100 0.1Grain Diameter 'D' (mm) 1 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 -4.40 - -4.85 BH NO.: BH-03 Depth (m) : -2.90 - -3.40 SAND MEDIUM GRAVEL CLA SILT FINE COARSE 2 0 41 57 0 0 -**4**2 57 0 0 0 1 100 90 80 70 <u>-</u>860 Finer 102 20 10 0 0.001 0.01 0.1 1 10 100 Grain Diameter 'D' (mm) BH NO.: Depth (m) : SAND GRAVEL CD. •: COARSE FINE MEDIUM -100 90 80 70 ર્જુ 60 Finer 050 Percentage F 05 05 20 10 0 0.001 0.01 10 100 0.1Grain Diameter 'D' (mm) 1 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): -10.60 - -10.83 SAND MEDIUM GRAVEL 1116141811811811414111111 FINE COARSE •: 30 -1 12 56 ------100 90 80 70 <u>~</u>60 Finer 1050 20 10 0 0.001 0.01 0.1 10 100 1 Grain Diameter 'D' (mm) BH NO.: Depth (m) : SAND GRAVEL CD. • COARSE FINE MEDIUM -100 90 80 70 ર્જુ60 Finer 0 2 Percentage F 05 05 20 10 0 0.001 0.01 10 100 0.1Grain Diameter 'D' (mm) 1 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 SAND MEDIUM GRAVEL |||||CLAY|& SILT||||| FINE COARSE •: 49 -15 8 14 14 ------100 90 80 70 <u>~</u>60 Finer 1050 20 10 0 0.001 0.01 0.1 1 10 100 Grain Diameter 'D' (mm) BH NO.: BH-06 Depth (m) : SAND GRAVEL SU) • COARSE FINE MEDIUM -100 90 80 70 ર્જુ60 Finer 0 2 Percentage F 05 05 20 10 0 0.001 0.01 10 100 0.1Grain Diameter 'D' (mm) 1 Tested By : P.M. Prepared By :V.N. Checked By :S.D. Approved By : S.T.



Liquid Limit (C	asagrande meth	od) and F	Plastic Lim	it			
Project : Geolo	gical Survey for the	Preparato	ry Survey on	the Project for C	onstruction of Mu	ımbai Tran	s Harbour Link
BH-01		_3 32	JOD NO. IDE	Sample No	ID-M-BH-01-D0000	Data :	21-07-2015
BH NO.: BH-01	Sample Depth(m) :	-4.82	5.27	Sample No. :	ID-M-BH-01-S1500	Date :	21-07-2015
			Test method :	S 2720 : Part 5			
PLASTIC LIMIT	Test no.	1	2	Average	1	2	Average
Container no.		A44	A61		A38	A57	
Mass of wet soil + cont	tainer g	24.20	22.40		23.50	27.70	
Mass of dry soil + cont	ainer 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 + cont	tainer (m ₃) g	37.20	37.50	36.70	42.40	31.80	34.40
Mass of dry soil + cont	ainer (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
80						Sample pre	paration
		•				washed on	425 μ m sieve
70						ovenuneu	
						Liquid limit	<mark>66</mark> %
%) 1 50						Plastic limit	27 %
Conte						Plasticity index	<mark>39</mark> %
40							74.04
N ois						Liquid limit	71 %
30							33 %
20						Plasticity index	38 %
						Operator	Checked Approved
10		*				P.M.	к.в. ѕ.т.
10		No.	of Bumps		100		



Liquid Limit <i>(Ca</i>	sagrande meth	<i>od)</i> and F	Plastic Lim	it			
Project : Geolog	ical Survey for the	Preparator	y Survey on	the Project for C	onstruction of Mu	mbai Tran	s Harbour Link
			Job No. IDE	EAL/028/015		T	Γ
BH NO.: BH-01	- Sample Depth(m) :	-6.32(6.77	Sample No. :	ID-M-BH-01-S3000	Date :	21-07-2015
BH-01		-/ .82(Test method :	Sample No. : IS 2720 : Part 5	ID-M-BH-01-54500	Date :	21-07-2015
PLASTIC LIMIT	Test no.	1	2	Average	1	2	Average
Container no.		A38	A51		A51	A55	
Mass of wet soil + conta	iner g	27.50	29.60		21.80	22.30	
Mass of dry soil + contai	iner 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 + conta	uiner (m ₃) g	35.60	32.90	32.00	37.60	36.20	34.40
Mass of dry soil + contai	iner (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
100 -						Sample pre	paration
90						washed on	425 μ m sieve
						oven dried	; 105 ⁰C
80						<u>. </u>	
70						Liquid limit	87 %
ut (%						Plastic limit	38 %
						Plasticity index	49 %
50							70 0/
×io W 40							10 %
30						Plasticity	46 %
							Checked Approve
20						Operator	
10 1						P.M.	к.в. ѕ.т.
10		No.	of Bumps		100		



Liquid	Limit (Cas	agrande m	eth	<i>od)</i> and F	Plastic Lim	nit							
Proje	ect : Geologi	cal Survey for	r the	Preparator	y Survey on	the Pr	oject for (Constru	ction o	of Mu	nbai Trans	s Harbou	ır Link
					Job No. ID	EAL/02	8/015						
BH NO.	BH-01	Sample Depth(m) :	-9.32	9.77	Sa	mple No. :	ID-M-I	3H-01-S	56000 57500	Date :	22-07-20	15
	DH-VI			-10.02	Test method :	IS 2720	: Part 5		511-01-2	57500	Date .	22-07-20	15
PLASTIC	C LIMIT	Tes	t no.	1	2	А	verage		1		2	Ave	rage
Container	۰no.			A4	A18			А	48		A42		
Mass of w	vet soil + contair	ner	g	28.20	28.40			24	.50		26.40		
Mass of d	lry soil + contair	ner	g	27.00	27.30	_		23	.00		25.50		
Mass of c	ontainer		g	23.29	23.78			17	.70		22.23		
Mass of n	noisture		g	1.20	1.10			1.	50		0.90		
Mass of d	lry 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 i	LIMIT	Tes	t no.	1	2		3		1		2	:	3
Number o	of bumps			15	25		46	1	3		26	4	15
Container	no.			A 8	A1		A32	А	12		A22	Α	33
Mass of w	vet soil + contair	ner (m ₃)	g	39.50	29.90		41.80	34	.30		37.00	41	.10
Mass of d	lry soil + contair	ner (m ₂)	g	31.20	25.40		35.20	28	.80		31.90	.90	
Mass of c	ontainer	(m ₁)	g	21.43	19.72		26.28	22	.53		25.63	.84	
Mass of n	noisture	(m ₃ - m ₂)	g	8.30	4.50		6.60	5.	50		5.10	6.	.20
Mass of d	lry soil	(m ₂ - m ₁)	g	9.77	5.68		8.92	6.	27		6.27	8.	.06
Water Co	ntent		%	84.95	79.23		73.99	87	.72		81.34	76	.92
100											Sample pre	paration	
00											washed on	425 μ m si	eve
50											oven dried	: 105	°C
80						-							
_ 70 -											Liquid limit	79	%
nt (%)											Plastic limit	32	%
onte											Plasticity	47	%
D en 1										_	Index		
Mois											Liquid limit	82	%
40 -											Plastic limit	28	%
30									+	-	Plasticity index	54	%
20 -											Operator	Checked	Approved
-													~ -
10 - 1	0				of Bumps		1			 100	P.M.	К.В.	S.T.



