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PROJECT

GEOTECHNICAL INVESTIGATION FOR THE PROPOSED CONSTRUCTIN OF HIGH RISE BUILDING Consisting of 2 Blocks Combined Extended Double Basement Floor (Tower-A & Tower-B) Tower-A: Stilt Floor + 8 Floors, Tower B: Stilt Floor + 12 Floors- totally 43 Dwelling Units comprising in Old S.No.5/11 (Part), New T.S.No.5/49 and Old S.No.177 & 177/1A, New T.S.No.5/13, Block No.5, situated at Door No.3/1, 196/1, 196/2 and 2/3D, Arcot Road (N.S.K. Salai), Vadapalani, Chennai-600 026

PROJECT CLIENT

M/s IVAR ESTATES PRIVATE LIMITED
NO.3, MANGESH STREET,
T.NAGAR, CHENNAI-600 017.

TITLE

GEOTECHNICAL INVESTIGATION REPORT

REPORT NO.: GT- 2313

DATE	REVISON	DESCRIPTION		AUTHORISED SIGNATORY
14/12/2021	FIRST SUBMISSION	SUBMISSION OF FINAL GEOTECHNICAL REPORT	SIGN	
			DATE	14/12/2021
			DESIGNATION	**MANAGING DIRECTOR**
			NAME	**DR. C.V.PRASAD**

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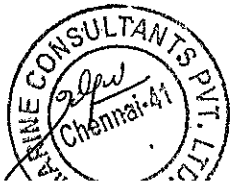
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REPORT TEXT



CHAPTER-1

INTRODUCTION

1.0 PROJECT INFORMATION MATRIX:

Nature of project : **RESIDENTIAL BUILDING**

Structure : **Extended Combined Double Basment Floor + STILT + 12 UPPER FLOORS**

Project Client : **M/s IVAR ESTATES PRIVATE LIMITED**

Project Location : **VADAPALANI, CHENNAI**

Job Code : **GT-2313**

1.1 SCOPE OF WORK:

1.1.1 FIELD WORK:

- Conducting four 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
  - From 12.0m to 20.0m SPT is conducted at every 2.0m depth interval
  - Beyond 20.0m SPT is conducted at every 2.5m depth interval till the termination depth.
  - In case of rock formation the core drilling shall be carried out and checked for recovery at every 1.0m or 1.5m depth interval
- The depth of investigation is 27.5m to 29.0m 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

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CHAPTER-2

INVESTIGATION METHODOLOGY & TEST RESULTS

2.0 PREAMBLE:

Four 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).

2.1.3 COLLECTION OF SOIL SAMPLES:

2.1.3.1 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.

2.1.3.2 UNDISTURBED SAMPLES:

From the soft to stiff clay layer, representative undisturbed samples were collected. These samples were used primarily to establish the compressibility parameters to estimate the settlements of shallow foundation system wherever applicable.

2.1.4 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.

<u>NOTE ON GROUNDWATER TABLE RECORD:</u>

- 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

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- ❖ 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 to 2.4. The graphical representation of grainsize distribution curve for the representative samples in each bore is presented in Fig. 2.6 to 2.9.

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 to 2.4. The graphical representation of hydrometer analyses curve for the representative samples in each bore is presented in Fig.2.10 to 2.19.

2.2.3 CHEMICAL ANALYSIS TESTS:

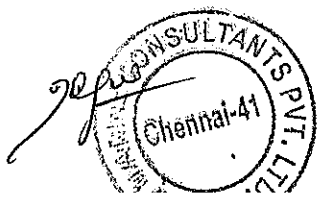
On representative soil and water samples chemical analysis tests were conducted to estimate pH, Chloride and Sulphates and these results are presented in Table – 2.5.

2.3 SUMMARY:

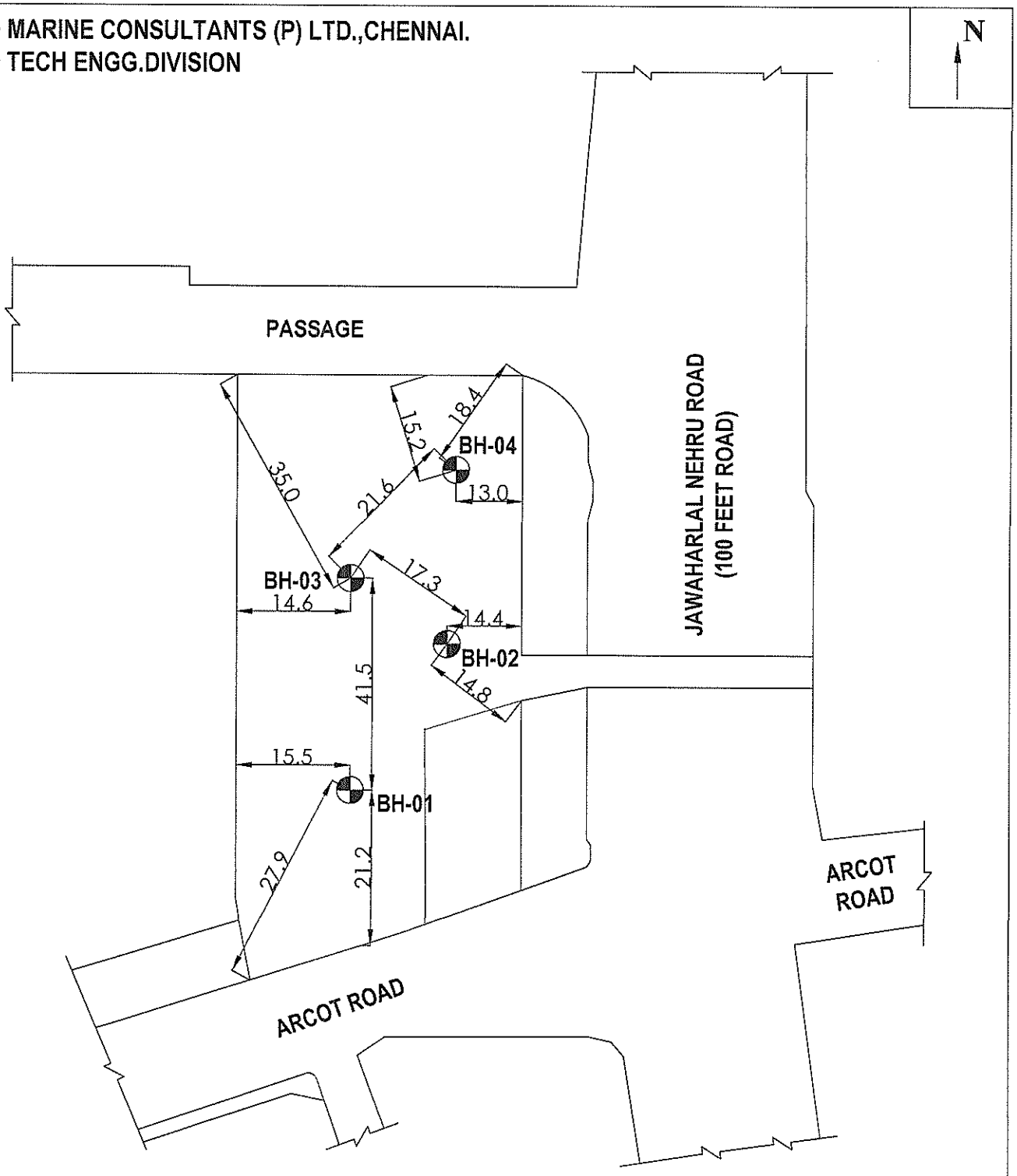
- ❖ The locations of the field investigation tests are shown in site plan given in Fig.2.0
- ❖ The sub soil profiles encountered at each location along with their classification and engineering properties are presented in Fig. 2.1 to 2.4.
- ❖ The cross sectional variation at different direction is presented in Fig. 2.5.
- ❖ The laboratory test results are presented in Table 2.1 to 2.4.
- ❖ The chemical test results are presented in Table 2.5.

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SITE PLAN



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2.0 SITE PLAN SHOWING THE LOCATION OF FIELD INVESTIGATION POINTS AT VADAPAZHANI

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SOIL PROFILES

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SITE INVESTIGATION RECORD

SHEET	1	OF	3

PROJECT NAME	PROPOSED CONSTRUCTION OF A RESIDENTIAL BUILDING	DIA OF BORE HOLE	150mm ✓ / NX

LOCATION	Vadapalani, Chennai	MACHINE No.	-	CHAINAGE (m)	-	BORE START DATE	30/11/2021
STRUCTURE	2B + S + 12 Floors	DRILLING METHOD	Rotary	CO-ORDINATES	N -	BORE END DATE	01/12/2021
JOB CODE	GT-2313	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	SPT Details: Blows/cm. 15-30	SPT Details: Blows/cm. 30-45	SPT 'N' Value	Sample Details: Depth	Sample Details: No.	Sample Details: Type	Sample Details: RL (m)	Layer Data: Legend	Layer Data: No	Layer Data: Depth	Geotechnical Description
1	30/11/2021	10	00 To 10 05	SC	-	-	1	0	0	0	1.00 / 1.45	1	SS	-0.5		L1	1.7	Building Debris (Sand & Concrete Debris Mix)
2		10	15 To 10 17	SC	-	-	8	10	12	22	2.00 / 2.45	2	SS	-1.5				
3		10	30 To 10 32	SC	-	-	11	17	20	37	3.00 / 3.45	3	SS	-2.5				
4		10	50 To 10 52	SC	-	-	8	9	12	21	4.00 / 4.45	4	SS	-3.5				
5		11	06 To 11 07	SC	-	-	12	14	20	34	5.00 / 5.45	5	SS	-4.5				Brown,Moist,Poorly Graded,Fine & Medium Grains Sand Particles,Medium Dense to Dense,**Silty SAND (SM & SP-SM)**
6		11	23 To 11 25	SC	-	-	17	20	21	41	6.00 / 6.45	6	SS	-5.5				
7		11	38 To 11 40	SC	-	-												
8		11	58 To 12 01	SC	-	-	12	15	16	31	7.50 / 7.95	7	SS	-7.0				
9							4	7	8	15	9.00 / 9.45	8	SS	-8.5		L2	9.0	
10		12	19 To 12 25	SC	-	-												Grey,Moist,Stiff,**Silty CLAY (CI)** Lean Clay of Medium Plasticity

CS - Core Sample	DS - Disturbed Sample	LOGGED	K. Loganathan	PROJECT SITE DETAILS	REMARKS
SS - Split Spoon Sample	SC - Soil Cutter	DATE	30/11/2021	GROUND LEVEL (m) 0.50	
UDS- Undisturbed Sample	TCB - Tungsten Carbide Bit	CHECKED	Navaneethan M	WATER TABLE (m) 1.00	
WS - Wash Sample	DB - Diamond Bit	DATE	04/12/2021	CASING DEPTH (m) 0.00	

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SITE INVESTIGATION RECORD

BORE HOLE No.	BH-01		
SHEET	2	OF	3
DIA OF BORE HOLE	150mm ✓		
	NX		

PROJECT NAME	PROPOSED CONSTRUCTION OF A RESIDENTIAL BUILDING					BORE START DATE	30/11/2021
LOCATION	Vadapalani, Chennai	MACHINE No.	-	CHAINAGE (m)	-		
STRUCTURE	2B + S + 12 Floors	DRILLING METHOD	Rotary	CO-ORDINATES	N -	BORE END DATE	01/12/2021
JOB CODE	GT-2313	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 'N' Value	Sample Details: Depth	No.	Type	RL (m)	Layer Data: Legend	No	Depth	Geotechnical Description
11	30/11/2021	12	44	SC	-	-	6	10	12	22	10.50	9	SS	-10.5				Grey,Moist,Stiff,**Silty CLAY (CI & CH)** Lean Clay of Medium & High Plasticity
		To									10.95							
		12	53															
12							2	2	4	6	12.00	10	SS	-12.0		L3	12.0	
											12.45							
		14	26															Grey,Moist,Medium Stiff,**Silty CLAY (CI)** Lean Clay of Medium Plasticity
13		To		SC	-	-												
		14	30															
14							16	21	38	59	14.00	11	SS	-14.0		L4	14.0	
											14.45							
		15	01															Brownish Grey,Moist,Poorly Graded, Fine Grains Sand Particles,Very Dense,**Silty SAND (SM)**
15		To		SC	-	-												
		15	03															
16							3	4	5	9	16.00	12	SS	-16.0		L5	16.0	
											16.45							
		15	41															
		To		SC	-	-												
17		15	43															
18							3	4	5	9	18.00	13	SS	-18.0				Grey,Moist,Stiff,**Silty CLAY (CH)** Clays of High Plasticity
											18.45							
		16	08															
19		To		SC	-	-												
		16	11															
20							5	5	8	13	20.00	14	SS	-20.0				
											20.45							

CS - Core Sample	DS - Disturbed Sample	LOGGED	K Loganathan	PROJECT SITE DETAILS	REMARKS
SS - Split Spoon Sample	SC - Soil Cutter	DATE	30/11/2021	GROUND LEVEL (m) 0.50	
UDS- Undisturbed Sample	TCB - Tungsten Carbide Bit	CHECKED	Navaneethan M	WATER TABLE (m) 1.00	
WS - Wash Sample	DB - Diamond Bit	DATE	04/12/2021	CASING DEPTH (m) 0.00	

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SITE INVESTIGATION RECORD

SHEET	3	OF	3				
PROJECT NAME	PROPOSED CONSTRUCTION OF A RESIDENTIAL BUILDING			DIA OF BORE HOLE	150mm ✓	NX ✓	
LOCATION	Vadapalani, Chennai	MACHINE No.	-	CHAINAGE (m)	-	BORE START DATE	30/11/2021
STRUCTURE	2B + S + 12 Floors	DRILLING METHOD	Rotary	CO-ORDINATES	N -	BORE END DATE	01/12/2021
JOB CODE	GT-2313	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 'N' Value	Sample Details: Depth	No.	Type	RL (m)	Layer Data: Legend	No	Depth	Geotechnical Description
21	01/12/2021	09 To 09	33 36	SC	-	-												
22							4	4	6	10	22.50 / 22.95	15	SS	-22.5				Grey,Moist,Stiff,**Silty CLAY (CH)** Clays of High Plasticity
23		10 To 10	11 15	SC	-	-												
24																		
25							11	10	9	19	25.00 / 25.45	16	SS	-25.0		L6	25.0	
26		11 To 11	00 04	SC	-	-												Grey,Moist,Very Stiff,**Silty CLAY (CL) With Lenses of Sand** Lean Clay of Low Plasticity
27																L7	27.0	
28		TOTAL DRILLING TIME 2 hr 39 mins		DB	17	0	15 Cm Penet for 72 blows			>100	27.50 / 27.65	17	SS	-27.5				Greenish Grey,Fine Grains Structure, Fissile,**SHALE** Sedimentary Rock of Gondwana Group
							-	-	-	-	28.50	18	CS	-28.5				
29		14 To 16	58 30	DB	32	0												
							-	-	-	-	29.50	19	CS	-29.5		L8	29.5	
30																		

CS - Core Sample	DS - Disturbed Sample	LOGGED	K Loganathan	PROJECT SITE DETAILS	REMARKS
SS - Split Spoon Sample	SC - Soil Cutter	DATE	01/12/2021	GROUND LEVEL (m) 0.50	
UDS- Undisturbed Sample	TCB - Tungsten Carbide Bit	CHECKED	Navaneethan M	WATER TABLE (m) 1.00	
WS - Wash Sample	DB - Diamond Bit	DATE	04/12/2021	CASING DEPTH (m) 0.00	

