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PROJECT

GEOTECHNICAL INVESTIGATION FOR THE PROPOSED RESIDENTIAL APARTMENTS CONSISTING OF STILT + 3 UPPER FLOORS IN PLOT No.5, BEARING No. P/606, VOC STREET, OLD MAHABALIPURAM ROAD, KOTTIVAKKAM, CHENNAI - 600041; COMPRISED IN OLD SURVEY Nos.278/10A & 278/10B, THEN SURVEY Nos.278/10A3 & 278/10B3, AS PER PATTA PRESENT SURVEY Nos.278/10A3A, 278/10A3B1, 278/10A3B2, 278/10B3A, 278/10B3B1 AND 278/10B3B2, SITUATED AT KOTTIVAKKAM VILLAGE, SHOLINGANALLUR TALUK, CHENNAI DISTRICT; LIES WITHIN THE LIMIT OF GREATER CHENNAI CORPORATION.

CLIENT

M/S ARIHANT FOUNDATIONS & HOUSING LTD,
NEW #3, OLD #25, GANAPATHY COLONY,
3RD LANE, OFF CENOTAPH ROAD,
TEYNAMPET, CHENNAI
TAMIL NADU- 600 018.

TITLE

GEOTECHNICAL INVESTIGATION REPORT

REPORT NO.: GT- 2626

GEO MARINE CONSULTANTS (P) LTD. Chennai 600 041

DATE	REVISON	DESCRIPTION		AUTHORISED SIGNATORY
01/09/2023	0.0	SUBMISSION OF GEOTECHNICAL REPORT	SIGN	
			DATE	01/09/2023
			DESIGNATION	**MANAGING DIRECTOR**
			NAME	**DR. C.V.PRASAD**

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REPORT TEXT

CHAPTER-1

INTRODUCTION

1.0 PROJECT INFORMATION MATRIX:

NATURE OF PROJECT: **PROPOSED RESIDENTIAL BUILDING**
STRUCTURE : **STILT+ 3 UPPER FLOORS**
PROJECT CLIENT : **M/s ARIHANT FOUNDATIONS & HOUSING LTD.,**
PROJECT LOCATION : **VOC STREET, KOTTIVAKKAM, CHENNAI**
JOB CODE : **GT-2626**

1.1 SCOPE OF WORK:

1.1.1 FIELD WORK:

- Conducting two soil investigation bore holes of 150 mm diameter in Soil & Overburden.
- In case of rock formation NX Diameter with Core barrel shall be adopted to progress the drilling up the termination depth.
- Conducting Standard Penetration Test (SPT) within the borehole at:
  - Every 1.0m depth interval up to 6.0m.
  - From 6.0m to 12.0m, SPT is conducted at every 1.5m depth interval
  - In case of rock formation, the core drilling shall be carried out and checked for recovery at every 1.5m depth interval
- The depth of investigation is 15.0m below the existing ground level.
- Collection of disturbed soil samples at SPT location and undisturbed samples from the clayey strata with SPT-value greater than 2 to less than 15 if met within the investigation depth
- Collection of disturbed soil sample (Split Spoon Sample) and rock core sample.
- Collection of water samples if groundwater table met within the investigation depth.

1.1.2 LABORATORY WORK:

- Natural Moisture Content
- Atterberg's limits
- Grain Size Analysis
- Chemical Analysis test on soil and water samples to give pH, Chlorides and Sulphates

1.2 STRUCTURE OF THE REPORT:

- Contents
- Introduction
- Investigation Methodology & Test Results
- Sub-Surface Stratification
- Liquefaction Studies
- Foundation System
- Recommendation
- Annexure

CHAPTER-2

INVESTIGATION METHODOLOGY & TEST RESULTS

2.0 PREAMBLE:

Two soil investigation boreholes were put as per the planning of the engineer in-charge and these locations are shown in Fig.2.0.

The equipment used and the methodology adopted to carry out the fieldwork is described below.

2.1 METHODOLOGY OF FIELD WORK:

2.1.1 EQUIPMENT USED AND METHOD OF DRILLING:

All the boreholes were sunk by conventional rotary drilling rigs. For borehole Methodology followed for boring conformed to IS: 1892 -2000. Boring was progressed by the cutting action of rotating bit with water circulation and stabilizing the side of the boreholes by using casing pipes/bentonite slurry up to required depth to prevent collapse of sidewall. Boring was continued by normal boring process using MS soil cutter in soil. However, Tungsten Carbide (TC) bit drilling was resorted to drill in highly weathered rock stratum where the normal boring process became slow. Diamond Core (DC) bit drilling was adopted in moderately weathered rock formations where penetration using TC bit was became slow.

2.1.2 STANDARD PENETRATION TESTS:

This is a field test to determine "Penetration Resistance of Stratum at the Test Depth" This has been conducted in the boreholes generally up to refusal depth using procedures described in IS: 2131- 2002. In this test, split spoon sampler (50.8 mm OD and 35 mm ID) has replaced driving bit. Sampler is then driven by dropping 63.5 kg hammer on top of driving collar with free fall of 75 cm. The length of sampler is 60 cm.

The tests were conducted at the depth intervals indicated in Chapter-1 (Sec.1.1.1).

2.1.4 COLLECTION OF SOIL SAMPLES:

2.1.4.1 DISTURBED SAMPLES:

The SPT-samples collected were used as disturbed soil samples. These samples were used for visual and physical identification and for conducting laboratory classification tests as per I.S.1498-1970.

2.1.5 COLLECTION OF GROUND WATER SAMPLES:

One representative water sample from each borehole was collected after 24 hours of completing the borehole if water table met within the investigated depth.

Note on Groundwater Table Record:

- Groundwater table observation in geotechnical report is predominantly to arrive at foundation design criteria and shall not be construed as design guidelines for the design of dewatering systems
- The groundwater level indicated in the bore logs is specific to the duration of investigation and intensity of the monsoon rains during the time of investigation. Hence, the level shall be taken as guidelines only to plan the investigation for the dewatering system

2.2 LABORATORY TESTING:

2.2.1 ON COARSE GRAINED SOIL:

On the representative samples, sieve analysis tests were conducted to arrive at grain size distribution. These tests were conducted as per I.S.2720 (part 4)-1985 and the results are presented in Tables-2.1 & 2.2. The graphical representation of grainsize distribution curve for the representative samples in each bore is presented in Fig. 2.3 & 2.4.

2.2.2 ON FINE GRAINED SOIL:

On the SPT sample index property tests were conducted to estimate consistency. These test results are presented in Tables-2.1 & 2.2. The graphical representation of hydrometer analyses curve for the representative samples in each bore is presented in Fig. 2.5 & 2.6.

2.2.3 CHEMICAL ANALYSIS TESTS:

On representative soil and water samples chemical analysis tests were conducted to estimate pH, Chloride and Sulphates and these results are presented in Table 2.3 & 2.4.

2.3 SUMMARY:

- The locations of the field investigation tests are shown in site plan given in Fig.2.0
- The sub soil profiles encountered at each location alonq with their classification and engineering properties are presented in Fig. 2.1 & 2.2.
- The laboratory test results are presented in Table 2.1 & 2.2.
- The chemical test results are presented in Table 2.3 & 2.4.

SITE PLAN

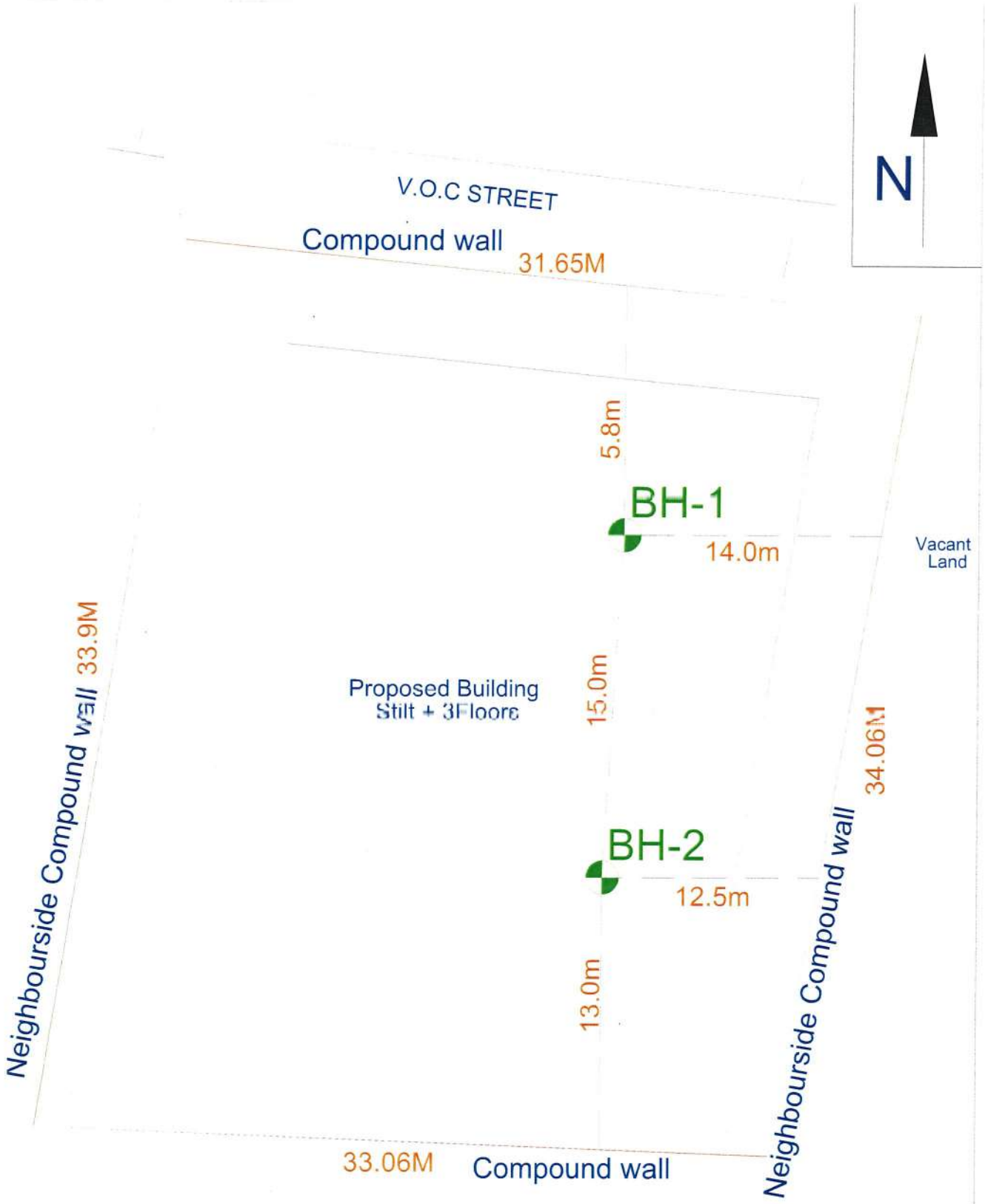


FIG. 2.0 SITE PLAN SHOWING THE FIELD INVESTIGATION BOREHOLE LOCATION

SOIL PROFILES

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SITE INVESTIGATION RECORD

BORE HOLE No.	BH-01						
SHEET	1	OF	2				
PROJECT NAME	PROPOSED CONSTRUCTION OF A RESIDENTIAL BUILDING					DIA OF BORE HOLE	150mm ✓ / NX
LOCATION	Kottivakkam, Chennai	MACHINE No.	CR-06	Free Fall Energy (%)	60	BORE START DATE	08/08/2023
STRUCTURE	Stilt + 3 Upper Floors	DRILLING METHOD	Rotary	CO-ORDINATES	N -	BORE END DATE	09/08/2023
JOB CODE	GT-2626	FLUSHING MEDIUM	Bentonite		E -	TOTAL DRILL DAYS	2