Liquid	Limit (Cas	sagrande m	eth	od) and F	Plastic Lim	it			
Proj	ect : Geologi	cal Survey for	[,] the	Preparato	ry Survey on	the Project for C	Construction of	⁻ Mumbai Tra	ns Harbour Link
				40.00	Job No. IDI	EAL/028/015		Data	. 22.07.2045
BH NO.	.: BH-01	Sample Depth(m) : -	-13.82	14.22	Sample No	ID-M-BH-01-S1	000 Date	· 22-07-2015
	Biror			10101	Test method :	IS 2720 : Part 5		Buie	
PLASTIC	C LIMIT	Tes	t no.	1	2	Average	1	2	Average
Container	r no.			A4	A18		A47	A64	
Mass of w	vet soil + contair	ner	g	28.20	28.40		21.80	22.60	_
Mass of d	dry soil + contair	ner	g	27.00	27.30		20.60	21.50	-
Mass of c	container		g	23.29	23.78		16.87	18.09	-
Mass of n	noisture		g	1.20	1.10		1.20	1.10	
Mass of d	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
l iqui d i	LIMIT	Tes	t no.	1	2	3	1	2	3
Number c	of bumps			15	25	46	14	24	44
Container	r no.			A8	A1	A32	A45	A49	A43
Mass of w	vet soil + contair	ner (m ₃)	g	39.50	29.90	41.80	29.80	32.20	30.70
Mass of d	dry soil + contair	ner (m ₂)	g	31.20	25.40	35.20	24.80	26.80	26.10
Mass of c	container	(m ₁)	g	21.43	19.72	26.28	17.83	18.71	18.41
Mass of n	noisture	(m ₃ - m ₂)	g	8.30	4.50	6.60	5.00	5.40	4.60
Mass of d	dry soil	(m ₂ - m ₁)	g	9.77	5.68	8.92	6.97	8.09	7.69
Water Co	ontent		%	84.95	79.23	73.99	71.74	66.75	59.82
100	1				•			Sample p	reparation
-	-							washed c	n 425 μ m sieve
90 -								oven drie	d ; 105 °C
80	- 							- [
70 -								Liquid lim	it 79 %
nt (%)								Plastic lin	nit 32 %
onter	1							Plasticity	47 %
D 1 1 1 1 1 1 1 1 1 1	1								
Moist								Liquid lim	it 66 %
- 40 -								Plastic lin	nit 32 %
30 -	-							Plasticity	34 %
20 -	1							Operato	Checked Approved
-									
- 10 1					of Bumps				к.в. S.T.



Liquid Limit (Casagrand	e meth	od) and F	Plastic L	.imit					
Project : Geological Surve	y for the	Preparato	ry Survey	on the Project fo	or Construction	of Mumbai	Tran	s Harbou	ır Link
			Job No	IDEAL/028/015					
BH NO. : BH-01 Sample D	epth(m) :	-15.32	15.77	Sample No. :	ID-M-BH-01-S	5 1200 Da	ate :	22-07	-2015
			Test meth	od : IS 2720 : Part 5					
PLASTIC LIMIT	Test no.	1	2	Average	1	2		Ave	rage
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					
100						Sam	ple pre	eparation	
90						wasl	ned on	425 μ m si	ieve
						over	n dried	i 105	°C
80						_			
7 ⁰						Liqu	id l imit	43	%
ent (%						Plas	tic l imi	t 22	%
						Plas	ticity x	21	%
en 50									0/
No 40						Liqu	tio limit		%
									70
30						Inde	ucity x		%
20		 				Оре	erator	Checked	Approve
							м	KP	QТ
10 10		× No.	of Bumps			100			0.1.