Borehole terminated at 29.5 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	3
DIA OF BORE HOLE	150mm ✓ / NX		
BORE START DATE	25/11/2021		
BORE END DATE	29/11/2021		
TOTAL DRILL DAYS	3		

PROJECT NAME	PROPOSED CONSTRUCTION OF A RESIDENTIAL BUILDING						
LOCATION	Vadapalani, Chennai	MACHINE No.	-	CHAINAGE (m)	-		
STRUCTURE	2B + S + 12 Floors	DRILLING METHOD	Rotary	CO-ORDINATES	N -		
JOB CODE	GT-2313	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	Sample Details: RL (m)	Layer Data: Legend	Layer Data: No	Layer Data: Depth	Geotechnical Description
0	25/11/2021	14	40															
		To		SC	-	-												
		14	42															
1		14	54				3	4	6	10	1.00 / 1.45	1	SS	-1.0				Brown,Moist,Poorly Graded,Fine & Medium Grains Sand Particles,Loose, **Silty SAND (SM)**
		To		SC	-	-												
		14	58															
2		15	12				13	20	22	42	2.00 / 2.45	2	SS	-2.0		L1	2.0	
		To		SC	-	-												
		15	14															
3		15	29				13	14	17	31	3.00 / 3.45	3	SS	-3.0				
		To		SC	-	-												
		15	31															
4		15	46				6	12	21	33	4.00 / 4.45	4	SS	-4.0				
		To		SC	-	-												Brown,Moist,Poorly Graded,Fine & Medium Grains Sand Particles, Dense,**Silty SAND (SP-SM)**
		15	48															
5		16	01				16	13	18	31	5.00 / 5.45	5	SS	-5.0				
		To		SC	-	-												
		16	03															
6		09	30				12	16	16	32	6.00 / 6.45	6	SS	-6.0				
		To		SC	-	-												
7		09	32													L2	7.2	
	26/11/2021						4	5	5	10	7.50 / 7.95	7	SS	-7.5				
8		09	46															
		To		SC	-	-												
		09	49															
9		10	10				4	6	8	14	9.00 / 9.45	8	SS	-9.0				Grey,Moist,Stiff,**Silty CLAY (CH)** Clays of High Plasticity
		To		SC	-	-												
10		10	21															

CS - Core Sample	DS - Disturbed Sample	LOGGED	K. Loganathan	PROJECT SITE DETAILS	REMARKS
SS - Split Spoon Sample	SC - Soil Cutter	DATE	26/11/2021	GROUND LEVEL (m) 0.00	
UDS- Undisturbed Sample	TCB - Tungsten Carbide Bit	CHECKED	Navaneethan M	WATER TABLE (m) 0.30	
WS - Wash Sample	DB - Diamond Bit	DATE	04/12/2021	CASING DEPTH (m) 0.00	

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SITE INVESTIGATION RECORD

SHEET	2	OF	3				
PROJECT NAME	PROPOSED CONSTRUCTION OF A RESIDENTIAL BUILDING			DIA OF BORE HOLE	150mm	✓	
					NX		
LOCATION	Vadapalani, Chennai	MACHINE No.	-	CHAINAGE (m)	-	BORE START DATE	25/11/2021
STRUCTURE	2B + S + 12 Floors	DRILLING METHOD	Rotary	CO-ORDINATES	N -	BORE END DATE	29/11/2021
JOB CODE	GT-2313	FLUSHING MEDIUM	Bentonite		E -	TOTAL DRILL DAYS	3

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 'N' Value	Sample Details: Depth	No.	Type	RL (m)	Layer Data: Legend	No	Depth	Geotechnical Description
							-	-	-	-	10.50	9	UDS	-10.5				
11		10	49	SC	-	-												Grey,Moist,Stiff,**Silty CLAY (CH)** *Clays of* High Plasticity
		To																
		10	53															
12							18	30	19	49	12.00	10	SS	-12.0		L3	12.0	
											12.45							
		11	25															
13		To		SC	-	-												Grey,Moist,Dense,**Sandy SILT (ML)** Sandy Silt of Little to Non Plastic
		11	27															
14							7	5	4	9	14.00	11	SS	-14.0		L4	14.0	
											14.45							
		11	50															
15	26/11/2021	To		SC	-	-												
		11	54															
16							2	3	4	7	16.00	12	SS	-16.0				
											16.45							
		12	21															
17		To		SC	-	-												Grey,Moist,Medium Stiff,**Silty CLAY (CH & CI)** Lean Clay of Medium & High Plasticity
		12	24															
18							3	3	3	6	18.00	13	SS	-18.0				
											18.45							
		12	55															
19		To		SC	-	-												
		12	58															
20							3	5	5	10	20.00	14	SS	-20.0		L5	20.0	
											20.45							Grey,Moist,Stiff,**Silty CLAY (CH)** Clays of High Plasticity

CS - Core Sample	DS - Disturbed Sample	LOGGED	K Loganathan	PROJECT SITE DETAILS		REMARKS
SS - Split Spoon Sample	SC - Soil Cutter	DATE	26/11/2021	GROUND LEVEL (m)	0.00	
UDS- Undisturbed Sample	TCB - Tungsten Carbide Bit	CHECKED	Navaneethan M	WATER TABLE (m)	0.30	
WS - Wash Sample	DB - Diamond Bit	DATE	04/12/2021	CASING DEPTH (m)	0.00	

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SITE INVESTIGATION RECORD

BORE HOLE No.	BH-02						
SHEET	3	OF	3				
PROJECT NAME	PROPOSED CONSTRUCTION OF A RESIDENTIAL BUILDING			DIA OF BORE HOLE	150mm ✓		
					NX ✓		
LOCATION	Vadapalani, Chennai	MACHINE No.	-	CHAINAGE (m)	-	BORE START DATE	25/11/2021
STRUCTURE	2B + S + 12 Floors	DRILLING METHOD	Rotary	CO-ORDINATES	N -	BORE END DATE	29/11/2021
JOB CODE	GT-2313	FLUSHING MEDIUM	Bentonite		E -	TOTAL DRILL DAYS	3

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	Sample Details: RL (m)	Layer Data: Legend	Layer Data: No	Layer Data: Depth	Geotechnical Description
21	26/11/2021	15	38	SC	-	-												
		To																
		15	43															
22																		
23							5	6	7	13	22.50 / 22.95	15	SS	-22.5				Grey,Moist,Stiff,**Silty CLAY (CH)** Clays of High Plasticity
		16	18	SC	-	-												
		To																
24		16	25															
25							21	45	18	63	25.00 / 25.45	16	SS	-25.0		L6	25.0	
	29/11/2021	12	17															Grey,Moist,Hard,**Sandy Silty CLAY (CL)** Sandy Silty Clay of Low Plasticity
26		To		SC	-	-												
		12	36															
							SPT Hammer Rebounded			>100	26.50	-	*SS	-26.5		L7	26.5	
27		14	01															Brownish Grey,Fine & Medium Grains Structure,Fissile at Times,Sandy Texture,**SILTSTONE to SANDSTONE** Sedimentary Rock of Gondwana Group
		To		DB	97	39												
		15	29				-	-	-	-	27.50	17	CS	-27.5		L8	27.5	
28																		
29																		
30																		

CS - Core Sample	DS - Disturbed Sample	LOGGED	K Loganathan	PROJECT SITE DETAILS	REMARKS
SS - Split Spoon Sample	SC - Soil Cutter	DATE	29/11/2021	GROUND LEVEL (m) 0.00	
UDS- Undisturbed Sample	TCB - Tungsten Carbide Bit	CHECKED	Navaneethan M	WATER TABLE (m) 0.30	*(F) - Sample Failed
WS - Wash Sample	DB - Diamond Bit	DATE	04/12/2021	CASING DEPTH (m) 0.00	

Borehole terminated at 27.5 m depth below E.G.L

FIG.2.2 Sub Soil Profile at BH-02 Location

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SITE INVESTIGATION RECORD

SHEET	1	OF	3				
PROJECT NAME	PROPOSED CONSTRUCTION OF A RESIDENTIAL BUILDING			DIA OF BORE HOLE	150mm	✓	
					NX		
LOCATION	Vadapalani, Chennai	MACHINE No.	-	CHAINAGE (m)	-	BORE START DATE	30/11/2021
STRUCTURE	2B + S + 12 Floors	DRILLING METHOD	Rotary	CO-ORDINATES	N -	BORE END DATE	01/12/2021
JOB CODE	GT-2313	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 'N' Value	Sample Details: Depth	No.	Type	RL (m)	Layer Data: Legend	No	Depth	Geotechnical Description
1		10	26															
		To		SC	-	-										L1	1.3	Building Debris (Sand & Concrete Debris Mix)
		10	41															
2							7	9	8	17	2.00	1	SS	-2.0				
		10	56								2.45							Brown,Moist,Poorly Graded,Medium to Coarse Sand With Gravels,Medium Dense,**Poorly Graded SAND (SP)**
		To		SC	-	-												
		10	57															
3							11	18	19	37	3.00	2	SS	-3.0		L2	3.0	
		11	15								3.45							
		To		SC	-	-												
		11	17															
4							12	19	21	40	4.00	3	SS	-4.0				
		11	40								4.45							
		To		SC	-	-												
		11	41															
5	30/11/2021						13	19	19	38	5.00	4	SS	-5.0				
		11	57								5.45							Brown,Moist,Poorly Graded,Fine & Medium Grains Sand Particles,Dense, **Silty SAND (SM/SP/SP-SM)**
		To		SC	-	-												
		11	58															
6							8	12	19	31	6.00	5	SS	-6.0				
		12	19								6.45							
		To		SC	-	-												
7		12	21															
							7	5	4	9	7.50	6	SS	-7.5		L3	7.6	
		12	45								7.95							
8		To		SC	-	-												
		12	47															
9							-	-	-	-	9.00	7	UDS	-9.0				Grey,Moist,Stiff,**Silty CLAY (CI & CH)** Clays of Medium & High Plasticity
		14	12															
		To		SC	-	-												
10		14	21															

CS - Core Sample	DS - Disturbed Sample	LOGGED	J.Baskar	PROJECT SITE DETAILS	REMARKS
SS - Split Spoon Sample	SC - Soil Cutter	DATE	30/11/2021	GROUND LEVEL (m) 0.00	
UDS- Undisturbed Sample	TCB - Tungsten Carbide Bit	CHECKED	Rhozen.D.R	WATER TABLE (m) 1.20	
WS - Wash Sample	DB - Diamond Bit	DATE	04/12/2021	CASING DEPTH (m) 0.00	

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SITE INVESTIGATION RECORD

BORE HOLE No.	BH-03		
SHEET	2	OF	3
DIA OF BORE HOLE	150mm ✓		
	NX		
BORE START DATE	30/11/2021		
BORE END DATE	01/12/2021		
TOTAL DRILL DAYS	2		

PROJECT NAME	PROPOSED CONSTRUCTION OF A RESIDENTIAL BUILDING						
LOCATION	Vadapalani, Chennai	MACHINE No.	-	CHAINAGE (m)	-		
STRUCTURE	2B + S + 12 Floors	DRILLING METHOD	Rotary	CO-ORDINATES	N	-	
JOB CODE	GT-2313	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	15-30	30-45	SPT 'N' Value	Sample Details: Depth	No.	Type	RL (m)	Layer Data: Legend	No	Depth	Geotechnical Description
							5	8	10	18	10.50	8	SS	-10.5		L4	10.5	Grey,Moist,Stiff,**Silty CLAY (CI & CH)** Clays of Medium & High Plasticity
11		14	41								10.95							
		To		SC	-	-												Grey,Moist,Very Stiff,**Silty CLAY (CH)** Clays of High Plasticity
		15	00															
12							2	7	24	31	12.00	9	SS	-12.0		L5	12.0	
											12.45							
		15	29															
13		To		SC	-	-												Grey,Moist,Hard,**Silty CLAY (CI)** Lean Clay of Medium Plasticity
		15	31															
14	30/11/2021						2	2	4	6	14.00	10	SS	-14.0		L6	14.0	
											14.45							
		16	04															
15		To		SC	-	-												
		16	08															
16							2	3	5	8	16.00	11	SS	-16.0				Grey,Moist,Medium Stiff to Stiff,**Silty CLAY (CH)** Clays of High Plasticity
											16.45							
		16	35															
17		To		SC	-	-												
		16	38															
18							2	2	4	6	18.00	12	SS	-18.0		L7	18.0	
											18.45							
		09	22															
19	01/12/2021	To		SC	-	-												Grey,Moist,Medium Stiff,**Silty CLAY (CI)** Lean Clay of Medium Plasticity
		09	25															
20							3	5	6	11	20.00	13	SS	-20.0		L8	20.0	
											20.45							Grey,Moist,Stiff,**Silty CLAY (CI)** Lean Clay of Medium Plasticity

CS - Core Sample	DS - Disturbed Sample	LOGGED	J.Baskar	PROJECT SITE DETAILS		REMARKS	
SS - Split Spoon Sample	SC - Soil Cutter	DATE	01/12/2021	GROUND LEVEL (m)	0.00		
UDS- Undisturbed Sample	TCB - Tungsten Carbide Bit	CHECKED	Rhozen.D.R	WATER TABLE (m)	1.20		
WS - Wash Sample	DB - Diamond Bit	DATE	04/12/2021	CASING DEPTH (m)	0.00		

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SITE INVESTIGATION RECORD

SHEET	3	OF	3
DIA OF BORE HOLE	150mm ✓		
	NX ✓		

PROJECT NAME	PROPOSED CONSTRUCTION OF A RESIDENTIAL BUILDING					BORE START DATE	30/11/2021
LOCATION	Vadapalani, Chennai	MACHINE No.	-	CHAINAGE (m)	-		
STRUCTURE	2B + S + 12 Floors	DRILLING METHOD	Rotary	CO-ORDINATES	N -	BORE END DATE	01/12/2021
JOB CODE	GT-2313	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 'N' Value	Sample Details: Depth	No.	Type	RL (m)	Layer Data: Legend	No	Depth	Geotechnical Description
21	01/12/2021	10	01	SC	-	-												Grey,Moist,Stiff,**Silty CLAY (CI)** Lean Clay of Medium Plasticity
		To																
		10	05															
22																		
							2	4	6	10	22.50	13	SS	-22.5		L9	22.5	
											22.95							
23																		
		11	19															
		To		SC	-	-												Grey,Moist,Stiff,**Silty CLAY (CH)** Clays of High Plasticity
24		11	25															
25							12	20	36	56	25.00	14	SS	-25.0		L10	25.0	
											25.45							
		14	07															
26		To		SC	-	-												Grey,Moist,Poorly Graded,Fine & Medium Grains Sand Particles,Very Dense,**Clayey Silty SAND (SC)**
		14	51															
27							7 Cm Penet for 50 Blows			>100	27.00	-	*SS	-27.0		L11	27.0	
											27.07							
		15	19															Brownish Grey,Fine & Medium Grains Structure,Fissile at Times,Sandy Texture,**SILTSTONE to SANDSTONE** Sedimentary Rock of Gondwana Group
		To		DB	99	90												
28		16	27				-	-	-	-	28.00	15	CS	-28.0		L12	28.0	
29																		
30																		

CS - Core Sample	DS - Disturbed Sample	LOGGED	J.Baskar	PROJECT SITE DETAILS		REMARKS
SS - Split Spoon Sample	SC - Soil Cutter	DATE	01/12/2021	GROUND LEVEL (m)	0.00	
UDS- Undisturbed Sample	TCB - Tungsten Carbide Bit	CHECKED	Rhozen.D.R	WATER TABLE (m)	1.20	*(F) - Sample Failed
WS - Wash Sample	DB - Diamond Bit	DATE	04/12/2021	CASING DEPTH (m)	0.00	

Borehole terminated at 28 m depth below E.G.L.