Depth below E.G.L. (m)	Drilling progress per metre: Date	Time: Hr.	Time: Min.	Type of Drill Bit (SC / TCB / DB)	Core Details: Total Core Recovery %	Core Details: R.Q.D %	SPT Details: Blows/cm. 0-15	Blows/cm. 15-30	Blows/cm. 30-45	SPT Value: N80	SPT Value: N	Sample Details	No.	Type	RL (m)	Legend	No	Depth	Layer Data: Geotechnical Description
0	08/08/2023	12	00	SC	-	-													
		To																	
		12	10				26	30	30	-	60	0.50	1	SS	-0.5				Brown,Fine & Medium Sand Grains With Gravel Size Particles,Very Dense,**Silty SAND (SM) With Brick Pieces/ Constructional Debris (Filled Up Soil)**
		12	25									0.95							
1		To		SC	-	-											L1	1.25	
		13	00				16	16	10	-	26	1.25	2	SS	-1.25				
		14	00									1.70							Brown,Moist,Poorly Graded,Fine & Medium Sand Grains,Medium Dense, **Clayey Silty SAND (SC) With Traces of Brick Pieces**
		To		SC	-	-													
2		14	01				1	2	2	-	4	2.00	3	SS	-2.0		L2	2.0	
		14	09									2.45							
		To		SC															Brown,Brown Grey,Moist,Soft,**Silty CLAY (CH)** Clay of High Plasticity
		14	10																
3							-	-	-	-	-	3.00	-	*UDS	-3.0		L3	3.0	
		14	30																
		To		SC	-	-													
		14	31																
4							1	1	1	-	2	4.00	4	SS	-4.0				
		14	40									4.45							
		To		SC	-	-													
		14	41																
5							1	1	1	-	2	5.00	5	SS	-5.0				Grey,Moist,Poorly Graded,Fine & Medium Sand Grains,Very Loose,**Silty SAND (SM) & Poorly Graded- Silty SAND (SP-SM)**
		14	50									5.45							
		To		SC	-	-													
		14	51																
6							1	1	1	-	2	6.00	6	SS	-6.0				
		15	00									6.45							
		To		SC	-	-													
7		15	01														L4	7.5	
							2	9	15	-	24	7.50	7	SS	-7.5				
		15	35									7.95							
8		To		SC	-	-													Grey,Moist,Poorly Graded,Fine & Medium Sand Grains,Medium Dense, **Poorly Graded- Silty SAND (SP-SM)**
		15	36																
9							8	18	21	-	39	9.00	8	SS	-9.0		L5	9.0	
		15	50									9.45							
		To		SC	-	-													
10		15	55														L6	10.0	Grey,Grey Brown,Fine to Coarse Sand Size Particles,Dense,**Residual Soil to Completely Weathered Rock- Grade W5 Weathered Rock Fromation** Disintegrated Hypersthene Granitic Rock

CS - Core Sample	DS - Disturbed Sample	LOGGED	S.Stephenraj	PROJECT SITE DETAILS		REMARKS	
SS - Split Spoon Sample	SC - Soil Cutter	DATE	08/08/2023	GROUND LEVEL (m)	0.00		
UDS- Undisturbed Sample	TCB - Tungsten Carbide Bit	CHECKED	G.Sharmila	WATER TABLE (m)	0.50	(*UDS)-Sample Failed	
WS - Wash Sample	DB - Diamond Bit	DATE	09/08/2023	CASING DEPTH (m)	0.00		

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SITE INVESTIGATION RECORD

BORE HOLE No.	BH-01						
SHEET	2	OF	2				
PROJECT NAME	PROPOSED CONSTRUCTION OF A RESIDENTIAL BUILDING					DIA OF BORE HOLE	150mm ✓ / NX ✓
LOCATION	Kottivakkam, Chennai	MACHINE No.	CR-06	Free Fall Energy (%)	60	BORE START DATE	08/08/2023
STRUCTURE	Stilt + 3 Upper Floors	DRILLING METHOD	Rotary	CO-ORDINATES	N -	BORE END DATE	09/08/2023
JOB CODE	GT-2626	FLUSHING MEDIUM	Bentonite		E -	TOTAL DRILL DAYS	2

Depth below E.G.L (m)	Drilling progress per metre: Date	Time: Hr.	Time: Min.	Type of Drill Bit (SC / TCB / DB)	Core Details: Total Core Recovery %	Core Details: R.Q.D %	SPT Details: Blows/cm. 0-15	15-30	30-45	SPT Value: N80	SPT Value: N	Sample Details: Depth	No	Type	RL (m)	Legend	Layer Data: No	Depth	Geotechnical Description
11	08/08/2023	16	20																
		To		OC	-	-													
		17	50																
12							5Cm Penet for 50 Blows			-	>100	10.50 / 10.55	-	WS	-10.5				Grey,Grey Brown,Fine to Coarse Sand Size Particles,Very Dense,**Residual Soil to Completely Weathered Rock- Grade W5 Weathered Rock Fromation** Disintegrated Hypersthene Granitic Rock
							5Cm Penet for 50 Blows			-	>100	12.00 / 12.05	0	SS	-12.0				
13	09/08/2023	09	00																
		To		DB	-	-													
		10	15																
							SPT-Hammer Rebound			-	>100	13.50	-	WS	-13.5				
14		10	40																
		To		DB	27	0													
		11	25																
15							-	-	-	-	-	15.00	10	CS	-15.0		L8	15.0	Grey,Grey Brown,Medium to Coarse Grain Structure,Highly Weathered & Fractured,**Moderately Weathered Rock- Grade W3 Rock Formation** Fractured Hypersthene Granitic Rock
16																			
17																			
18																			
19																			
20																			

CS - Core Sample	DS - Disturbed Sample	LOGGED	S.Stephenraj	PROJECT SITE DETAILS		REMARKS
SS - Split Spoon Sample	SC - Soil Cutter	DATE	09/08/2023	GROUND LEVEL (m)	0.00	
UDS- Undisturbed Sample	TCB - Tungsten Carbide Bit	CHECKED	G.Sharmila	WATER TABLE (m)	0.50	
WS - Wash Sample	DB - Diamond Bit	DATE	09/08/2023	CASING DEPTH (m)	0.00	

Borehole terminated at 15 m depth below E.G.L

FIG.2.1 Sub Soil Profile at BH-01 Location

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SITE INVESTIGATION RECORD

BORE HOLE No. **BH-02**
SHEET 1 OF 2

PROJECT NAME	PROPOSED CONSTRUCTION OF A RESIDENTIAL BUILDING					DIA OF BORE HOLE	150mm ✓ / NX
LOCATION	Kottivakkam, Chennai	MACHINE No.	CR-06	Free Fall Energy (%)	60	BORE START DATE	09/08/2023
STRUCTURE	Stilt + 3 Upper Floors	DRILLING METHOD	Rotary	CO-ORDINATES	N -	BORE END DATE	10/08/2023
JOB CODE	GT-2626	FLUSHING MEDIUM	Bentonite		E -	TOTAL DRILL DAYS	2

Depth below E.G.L. (m)	Drilling progress per metre: Date	Time: Hr.	Time: Min.	Type of Drill Bit (SC / TCB / DB)	Core Details: Total Core Recovery %	Core Details: R.Q.D %	SPT Details: Blows/cm. 0-15	Blows/cm. 15-30	Blows/cm. 30-45	SPT Value: N80	SPT Value: N	Sample Details:	No.	Type	RL (m)	Layer Data: Legend	No	Depth	Geotechnical Description
1	09/08/2023	15	00 To 15 01	SC	-	-	10	20	24	-	44	0.50 ↓ 0.95	1	SS	-0.5		L1	1.25	Brown,Poorly Graded,Fine & Medium Sand Grains with Traces of Gravel Fractions,Very Dense,**Silty SAND With Brick Pieces/ Constructional Debris** (Filled Up Soil)
		15	20 To 15 25	SC	-	-	2	2	6	-	8	1.25 ↓ 1.70	2	SS	-1.25				
2		17	00 To 17 01	SC	-	-	4	6	10	-	16	2.00 ↓ 2.45	3	SS	-2.0		L2	2.00	Brown,Moist,Fine Sand Grains & Gravel Mix,Stiff,**Sandy Silty CLAY (CI)** Sandy Clay of Medium Plasticity
3		09	00 To 09 01	SC	-	-	5	3	2	-	5	3.00 ↓ 3.45	4	SS	-3.0		L3	3.00	Brown,Moist,Poorly Graded, Predominantly Fine Sand Grains, Medium Dense,**Silty SAND (SM)**
4		09	10 To 09 11	SC	-	-	2	2	2	-	4	4.00 ↓ 4.45	5	SS	-4.0				
5		09	20 To 00 21	SC	-	-	1	1	1	-	2	5.00 ↓ 5.45	6	SS	-5.0				
6	10/08/2023	09	30 To 09 31	SC	-	-	1	1	1	-	2	6.00 ↓ 6.45	7	SS	-6.0				Grey,Brown Grey,Moist,Poorly Graded,Fine & Medium Sand Grains,Very Loose & Loose,**Silty SAND (SM), Poorly Graded- Silty SAND (SP-SM) & Poorly Graded SAND (SP)**
7		09	50 To 09 51	SC	-	-													
8		10	10 To 10 14	SC	-	-	1	1	1	-	2	7.50 ↓ 7.95	8	SS	-7.5				
9		10	30 To 10 45	SC	-	-	20	61	Hammer Rebound	-	>100	9.00 ↓ 9.30	9	SS	-9.0		L4	9.00	
10																+ + + + + + + + + + + +			Grey,Brown Grey,Moist,Fine & Medium Sand Grains Particles,Very Dense,**Residual Soil to Completely Weathered Rock- Grade W5 Rock Formation** Disintegrated Hypersthene Granitic Rock

CS - Core Sample	DS - Disturbed Sample	LOGGED	S.Stephenraj	PROJECT SITE DETAILS		REMARKS
SS - Split Spoon Sample	SC - Soil Cutter	DATE	10/08/2023	GROUND LEVEL (m)	0.00	
UDS- Undisturbed Sample	TCB - Tungsten Carbide Bit	CHECKED	G.Sharmila	WATER TABLE (m)	2.00	
WS - Wash Sample	DB - Diamond Bit	DATE	14/08/2023	CASING DEPTH (m)	0.00	

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SITE INVESTIGATION RECORD

BORE HOLE No.	BH-02						
SHEET	2	OF	2				
PROJECT NAME	PROPOSED CONSTRUCTION OF A RESIDENTIAL BUILDING					DIA OF BORE HOLE	150mm / NX ✓
LOCATION	Kottivakkam, Chennai	MACHINE No.	CR-06	Free Fall Energy (%)	60	BORE START DATE	09/08/2023
STRUCTURE	Stilt + 3 Upper Floors	DRILLING METHOD	Rotary	CO-ORDINATES	N -	BORE END DATE	10/08/2023
JOB CODE	GT-2626	FLUSHING MEDIUM	Bentonite		E -	TOTAL DRILL DAYS	2

Depth below E.G.L (m)	Drilling progress per metre: Date	Time: Hr.	Time: Min.	Type of Drill Bit (SC / TCB / DB)	Core Details: Total Core Recovery %	Core Details: R.Q.D %	SPT Details: Blows/cm. 0-15	Blows/cm. 15-30	Blows/cm. 30-45	SPT Value: N80	SPT Value: N	Sample Details: Depth	No.	Type	RL (m)	Legend	Layer Data: No	Depth	Geotechnical Description
11	10/08/2023	11	00	DB	-	-	10Cm Penet for 50Blows			-	>100	10.50 / 10.60	10	SS	-10.5				Grey,Brown Grey,Moist,Fine & Medium Sand Grains Particles,Very Dense,**Residual Soil to Completely Weathered Rock- Grade W5 Rock Formation** Dicintegrated Hyperathene Granitic Rock
		To																	
		11	35																
12							SPT-Hammer Rebound			-	>100	12.00	-	WS	-12.0		L5	12.0	
		11	55																
13		To		DB	18	0													
		13	00				-	-	-	-	-	13.50	11	CS	-13.5				Grey,Brown Grey,Medium to Coarse Grain Structure,Highly Weathered & Fractured,**Moderately Weathered Rock- Grade W3 Rock Formation** Fractured Hypersthene Granitic Rock
14		14	00																
		To		DB	24	0													
		15	10																
15							-	-	-	-	-	15.00	12	CS	-15.0		L6	15.0	
16																			
17																			
18																			
19																			
20																			