$ \begin{array}{ c c c c c c c c c c c c c c c c c c c$	
BH-02 BH-02 Sample Deptime <	r Link
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	
BH-02 H-4.54 - 4.99 Sample No. ID-M-BH-02-S1500 Date: 08-07-20 Test method : IS 2720 : Part 5 Test method : IS 2720 : Part 5 PLASTIC LIMIT Test no. 1 2 Average 1 2 Average Mass of wet soil + container g 27.30 28.63 30.21 28.20 28.20 27.38 25.74 Mass of wet soil + container g 2.66 2.95 18.57 18.09 2.63 2.46 Mass of moisture g 2.66 2.95 2.83 2.46 30.21 28.20 28.33 2.46 30.21 28.20 28.33 2.46 28.30 2.46 28.33 2.46 30.21 28.20 28.33 2.46 30.21 28.21 30.00 32.42 30.4 28 30.21 28.21 30.20 32.42 30.4 28 44 44 44 44 44 44 44 44 44 44 44 44 44<	15
Vertication of bit of transmission of transmissic transmissi transmissi transmission of transmission of transmissi	15
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Mass of velt soil + container g 22,30 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 dry soil g 2,66 2,95 2,83 2,46 Mass of dry soil g 8,04 8,96 2,83 2,46 Moisture Content % 33,08 32,92 33,00 32,12 32,16 32 LiQUID LIMIT Test no. 1 2 3 1 2 3 1 2 Number of bumps 15 26 48 14 26 4 Container no. A20 A35 A26 A60 A44 A Mass of dry soil + container (m ₂) g 33,13 35,08 32,37 24,07 26,24 24 Mass of moisture (m ₂ -m ₂) g 5,08 4,51 3,46 5,15 4,40 4 Mass of dry soil (m ₂ -m ₁) g 8,12 7,7	
Mass of dry soil + container g 24.64 25.66 27.38 25.74 Mass of container g 16.00 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 28.31 2.16 32.16 Moisture Content % 33.08 32.92 23.00 32.12 32.16 32 LQUID LIMIT Test no. 1 2 3 1 2 3 1 2 Number of bumps 15 26 48 14 26 44 A Mass of wet soil + container (m_2) g 38.21 39.59 35.83 29.22 30.64 28 Mass of ordry soil + container (m_2) g 33.13 35.08 32.37 24.07 26.24 24 Mass of dry soil + container (m_1) g 25.01 27.33 25.90 16.78 19.44 17 Mass of dry soil (m_2-m_1) g 5.08 4.51 3.46 5.15 4.40 4.40	
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 6.96 8.81 7.65 Moisture Content % 33.08 32.92 33.00 32.12 32.16 32 LIQUID LIMIT Test no. 1 2 3 1 2 3 1 2 32 Number of bumps 15 26 48 14 26 4 Container no. A20 A35 A26 A60 A44 A Mass of dry soil + container (m2) g 33.13 35.08 32.37 24.07 26.24 24 Mass of container (m1) g 25.01 27.33 26.90 16.78 19.44 17 Mass of dry soil (m2-m1) g 8.12 7.75 6.47 7.29 6.80 6.80 Water Content % 62.56 58.19 53.48 70.64 64.71 58 %	
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 LIQUID LIMIT Test no. 1 2 3 1 2 3 1 2 Number of bumps 15 26 48 14 26 44 Container no. A20 A35 A26 A60 A44 A Mass of wet soil + container (m ₂) g 33.13 35.08 32.37 24.07 26.24 24 Mass of container (m ₁) g 25.01 27.33 25.90 16.78 19.44 17 Mass of dry soil (m ₂ -m ₁) g 8.12 7.75 6.47 7.29 6.80 6 Water Content % 62.56 58.19 53.48 70.64 64.71 58 0 0 0 0 0 0 0 0 0 0 0	
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 LIQUID LIMIT Test no. 1 2 3 1 2 3 1 2 Number of bumps 15 26 48 14 26 44 Container no. A20 A35 A26 A60 A44 A Mass of wet soil + container (m ₃) g 38.21 39.59 35.83 29.22 30.64 28 Mass of dry soil + container (m ₂) g 33.13 35.08 32.37 24.07 26.24 24 Mass of container (m ₁) g 25.01 27.33 25.90 16.78 19.44 17 Mass of dry soil (m ₂ - m ₁) g 8.12 7.75 6.47 7.29 6.80 6 Water Content % 62.56 58.19 53.48 70.64 64.71 58 Mass of dry soil (m ₂ - m ₁) g 8.12 7.75 6.47 7.29 6	
Moisture Content $%$ 33.08 32.92 33.00 32.12 32.16 32 LIQUID LIMIT Test no. 1 2 3 1 2 3 1 2 3 1 2 3 1 2 3 1 2 3 1 2 3 1 2 3 1 2 3 1 2 3 1 2 3 1 2 3 1 2 3 1 2 3 1 2 3 1 2 3 1 2 3 1 2 3	
LIQUID LIMIT Test no. 1 2 3 1 2 Number of bumps 15 26 48 14 26 44 Container no. A20 A35 A26 A60 A44 A Mass of wet soil + container (m ₃) g 38.21 39.59 35.83 29.22 30.64 28 Mass of dry soil + container (m ₂) g 33.13 35.08 32.37 24.07 26.24 24 Mass of container (m ₁) g 25.01 27.33 25.90 16.78 19.44 17 Mass of moisture (m _b -m ₂) g 5.08 4.51 3.46 5.15 4.40 4 Mass of dry soil (m ₂ -m ₁) g 8.12 7.75 6.47 7.29 6.80 6 Vater Content % 62.56 58.19 53.48 70.64 64.71 58 0 <td< td=""><td>,14</td></td<>	,14
Number of bumps 15 26 48 14 26 44 Container no. A20 A35 A26 A60 A44 A Mass of wet soil + container (m ₃) g 38.21 39.59 35.83 29.22 30.64 28 Mass of dry soil + container (m ₂) g 33.13 35.08 32.37 24.07 26.24 24 Mass of container (m ₁) g 25.01 27.33 25.90 16.78 19.44 17 Mass of moisture (m ₅ -m ₂) g 5.08 4.51 3.46 5.15 4.40 4.4 Mass of dry soil (m ₂ -m ₁) g 8.12 7.75 6.47 7.29 6.80 6 Water Content % 62.56 58.19 53.48 70.64 64.71 58 9 0	3
Container no. A20 A35 A26 A60 A44 A Mass of wet soil + container (m ₃) g 38.21 39.59 35.83 29.22 30.64 28 Mass of dry soil + container (m ₂) g 33.13 35.08 32.37 24.07 26.24 24 Mass of container (m ₁) g 25.01 27.33 25.90 16.78 19.44 17 Mass of moisture (m ₃ -m ₂) g 5.08 4.51 3.46 5.15 4.40 4 Mass of dry soil (m ₂ -m ₁) g 8.12 7.75 6.47 7.29 6.80 6 Water Content % 62.56 58.19 53.48 70.64 64.71 58 0	8
Mass of wet soil + container (m ₃) g 38.21 39.59 35.83 29.22 30.64 28 Mass of wet soil + container (m ₂) g 33.13 35.08 32.37 24.07 26.24 24 Mass of container (m ₁) g 25.01 27.33 25.90 16.78 19.44 17 Mass of container (m ₁) g 25.01 27.33 25.90 16.78 19.44 17 Mass of container (m ₃ - m ₂) g 5.08 4.51 3.46 5.15 4.40 4.40 Mass of dry soil (m ₂ - m ₁) g 8.12 7.75 6.47 7.29 6.80 6 Water Content % 62.56 58.19 53.48 70.64 64.71 58 Sample preparation washed on 425 µ m s oven dried : 105 105 105 105 105 105 Sample preparation washed on 425 µ m s oven dried : 105 105 105 105 105 105 Mass of dry soil 105 106 106	48
Mass of dry soil + container (m_2) g 33.13 35.08 32.37 24.07 26.24 24 Mass of container (m_1) g 25.01 27.33 25.90 16.78 19.44 17 Mass of moisture $(m_3 - m_2)$ g 5.08 4.51 3.46 5.15 4.40 4 Mass of dry soil $(m_2 - m_1)$ g 8.12 7.75 6.47 7.29 6.80 6 Water Content % 62.56 58.19 53.48 70.64 64.71 58 80 $70^{-10^{-10^{-10^{-10^{-10^{-10^{-10^{-1$.67
Mass of container (m ₁) g 25.01 27.33 25.90 16.78 19.44 17 Mass of moisture (m ₃ -m ₂) g 5.08 4.51 3.46 5.15 4.40 4.40 Mass of dry soil (m ₂ -m ₁) g 8.12 7.75 6.47 7.29 6.80 6. Water Content % 62.56 58.19 53.48 70.64 64.71 58 0 $\frac{70}{60}$ $\frac{60}{256}$ $\frac{58.19}{50}$ $\frac{53.48}{250}$ 70.64 $\frac{64.71}{250}$ $\frac{58}{200}$ $\frac{80}{50}$ $\frac{62.56}{50}$ $\frac{58.19}{50}$ $\frac{53.48}{200}$ 70.64 $\frac{64.71}{250}$ $\frac{58}{200}$ $\frac{80}{50}$ $\frac{62.56}{50}$ $\frac{58.19}{200}$ $\frac{53.48}{200}$ $\frac{70}{200}$ $\frac{100}{200}$ 1	.60
Mass of moisture $(m_3 - m_2)$ g 5.08 4.51 3.46 5.15 4.40 4.40 Mass of dry soil $(m_2 - m_1)$ g 8.12 7.75 6.47 7.29 6.80 6.80 Water Content % 62.56 58.19 53.48 70.64 64.71 58 Sample preparation washed on 425 μ m s oven dried : 105 Liquid limit 58 State Sample preparation washed on 425 μ m s oven dried : 105 Liquid limit 58	.70
Mass of dry soil $(m_2 - m_1)$ g 8.12 7.75 6.47 7.29 6.80 6. Water Content % 62.56 58.19 53.48 70.64 64.71 58 80 <	07
Water Content % 62,56 58,19 53,48 70,64 64,71 58 80 70 60 60 60 50 50 70 60 50 50 58,19 53,48 70,64 64,71 58 80 70 60 50 50 58,19 53,48 70,64 64,71 58 80 70 60 60 60 60 60 60 60 60 60 60 60 60 60	90
80 70 60 60 50 50 50 50 50 50 50 50 50 5	,99
70 washed on 425 μ m s oven dried : 105 60 Liquid limit 58 80 Plastic limit 33	
70 60 $\underbrace{S}_{\underline{U}}$ 50 $\underbrace{S}_{\underline{U}}$ 50 S	eve
60 8 50 50 50 50 50 50 50 50 50 50	°C
60 (\$) to 50 (\$)	
S T B 50 Plastic limit 33	%
	%
25 g	%
E 40 Liquid limit 65	%
Plastic limit 32	%
30 Plasticity index 33	%
20 Operator Checked	Approved
10 P.M. K.B.	S.T.