FIG.2.3 Sub Soil Profile at BH-03 Location

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SITE INVESTIGATION RECORD

BORE HOLE No.	BH-04		
SHEET	1	OF	3
DIA OF BORE HOLE	150mm ✓		
	NX		

PROJECT NAME	PROPOSED CONSTRUCTION OF A RESIDENTIAL BUILDING					BORE START DATE	26/11/2021
LOCATION	Vadapalani, Chennai	MACHINE No.	-	CHAINAGE (m)	-		
STRUCTURE	2B + S + 12 Floors	DRILLING METHOD	Rotary	CO-ORDINATES	N -	BORE END DATE	29/11/2021
JOB CODE	GT-2313	FLUSHING MEDIUM	Bentonite		E -	TOTAL DRILL DAYS	3

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	Sample Details: RL (m)	Layer Data: Legend	Layer Data: No	Layer Data: Depth	Geotechnical Description
		09	30															
		To		SC	-	-												
		09	32													L1	0.8	Building Debris (Sand & Concrete Debris Mix)
1							2	4	4	8	1.00	1	SS	-1.0				
		09	41								1.45							
		To		SC	-	-												
		09	43															
2							6	9	10	19	2.00	2	SS	-2.0				
		09	53								2.45							
		To		SC	-	-												
		09	55															
3							9	10	14	24	3.00	3	SS	-3.0				Brown,Moist,Poorly Graded,Fine & Medium Grains Sand Particles, Loose to Medium Dense,**Silty SAND (SP-SM)**
		10	06								3.45							
		To		SC	-	-												
		10	07															
4							8	10	12	22	4.00	4	SS	-4.0				
		10	21								4.45							
		To		SC	-	-												
		10	23															
5	26/11/2021						14	21	25	46	5.00	5	SS	-5.0		L2	5.0	
		10	35								5.45							
		To		SC	-	-												
		10	36															
6							11	19	20	39	6.00	6	SS	-6.0				
		10	51								6.45							
		To		SC	-	-												
		10	52															Brown,Moist,Poorly Graded,Fine & Medium Grains Sand Particles, Dense, **Silty SAND (SP-SM) & Poorly Graded SAND (SP)**
7							21	25	27	52	7.50	7	SS	-7.5				
		11	25								7.95							
		To		SC	-	-												
		11	31															
8																		
9							3	4	5	9	9.00	8	SS	-9.0		L3	9.0	
		11	52								9.45							
		To		SC	-	-												
10		12	02															Grey,Moist,Stiff,**Silty CLAY (CH)** Clays of High Plasticity

CS - Core Sample	DS - Disturbed Sample	LOGGED	Loganathan	PROJECT SITE DETAILS	REMARKS
SS - Split Spoon Sample	SC - Soil Cutter	DATE	26/11/2021	GROUND LEVEL (m) 0.00	
UDS- Undisturbed Sample	TCB - Tungsten Carbide Bit	CHECKED	Navaneethan M	WATER TABLE (m) 0.60	
WS - Wash Sample	DB - Diamond Bit	DATE	04/12/2021	CASING DEPTH (m) 0.00	

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SITE INVESTIGATION RECORD

SHEET 2 OF 3

PROJECT NAME	PROPOSED CONSTRUCTION OF A RESIDENTIAL BUILDING					DIA OF BORE HOLE	150mm ✓ / NX
LOCATION	Vadapalani, Chennai	MACHINE No.	-	CHAINAGE (m)	-	BORE START DATE	26/11/2021
STRUCTURE	2B + S + 12 Floors	DRILLING METHOD	Rotary	CO-ORDINATES	N -	BORE END DATE	29/11/2021
JOB CODE	GT-2313	FLUSHING MEDIUM	Bentonite		E -	TOTAL DRILL DAYS	3

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 'N' Value	Sample Details: Depth	No.	Type	RL (m)	Layer Data: Legend	No	Depth	Geotechnical Description
11		12	27				-	-	-	-	10.50	9	UDS	-10.5				
		To		SC	-	-												
		12	33															
12							7	4	9	13	12.00	10	SS	-12.0				Grey,Moist,Stiff,**Silty CLAY (CH & CL)** Clays of High & Low Plasticity
											12.45							
	26/11/2021	15	09															
13		To		SC	-	-												
		15	12															
14							2	2	4	6	14.00	11	SS	-14.0		L4	14.0	
											14.45							
		15	55															
15		To		SC	-	-												
		16	00															
16							2	3	4	7	16.00	12	SS	-16.0				
											16.45							
		09	49															
17		To		SC	-	-												Grey,Moist,Medium Stiff,**Silty CLAY (CI & CH)** Clays of High & Medium Plasticity
		09	54															
18	27/11/2021						1	2	3	5	18.00	13	SS	-18.0				
											18.45							
		10	44															
19		To		SC	-	-												
		10	48															
20							1	3	5	8	20.00	14	SS	-20.0		L5	20.0	
											20.45							Grey,Moist,Stiff,**Silty CLAY (CH)** Clays fo High Platicity

CS - Core Sample	DS - Disturbed Sample	LOGGED	Baskar. J	PROJECT SITE DETAILS		REMARKS	
SS - Split Spoon Sample	SC - Soil Cutter	DATE	27/11/2021	GROUND LEVEL (m)	0.00		
UDS- Undisturbed Sample	TCB - Tungsten Carbide Bit	CHECKED	Navaneethan M	WATER TABLE (m)	0.60		
WS - Wash Sample	DB - Diamond Bit	DATE	04/12/2021	CASING DEPTH (m)	0.00		

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SITE INVESTIGATION RECORD

BORE HOLE No.	BH-04		
SHEET	3	OF	3
DIA OF BORE HOLE	150mm ✓		
	NX ✓		

PROJECT NAME	PROPOSED CONSTRUCTION OF A RESIDENTIAL BUILDING					BORE START DATE	26/11/2021
LOCATION	Vadapalani, Chennai	MACHINE No.	-	CHAINAGE (m)	-		
STRUCTURE	2B + S + 12 Floors	DRILLING METHOD	Rotary	CO-ORDINATES	N -	BORE END DATE	29/11/2021
JOB CODE	GT-2313	FLUSHING MEDIUM	Bentonite		E -	TOTAL DRILL DAYS	3

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 'N' Value	Sample Details: Depth	No.	Type	RL (m)	Layer Data: Legend	No	Depth	Geotechnical Description
21		11	28															
		To		SC	-	-												
22		11	32															
							2	4	5	9	22.50	15	SS	-22.5				Grey,Moist,Stiff,**Silty CLAY (CH)** Clays fo High Plaicity
23											22.95							
	27/11/2021	12	07															
		To		SC	-	-												
24		12	13															
25							13	12cm Penet for 50 Blows		>100	25.00	16	SS	-25.0		L6	25.0	
											25.28							
26		14	37															Brownish Grey,Moist,Hard,**Silty CLAY (CI)** Clays of Medium Plasticity
		To		SC	-	-												
		15	45															
27							5 Cm Penet for 50 Blows			>100	27.00	-	*SS	-27.0		L7	27.0	
	29/11/2021										27.05							
		10	29															Brownish Grey,Fine & Medium Grains Structure,Fissile at Times,Sandy Texture,**SILTSTONE to SANDSTONE** Sedimentary Rock of Gondwana Group
		To		DB	99	46												
28		11	57				-	-	-	-	28.00	17	CS	-28.0		L8	28.0	
29																		
30																		

CS - Core Sample	DS - Disturbed Sample	LOGGED	Baskar J	PROJECT SITE DETAILS	REMARKS
SS - Split Spoon Sample	SC - Soil Cutter	DATE	29/11/2021	GROUND LEVEL (m) 0.00	
UDS- Undisturbed Sample	TCB - Tungsten Carbide Bit	CHECKED	Navaneethan M	WATER TABLE (m) 0.60	
WS - Wash Sample	DB - Diamond Bit	DATE	04/12/2021	CASING DEPTH (m) 0.00	

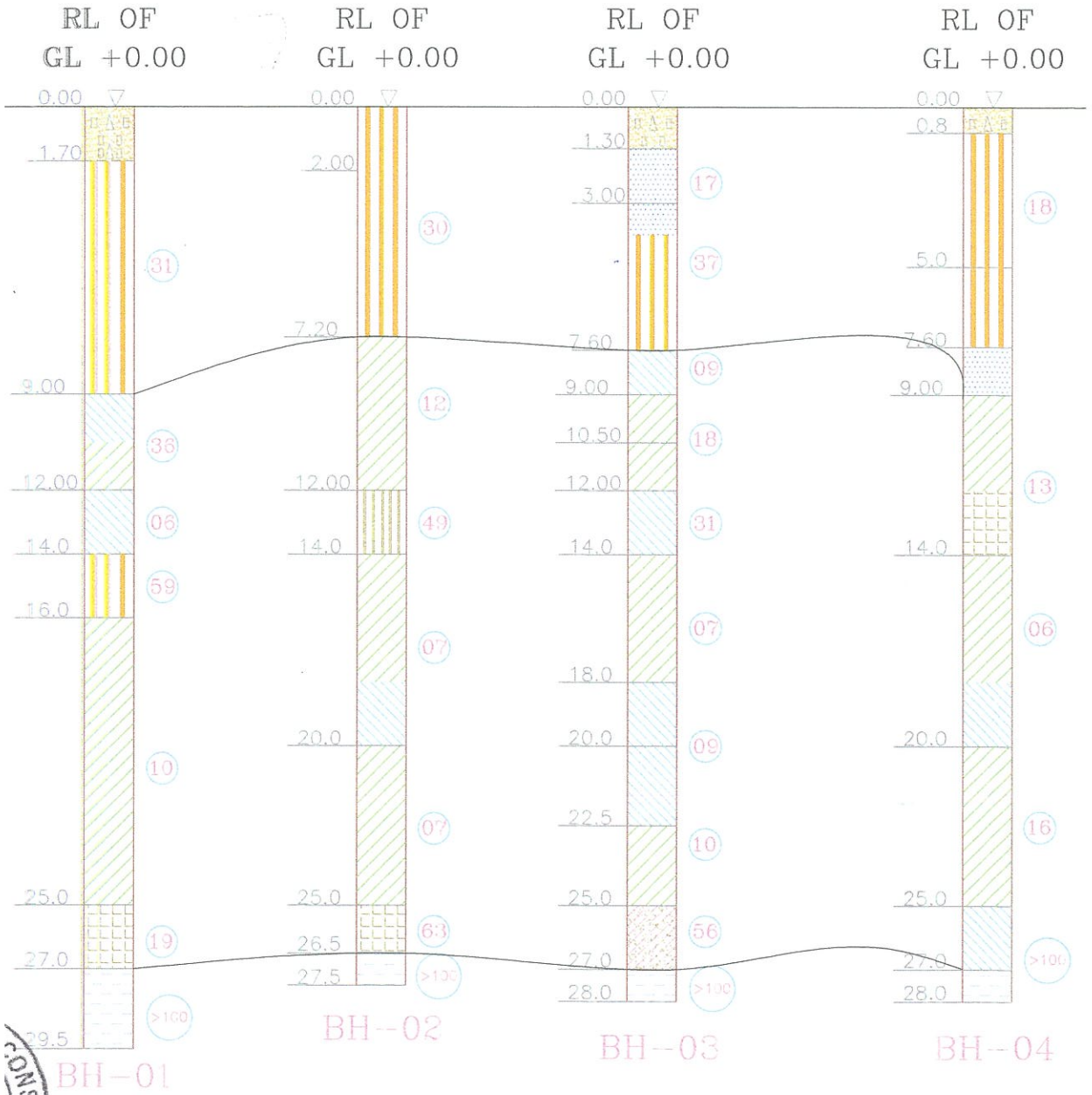
Borehole terminated at 28 m depth below E.G.L

FIG.2.4 Sub Soil Profile at BH-04 Location

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CROSS SECTION PROFILE

GEO MARINE SULTANTS PVT. LTD. Chennai-41



LEGEND

- SILTY SAND (SM)
- SILTY CLAY (CI)
- SILTY CLAY (CI)
- CLAYEY SILTY SAND (SC)
- SILTY CLAY (CH)
- SANDY SILTY CLAY (CL)
- SHALE
- POORLY GRADED SAND(SP)
- SANDY SILT(ML)