CS - Core Sample	DS - Disturbed Sample	LOGGED	S.Stephenraj	PROJECT SITE DETAILS	REMARKS
SS - Split Spoon Sample	SC - Soil Cutter	DATE	10/08/2023	GROUND LEVEL (m) 0.00	
UDS- Undisturbed Sample	TCB - Tungsten Carbide Bit	CHECKED	G.Sharmila	WATER TABLE (m) 2.00	
WS - Wash Sample	DB - Diamond Bit	DATE	14/08/2023	CASING DEPTH (m) 0.00	

Borehole terminated at 15 m depth below E.G.L

FIG.2.2 Sub Soil Profile at BH-02 Location

GRAIN SIZE DISTRIBUTION CURVE

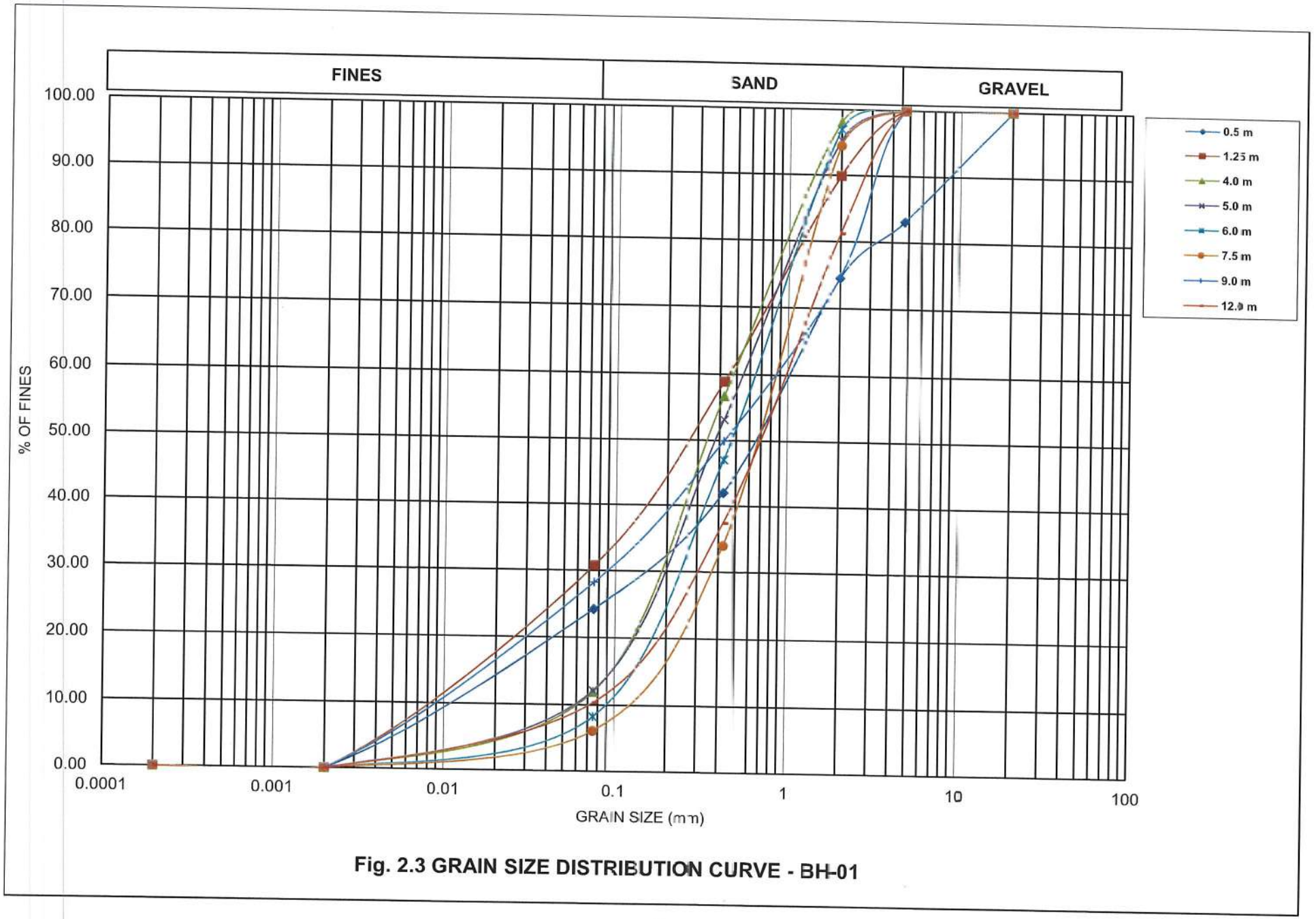


Fig. 2.3 GRAIN SIZE DISTRIBUTION CURVE - BH-01

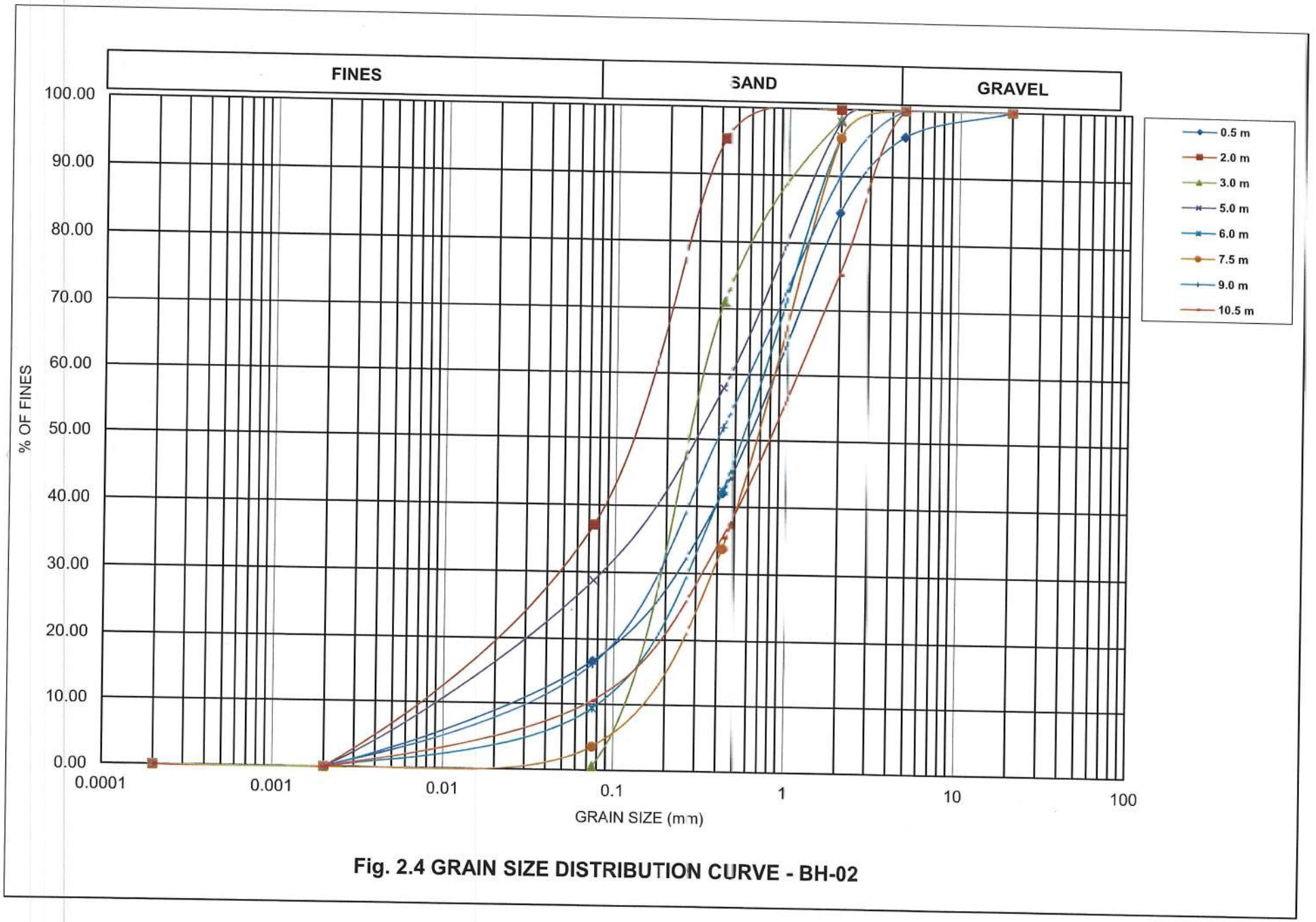


Fig. 2.4 GRAIN SIZE DISTRIBUTION CURVE - BH-02

HYDROMETER ANALYSIS CURVE

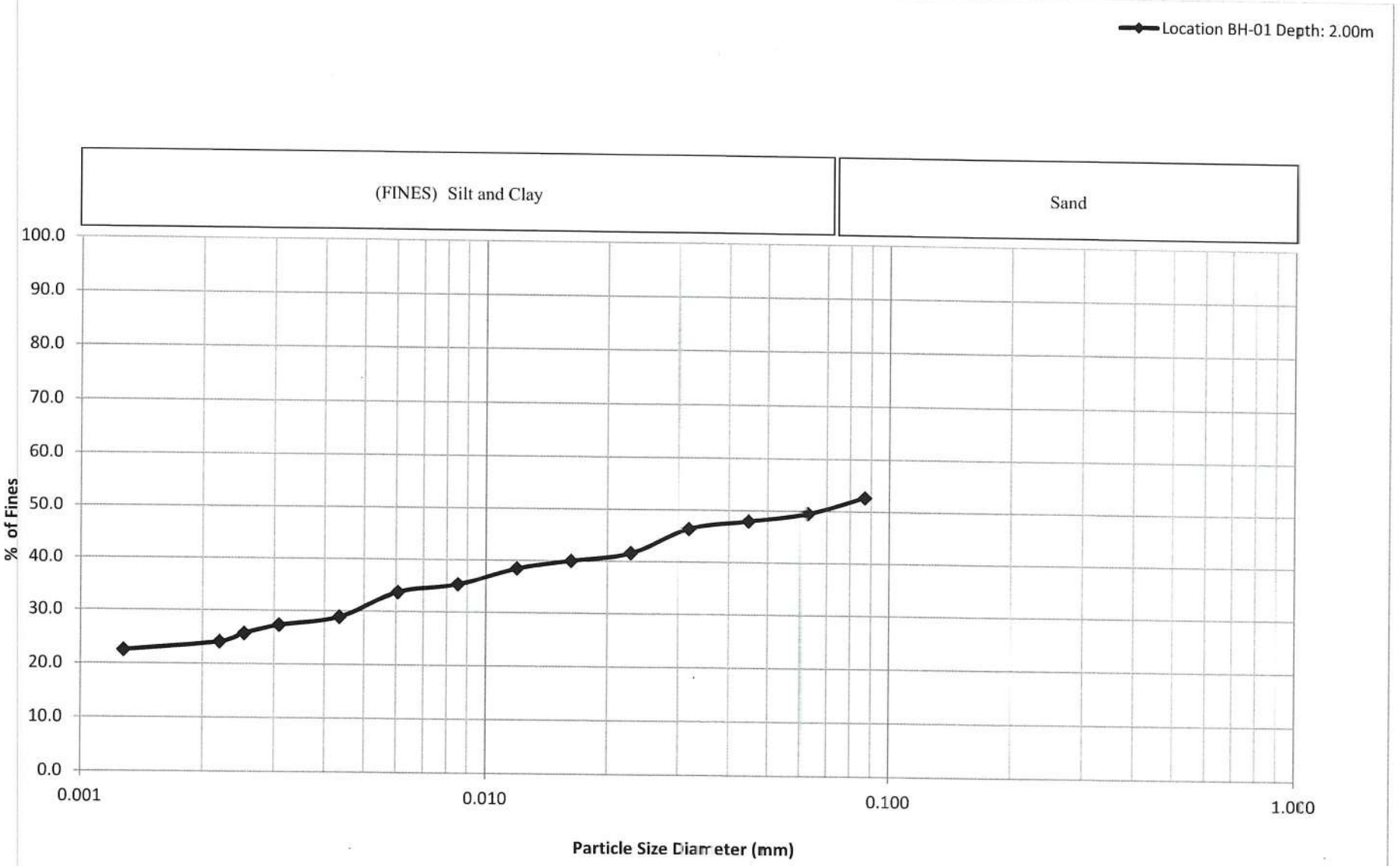


Fig 2.5 Hydrometer Analysis Master Curve

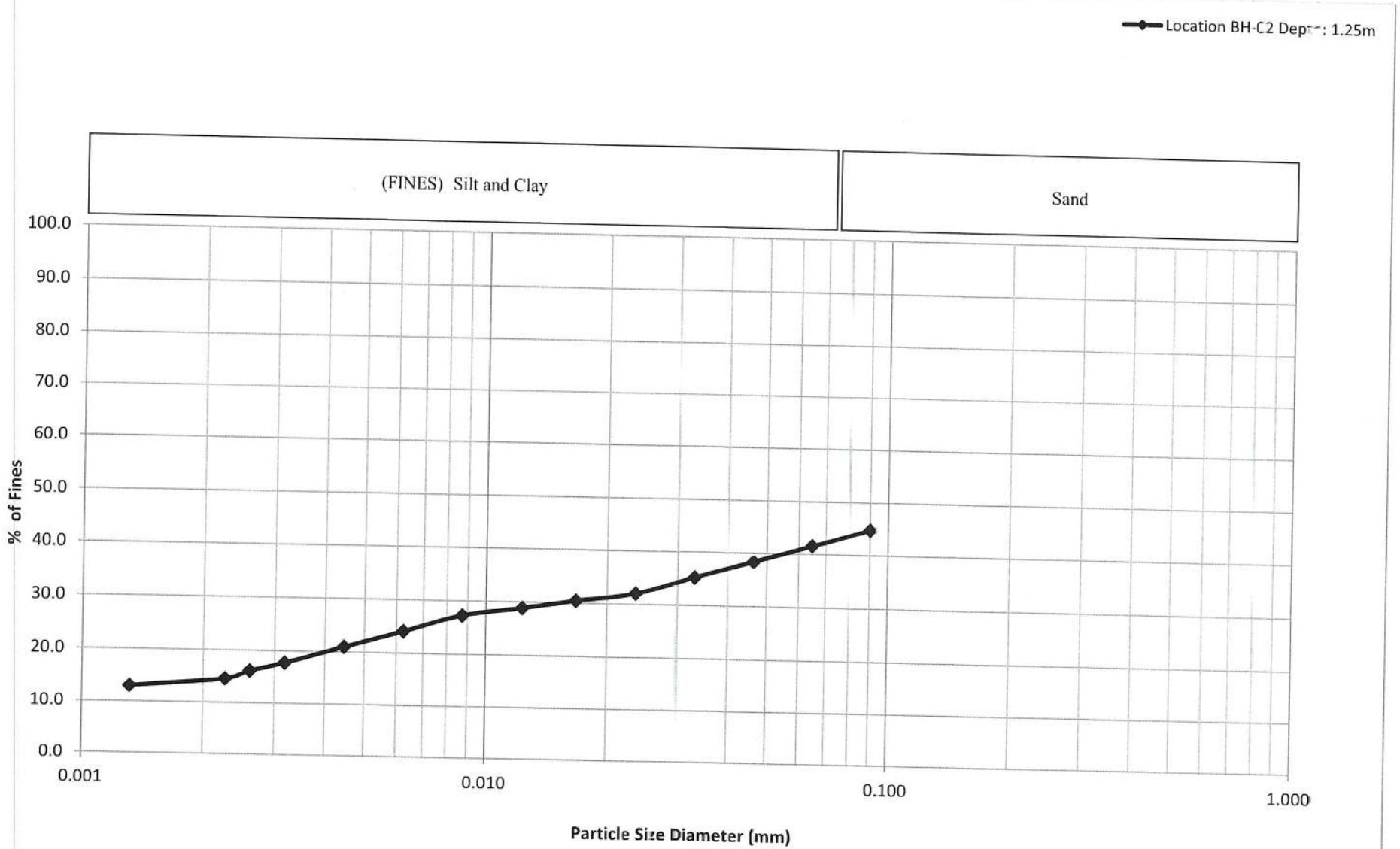


Fig 2.6 Hydrometer Analysis Master Curve

LABORATORY TEST RESULTS

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Phone No.: 044-24481485, 044-24480305
ULR No : TC114102300000096F

LABORATORY TEST REPORT

GEOMARINE CONSULTANTS PVT LTD- GEOTECHNICAL LABORATORY
NO.11 2nd MAIN ROAD, KANNAPA NAGAR EXTN,
KOTTIVAKKAM, CHENNAI

TC-11410

Name & Address of the Customer	:	**M/s ARIHANT FOUDNATIONS & HOUSING LTD.,**	**Customer Reference**	: By Email
Sample Description	:	Soil Sample	**Period of Testing**	: 11/08/2023 to 21/08/2023
Source of Sample	:	Customer Supplied- Borehole No. BH-01	**Sample Identification Number**	: GMC/0823/716
Sample Condition	:	Satisfactory	**Test Report No.**	: GT-2626
Test Method	:	As per Bureau of Indian Standards	**Report Date**	: 01/09/2023
Sample Receipt Date	:	11/08/2023	**Test Report Pages**	: One Page

Table-2.1 Laboratory Classification of Soil Samples from BH-01

Sample Depth (m)	SPT- "N" Value	Type of Sample	Fine Grained (FG)											Coarse Grained (CG)														
			Moisture Content (%) AS PER IS 2720 (P-II) - 1973, RA-2015	LIQUID LIMIT (%) AS PER IS 2720 (P-V) - 1985, RA-2015	PLASTIC LIMIT (%) AS PER IS 2720 (P-V) - 1985, RA-2015	Plasticity Index (I_P= LL-PL)	Consistency Index (Ic=LL-NMC/I_P)	SHRINKAGE LIMIT (%) AS PER IS 2720 (P-VI) - 1972, RA-2011	FREE SWELL INDEX (%) AS PER IS 2720 (P-XL) - 1977, RA-2011	Consistancy	Position With Respect to A-Aline	IS:Notation	SPECIFIC GRAVITY AS PER IS 2720 (P-III, SEC-1) - 1980, RA-2010	GRAIN SIZE ANALYSIS AS PER IS 2720 (P-IV) - 1985, RA-2015						D_{10} (mm)	D_{30}(mm)	D_{60} (mm)	Uniformity Co-Efficient $C_U=D_{60}/D_{10}$	Co-Efficient of Curvature $C_c=D_{30}^2/(D_{10}xD_{60})$	Relative Density	IS-Notation	
														Gravel (%)	Coarse (%)	Medium (%)	Fine (%)	Silt (%)	Clay (%)							Gravel	Sand
0.5	60	SS	11.0	-	-	-	-	-	-	CG>50%	-	-	-	16.8	8.6	32.5	17.7	24.3		-	-	-	-	-	V.Dense	<50%	SM
1.25	26	SS	17.7	24.1	15.0	9.0	0.7	-	0.0	CG>50%	Above	-	-	0.0	10.1	31.0	28.2	30.8		-	-	-	-	-	M.Dense	<50%	SC
2.0	4	SS	39.9	53.8	23.7	30.1	0.5	10.7	6.7	Soft	Above	CH	-	-	-	-	-	75.9	24.1	-	-	-	-	-	FG>50%	FG>50%	FG>50%
4.0	2	SS	21.5	-	-	-	-	-	-	CG>50%	-	-	-	0.0	7.8	41.4	44.8	12.0		-	-	-	-	-	V.Loose	<50%	SP-SM
5.0	2	SS	18.2	-	-	-	-	-	-	CG>50%	-	-	-	0.0	4.6	42.2	41.0	12.2		-	-	-	-	-	V.Loose	<50%	SM
6.0	2	SS	18.0	-	-	-	-	-	-	CG>50%	-	-	2.58	0.0	3.0	49.9	38.8	8.3		-	-	-	-	-	V.Loose	<50%	SP-SM
7.5	24	SS	15.6	-	-	-	-	-	-	CG>50%	-	-	-	0.0	5.5	60.5	27.8	6.2		-	-	-	-	-	M.Dense	<50%	SP-SM
9.0	39	SS	25.5	39.6	24.0	15.7	0.9	-	0.0	CG>50%	Above	-	-	0.0	25.3	24.8	21.7	28.3		-	-	-	-	-	Dense	<50%	SC