Liquid Limit <i>(Casa</i>	grande meth	od) and F	Plastic Lim	it			
Project : Geological	Survey for the	e Preparato	y Survey on	the Project for C	Construction of M	umbai Tran	s Harbour Link
BH-02		-6.04	6.49	Sample No. :	ID-M-BH-02-S300	Date :	08-07-2015
BH NO. : BH-02 Sa	ample Depth(m) :	-7.54	7.99	Sample No :	ID-M-BH-02-U450	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
100						Sample pre	eparation
						washed on	425 μ m sieve
30						oven dried	، 105 ⁰C
80							
70				*		Liquid l imit	<mark>63</mark> %
1t (%)						Plastic limi	29 %
00 dute						Plasticity	34 %
5 0						index	
Moist		÷				Liquid limit	80 %
40						Plastic limi	36 %
30						Plasticity index	44 %
20		• •				Operator	Checked Approve
10						P.M.	к.в. ѕ.т.
10		No.	of Bumps		10	0	



Projec	t : Geologi	cal Survey fo	or the	Preparato	ry Surve	on the Project for	Construction of	of Mur	nbai Tran	s Harbou	ır Link
•				•	Job No	. IDEAL/028/015					
BH NO.:	BH-02	Sample Depth	(m) :	-9.04	9.49	Sample No. :	ID-M-BH-02-S	6000	Date :	08-07	-2015
					Test meth	od : IS 2720 : Part 5		-	-		
PLASTIC I	IMIT	Te	st no.	1	2	Average	1		2	Ave	rage
Container n	b.			A47	A52						
Mass of wet	soil + contai	ner	g	28.77	30.21						
Mass of dry	soil + contai	ner	g	26.44	27.93	i					
Mass of con	tainer		g	16.87	19.14						
Mass of moi	sture		g	2.33	2.28						
Mass of dry	soil		g	9.57	8.79						
Moisture Co	ntent		%	24,35	25.94	25.14					
LIQUID LII	ΛİT	Te	st no.	1	2	3	1		2		3
Number of b	oumps			46	26	14					
Container n	р.			A11	A36	A4					
Mass of wet	soil + contai	ner (m ₃)	g	33.40	39.19	35.51					
Mass of dry	soil + contai	ner (m ₂)	g	29.79	35.21	30.74					
Mass of con	tainer	(m ₁)	g	23.13	28.4	23.29					
Mass of moi	sture	(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 Conte	ent		%	54.20	58.88	64.03					
80									Sample pre	paration	
-									washed on	425 μ m si	eve
70								_	oven dried	i 105	⁰C
-											
60									Liquid limit	59	%
it (%)									Plastic limit	25	%
outer									Plasticity	34	%
									Index		
Aoisti									Liquid limit		%
- 30									Plastic limit		%
									Plasticity index		%
20									Operator	Checked	Approv
-											