FIG No.2.5 CROSS SECTIONAL VARIATION OF SUB SOIL PROFILE THROUGH BH-01 TO 04

GRAIN SIZE DISTRIBUTION CURVE

GEO MARINE CONSULTANTS PVT. LTD. Chennai-41

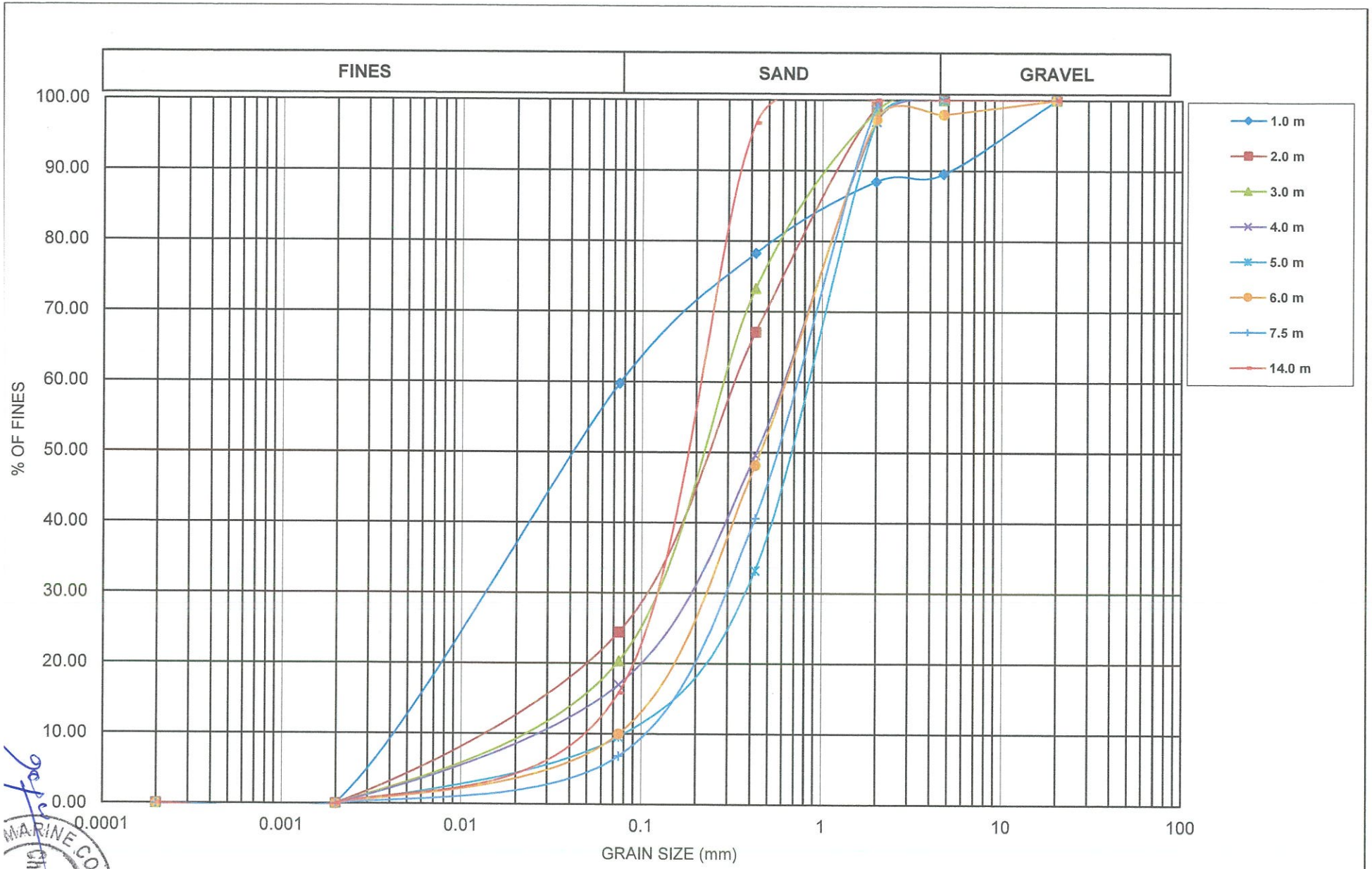
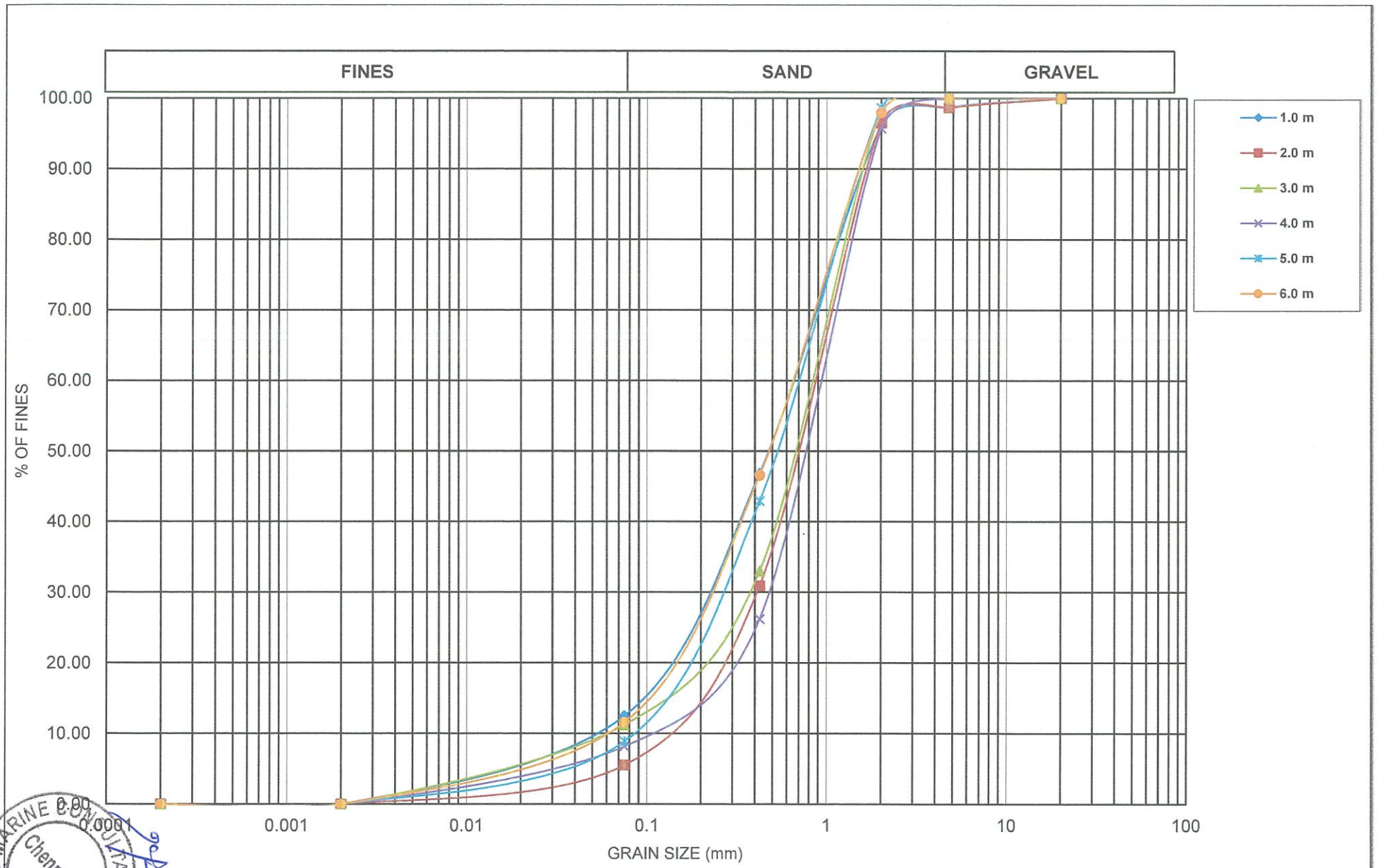