10.5	>100	WS	SPT Hammer Rebounded. Wash Sample Collected for Observation											23.1	29.3	35.3	7.3	0.0		-	-	-	-	-	V.Dense	<50%	SP
12.0	>100	SS	23.0	-	-	-	-	-	-	CG>50%	-	-	-	0.0	18.8	43.8	27.0	10.4		-	-	-	-	-	V.Dense	<50%	SP-SM
13.5	>100	WS	SPT Hammer Rebounded. Wash Sample Collected for Observation											0.0	4.7	83.7	10.6	1.1		-	-	-	-	-	V.Dense	<50%	SP

** END OF REPORT**

Terms and Conditions

(1) The test results furnished corresponds to the sample received
(2) The tested sample will not be retained for more than 45 days from the date of issue of test report except in the case as required by the applicable regulations.
(3) Any correction in this reports invalidates the reports

Authorised Signatory

A. VINOTH
(Technical Manager)

GEOMARINE
THE SPIRIT OF ENGINEERING
Phone No.: 044-24481485, 044-24480305
ULR No : TC114102300000096F

LABORATORY TEST REPORT

GEOMARINE CONSULTANTS PVT LTD- GEOTECHNICAL LABORATORY
NO.11 2nd MAIN ROAD, KANNAPA NAGAR EXTN,
KOTTIVAKKAM, CHENNAI

TC-11410

Name & Address of the Customer	:	**M/s ARIHANT FOUDNATIONS & HOUSING LTD.,**	**Customer Reference**	: By Email
Sample Description	:	Soil Sample	**Period of Testing**	: 11/08/2023 to 21/08/2023
Source of Sample	:	Customer Supplied- Borehole No. BH-02	**Sample Identification Number**	: GMC/0823/716
Sample Condition	:	Satisfactory	**Test Report No**	: GT-2626
Test Method	:	As per Bureau of Indian Standards	**Report Date**	: 01/09/2023
Sample Receipt Date	:	11/08/2023	**Test Report Pages**	: One Page

Table-2.2 Laboratory Classification of Soil Samples from BH-02

Sample Depth (m)	SPT- "N" Value	Type of Sample	Fine Grained (FG)										Coarse Grained (CG)												
			Moisture Content (%) AS PER IS 2720 (P-II) - 1973, RA-2015	LIQUID LIMIT (%) AS PER IS 2720 (P-V) - 1985, RA-2015	PLASTIC LIMIT (%) AS PER IS 2720 (P-V) - 1985, RA-2015	Plasticity Index (I_p= LL-PL)	Consistency Index (Ic=LL-NMC/I_p)	SHRINKAGE LIMIT (%) AS PER IS 2720 (P-VI) - 1972, RA-2011	FREE SWELL INDEX (%) AS PER IS 2720 (P-XL) - 1977, RA-2011	Consistency	Position With Respect to A-Aline	I.S.Notation	SPECIFIC GRAVITY AS PER IS 2720 (P-III, SEC-1) - 1980, RA-2010	GRAIN SIZE ANALYSIS AS PER IS 2720 (P-IV) - 1985, RA-2015						D_{10} (mm)	D_{30}(mm)	D_{60} (mm)	Uniformity Co-Efficient $C_U=D_{60}/D_{10}$	Co-Efficient of Curvature $C_c=D_{30}^2/(D_{10}XD_{60})$	Relative Density	IS-Notation	
													Gravel (%)	Coarse (%)	Medium (%)	Fine (%)	Silt (%)	Clay (%)							Gravel	Sand
0.5	44	SS	14.4	-	-	-	-	-	-	CG>50%	-	-	-	3.9	11.5	42.5	25.4	16.7		-	-	-	-	-	Dense	<50%	SM
1.25	8	SS	18.1	36.2	16.2	20.0	0.9	11.0	0.0	Stiff	Above	CI	-	7.3	1.3	7.7	17.0	57.1	9.7	-	-	-	-	-	FG>50%	FG>50%	FG>50%
2.0	16	SS	24.5	Binder					0.0	CG>50%	-	-	-	0.0	0.0	4.7	58.2	37.1		-	-	-	-	-	M.Dense	<50%	SM
3.0	5	SS	25.7						0.0	CG>50%	-	-	2.30	0.0	1.6	27.3	35.2	35.9		-	-	-	-	-	Loose	<50%	SM
5.0	2	SS	19.8	-	-	-	-	-	-	CG>50%	-	-	-	0.0	1.8	40.2	29.1	28.8		-	-	-	-	-	V.Loose	<50%	SM
6.0	2	SS	20.3	-	-	-	-	-	-	CG>50%	-	-	-	0.0	4.1	53.5	33.1	9.4		-	-	-	-	-	V.Loose	<50%	SP-SM
7.5	2	SS	16.1	-	-	-	-	-	-	CG>50%	-	-	-	0.0	4.3	31.9	30.2	33.6		-	-	-	-	-	V.Loose	<50%	SP
9.0	>100	SS	17.7	-	-	-	-	-	-	CG>50%	-	-	-	0.0	9.9	38.2	35.7	16.2		-	-	-	-	-	V.Dense	<50%	SM
10.5	>100	SS	16.6	-	-	-	-	-	-	CG>50%	-	-	-	0.0	24.6	40.0	24.9	10.6		-	-	-	-	-	V.Dense	<50%	SP-SM
12.0	>100	WS	SPT Hammer Rebounded. Wash Sample Collected for Observation											0.0	16.2	75.6	7.7	0.5		-	-	-	-	-	V.Dense	<50%	SP