Liquid I	Limit (Cas	sagrande n	neth	od) and I	rastic Lin	าเซ			
Proje	ct : Geologi	cal Survey fo	or the	Preparato	ry Survey or	the Project for C	construction of	f Mumbai Tra	ns Harbour Link
	BH-02			-10 54	JOD NO. IL	Sample No	ID-M-BH-02-S7	7500 Date	08-07-2015
BH NO.:	BH-02	Sample Depth	ı(m) :	-12.04	12.49	Sample No. :	ID-M-BH-02-S9	000 Date	: 08-07-2015
					Test method :	IS 2720 : Part 5			
PLASTIC	LIMIT	Te	st no.	1	2	Average	1	2	Average
Container r	10.			A42	A53		A39	A41	
Mass of we	et soil + contai	ner	g	34.41	28.88		29.62	29.40	
Mass of dry	y soil + contair	ner	g	31.64	26.35		27.15	26.73	
Mass of co	ntainer		g	22.23	17.55		18.46	17.55	
Mass of mo	oisture		g	2.77	2.53		2.47	2.67	
Mass of dry	y soil		g	9.41	8.80	-	8.69	9.18	-
Moisture C	ontent		%	29.44	28.75	29.09	28.42	29.08	28.75
liquid li	IMIT	Te	st no.	1	2	3	1	2	3
Number of	bumps			26	47	16	15	26	46
Container r	no.			A5	A27	A19	A51	A61	A45
Mass of we	et soil + contair	ner (m ₃)	g	34.10	37.98	37.17	32.29	30.10	31.70
Mass of dry	y soil + contair	ner (m ₂)	g	29.75	33.72	32.34	26.68	25.43	26.61
Mass of co	ntainer	(m ₁)	g	22.38	25.88	24.68	18.03	17.81	17.83
Mass of mo	oisture	(m ₃ - m ₂)	g	4.35	4.26	4.83	5.61	4.67	5.09
Mass of dry	y soil	(m ₂ - m ₁)	g	7.37	7.84	7.66	8.65	7.62	8.78
Water Cont	tent		%	59.02	54.34	63.05	64.86	61_29	57.97
80								Sample p	reparation
-								washed o	n 425 μ m sieve
70								oven drie	d ; 105 °C
-		-							
60								Liquid lim	it 59 %
(%)								- Plastic lin	nit 29 %
								Plasticity	
e Cor								index	30 %
opistur								Liquid lim	it 62 %
Ĭ								Plastic lir	nit 29 %
30								Plasticity index	33 %
20								Operato	r Checked Approve
10					of Bumps			P.M.	K.B. S.T.



BH NO. :	•			Fieparato	ry Survey	on the Project for	Construction	otiviui	ndai irans	5 Mainuu	Ir Link
BH NO.:				•	Job No	. IDEAL/028/015					
	BH-02	Sample Depth	ı(m) :	-13.54	13.99	Sample No. :	ID-M-BH-02-	S1050	Date :	08-07	-2015
		1			Test meth	od : IS 2720 : Part 5					
PLASTIC L	.IMIT	Те	st no.	1	2	Average	1		2	Ave	rage
Container no).			A49	A38						
Mass of wet	soil + contai	ner	g	29.58	29.38						
Mass of dry	soi l + contair	ner	g	27.53	27.29						
Mass of con	tainer		g	18.71	18.28						
vlass of moi	sture		g	2.05	2.09						
Mass of dry	soil		g	8.82	9.01						
Moisture Co	ntent		%	23.24	23.20	23.22					
LIQUID LIN	ΛİT	Те	st no.	1	2	3	1		2		3
Number of b	umps			15	25	47					
Container no).			A7	A30	A28					
Mass of wet	soil + contai	ner (m ₃)	g	34.90	38.87	35.70					
Mass of dry	soi l + contair	ner (m ₂)	g	30.20	34.44	32.64					
Mass of con	tainer	(m ₁)	g	22.00	26.22	26.58					
Mass of moi	sture	(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 Conte	ent		%	57.32	53.89	50.50					
80									Sample pre	paration	
-									washed on	425 μ m s	ieve
70								_	oven dried	105	⁰C
-											
60									Liquid limit	54	%
t (%)				*					Plastic limit	23	%
10 50									Plasticity	21	0/_
e S									index	31	70
									Liquid limit		%
2									Plastic limit		%
-									Plasticity index		%
20									Operator	Checked	Approv



Liquid	Limit <i>(Cas</i>	agrande n	neth	<i>od)</i> and F	Plastic Lim	it			
Proje	ect : Geologi	cal Survey fo	r the	Preparator	ry Survey on	the Project for (Construction of N	lumbai Tran	s Harbour Link
	BH-03			-2.90	3.40	Sample No :	ID-M-BH-01-S000	0 Date ·	22-07-2015
BH NO.	: BH-03	Sample Depth	(m) :	-4.40/	4.85	Sample No. :	ID-M-BH-01-D150	Date :	22-07-2015
					Test method :	IS 2720 : Part 5		Date :	
PLASTIC	CLIMIT	Te	st no.	1	2	Average	1	2	Average
Container	no.			A62	A52		A41	A65	
Mass of w	et soil + contair	ner	g	27.70	26.90		23.50	23.60	
Mass of di	ry soil + contain	er	g	25.80	25.30		21.70	21.80	
Mass of co	ontainer		g	18.57	19.14		17.55	17.53	
Mass of m	noisture		g	1.90	1.60		1.80	1.80	
Mass of di	ry soil		g	7.23	6.16		4.15	4.27	
Moisture (Content		%	26.28	25.97	26.13	43.37	42.15	42.76
l iq uid l	IMIT	Tes	st no.	1	2	3	1	2	3
Number o	f bumps			14	25	48	14	26	47
Container	no.			A11	A27	A9	A35	A14	A24
Mass of w	et soil + contair	ner (m ₃)	g	36.80	35.00	33.50	39.90	31.60	33.20
Mass of di	ry soil + contain	er (m ₂)	g	31.30	31.50	29.40	35.00	27.70	30.00
Mass of co	ontainer	(m ₁)	g	23.13	25.88	22.09	27.33	21.27	24.37
Mass of m	noisture	(m ₃ - m ₂)	g	5.50	3.50	4.10	4.90	3.90	3.20
Mass of di	ry soil	(m ₂ - m ₁)	g	8.17	5.62	7.31	7.67	6.43	5.63
Water Cor	ntent		%	67.32	62.28	56.09	63.89	60.65	56.84
80 丁								Sample pre	eparation
-								washed on	425 μ m sieve
70 🕂								oven dried	; 105 ⁰C
-									
60								Liquid limit	<mark>62</mark> %
(%)								Plastic limit	26 %
								Plasticity	
e Col								index	36 %
oistur								Liquid limit	62 %
20								Plastic limit	43 %
30 +								Plasticity index	19 %
20								Operator	Checked Approve
10 + 10					of Bumps			P.M.	к.в. S.T.