Fig. 2.6 GRAIN SIZE DISTRIBUTION CURVE - BH-01

MARINE CONSULTANTS PVT Chennai-41



GEO MARINE CONSULTANTS PVT. LTD. Chennai-41

Fig. 2.7 GRAIN SIZE DISTRIBUTION CURVE - BH-02

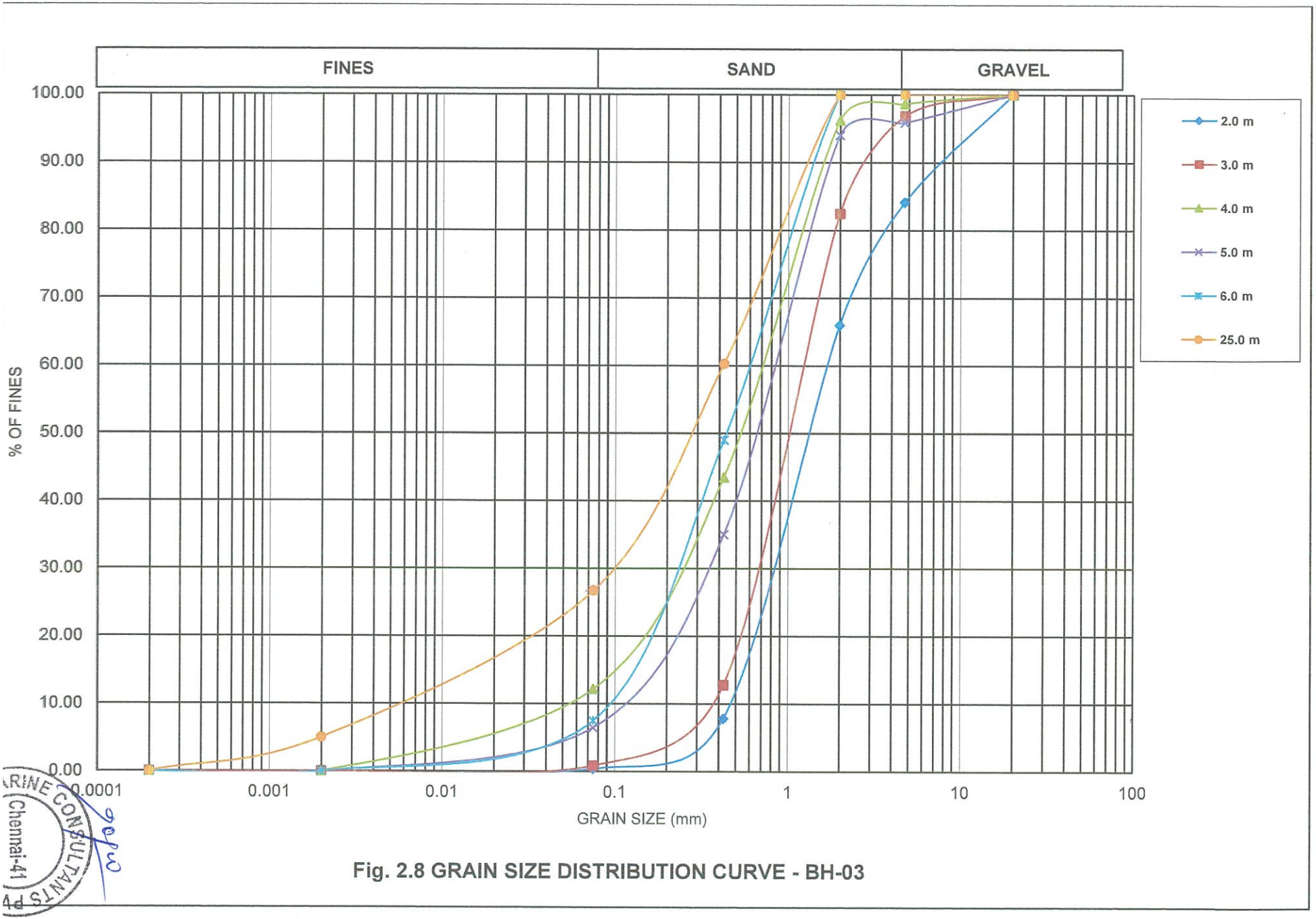


Fig. 2.8 GRAIN SIZE DISTRIBUTION CURVE - BH-03

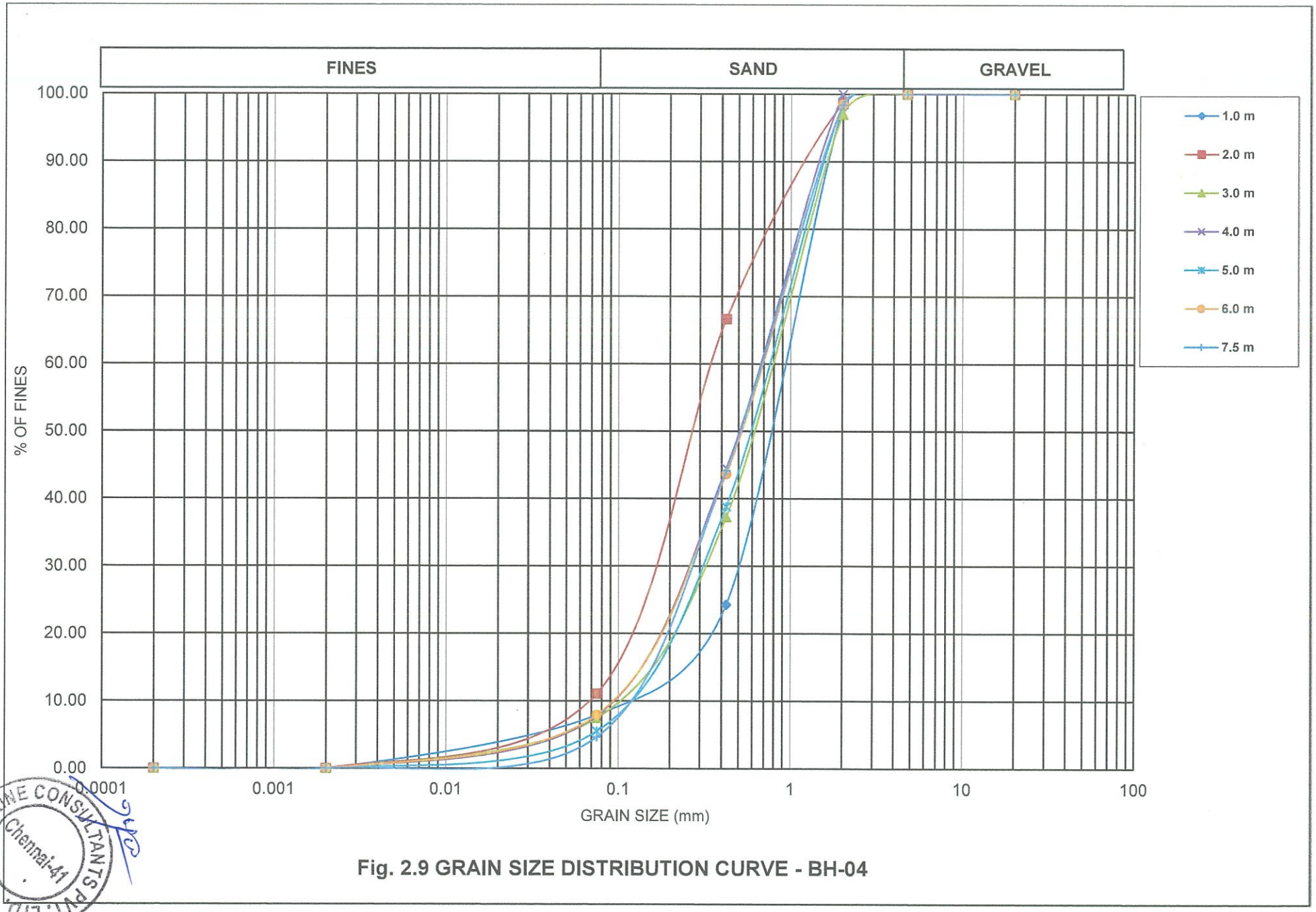


Fig. 2.9 GRAIN SIZE DISTRIBUTION CURVE - BH-04

GEO MARINE CONSULTANTS PVT. LTD. Chennai-41

HYDROMETER ANALYSIS CURVE

MARINE CONSULTANTS PVT. Chennai-41

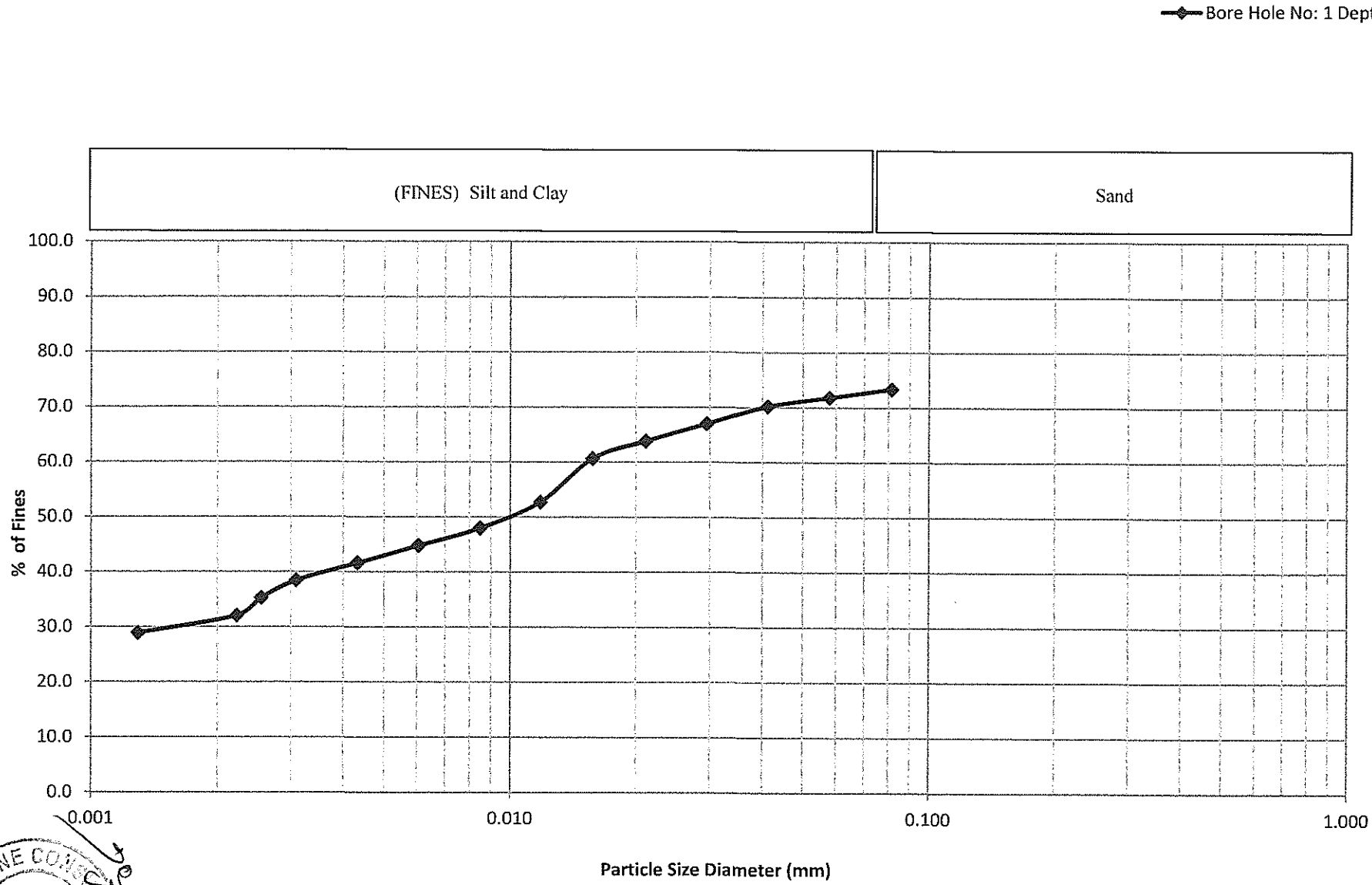


Fig 2.10 Hydrometer Analysis Master Curve

GEO MARINE CONSULTANTS PVT. LTD. Chennai-41

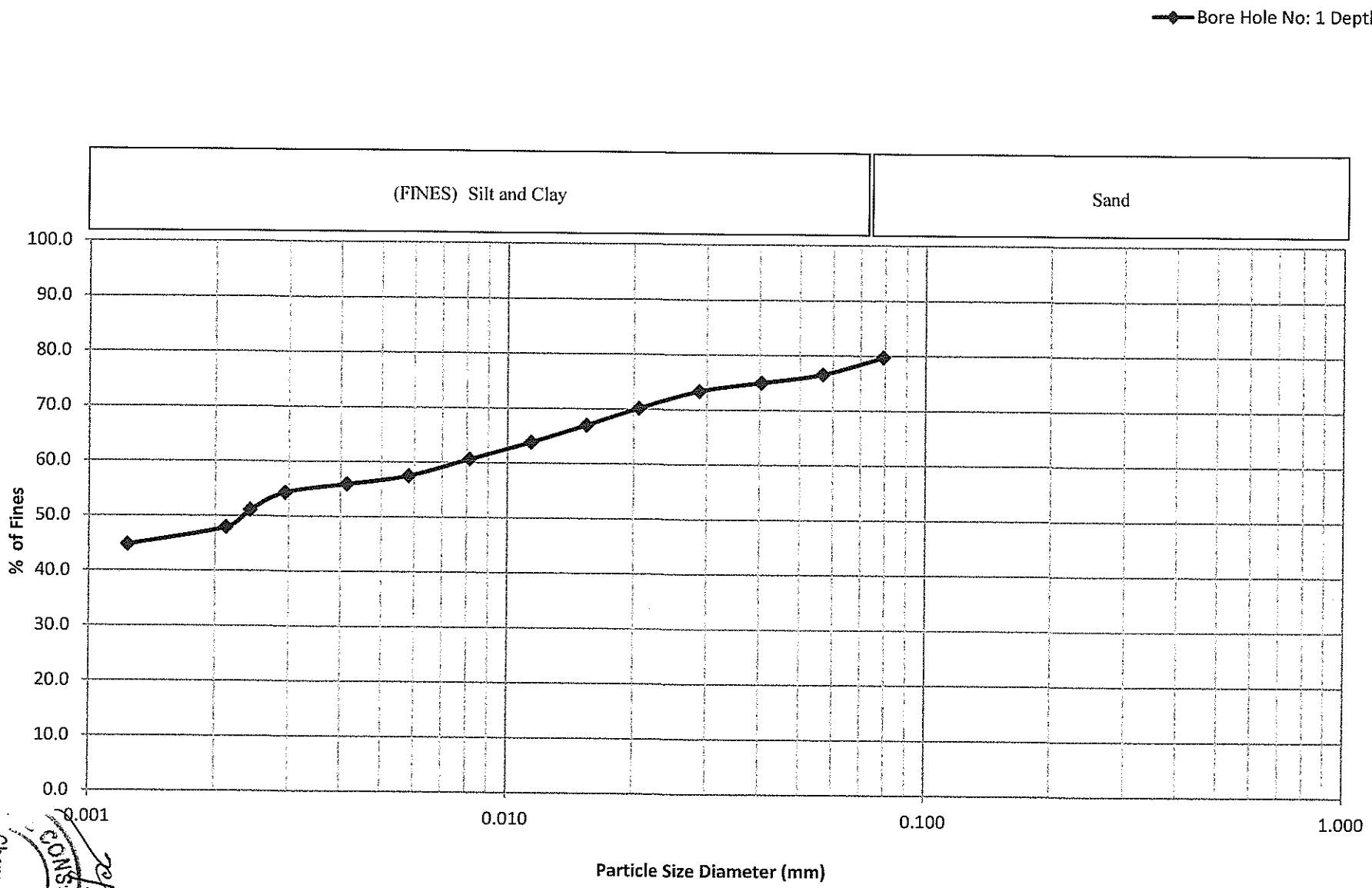


Fig 2.11 Hydrometer Analysis Master Curve

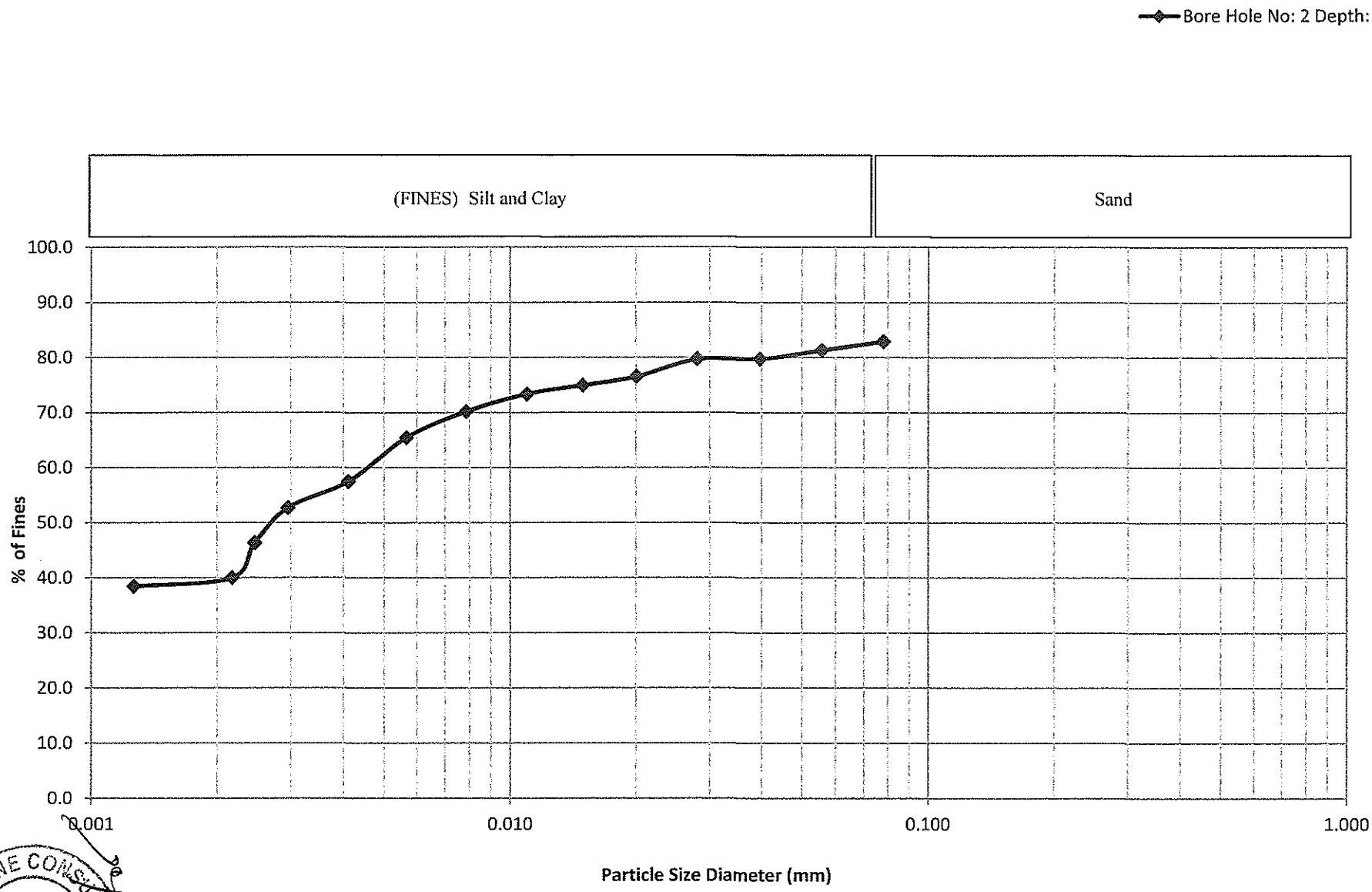


Fig 2.12 Hydrometer Analysis Master Curve

GEO MARINE CONSULTANTS PVT. LTD. Chennai-41

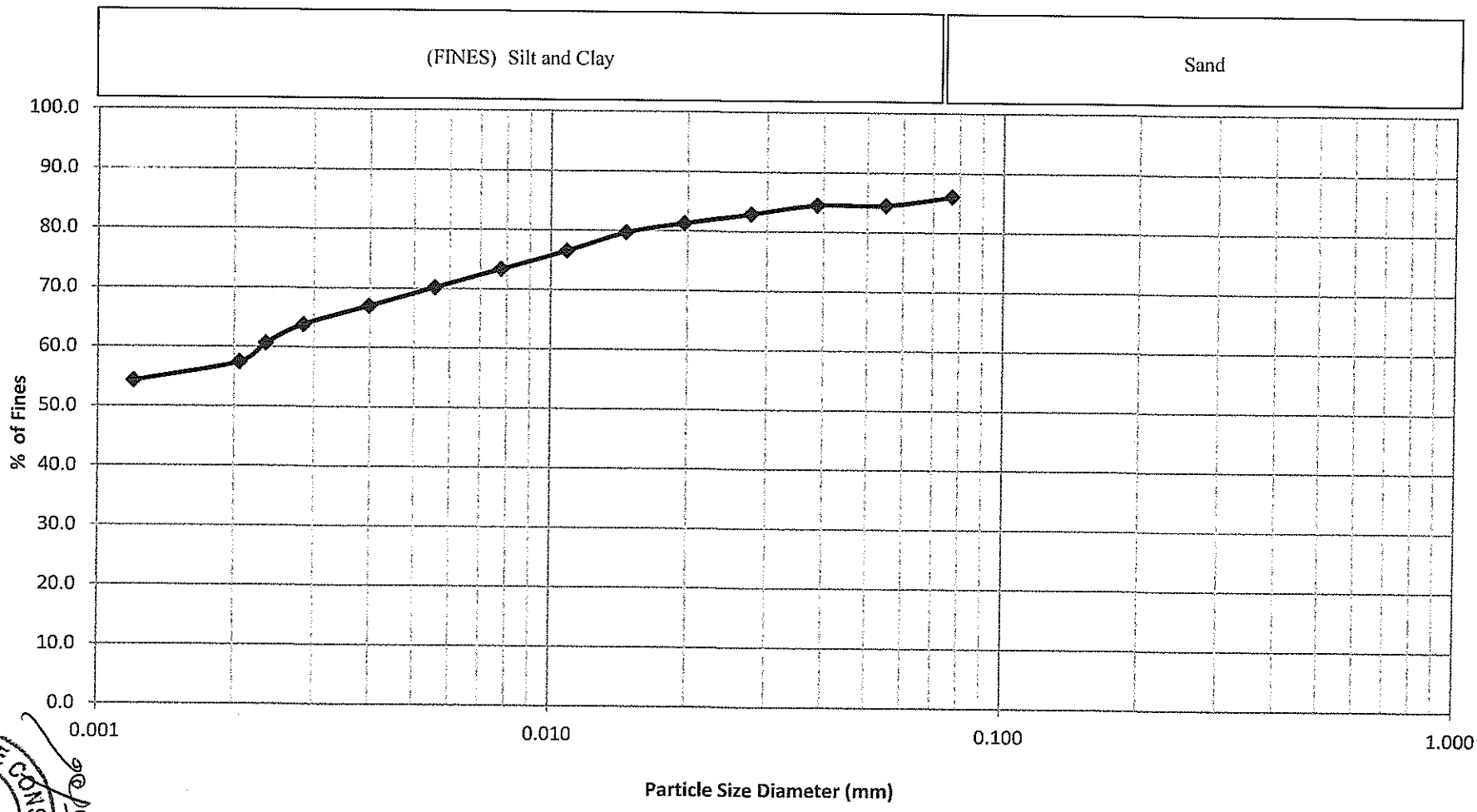


Fig 2.13 Hydrometer Analysis Master Curve

GEO MARINE CONSULTANTS P Chennai-41

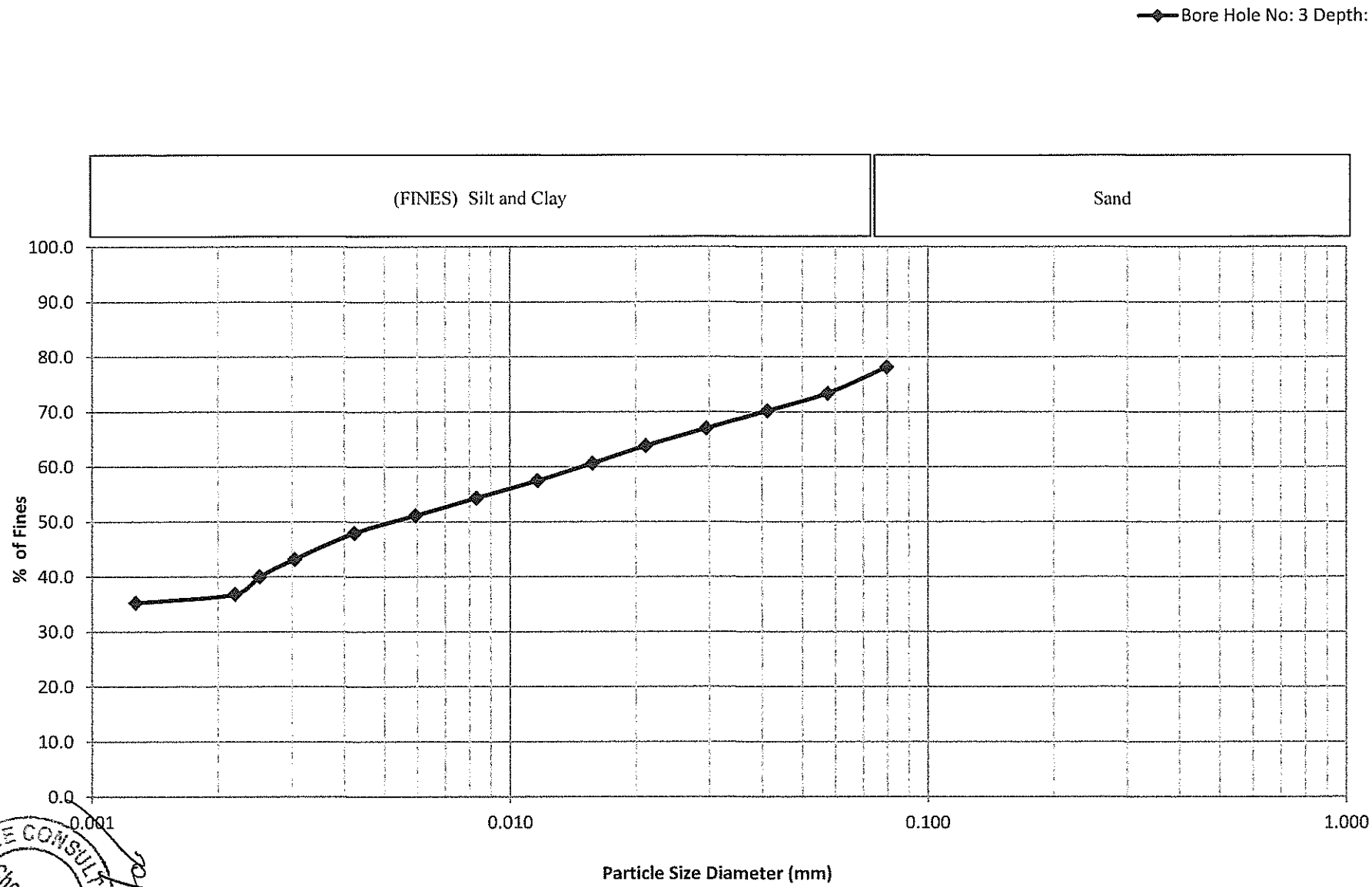


Fig 2.14 Hydrometer Analysis Master Curve

GEO MARINE CONSULTANTS PVT. LTD. Chennai-41

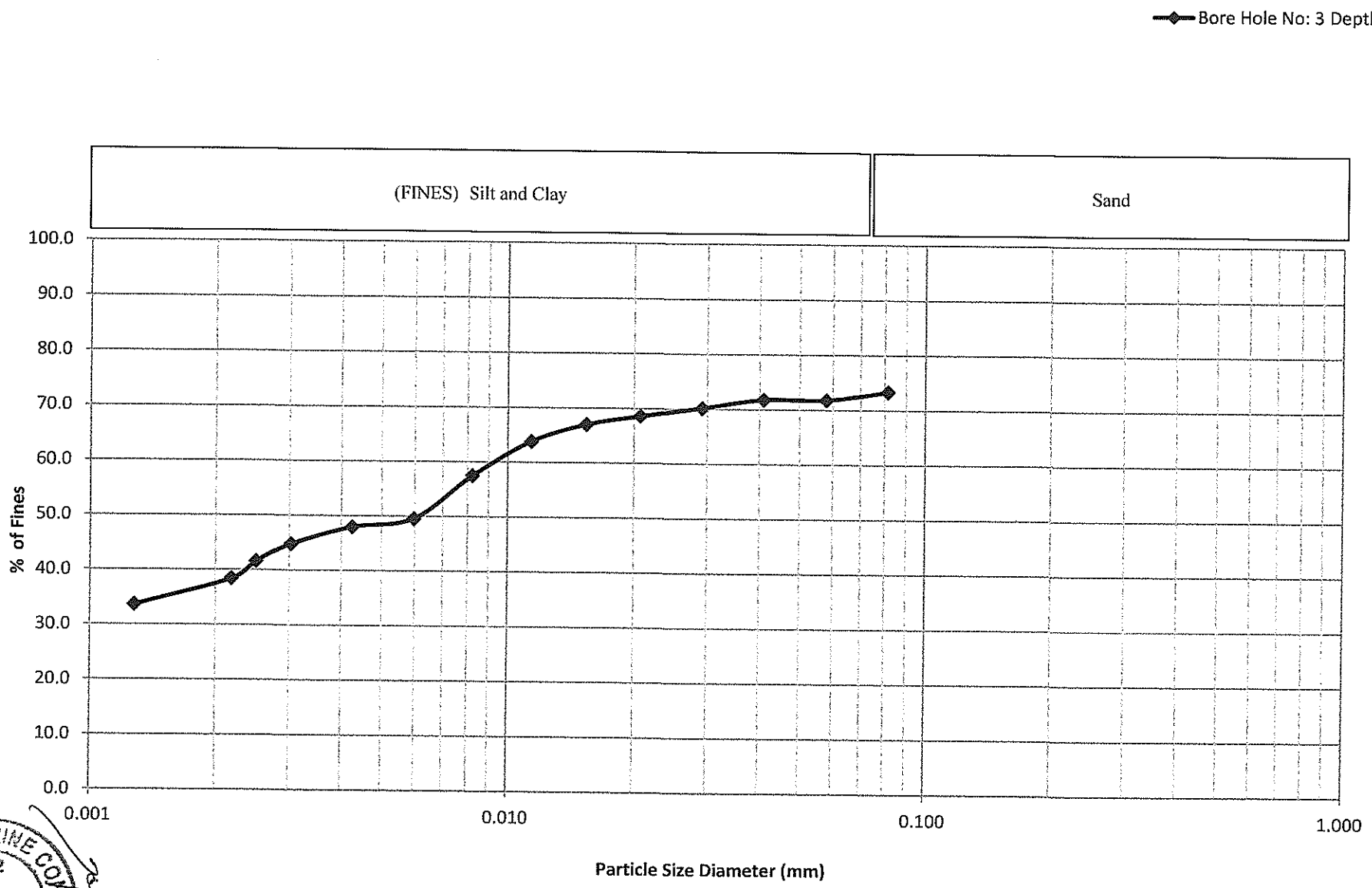


Fig 2.15 Hydrometer Analysis Master Curve

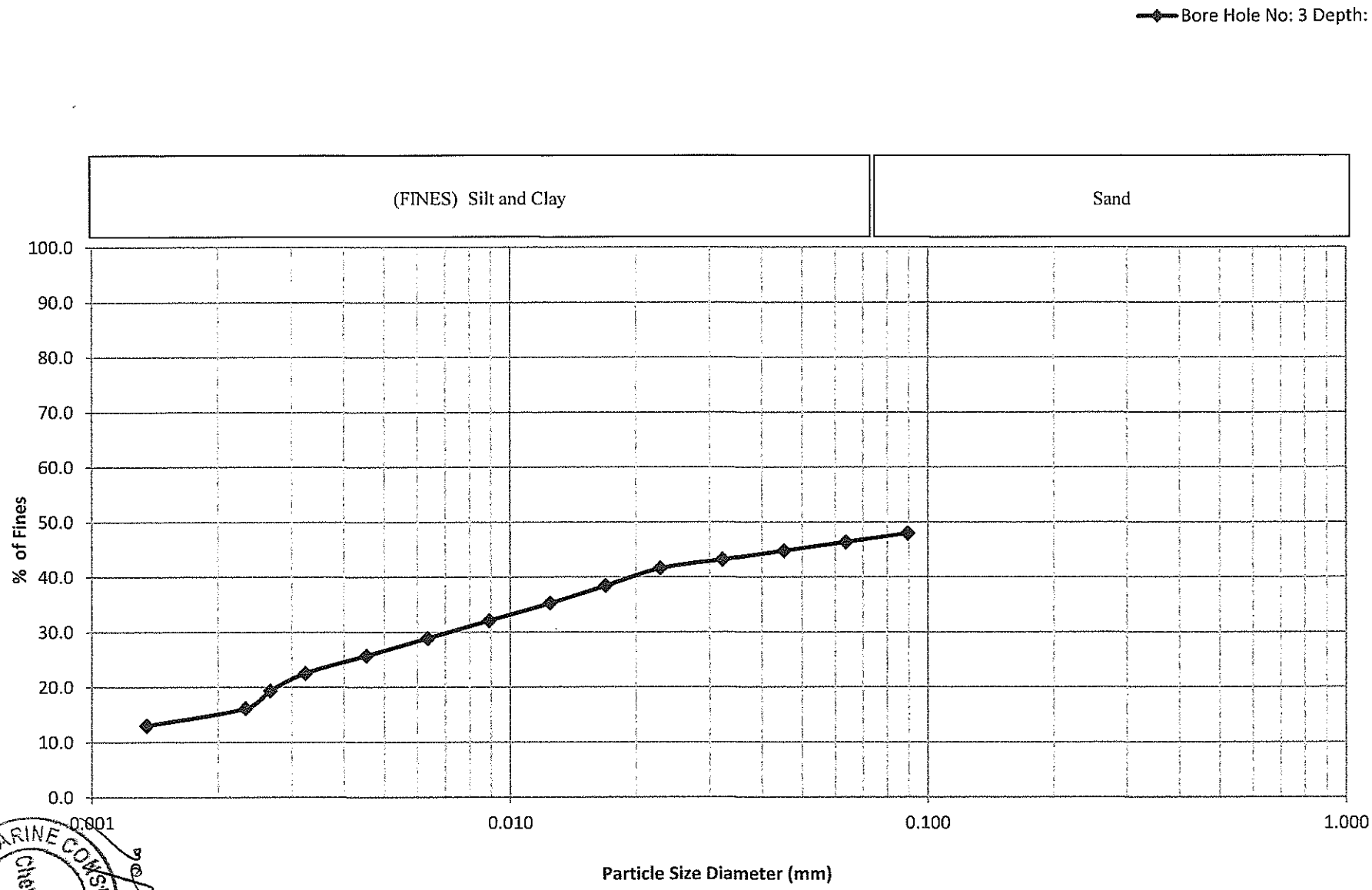


Fig 2.16 Hydrometer Analysis Master Curve

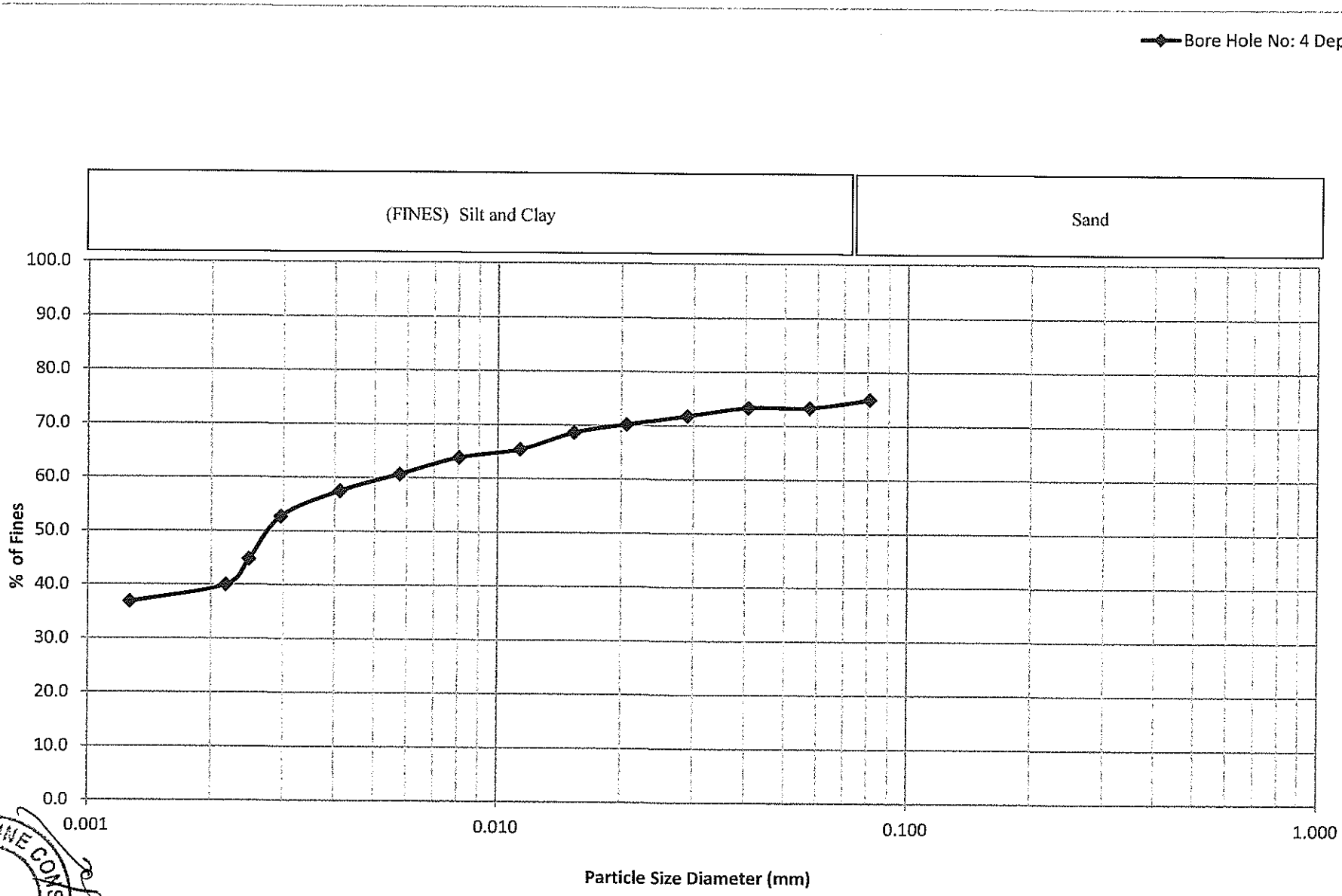


Fig 2.17 Hydrometer Analysis Master Curve

GEO MARINE CONSULTANTS PVT Chennai-41

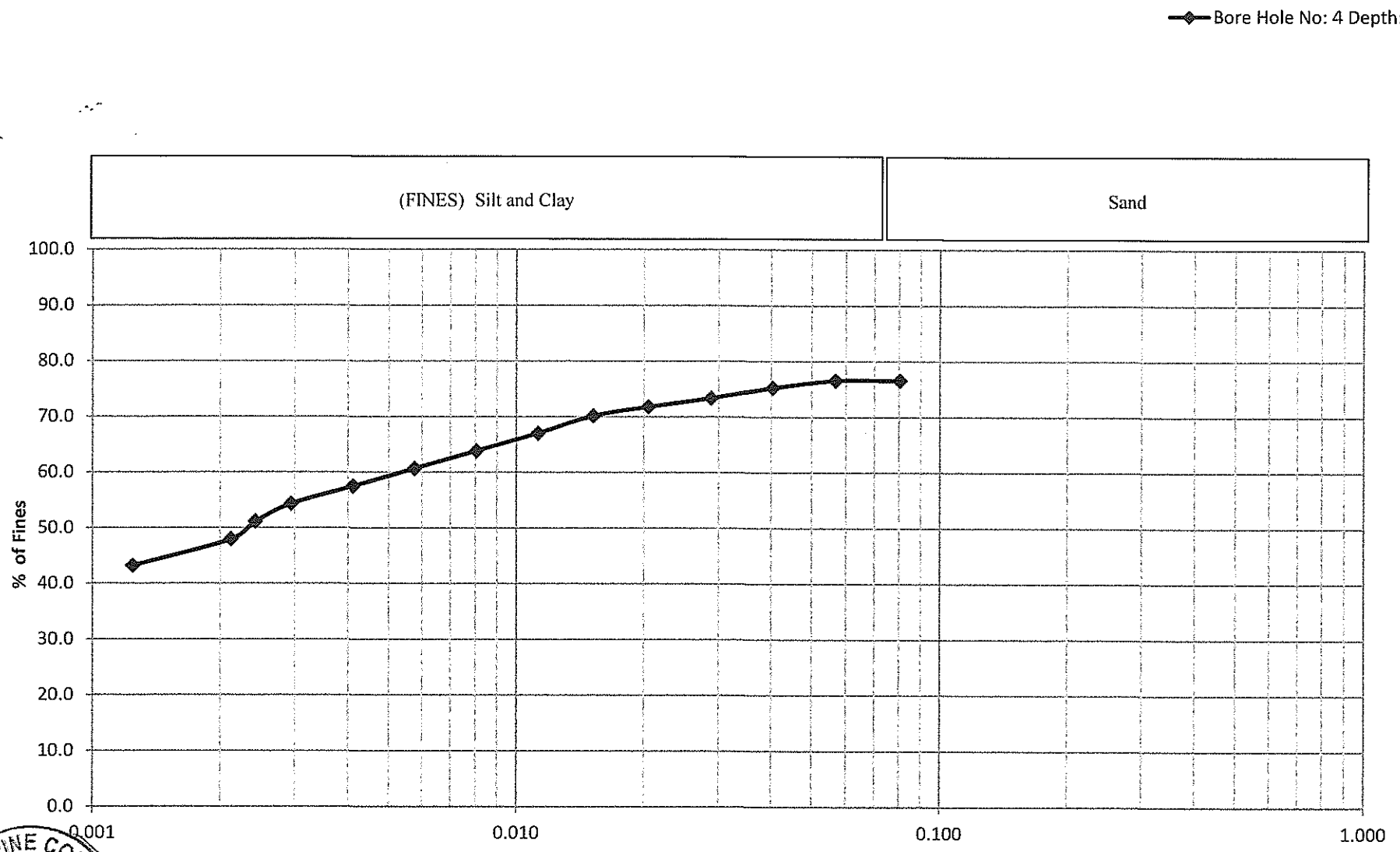


Fig 2.18 Hydrometer Analysis Master Curve

GEO MARINE CONSULTANTS PVT. LTD. Chennai-41

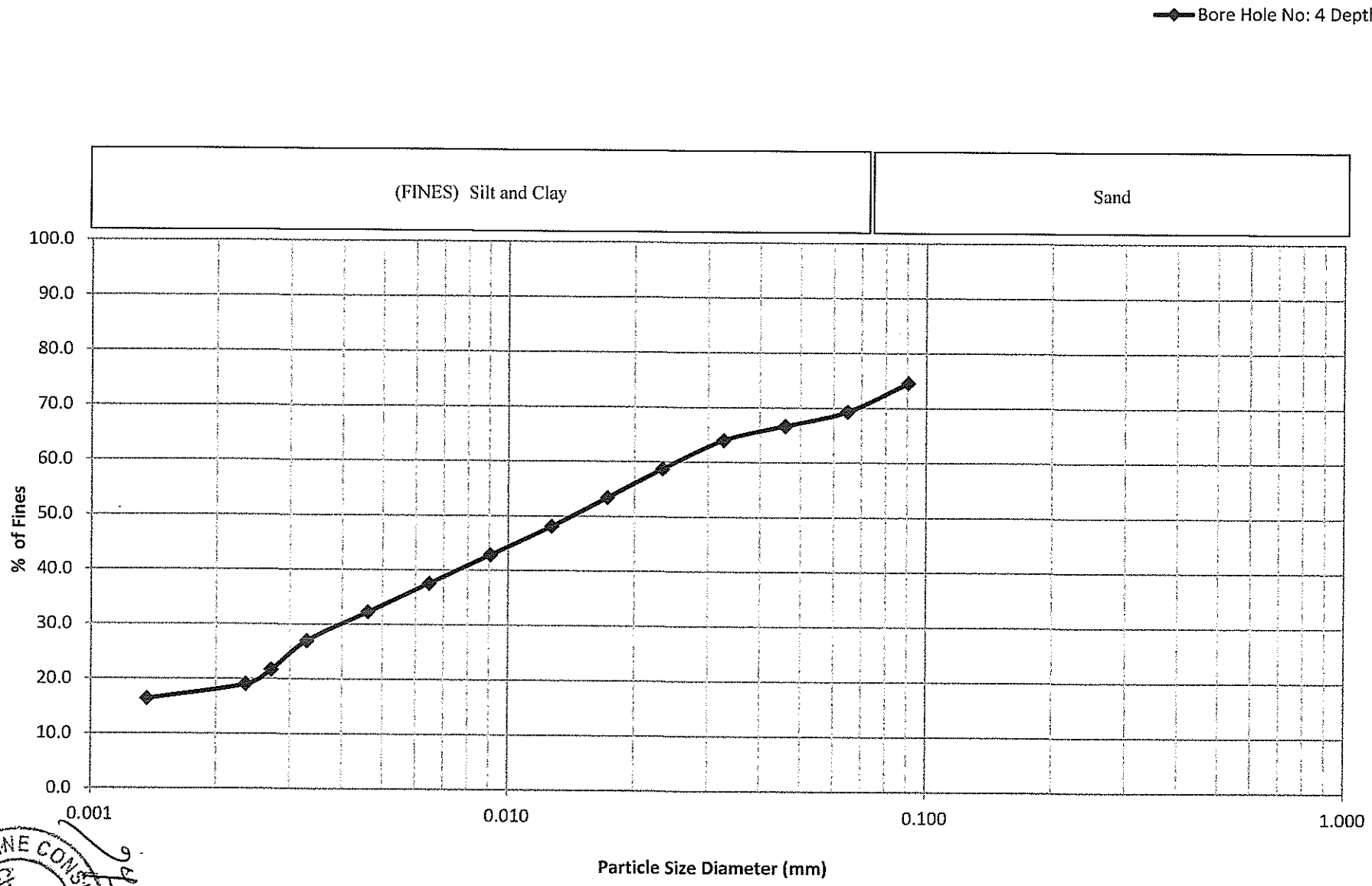
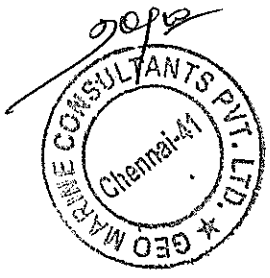


Fig 2.19 Hydrometer Analysis Master Curve

GEOMARINE CONSULTANTS PVT. LTD. Chennai-41

LABORATORY TEST RESULTS



ARINE
.: 044-24481485, 044-24480305

LABORATORY TEST REPORT

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

Name & Address of the Customer	:	**M/s IVAR ESTATES PRIVATE LIMITED, CHENNAI**	**Customer Reference**	:	By Email
Sample Description	:	Soil Sample	**Period of Testing**	:	01/12/2021 to 11/12/2021
Source of Sample	:	Customer Supplied- Borehole No. BH-01	**Sample Identification Number**	:	SS/GMC/112021/420/BH01
Sample Condition	:	Satisfactory	**Test Report No.**	:	GT-2313/BH-01