** END OF REPORT**

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Authorised Signatory

A. VINOTH
(Technical Manager)

CHEMICAL LABORATORY TEST RESULTS

GEOMARINE
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LABORATORY TEST REPORT
GEOMARINE CONSULTANTS PVT LTD- GEOTECHNICAL LABORATORY
NO.11 2nd MAIN ROAD, KANNAPA NAGAR EXTN,
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TC-11410

Table 2.3 Result of Chemical Test

Name & Address of the Customer:	**M/s ARIHANT FOUNDATIONS & HOUSING LTD.,**		
Sample Description:	Water and Soil	**Sample Identification Number:**	GMC/0823/716
Source of Sample:	Customer Supplied	**Period of Testing:**	14/08/2023
Sample Condition:	Satisfactory	**Report Date:**	01/09/2023
Test Method	As per Bureau of Indian Standards	**Test Report No.:**	GT-2626
Sample Receipt Date:	11/08/2023	**Test Report Pages:**	One Page

S No.	Bore Hole Number	Water				SOIL (2:1)	
		DEPTH OF SAMPLE (m)	pH AS PER IS 3025 (P-XI) - 2022	SULPHATES (mg/l) AS PER APHA 23rd Edn.2017-4500	CHLORIDES (mg/l) AS PER IS 3025(P-XXXII) - 1988, RA-2019	DEPTH OF SAMPLE (m)	pH AS PER IS 2720 (P-XXVI) - 1987, RA-2021
1.0	BH-01	0.60	7.09	216.8	296.3	1.25	5.65
2.0	BH-02	2.00	7.75	350.9	315.7	2.00	5.51

** END OF REPORT **

Authorised Signatory

A. VINOTH
(Technical Manager)

Terms and Conditions

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(3) Any correction in this reports invalidates the reports

Table-2.4 Results of Chemical Test for Soil Sample				
SL No.	Bore HoleNo.	Soil (2:1)		
		Depth of Sample (m)	SULPHATES (mg/kg)	CHLORIDES (mg/kg)
1.0	BH-01	1.25	156.4	63.1
2.0	BH-02	2.00	314.9	165.0

CHAPTER-3

GEOLOGY & SUB-SURFACE STRATIFICATION

3.0 PREAMBLE:

Geotechnical investigation carried out at a specific site provides location specific sub surface engineering characteristics. However in major project sites where the construction activities spread over a very large area location specific sub surface strata characteristics are studied together with the geological mapping data.

This is required to incorporate the impact of any documented macro-level geological characteristics of the region on the foundation design, irrespective of the location specific sub surface strata characteristics.

In view on the above, though it is beyond the scope of the present study to carry out macro-level geological investigation the regional geology based on the published data is presented and discussed.

3.1 CLIMATE AND RAINFALL:

The study area receives the rain under the influence of both southeast and northeast monsoons. Predominantly northeast monsoon contributes rainfall and most of the precipitation occurs in the form of cyclonic storm caused due to the depressions in Bay of Bengal. The north east monsoon occurs between October & December. The southwest monsoon rainfall is highly erratic and summer rains are negligible.

The normal annual rainfall over the study area varies from 1100 mm to 1200mm.

3.2 GEOMORPHOLOGY:

Chennai district forms part of coastal plains of northern Tamil Nadu. Major part of the district is having flat topography with very gentle slope towards east. The altitudes of land surface vary from 10 m above MSL in the west to sea level in the east.

Fluvial, marine and erosional landforms are noticed in the district. Marine transgression and regressions and neo-tectonic activity during the recent past have influenced the morphology and resulted in various present landforms.

Meandering streams with small sand bars are present along the course of Adyar River. The pediment and buried pediment in Guindy area in and around the reserved forest, is the only area where the ecological system is less disturbed, while the other areas are completely disturbed by built up area with large-scale human interference and pollution.

3.3 GEOLOGY OF CHENNAI DISTRICT:

Chennai district is underlain by various geological formations from ancient Archaean to the Recent Alluvium. The geological formations of the district can be grouped into three units, namely

- Archaean crystalline rocks
- Gondwana (Consolidated Clay/Clayey Silt) and Tertiary sediments and
- Recent Alluvium.

The Archaean crystalline rocks of the district comprise chiefly of Charnockite, gneisses and the associated basic and ultra-basic intrusive dykes.

3.4 GEOLOGICAL ORDER OF THE STUDY AREA:

The stratigraphy of the study area can be classified as recent formation which is underlain by basement rock of meta-igneous origin (hypersthene granite/ Charnockite rock)

↑ Deposits of Recent Age

---------- Eparchean Unconformity ----------

Archaean Basement Rock (Charnockite Rock / Hypersthene Granite)

3.5 DESIGN SUB SOIL PROFILE: (WRT Foundation Engineering Application)

The sub soil characteristics obtained at the test location are further processed to arrive at the design soil parameters required for the design of sub structure using the following shear strength correlations with respect to the Standard Penetration Test Values of different layers.

- For Coarse Grained Material, Ref. IS: 6403 to estimate Angle of Shearing Resistance (Reproduced and shown in Fig A1)
- For Fine Grained Material, Ref. Terzaghi & Peck, 1948, to estimate Unconfined Compressive Strength (Reproduced and shown in Fig.A2)

Based on the above, the average design soil characteristics are given below:

REFERENCE BORE HOLE					BH-01	Ref R.L. of G.L. (m):			0.00		
Layer No.	Layer Thk. (m)			Type of Strata	Colour	Ave. Design SPT	Relative Density	Consistency	(γ) kN/m³	Shear Parameters	
	Top BGL	Bottom BGL	Thickness							(Cu) kPa	(ϕ) Deg.
1.0	0.00	1.25	1.25	Silty Sand	Brown	60	Very Dense	-	20.5	-	43
2.0	1.25	2.00	0.75	Clayey Silty Sand	Brown	26	Medium Dense	-	19	-	35
3.0	2.00	3.00	1.00	Silty Clay	Brown	4	-	Soft	14.5	27	-
4.0	3.00	7.50	4.50	Silty Sand	Grey	4	Very Loose	-	13.5	-	20
5.0	7.50	9.00	1.50	Silty Sand	Grey	24	Medium Dense	-	18.5	-	34
6.0	9.00	10.00	1.00	Residual Soil to CWR	Grey	36	Dense	-	19.5	-	38
7.0	10.00	13.50	3.50	Residual Soil to CWR	Grey	>100	Very Dense	-	21	-	43
8.0	13.50	15.00	1.50	Moderately Weathered Rock	Grey	CRR- 27% : RQD - 0%					

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REFERENCE BORE HOLE					BH-02	Ref R.L. of G.L. (m):			0.00		
Layer No.	Layer Thk. (m)			Type of Strata	Colour	Ave. Design SPT	Relative Density	Consistency	(γ) kN/m³	Shear Parameters	
	Top BGL	Bottom BGL	Thickness							(Cu) kPa	(ϕ) Deg.
1.0	0.00	1.25	1.25	Silty Sand	Brown	44	Dense	-	20	-	40
2.0	1.25	2.00	0.75	Silty Clay	Brown	8	-	Medium Stiff	16.5	53	-
3.0	2.00	3.00	1.00	Silty Sand	Brown	16	Medium Dense	-	18	-	32
4.0	3.00	9.00	6.00	Silty Sand	Grey	3	Very Loose	-	13	-	20
5.0	9.00	12.00	3.00	Residual Soil to CWR	Grey	>100	Very Dense	-	21	-	43
6.0	12.00	15.00	3.00	Moderately Weathered Rock	Grey	CRR- 18% to 24% RQD - 0%					

FOUNDATION SYSTEM

CHAPTER-4

FOUNDATION SYSTEM

4.0 PREAMBLE:

In the design of foundation system, the stress-strain compatibility of the super structure, sub structure and the bearing strata should be satisfied both individually and as a combined system. In view of this, the following data are needed for the design of foundation system, defined in terms of the type of sub structure and the bearing strata characteristics.

- The super structure characteristics along with the loading pattern on the sub structure
- The sub soil characteristics that define the required substructure configuration for a safe transfer of super-structural loads to the bearing strata

Considering the above aspects of the foundation design, the suitable type of foundation system is presented below.

4.1 PROPOSED STRUCTURES

An understanding of the proposed construction and the order of loads on the foundations is needed for choosing the appropriate foundation system. In the present case, the proposed structure is configured with stilt and three upper floors, and is meant for residential occupancy. For this kind of structure, the column loads could vary between 700 kN to 1500 kN.

The above-mentioned loads have no bearing on the design of either sub or super structures and are mentioned just to provide an insight to choose an appropriate foundation system with respect to subsoil conditions.

4.2 SUB SURFACE CHARACTERISTICS:

The geological succession of the project site with respect to the geotechnical investigation is classified based on the investigation boreholes and presented below:

0.0m to 1.25m	Filled Up Soil
1.25m to 2.0m	Medium Dense, Clayey Silty Sand with Brick Pieces in BH-01 Stiff, Sandy Silty Clay in BH-02
2.0m to 3.0m	Soft, Silty Clay in BH-01 Medium Dense, Silty Sand in BH-02
3.0m to 9.0m	Very Loose & Loose, Silty Sand with Medium Dense, Silty Sand between 7.5m to 9.0m in BH-01
9.0m to 12.0m/13.5m	Residual Soil to Completely Weathered Rock
12.0m/ 13.5m to 15.0m	Moderately Weathered Rock- Grade W3 Rock Formation

4.3 FOUNDATION SYSTEM:

For the kind of proposed construction, it is not feasible to adopt shallow foundation system based on shear and compressibility characteristics. Hence, adopt pile foundation system. The piles can be installed by drilling with direct mud circulation technique *(Bored Cast Insitu Piles)* and the recommended safe load carrying capacity of bored cast insitu piles in compression, pull out and lateral for different diameters is worked out as per IS 2911-Part-I-Section-2 and are presented in Table-4.1.

Typical computations are presented in Annexure-I.