Liquid	I Limit <i>(Cas</i>	agrande n	neth	od) and I	Plastic Lin	nit					
Proj	ect : Geologio	cal Survey fo	r the	Preparato	ry Survey or	the Project fo	r Construction	of Mu	nbai Trans	s Harbou	r Link
				E 60	Job No. ID	EAL/028/015		D0000	Dete	02 07 20	45
BH NO	BH-04	Sample Depth	(m) :	-5.00	7 55	Sample No	ID-M-BH-04-	S1500	Date :	02-07-20	15
	BII-04			-7110	Test method :	IS 2720 : Part 5		01000	Date .	02-01-20	10
PLASTI	C LIMIT	Tes	st no.	1	2	Average	1		2	Ave	rage
Containe	r no.			A37	A60		A56		A50		
Mass of v	wet soil + contair	ner	g	27.00	27.00		29.44		26.57		
Mass of o	dry soil + contain	ier	g	25.03	25.01		27.31		24.51		
Mass of o	container		g	16.72	16.78		19.07		16.60		
Mass of r	moisture		g	1.97	1.99		2.13		2.06		
Mass of o	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	Tes	st no.	1	2	3	1		2	:	3
Number o	of bumps			45	24	13	46		23	1	3
Containe	r no.			A55	A61	A48	A65		A45	Α	41
Mass of v	wet soil + contair	ner (m ₃)	g	27.90	25.46	32.47	24.18		26.49	27	.10
Mass of o	dry soil + contain	ier (m ₂)	g	25.76	23.44	28.26	22.25		23.67	23	.74
Mass of d	container	(m ₁)	g	18.98	17.81	17.70	17.53		17.83	17	.55
Mass of r	moisture	(m ₃ - m ₂)	g	2.14	2.02	4.21	1.93		2.82	3.	36
Mass of o	dry soil	(m ₂ - m ₁)	g	6.78	5.63	10.56	4.72		5.84	6.	19
Water Co	ontent		%	31.56	35.88	39.87	40.89		48,29	54	.28
80 _T					•	•			Sample pre	paration	
-									washed on	425 u m si	eve
70 -									oven dried	i 105	°C
1											
60 -									Liquid limit	36	%
(%)									Plastic limit	24	%
10 = 1			<u> </u>	•					Plasticity		
e Co	_								index	12	%
oistu									Liquid limit	47	%
Σ 1 30									Plastic limit	26	%
30 -									Plasticity index	21	%
20 -									Operator	Checked	Approve
									РМ	KR	SТ
10 + 10)			× No.	of Bumps	II	I		'.\v.	N.D.	5.1.



Liquid L	_imit (Cas	sagrande n	neth	<i>od)</i> and I	Plastic Lim	it				
Projec	ct : Geologi	cal Survey fo	or the	Preparato	ry Survey on	the Project for C	onstruction of Mu	mbai Tran	s Harbour	Link
					Job No. ID	EAL/028/015	Γ		I	
BH NO.:	BH-04	Sample Depth	(m) :	-10.10	10.55	Sample No. :	ID-M-BH-04-S4500	Date :	02-07-201	5
	BH-04			-11.60	Test method :	Sample No. : IS 2720 : Part 5	ID-M-BH-04-S6000	Date :	02-07-201	5
PI ASTIC		Te	st no	1	2	Average	1	2	Avera	ade
Container n				Δ42	A53	, tionago	Δ38	Δ 47		-9-
Mass of wo	t soil + contair	or	0	32.60	26.03		27.77	25.61	-	
Mass of dru			g	30.38	24.01	-	25.72	23.75	-	
Mass of or			g	22.22	17.55	-	19.29	16.97		
	iature		g	22.23	2.02	-	2.05	1 96	-	
			g	0.15	7.02	-	7.44	0.00	-	
Maisture Cr			g v	0.10	27.45	27.04	27.55	27.02	27.00	
Moisture Co	ontent		%	21,24	27,45	27.34	27,55	27.03	21,2	29
liquid li	МІТ	Te	st no.	1	2	3	1	2	3	
Number of I	bumps			44	24	14	24	44	13	3
Container n	10.			A28	A15	A27	A26	A7	A3	4
Mass of we	t soil + contair	ner (m ₃)	g	34.80	34.42	38.14	35.22	30.20	35.9	93
Mass of dry	soil + contair	ner (m ₂)	g	32.39	31.06	33.72	31.76	27.58	32.0	03
Mass of cor	ntainer	(m ₁)	g	26.58	24.23	25.88	25.90	22.00	26.5	59
Mass of mo	isture	(m ₃ - m ₂)	g	2.41	3.36	4.42	3.46	2.62	3.9	0
Mass of dry	r soil	(m ₂ - m ₁)	g	5.81	6.83	7.84	5.86	5.58	5.4	4
Water Cont	ent		%	41.48	49.19	56.38	59.04	46.95	71.6	69
80								Sample pre	eparation	
								washed on	425 μ m sie	ve
70								oven dried	، 105 ^م	С
-										
60								Liquid limit	49 9	%
ut (%								Plastic limit	t 27 9	%
						•		Plasticity	22 9	%
								Index		
Moist								Liquid limit	58 9	%
30								Plastic limit	t 27 %	%
								Plasticity index	31 9	%
20								Operator	Checked /	Approved
10								P.M.	K.B.	S.T.
10 +				No.	of Bumps		100			5