Test Method	:	As per Bureau of Indian Standards	**Report Date**	:	13/12/2021
Sample Receipt Date	:	01/12/2021	**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	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
1.0	0	SS	FILLED UP (BUILDING DEBRIS & SAND)										10.5	1.1	10.2	18.5	59.8		-	-	-	-	-	FG>50%	FG>50%	FG>50%
2.0	22	SS	-	-	-	-	-	-	-	CG>50%	-	-	0.0	0.9	32.0	42.6	24.5		-	-	-	-	-	M.Dense	<50%	SM
3.0	37	SS	-	-	-	-	-	-	-	CG>50%	-	-	0.0	1.5	25.2	52.9	20.4		-	-	-	-	-	Dense	<50%	SM
4.0	21	SS	-	-	-	-	-	-	-	CG>50%	-	-	0.0	3.1	47.3	32.6	17.0		-	-	-	-	-	M.Dense	<50%	SM
5.0	34	SS	-	-	-	-	-	-	-	CG>50%	-	-	0.0	3.0	63.7	23.7	9.6		-	-	-	-	-	Dense	<50%	SP-SM
6.0	41	SS	-	-	-	-	-	-	-	CG>50%	-	-	2.0	0.7	49.1	38.2	10.0		-	-	-	-	-	Dense	<50%	SP-SM
7.5	31	SS	-	-	-	-	-	-	-	CG>50%	-	-	0.0	1.0	58.4	33.8	6.9		-	-	-	-	-	Dense	<50%	SP-SM
9.0	15	SS	25.7	43.7	23.9	19.8	0.9	13.4	12.0	Stiff	Above	CI	-	-	-	-	67.9	32.1	-	-	-	-	-	FG>50%	FG>50%	FG>50%
10.5	22	SS	28.5	54.3	28.5	25.8	1.0	14.0	37.5	V.Stiff	Above	CH	-	-	-	-	100.0		-	-	-	-	-	FG>50%	FG>50%	FG>50%
12.0	6	SS	26.8	40.0	17.3	22.7	0.6	14.5	21.7	M.Stiff	Above	CI	-	-	-	-	100.0		-	-	-	-	-	FG>50%	FG>50%	FG>50%
14.0	59	SS	-	-	-	-	-	-	-	CG>50%	-	-	0.0	0.0	3.3	80.9	15.8		-	-	-	-	-	V.Dense	<50%	SM
16.0	9	SS	50.4	96.6	38.4	58.2	0.8	8.4	131.8	Stiff	Above	CH	-	-	-	-	100.0		-	-	-	-	-	FG>50%	FG>50%	FG>50%
18.0	9	SS	40.1	73.8	34.3	39.5	0.9	10.2	100.0	Stiff	Above	CH	-	-	-	-	52.1	47.9	-	-	-	-	-	FG>50%	FG>50%	FG>50%
20.0	13	SS	45.5	94.4	36.6	57.8	0.8	9.5	116.7	Stiff	Above	CH	-	-	-	-	100.0		-	-	-	-	-	FG>50%	FG>50%	FG>50%
22.5	10	SS	36.6	66.4	31.6	34.8	0.9	10.8	62.5	Stiff	Above	CH	-	-	-	-	100.0		-	-	-	-	-	FG>50%	FG>50%	FG>50%
25.0	19	SS	16.7	34.9	17.1	17.8	1.0	16.5	22.2	V.Stiff	Above	CL	-	-	-	-	100.0		-	-	-	-	-	FG>50%	FG>50%	FG>50%
27.5	>100	SS	12.2	32.3	21.6	10.7	1.9	-	-7.1	Hard	Above	CL	-	-	-	-	100.0		-	-	-	-	-	FG>50%	FG>50%	FG>50%

** 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
Phone No.: 044-24481485, 044-24480305

LABORATORY TEST REPORT

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

Name & Address of the Customer	:	M/s IVAR ESTATES PRIVATE LIMITED, CHENNAI	**Customer Reference**	:	By Email