TABLE:- 4.1 RECOMMENDED SAFE LOAD CARRYING CAPACITIES OF BORED CAST-IN SITU PILES

Sl.No	Reference Bore hole No.	Length of Pile below E.G.L	Assumed Length of Cut-Off Below E.G.L	Length of Pile below Cut-off	Dia.of Pile in (mm)	SAFE LOAD CARRYING CAPACITY (kN)		
						Vertical Load Carrying Capacity	Pull Out Capacity	Lateral Load Carrying Capacity
1.0	BH-02	12.5	1.0	11.50	500	1000	170	20
2.0					550	1300	190	25
3.0					600	1600	210	30
4.0					650	1800	230	35
5.0					750	2100	260	45

RECOMMENDATIONS

CHAPTER-5

RECOMMENDATIONS

5.1 RECOMMENDATION FOR PILE FOUNDATION SYSTEM:

- For the kind of proposed structure Bored Cast in situ piles are recommended as the suitable foundation system.
- The allowable safe load carrying capacities of different diameters of piles as given in Table-4.1 can be adopted as provisional design loads, as the load carrying capacity of piles is not only depends upon the sub soil properties, but also depends on the care and experience of installation piles.
- The theoretical load carrying estimates of piles shall be confirmed by conducting pile loads tests as per the guide lines laid down in IS: 2911-Part-IV.
- The boring shall be carried out using direct mud circulation prepared out of sodium bentonite.
- After reaching the borehole termination depth, the borehole shall be cleaned using mud circulation for a minimum period of 30min or till the return mud is relatively clear of soil particles.
- After ensuring the borehole is clean, the tremie pipe shall be lowered and concreting can be done.

5.1.1 CONSTRUCTION METHOD STATEMENT OF PILE FOUNDATION:

- For the bored cast in situ piles, a guide casing of suitable length can be adopted
- The mud used shall be made out of sodium bentonite with minimum free swell index of more than 300% and liquid limit more than 100%. The silt content in bentonite shall not more than 5%.
- The mud was prepared using sodium bentonite with a density of 1.10 to 1.15 g/cc

5.2 GENERAL RECOMMENDATIONS:

- The present site falls in seismic zone-III as per IS 1893-P-1
- The chlorides content in soil-water extract is less than the permissible limit of 500 mg/l as per IS 456 Table 1.0. Hence no special reinforcement is required for the construction.
- Corresponding to the sulphate content in 2:1 Water-Soil extract use Table 4.0 of IS 456 Clause 1.0 for minimum cement content and maximum water cement ratio. Hence ordinary Portland cement can be used.

AUTHORISED SIGNATORY

GEO MARINE CONSULTANTS PVT. LTD. Chennai 600 041

DR. C.V. PRASAD,
GEOMARINE CONSULTATNS PVT LTD.,

ANNEXURE-I

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ESTIMATION OF SAFE LOAD CARRYING CAPACITY OF BORED CAST-INSITU PILES

Type of Pile	Bored	Diameter of Pile			Length of Pile below G.L. (m)	12.5	As Per IS:2911-(P-I,S-2)-2010
Reference Bore Hole	BH-01		500	mm	Surcharge Pressure	0	kPa

Layer No.	Layer Thk. (m) Top. R.L.	Bot. R.L.	Thickness	Type of Strata	Ave. SPT	(γ) kN/m³ of Layer	Ave. upto Layer	Shear Parameters (C_u) kPa	(ϕ) Deg.	Effective Overburden Pressure (kPa) At top of Layer	At Bot. of Layer	At Mid. of Layer	Adhesion Factor (α)	Earth Pressure Coefficient (K)			Skin Friction (Q_f) kN
1.0	0.0	1.0	1.0	Cut-Off Level													
2.0	1.0	2.0	1.0	Clayey Sand	26	19.0	19.0	-	35	0.0	9.0	4.5	-	1.2	qf	2	6.1
3.0	2.0	3.0	1.0	Silty Clay	4	14.5	16.8	27	-	9.0	13.5	11.3	1.0	-	qf	3	42.4
4.0	3.0	7.5	4.5	Silty Sand	2	13.0	13.8	-	20	13.5	27.0	20.3	-	1.0	qf	4	51.9
5.0	7.5	9.0	1.5	Silty Sand	24	18.5	15.8	-	34	27.0	39.8	33.4	-	1.2	qf	5	64.8
6.0	9.0	10.5	1.5	Residual Soil	39	19.5	19.0	-	38	39.8	54.0	46.9	-	1.4	qf	6	125.5
7.0	10.5	12.5	2.0	Completely Weathered Rock	100	21.0	20.3	-	41	54.0	76.0	65.0	-	1.5	qf	7	266.3

Summation of Positive Skin Resitance (kN) Q_f= 556.91

Summation of Negative Skin Resistance (kN) -Qf= 0.00

Computation of End Bearing Resistance

		SPT	ϕ	C_u	N_q	N_c			
Bearing Stratum	Weathered Rock	100	41.00	-	157.31	-	Eff Ht of Overburden	10	m
							Effective Overburden Pressure	74.17	kN/m²

End Bearing Resistance (kN) Q_p= 2290.81

Skin Resistance in Clay Layer is $\pi*d*T_i*C_u*\alpha$	Ultimate Load Carrying Capacity (Q_{ult})	**$Q_u=Q_f-Q_f+Q_p$ (kN)**	2847.72
Skin Resistance in Sand Layer is $\pi*d*T_i*q_i*K*Tan(\phi)$	Safe Load Carrying Capacity (Q_{safe})	**$Q_u/2.5$ (kN)**	1139.09
End Bearing Resistance in Clay Layer is $\pi*d^2/4*C_u*N_c$	Allowable Safe Load Carrying Capacity	**$Q_{A\text{-}safe}$ (kN)**	1139.09
End Bearing Resistance in Sand Layer is $\pi*d^2/4*Q*N_q$	Allowable Safe Pull out Capacity	**$Q_{A\ pull}$: 0.7/3 (kN)**	185.64

Where

Cu=Undrained Shear Strength of Clay
K=Coef. Earth Pressure at Rest
d-Dia. Of Pile
ϕ=Angle of Shearing Resistance
q_i=Effecitve Overburden Pressure at middle of Layer
α=Adhesion Factor
N_c=Bearing Capacity Factor = 9
N_q=Bearing Capacity Factor, Ref. Fig.1 of IS: Code Referred above
T_i=Thickness of Layer
Q (i.e) Effecitve Overburden Pressure at pile tip=Effective height of overburden x (γ-10)

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ESTIMATION OF SAFE LOAD CARRYING CAPACITY OF BORED CAST-INSITU PILES

Type of Pile	Bored	Diameter of Pile		Length of Pile below G.L. (m)	12.5	As Per IS:2911-(P-I,S-2)-2010
Reference Bore Hole	BH-02	500	mm	Surcharge Pressure	0	kPa

Layer No.	Layer Thk. (m) Top. R.L.	Bot. R.L.	Thickness	Type of Strata	Ave. SPT	(γ) kN/m³ of Layer	Ave. upto Layer	Shear Parameters (C_u) kPa	(ϕ) Deg.	Effective Overburden Pressure (kPa) At top of Layer	At Bot. of Layer	At Mid. of Layer	Adhesion Factor (α)	Earth Pressure Coefficient (k)	Skin Friction (Q_f) kN		
1.0	0.0	1.0	1.0	Cut-Off Level													
2.0	1.0	2.0	1.0	Sandy Clay	8	16.5	16.5	53	-	0.0	6.5	3.3	0.9	-	qf	2	74.9
3.0	2.0	3.0	1.0	Silty Sand	16	18.0	17.3	-	32	6.5	14.5	10.5	-	1.1	qf	3	11.2
4.0	3.0	9.0	6.0	Silty Sand	3	13.0	15.5	-	20	14.5	32.5	23.5	-	1.0	qf	4	80.9
5.0	9.0	12.5	3.5	Completely Weathered Rock	100	21.0	17.0	-	41	32.5	71.0	51.8	-	1.5	qf	5	371.0

Summation of Positive Skin Resitance (kN) Q_f= 537.97

Summation of Negative Skin Resistance (kN) -Qf= 0.00

Computation of End Bearing Resistance

		SPT	ϕ	C_u	N_q	N_c			
Bearing Stratum	Weathered Rock	100	41.00	-	157.31	-	Eff.Ht.of Overburden	10	m
							Effective Overburden Pressure	65.63	kN/m²

End Bearing Resistance (kN) Q_p= 2026.98

Skin Resistance in Clay Layer is $\pi*d*T_i*C_u*\alpha$

Skin Resistance in Sand Layer is $\pi*d*T_i*q_i*K*Tan(\phi)$

End Bearing Resistance in Clay Layer is $\pi*d^2/4*C_u*N_c$

End Bearing Resistance in Sand Layer is $\pi*d^2/4*Q*N_q$

Where

Cu=Undrained Shear Strength of Clay

ϕ=Angle of Shearing Resistance

N_c=Bearing Capacity Factor = 9

Q (i.e) Effecitve Overburden Pressure at pile tip=Effective height of overburden X (γ 10)

K=Coef. Earth Pressure at Rest

q_i=Effecitve Overburden Pressure at middle of Layer

N_q=Bearing Capacity Factor, Ref. Fig.1 of IS: Code Referred above

d=Dia. Of Pile

α=Adhesion Factor

T_i=Thickness of Layer

Ultimate Load Carrying Capacity (Q_{ult})	$Q_u=Q_f-Q_f+Q_p$ (kN)	2564.96
Safe Load Carrying Capacity (Q_{safe})	$Q_u/2.5$ (kN)	1025.98
Allowable Safe Load Carrying Capacity	$Q_{A\text{-}safe}$ (kN)	1025.98
Allowable Safe Pull out Capacity	$Q_{A\ pull}$: Qf/3 (kN)	179.32

GEOMARINE
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LATERAL LOAD CARRYING CAPACITY OF BORED CAST- SITU PILES

1.0 Geometrical Data

Type of Pile Head Considered		Fixed	
Diameter of Pile (d)	:	0.60	m
Free standing Length of Pile (e)	:	0	m
Length of Pile below E.G.L (Le)	:	12.0	m
Cut-Off Level From E.G.L	:	1.0	
Length of Pile below Cut-Off Level (Le)	:	11.0	m
Grade of Concrete (M)	:	25	MN/m^2
Young's Modulus of Concrete (E)	:	25000000	kN/m^2
Momemnt of Inertia (I)	:	0.003068	m^4

2.0 Determination of Depth of Fixity

Type of Soil Strata	:	Sand	
Ground Water Condition	:	Submerged	
Design SPT "N" Value	:	6	
T=(EI/nh)1/5			
(n can be read as h in the above and below equation in case of Sand)			
nh=	:	600	kN/m^3
In Case of Sand	:	-	kN/m^4
T=	:	2.64	m
L1/T	:	0.00	
Lf/T	:	2.20	
Depth of Fixity below Cut off (z_f)	:	5.80	m

3.0 Determincation of Lateral Load and Moment Carrying Capacity for 0.005 m Lateral Deflection:

Allowable Lateral Deflection (Y)	:	0.005	m
Lateral Load Carrying Capacity (H)= Y*12EI/(e+zf)^3	:	23.53	kN
Recommended Design Lateral Load carrying Capacity	:	**20**	**kN**
Fixed End Moment,M_F=H(e+z_f)/2		68	
Reduction Factor (L_1/T)	:	0.83	m
Actual Moment (Fixed End Moment/Reduction Factor),M_F		**57**	kN-m

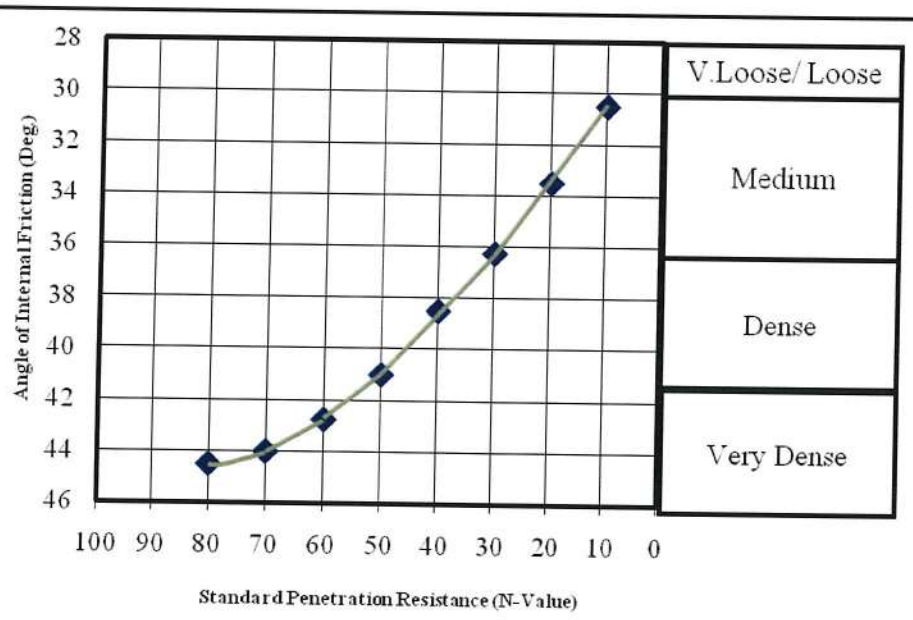


FIG. A1 Relation Ship between Angle of Internal Friction & N-value (Reproduced from IS:6403-1981)