		ayianue me	sunc			int int				
Projec	ct : Geologio	cal Survey for	the	Preparator	y Survey on	the Project for	Construction of I	Mumbai Tran	s Harbou	r Link
	BH-05			_3 10		Sample No	ID-M-BH-05-D00	00 Date :	02-07-20	15
BH NO.:	: BH-05	Sample Depth(m	1) : –	-12.10	12.55	Sample No. :	ID-M-BH-05-S90	00 Date :	02-07-20	15
					Test method :	IS 2720 : Part 5		Duio		
PLASTIC	LIMIT	Test	no.	1	2	Average	1	2	Ave	rage
Container r	no.			A39	A51		A59	A52		
Mass of we	et soil + contair	ner	g	27.32	27.25		34.12	29.93	1	
Mass of dry	y soil + contain	ier	g	25.69	25.57		32.05	28.12	1	
Mass of co	ontainer		g	18.46	18.03		21.93	19.14	1	
Mass of mo	oisture		g	1.63	1.68		2.07	1.81	1	
Mass of dry	y soil		g	7.23	7.54		10.12	8.98	l	
Moisture C	content		%	22,54	22.28	22.41	20.45	20.16	20	.31
LIQUID LI		Test	no.	1	2	3	1	2	;	3
Number of	bumps			13	24	44	13	38	5	58
Container r	no.			A16	A20	A9	A11	A19	A	40
Mass of we	et soil + contair	ner (m ₃)	g	37.11	35.10	31.40	34.50	38.03	34	.50
Mass of dry	y soil + contain	ier (m ₂)	g	32.66	32.08	28.82	31.51	34.94	31	.00
Mass of co	ontainer	(m ₁)	g	23.12	25.01	22.09	23.13	24.68	18	.36
Mass of mo	oisture	(m ₃ - m ₂)	g	4.45	3.02	2.58	2.99	3.09	3.	50
Mass of dry	y soil	(m ₂ - m ₁)	g	9.54	7.07	6.73	8.38	10.26	12	.64
Water Cont	itent		%	46.65	42.72	38.34	35_68	30.12	27	.69
80								Sample pre	eparation	
70								washed on oven dried	425 μ m si ; 105	eve ⁰C
60								Liquid limit	42	%
t (%)								Plastic limi	t 22	%
e Conteni								Plasticity index	20	%
040								Liquid limit	32	%
ž]								Plastic limi	t 20	%
30						-		Plasticity index	12	%
20								Operator	Checked	Approve
								D M	KB	sт
10 10		I		No.	of Bumps			100	К. В .	0.1.



Liquid L	imit (Ca	sagrande n	neth	od) and I	Plastic I	Limi	t							
Projec	t : Geologi	cal Survey fo	or the	Preparato	ry Survey	/ on t	the Project	for C	onstru	ction o	of Mui	mbai Trans	s Harbou	ır Link
					Job No	. IDE	AL/028/015							
BH NO.:	BH-05	Sample Depth	(m) :	-13.60	14.05	S	Sample No. :		ID-M-E	8H-05-D	1050	Date :	26-06	-2015
					Test meth	od : I S	S 2720 : Part	5						
PLASTIC	LIMIT	Те	st no.	1	2		Average	•	1			2	Ave	rage
Container n	0.			A44	A46									
Mass of we	t soil + contai	ner	g	29.23	29.00)								
Mass of dry	soil + contair	ner	g	27.45	27.07	7								
Mass of cor	ntainer		g	19.44	18.37	,								
Mass of mo	isture		g	1.78	1.93									
Mass of dry	soil		g	8.01	8.70									
Moisture Co	ontent		%	22,22	22 <u>.</u> 18		22.20							
liquid li	MIT	Те	st no.	1	2		3		1	I		2		3
Number of I	bumps			13	35		54							
Container n	0.			A6	A17		A9							
Mass of we	t soil + contai	ner (m ₃)	g	30.80	34.04	Ļ	31.20							
Mass of dry	soil + contair	ner (m ₂)	g	27.89	31.07	,	28.82							
Mass of cor	ntainer	(m ₁)	g	21.46	23.29)	22.09							
Mass of mo	isture	(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 Cont	ent		%	45,26	38,17	,	35.36					_		
80												Sample pre	paration	
-												washed on	425 μ m si	ieve
70											_	oven dried	105	°C
-														
60												Liquid limit	41	%
nt (%)												Plastic limit	22	%
												Plasticity	19	%
Moist						+						Liquid limit		%
30 -									_			Plastic limit		%
-												Plasticity index		%
20								_		+		Operator	Checked	Approved
-														
10 — 10			I	No-	of Bumps						 100	P.M.	K.B.	S.T.
10											.00	J		



Liquid L	imit (Cas	sagrande n	neth	od) and F	Plastic	Limit								
Projec	t : Geologi	cal Survey fo	or the	Preparato	ry Survey	/ on the	Project fo	or Co	onstru	ction	of Mu	nbai Trans	s Harbou	ır Link
						DEAL	_/028/015							
BH NO.:	BH-06	Sample Depth	i(m) :	-2.91	3.36	Sar	nple No. :		ID-M-E	3H-06-[00000	Date :	26-06	5-2015
			-		Test meth	nod : IS 2	720 : Part 5	_			1			
PLASTIC I	_IMIT	Te	st no.	1	2		Average			1		2	Ave	erage
Container n	0.			A49	A62									
Mass of wet	soil + contai	ner	g	29.90	30.34	ļ.								
Mass of dry	soil + contair	ner	g	27.49	27.80)								
Mass of con	itainer		g	18.71	18.57	7								
Mass of moi	isture		g	2.41	2.54									
Mass of dry	soil		g	8.78	9.23									
Moisture Co	ontent		%	27.45	27.52	2	27.48							
liquid lii	ИІТ	Te	st no.	1	2		3			1		2		3
Number of b	oumps			13	40		54							
Container n	0.			A29	A5		A9							
Mass of wet	soil + contai	ner (m ₃)	g	38.70	36.20)	31.40							
Mass of dry	soil + contair	ner (m ₂)	g	34.58	32.17	7	28.82							
Mass of con	itainer	(m ₁)	g	26.13	22.38	3	22.09							
Mass of moi	isture	(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 Conte	ent		%	48.76	41.16	5	38.34							
80												Sample pre	paration	
-												washed on	425 u m s	
70												oven dried	μin 3 105	°C
-														
60 -											_	Liquid limit	44	%
(%)												Plastic limit	27	%
10 10 10 10 10 10 10 10 10 10 10 10 10 1											-	Plasticity		
e												index	17	%
oistu									\pm			Liquid limit		%
Σ												Plastic limit		%
30 +												Plasticity index		%
20									-			Operator	Checked	Approv
-														
10 +				* No	of Bumps							P.M.	K.B.	S.T.