Sample Description	:	Soil Sample	**Period of Testing**	:	01/12/2021 to 11/12/2021
Source of Sample	:	Customer Supplied- Borehole No. BH-02	**Sample Identification Number**	:	SS/GMC/112021/420/BH02
Sample Condition	:	Satisfactory	**Test Report No.**	:	GT-2313/BH-02
Test Method	:	As per Bureau of Indian Standards	**Report Date**	:	13/12/2021
Sample Receipt Date	:	01/12/2021	**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	Consistancy	Position With Respect to A-Aline	IS:Notation	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 $C_c=D_{30}^2/(D_{10}\times D_{60})$	Relative Density	IS-Notation	
													Gravel (%)	Coarse (%)	Medium (%)	Fine (%)	Silt (%)	Clay (%)							Gravel	Sand
1.0	10	SS	-	-	-	-	-	-	-	CG>50%	-	-	1.3	2.5	49.4	34.4	12.5		-	-	-	-	-	Loose	<50%	SM
2.0	42	SS	-	-	-	-	-	-	-	CG>50%	-	-	1.3	2.2	65.6	25.4	5.5		-	-	-	-	-	Dense	<50%	SP-SM
3.0	31	SS	-	-	-	-	-	-	-	CG>50%	-	-	0.0	1.5	65.5	21.8	11.2		-	-	-	-	-	Dense	<50%	SP-SM
4.0	33	SS	-	-	-	-	-	-	-	CG>50%	-	-	0.0	4.3	69.5	18.0	8.2		-	-	-	-	-	Dense	<50%	SP-SM
5.0	31	SS	-	-	-	-	-	-	-	CG>50%	-	-	0.0	1.4	55.8	34.0	8.9		-	-	-	-	-	Dense	<50%	SP-SM
6.0	32	SS	-	-	-	-	-	-	-	CG>50%	-	-	0.0	2.0	51.4	35.0	11.6		-	-	-	-	-	Dense	<50%	SP-SM
7.5	10	SS	29.7	50.7	25.2	25.5	0.8	13.0	16.7	Stiff	Above	CH	-	-	-	-	100.0		-	-	-	-	-	FG>50%	FG>50%	FG>50%
9.0	14	SS	25.8	55.7	25.5	30.2	1.0	11.9	25.0	Stiff	Above	CH	0.0	0.0	2.0	0.9	97.1		-	-	-	-	-	FG>50%	FG>50%	FG>50%
12.0	49	SS	Non Plastic						0.0	-	Above	ML	0.0	0.0	1.2	32.5	66.3		-	-	-	-	-	FG>50%	FG>50%	FG>50%
14.0	9	SS	Sample Failed																							
16.0	7	SS	53.8	86.5	34.7	51.8	0.6	9.9	142.9	M.Stiff	Above	CH	-	-	-	-	60.0	40.0	-	-	-	-	-	FG>50%	FG>50%	FG>50%
18.0	6	SS	32.1	43.4	23.9	19.5	0.6	14.5	50.0	M.Stiff	Above	CI	-	-	-	-	100.0		-	-	-	-	-	FG>50%	FG>50%	FG>50%
20.0	10	SS	50.9	99.2	36.7	62.5	0.8	8.4	143.5	Stiff	Above	CH	-	-	-	-	42.5	57.5	-	-	-	-	-	FG>50%	FG>50%	FG>50%
22.5	13	SS	42.0	92.2	35.6	56.6	0.9	8.9	112.5	Stiff	Above	CH	-	-	-	-	100.0		-	-	-	-	-	FG>50%	FG>50%	FG>50%
25.0	63	SS	14.2	35.0	17.4	17.6	1.2	14.8	80.0	Hard	Above	CL	0.0	0.0	16.3	17.9	65.9		-	-	-	-	-	FG>50%	FG>50%	FG>50%