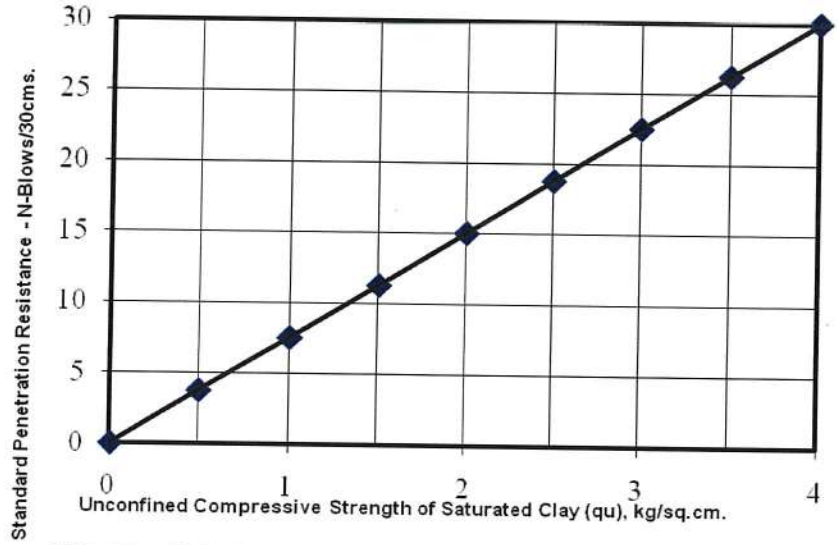


FIG. A2 : Relationship between UCC & SPT-Value (N) of Saturated Clay (AfterTerzhagi & Peck, 1948)

ANNEXURE-II

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SITE INVESTIGATION RECORD

BORE HOLE No.	01
PAGE No.	01
DIA OF BORE HOLE	150mm / 100mm
BORE START DATE	08/08/2023
BORE END DATE	09/08/2023
TOTAL DRILLING DAYS	

PROJECT NAME	ARIHANT - KOTTIVAKKAM					
LOCATION	G+3	MACHINE No.		CHAINAGE (m)		
STRUCTURE		DRILLING METHOD	Rotary	CO-ORDINATES	N	
JOB CODE		FLUSHING MEDIUM	Bentonite		E	

Depth below E.G.L. (m)	Drilling progress per metre: Date	Time: Hr.	Time: Min	Type of Drill Bit (SC / TCB / DB)	Core Details: Total Core Recovery %	Core Details: R.Q.D %	SPT Details: Blows/cm. 0-15	Blows/cm. 15-30	Blows/cm. 30-45	SPT 'N' Value	Sample Details: Depth	No.	Type	Layer Data: Depth (m)	Geotechnical Description
0	08/08/2023	12	00				26	30	30	60	0.50	1	S.S.	0.50	Filled up soil
		12	10												
1		12	25				16	16	10	26	1.25	2	S.S	1.25	-DO-
		13	00												
2		14	00				1	2	2	4	2.0	3	S.S.	2.0	Brownish Soft Clay
		14	01												
3		14	09				U	D	S		3.0	4	UDS (UNDISTURBED)	3.0	Sample Taken
		14	10												
4		14	30				1	1	1	2	4.0	4	S.S.	4.0	Greyish Loose Silty Sand
		14	31												
5		14	40				1	1	1	2	5.0	5	S.S.	5.0	-DO-
		14	41												
6		14	50				1	1	1	2	6.0	6	S.S	6.0	-DO-
		14	51												
7		15	00				2	9	15	24	7.50	7	SS.	7.0	Greyish Medium Dense Sand with Shells
		15	01												
8															
9		15	35				8	18	21	39	9.0	8	9.0	9.0	Grey, Brown, Soft Rock
		15	36												
0															

CS - Core Sample	DS - Disturbed Sample	SUPERVISOR NAME	S STEPHENRAJ	PROJECT SITE DETAILS	
SS - Split Spoon Sample	SC - Soil Cutter	SIGNATURE		GROUND LEVEL (m)	
UDS-Undisturbed Sample	TCB - Tungsten Carbide Bit	DATE	08/08/2023	WATER TABLE (m)	
WS - Wash Sample	DB - Diamond Bit	CLIENT IN-CHARGE		CASING DEPTH (m)	

GEOMARINE
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SITE INVESTIGATION RECORD

BORE HOLE No.	B1
PAGE No.	02
DIA OF BORE HOLE	150mm ✓ / 100mm
BORE START DATE	08/08/2023
BORE END DATE	09/08/2023
TOTAL DRILLING DAYS	

PROJECT NAME	ARIHANT - KOTTIVAKKAM					
LOCATION		MACHINE No.		CHAINAGE (m)		
STRUCTURE		DRILLING METHOD	Rotary	CO-ORDINATES	N	
JOB CODE		FLUSHING MEDIUM	Bentonite		E	

Depth below E.G.L. (m)	Drilling progress per metre: Date	Time: Hr.	Time: Min	Type of Drill Bit (SC / TCB / DB)	Core Details: Total Core Recovery %	Core Details: R.Q.D %	SPT Details: Blows/cm. 0-15	SPT Details: Blows/cm. 15-30	SPT Details: Blows/cm. 30-45	SPT 'N' Value	Sample Details: Depth	Sample Details: No.	Sample Details: Type	Layer Data: Depth (m)	Geotechnical Description
0	08/08/2023	15	50				5cm								
1		15	55				50 blows	Hammer Rebound			10.50	9	W.S.	10.5	Grey, Black Brown weathered Rock
2		16	20												
		17	10	DRY MONO BIT			5cm			N7100	12.0	10	S.S.	12.0	—DO—
3							50 blows								
		9	00				Hammer Rebound								
4	09/08/2023	10	15				No Penetration			N7100		11	W.S.	13.5	—DO—
5															
		10	40												
6		11	25		270							12	C.S.	15.0	Grayish Hard Rock
7															Bore Hole Terminated at 15.0M Below the Ground level
8															
9															
0															

CS - Core Sample	DS - Disturbed Sample	SUPERVISOR NAME	S. STEPHENRAJ	PROJECT SITE DETAILS	
SS - Split Spoon Sample	SC - Soil Cutter	SIGNATURE		GROUND LEVEL (m)	
UDS-Undisturbed Sample	TCB - Tungsten Carbide Bit	DATE	09/08/2023	WATER TABLE (m)	
WS - Wash Sample	DB - Diamond Bit	CLIENT IN-CHARGE		CASING DEPTH (m)	

GEOMARINE
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SITE INVESTIGATION RECORD

BORE HOLE No. C12
PAGE No. 01
DIA OF BORE HOLE 150mm ✓ / 100mm
BORE START DATE 09/08/2023
BORE END DATE 10/08/2023
TOTAL DRILLING DAYS

PROJECT NAME: ARIHANT - KOTTIVAKKAM
LOCATION:
MACHINE No.: GR-06
CHAINAGE (m):
STRUCTURE:
DRILLING METHOD: Rotary
CO-ORDINATES: N, E
JOB CODE:
FLUSHING MEDIUM: Bentonite

Depth below E.G.L. (m)	Drilling progress per metre: Date	Time: Hr.	Time: Min	Type of Drill Bit (SC / TCB / DB)	Core Details: Total Core Recovery %	Core Details: R.Q.D %	SPT Details: Blows/cm. 0-15	SPT Details: Blows/cm. 15-30	SPT Details: Blows/cm. 30-45	SPT 'N' Value	Sample Details: Depth	Sample Details: No.	Sample Details: Type	Layer Data: Depth (m)	Layer Data: Geotechnical Description
0	09/08/2023	15	00	SOIL CUTTER			10	20	24	44	0.50	1	SPLIT SPOON SAMPLE	0.50	Filled up soil
1		15	01												
		15	20				2	2	6	8	1.25	2		1.25	Brownish Medium Stiff Clay
2		15	25												
		17	00				4	6	10	16	2.0	3		2.0	Brown, Grey silty sand
3		17	01												
		9	00				5	3	2	5	3.0	4		3.0	-DO-
		9	01												
4		9	10				2	2	2	4	4.0	5		4.0	Brown, Grey silty Sand
		9	11												
5		9	20				1	1	1	2	5.0	6		5.0	Brown, Grey silty sand
		9	21												
6		9	30				1	1	1	2	6.0	7		6.0	-DO-
		9	31												
7	10/08/2023	9	50				1	1	1	2	7.50	8		7.50	-DO-
		9	51												
8															
		10	10				20	61	N710		9.0	9		9.0	Grey, Brown Weathered Rock
9		10	14												
10															

CS - Core Sample
SS - Split Spoon Sample
UDS-Undisturbed Sample
WS - Wash Sample

DS - Disturbed Sample
SC - Soil Cutter
TCB - Tungsten Carbide Bit
DB - Diamond Bit

SUPERVISOR NAME: S. STEPHEN RAJ
SIGNATURE
DATE: 10/08/2023
CLIENT IN-CHARGE

PROJECT SITE DETAILS
GROUND LEVEL (m)
WATER TABLE (m): 2.0M
CASING DEPTH (m)

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SITE INVESTIGATION RECORD

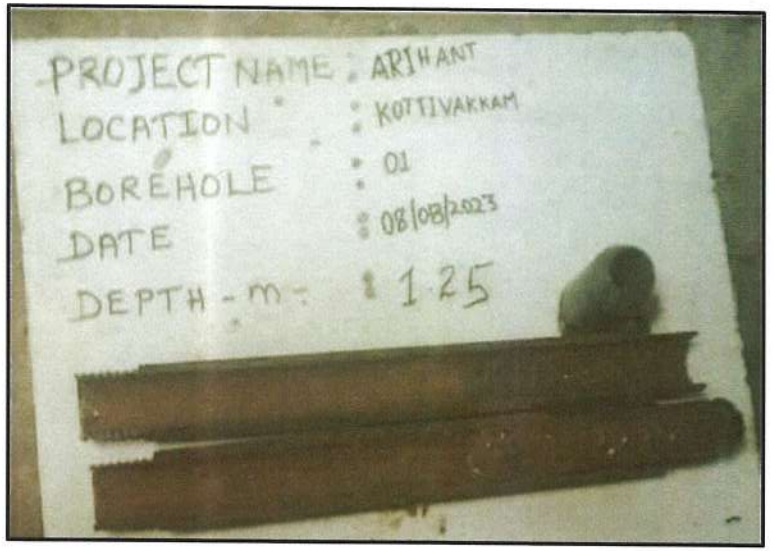
BORE HOLE No.	02		
PAGE No.	02		
PROJECT NAME	ARIHANT – KOTTAVAKKAM	DIA OF BORE HOLE	150mm ✓ / 100mm
LOCATION		MACHINE No.	CHAINAGE (m)
STRUCTURE		DRILLING METHOD: Rotary	CO-ORDINATES N / E
JOB CODE		FLUSHING MEDIUM: Bentonite	TOTAL DRILLING DAYS
BORE START DATE	09/08/2023		
BORE END DATE	10/08/2023		

Depth below E.G.L. (m)	Drilling progress per metre: Date	Time: Hr.	Time: Min	Type of Drill Bit (SC / TCB / DB)	Core Details: Total Core Recovery %	Core Details: R.Q.D %	SPT Details: Blows/cm. 0-15	SPT Details: Blows/cm. 15-30	SPT Details: Blows/cm. 30-45	SPT 'N' Value	Sample Details: Depth	Sample Details: No.	Sample Details: Type	Layer Data: Depth (m)	Geotechnical Description
1	10/08/2023	10	30				10CM				10.50	10	S.S.	10.50	Greyish Hard Rock
		10	45				50 Blows								
2		11	00	DIAMOND BIT			Hammer Related					11	WS	12.50	-DO-
3		11	35				NO Penetration								
							N > 100								
4		11	55									12	C.S.	13.50	Greyish Rock
		13	00		18	0									
5		14	00									13	C.S	15.0	-DO-
		15	10		24	0									
6	Bore Hole Terminated at 15.0M Below the Ground level														
7															
8															
9															
0															