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APPENDIX-D - STRENGTH TEST RESULTS





PRO	JEC	CT : G	eologic	al Surv	ey for t	he Pre	eparate	ory Sur Harbou	vey on r Link	the \overline{Pr}	oject fo	r Cons	structic	on of M	umbai	Fran s
						Un	JOD N	ned Con	AL/02	sion Tes	st					
Borehol	e:	BH-1		Sample	Diamete	r (mm):	38	Bulk De	nsity(g/o	cm ³)	1.60	q _u :	3	32.0 kF	Pa	
Depth (m):	-6.32 -	-6.77	Sample	Height (r	nm):	76	Dry Den	sity (g/o	cm ³)	0.96	c _u :		16.0 kF	°a	
	^{‡0} [
:	38						_								_	
:	36														_	
:	34															
:	32										-	•				
:	30														•	
:	28															
:	26							,								
:	24						+/	/								
(Pa)	22															
tress (k	20															
Axial S	18															
	16															
	14		-/	/												
	12															
	10															
	8															
	6															
	4															
	2	<u> </u>								_						
	0		ļ													
	0.0	00 1	.00 2	2.00 3	.00 4.	.00	5.00	6.00 Axial	7.00 Strain	8.00 (%)	9.00	10.00	11.00	12.00	13.00	14.00
qu = Unc cu = Und	onfine	ed Comp d Cohesi	ressive Sti on	rength		_									Pla	ate-D





PROJE	CT : G	eologic	al Sur	vey for	the Pi	reparat Job N	tory Su Harbo No.: ID	rvey o ur Link EAL/02	n the P : :8/015	roject	for Co	nstruc	tion of	Mumb	ai Trans
			T		U	nconfi	ned Co	mpres	sion Te	est					
Borehole:	BH-2		Sample	e Diame	ter (mm)): 38	Bulk D	ensity(g	/cm ³)	1.6	D q.	.:	8.0	kPa	
Depth (m):	-7.54 -	-7.99	Sample	e Height	(mm):	76	Dry De	ensity (g/	cm ³)	0.72	2 Շ _ւ	:	4.0	kPa	
10															
9															
8										•	*			•	
7									×	/					
Stress (kPa) G					_ x	-									
Axial				×											
3			^												
	•	×													
2															
0.	• .00 1.	00 2.0	00 3.0	00 4.	00 5.	00 6.	00 7. Axia	00 8.0 al Strain	00 9.0 (%)	00 10.	00 11	.00 12	.00 13	+ .00 14	.00 15.00

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APPENDIX-E - COMPRESSIBILITY TEST RESULTS





Proiect	::Geologica	al Survey	/ for the Pre	CONSOLIDATION TES	ST RESULTS	tion of Mumbai	Trans Harbour Link
		quartey		Job No.: IDEAL/0	28/015		
BH-No	: BH-01			Diameter of Specimen(cm)	6		
Depth (m)	: -6.326.77	,		Area of Specimen,A (cm ²)	27.94	σ	。: 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	ງ: 1.699
				Height of Solids (H _s) :	7.41		
Applied Pressure σ (kN/m²)	Final Dial Reading	Dial Change	Dial Change ∆H(mm)	Specimen Height (H=H ₁ + Δ H) (mm)	Height of voids= H-H _s (mm)	Void Ratio e=(H-H _s)/H _s	Coefficient of Volume Change M _v =(∆e/1+e _o)/∆σ(m²/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						
1.750							
1.700							
		-					
- 1.650 -							
-							
1.600 -							
1.550 -							
1.500							
1.450 -						$ \rangle $	
1.400 -							
						$ $ λ	
-							
1.350 -							
1			\searrow				
]							
1.300 -							
•							\rightarrow
]							
1.250							
1	0				100		1000
				Pressur	e kN/m²		





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 Area of Specimen,A (cm²) $\sigma_{\rm c}$: 46 KN/m² Depth (m) : -7.54 - -7.99 27.94 Wt. of Dry Soil (gm) 42.90 Specific Gravity of Sample 2.54 C_C : 0.851 e₀: 2.308 Dial Gauge L.C.,mm Initial Height of Sample (H_{o}) : 20.0 0.002mm Height of Solids (H_s) : 6.05 Dia Dial Change Applied Pressure Final Dial Specimen Height Height of voids= Void Ratio Coefficient of Volume Change σ (kN/m²) ∆H(mm) (H=H₁+ Δ H) (mm) $M_v = (\Delta e/1 + e_o)/\Delta \sigma (m^2/kN)$ Reading Change H-H_s(mm) e=(H-H_s)/H_s 0 3500 -5 -0.01 20.000 13.95 2.308 3495 -0.17 10 -83 19.990 13.94 2.306 5.0000E-05 -376 20 3412 -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 1540 -869 -1.74 16.080 10.03 1.660 9.6325E-04 200 1.372 400 671 217 14.342 8.30 5.4042E-04 0.43 50 888 170 0.34 14.776 8.73 1.444 8.6459E-05 146 9.07 1.500 7.6701E-04 1058 0.29 15.116 20 0 1204 2.400 2.300 2.200 2.100 2.000 1.900 1.800 1.700 1.600 1.500 1.400 1.300 100 1000 10 Pressure kN/m²

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APPENDIX-F - CORE BOX PHOTOGRAPHS







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

















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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







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BOREHOLE NO. : BH-03

Depth (m) : -26.90 - -28.40











Depth (m) : -16.10 - -25.60

Core Box 01 of 02



BOREHOLE NO. : BH-04

Depth (m) : -25.60 - -31.80









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







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