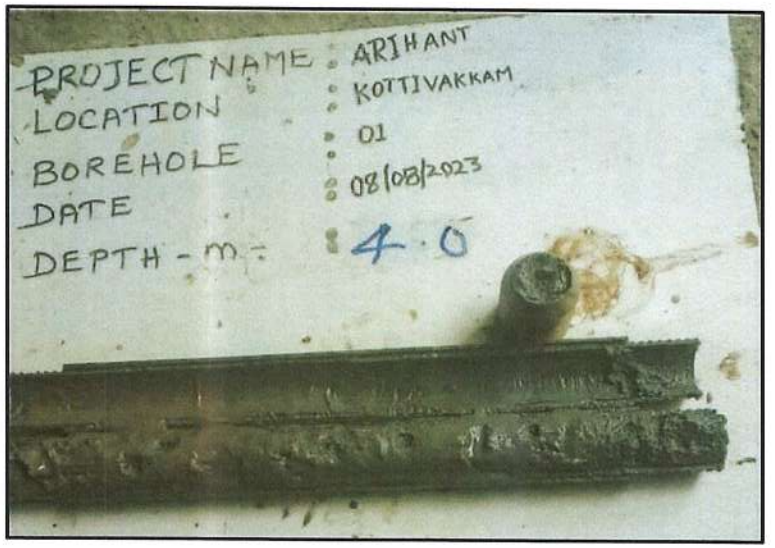
CS - Core Sample	DS - Disturbed Sample	SUPERVISOR NAME	S. STEPHEN RAJ	PROJECT SITE DETAILS	
SS - Split Spoon Sample	SC - Soil Cutter	SIGNATURE		GROUND LEVEL (m)	
UDS-Undisturbed Sample	TCB - Tungsten Carbide Bit	DATE	10/08/2023	WATER TABLE (m)	
WS - Wash Sample	DB - Diamond Bit	CLIENT IN-CHARGE		CASING DEPTH (m)	

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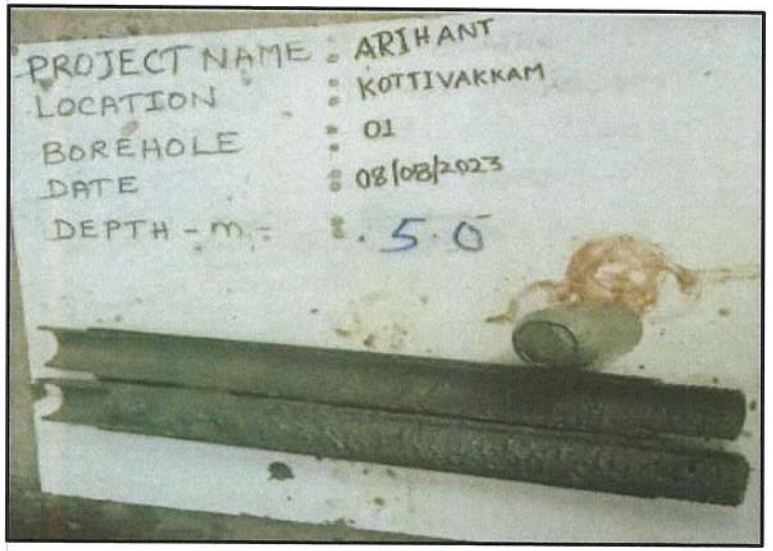




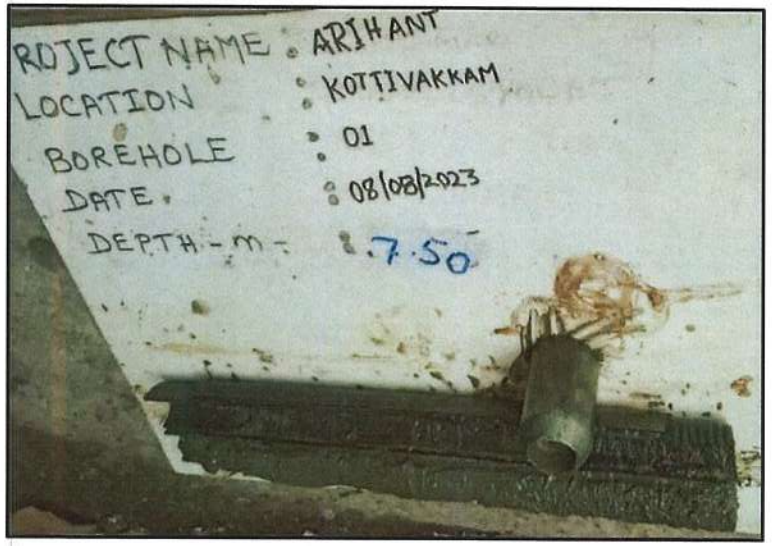




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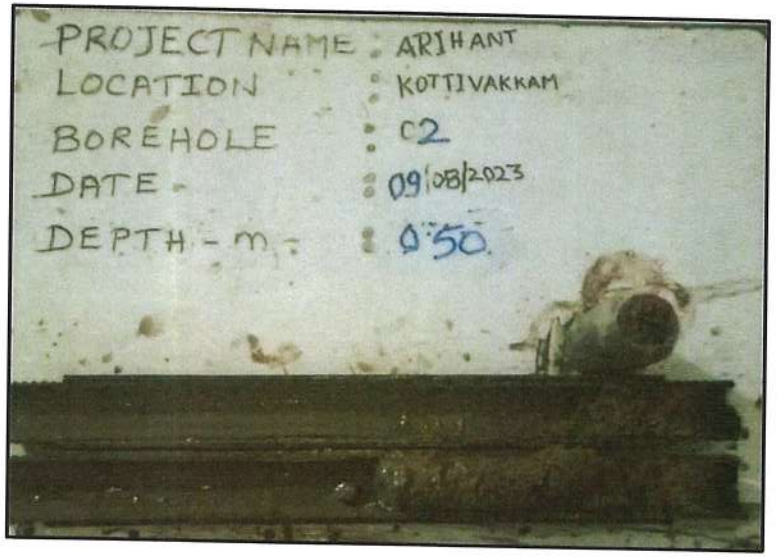






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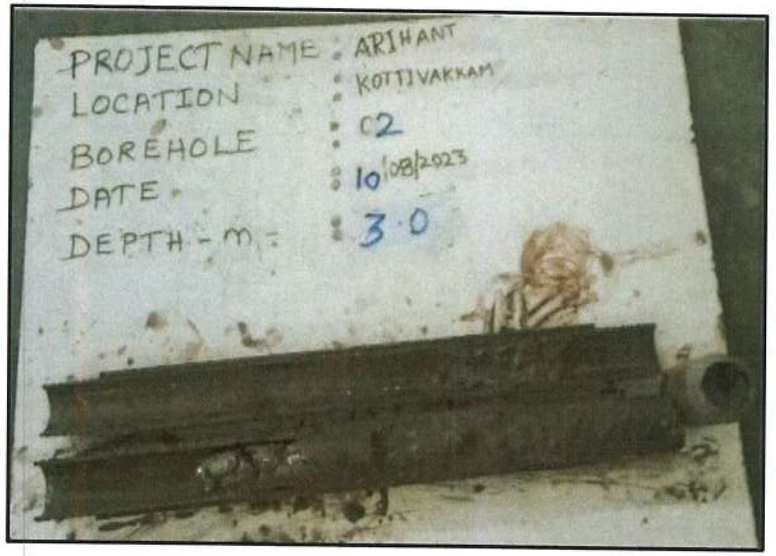




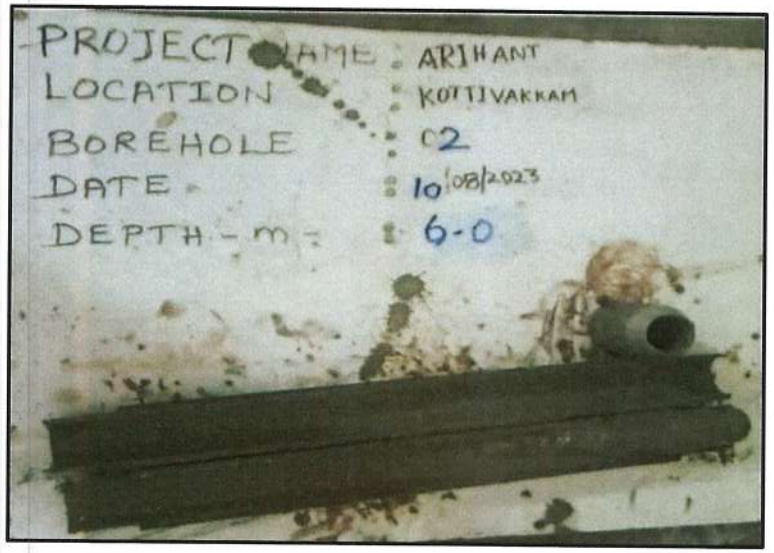


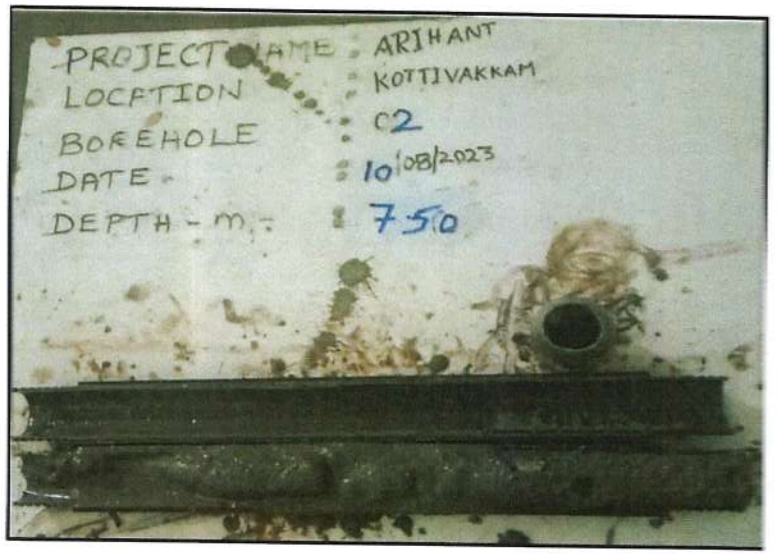


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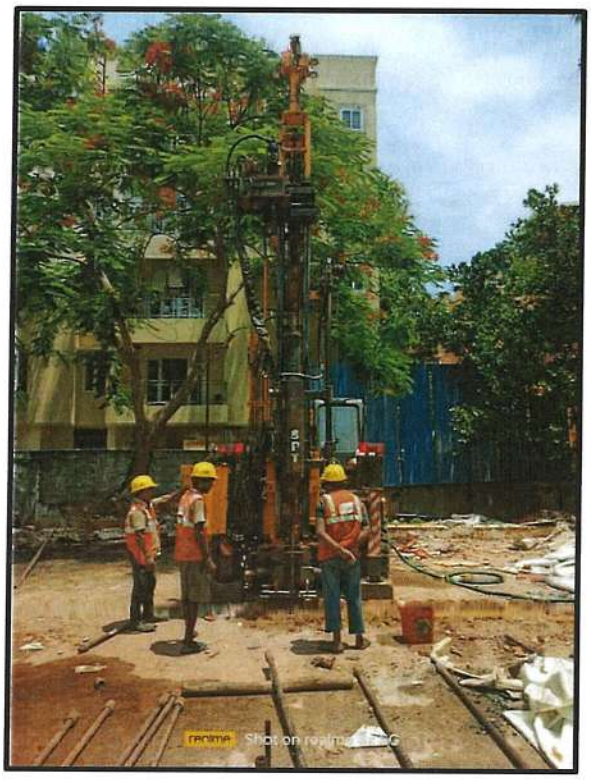


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