** END OF REPORT**

Terms and Conditions

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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)

ARINE
o.: 044-24481485, 044-24480305

LABORATORY TEST REPORT

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

ame & Address of the Customer	:	M/s IVAR ESTATES PRIVATE LIMITED, CHENNAI	Customer Reference	:	By Email
mple Description	:	Soil Sample	Period of Testing	:	01/12/2021 to 11/12/2021
ource of Sample	:	Customer Supplied- Borehole No. BH-03	Sample Identification Number	:	SS/GMC/112021/420/BH03
mple Condition	:	Satisfactory	Test Report No.	:	GT-2313/BH-03
st Method	:	As per Bureau of Indian Standards	Report Date	:	13/12/2021
mple Receipt Date	:	01/12/2021	Test Report Pages	:	One Page

Table-2.3 Laboratory Classification of Soil Samples from BH-03

			Fine Grained (FG)										Coarse Grained (CG)												
													GRAIN SIZE ANALYSIS AS PER IS 2720 (P-IV) - 1985, RA-2015											IS-Notation	
	SPT- "N" Value	Type of Sample	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 (I_c=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	Gravel (%)	Coarse (%)	Medium (%)	Fine (%)	Silt (%)	Clay (%)	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	Gravel	Sand
0	17	SS	-	-	-	-	-	-	-	CG>50%	-	-	15.8	18.2	58.2	7.4	0.4		-	-	-	-	-	M.Dense	<50%	SP
0	37	SS	-	-	-	-	-	-	-	CG>50%	-	-	3.1	14.4	69.7	11.9	0.9		-	-	-	-	-	Dense	<50%	SP
0	40	SS	-	-	-	-	-	-	-	CG>50%	-	-	1.3	2.4	52.8	31.3	12.2		-	-	-	-	-	Dense	<50%	SM
0	38	SS	-	-	-	-	-	-	-	CG>50%	-	-	4.1	1.9	59.0	28.6	6.5		-	-	-	-	-	Dense	<50%	SP-SM
0	31	SS	-	-	-	-	-	-	-	CG>50%	-	-	0.0	0.0	51.0	41.5	7.5		-	-	-	-	-	Dense	<50%	SP-SM
5	9	SS	21.3	36.5	18.8	17.7	0.9	15.0	-10.0	Stiff	Above	CI	-	-	-	-	100.0		-	-	-	-	-	FG>50%	FG>50%	FG>50%
0	-	UDS	34.4	45.2	23.0	22.2	0.5	14.0	17.5	-	Above	CI	-	-	-	-	100.0		-	-	-	-	-	FG>50%	FG>50%	FG>50%
.5	18	SS	21.6	56.7	23.5	33.3	1.1	12.0	23.8	V.Stiff	Above	CH	-	-	-	-	63.2	36.8	-	-	-	-	-	FG>50%	FG>50%	FG>50%
.0	31	SS	20.5	45.2	25.3	19.9	1.2	14.0	19.2	Hard	Above	CI	0.0	0.0	1.2	32.5	66.3		-	-	-	-	-	FG>50%	FG>50%	FG>50%
.0	6	SS	36.6	55.8	25.6	30.2	0.6	12.5	14.3	M.Stiff	Above	CH	-	-	-	-	61.6	38.4	-	-	-	-	-	FG>50%	FG>50%	FG>50%
.0	8	SS	36.8	64.0	30.9	33.1	0.8	11.8	30.8	Stiff	Above	CH	-	-	-	-	100.0		-	-	-	-	-	FG>50%	FG>50%	FG>50%
.0	6	SS	30.7	45.4	22.1	23.3	0.6	14.5	36.4	M.Stiff	Above	CI	-	-	-	-	100.0		-	-	-	-	-	FG>50%	FG>50%	FG>50%
.0	11	SS	24.1	44.5	22.4	22.1	0.9	14.3	13.0	Stiff	Above	CI	-	-	-	-	100.0		-	-	-	-	-	FG>50%	FG>50%	FG>50%
.5	10	SS	43.1	89.1	31.4	57.7	0.8	10.2	31.8	Stiff	Above	CH	-	-	-	-	100.0		-	-	-	-	-	FG>50%	FG>50%	FG>50%
.0	56	SS	24.3	54.9	26.8	28.1	1.1	12.5	36.4	CG>50%	Above	-	0.0	0.0	39.7	29.9	25.4	5.0	-	-	-	-	-	V.Dense	<50%	SC

** END OF REPORT**

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Authorised Signatory

A. VINOTH
(Technical Manager)

GEOMARINE
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Phone No.: 044-24481485, 044-24480305

LABORATORY TEST REPORT

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

Name & Address of the Customer	:	**M/s IVAR ESTATES PRIVATE LIMITED, CHENNAI**	**Customer Reference**	:	By Email
Sample Description	:	Soil Sample	**Period of Testing**	:	01/12/2021 to 11/12/2021
Source of Sample	:	Customer Supplied- Borehole No. BH-04	**Sample Identification Number**	:	SS/GMC/112021/420/BH04
Sample Condition	:	Satisfactory	**Test Report No.**	:	GT-2313/BH-04
Test Method	:	As per Bureau of Indian Standards	**Report Date**	:	13/12/2021
Sample Receipt Date	:	01/12/2021	**Test Report Pages**	:	One Page

Table-2.4 Laboratory Classification of Soil Samples from BH-04

Sample Depth (m)	SPT- "N" Value	Type of Sample	Fine Grained (FG)										Coarse Grained (CG)											IS-Notation	
			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	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		
													Gravel (%)	Coarse (%)	Medium (%)	Fine (%)	Silt (%)	Clay (%)							Gravel	Sand
1.0	8	SS	-	-	-	-	-	-	-	CG>50%	-	-	0.0	2.1	73.7	16.3	7.9		-	-	-	-	-	Loose	<50%	SP-SM
2.0	19	SS	-	-	-	-	-	-	-	CG>50%	-	-	0.0	1.3	32.1	55.6	11.1		-	-	-	-	-	M.Dense	<50%	SP-SM
3.0	24	SS	-	-	-	-	-	-	-	CG>50%	-	-	0.0	3.0	59.7	29.8	7.5		-	-	-	-	-	M.Dense	<50%	SP-SM
4.0	22	SS	-	-	-	-	-	-	-	CG>50%	-	-	0	0	55.5	36.7	7.8		-	-	-	-	-	M.Dense	<50%	SP-SM
5.0	46	SS	-	-	-	-	-	-	-	CG>50%	-	-	0.0	1.5	59.7	33.3	5.5		-	-	-	-	-	Dense	<50%	SP-SM
6.0	39	SS	-	-	-	-	-	-	-	CG>50%	-	-	0.0	1.5	54.8	35.8	8.0		-	-	-	-	-	Dense	<50%	SP-SM
7.5	52	SS	-	-	-	-	-	-	-	CG>50%	-	-	0.0	1.7	54.2	39.4	4.7		-	-	-	-	-	V.Dense	<50%	SP
9.0	9	SS	32.8	58.0	26.2	31.8	0.8	11.9	23.5	Stiff	Above	CH	-	-	-	-	60.0	40.0	-	-	-	-	-	FG>50%	FG>50%	FG>50%
10.5	-	UDS	30.9	48.5	24.3	24.2	0.7	13.8	19.9	-	Above	CI	-	-	-	-	100.0		-	-	-	-	-	FG>50%	FG>50%	FG>50%
12.0	13	SS	20.9	30.3	19.0	11.3	0.8	19.3	-8.7	Stiff	Above	CL	0.0	0.0	3.5	16.7	79.8		-	-	-	-	-	FG>50%	FG>50%	FG>50%
14.0	6	SS	46.8	76.0	32.2	43.8	0.7	10.2	65.0	M.Stiff	Above	CH	-	-	-	-	52.1	47.9	-	-	-	-	-	FG>50%	FG>50%	FG>50%
16.0	7	SS	55.6	91.5	36.5	55.0	0.7	9.0	91.7	M.Stiff	Above	CH	-	-	-	-	100.0		-	-	-	-	-	FG>50%	FG>50%	FG>50%
18.0	5	SS	28.7	40.4	19.4	21.1	0.6	14.0	25.0	M.Stiff	Above	CI	-	-	-	-	100.0		-	-	-	-	-	FG>50%	FG>50%	FG>50%
20.0	8	SS	49.7	97.3	36.5	60.8	0.8	8.5	85.7	Stiff	Above	CH	-	-	-	-	100.0		-	-	-	-	-	FG>50%	FG>50%	FG>50%
22.5	9	SS	37.9	78.1	34.3	43.8	0.9	9.9	85.2	Stiff	Above	CH	-	-	-	-	100.0		-	-	-	-	-	FG>50%	FG>50%	FG>50%
25.0	>100	SS	14.8	43.5	18.7	24.8	1.2	13.8	27.3	Hard	Above	CI	-	-	-	-	81.0	19.0	-	-	-	-	-	FG>50%	FG>50%	FG>50%

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A. VINOTH
(Technical Manager)

TABLE-2.5 RESULTS OF CHEMICAL ANALYSIS

SL No.	Bore HoleNo.	Water						Soil (2:1)			
		Depth of Sample (m)	pH	Chlorides (ppm)	Sulphates (ppm)	Total Dissolved Solids (ppm)	Electrical Conductivity (mhos/cm)	Depth of Sample (m)	pH	Chlorides (ppm)	Sulphates (ppm)
1.0	BH-01	1.00	7.17	353.9	441.0	1293	5.46	2.0	7.15	98.5	49.5
2.0	BH-02	0.30	7.28	240.5	447.0	883	3.47	2.0	7.12	105.3	83.2
3.0	BH-03	1.20	7.30	267.5	425.0	645	3.12	3.0	7.19	90.1	77.9
4.0	BH-04	0.60	7.21	113.4	431.0	508	2.58	2.0	7.18	114.2	108.7

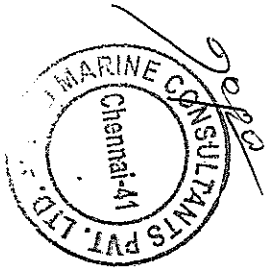
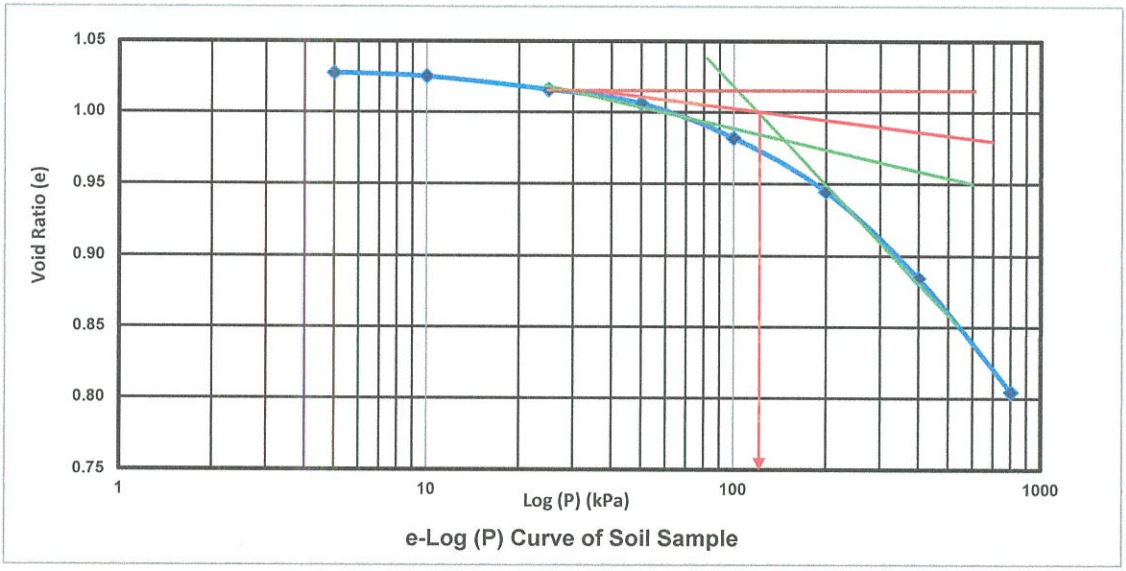


Table-2.7 Results of Consolidation Test



e-Log (P) Curve of Soil Sample

Results :

Natural Moisture Content	34.41 %
Initial Void Ratio	1.03
Pre Consolidation Pressure	125 kPa
Compression Index @200 kPa	0.124
Compression Index @400 kPa	0.199

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(Technical Manager)

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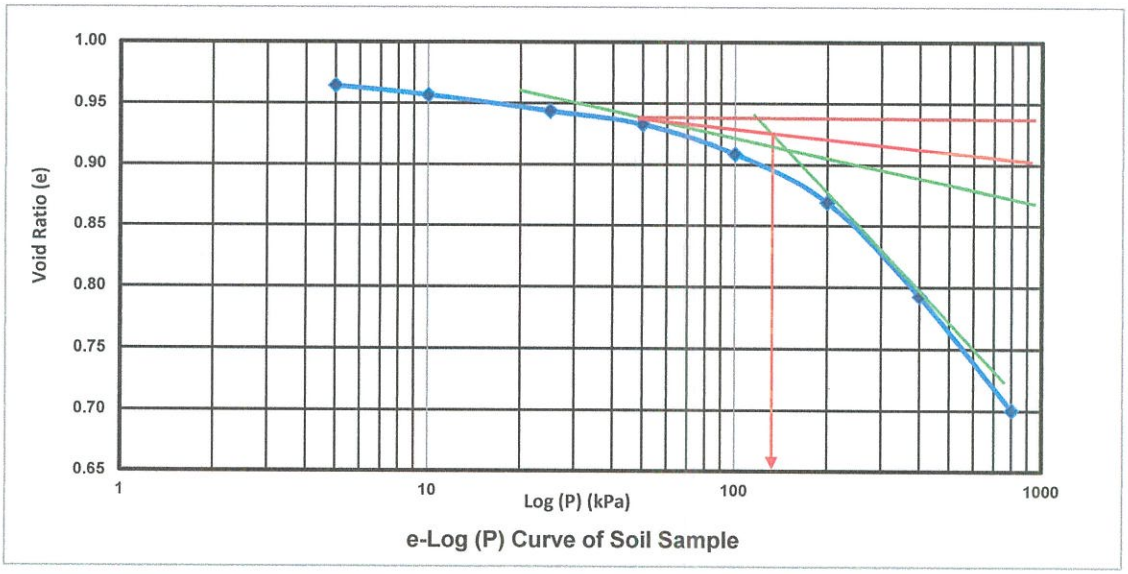
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Table-2.8 Results of Consolidation Test



e-Log (P) Curve of Soil Sample

Results :

Natural Moisture Content	30.88 %
Initial Void Ratio	0.965
Pre Consolidation Pressure	135 kPa
Compression Index @200 kPa	0.132
Compression Index @400 kPa	0.254

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(Technical Manager)

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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

i) Archaean crystalline rocks

ii) Gondwana (Consolidated Clay/Clayey Silt) and Tertiary sediments and

iii) 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:

Geologically, the present site is located in a coastal region with sub surface consisting of sedimentary deposits. The top sedimentary deposit is under laid by upper Gondwana system, particularly lower stage of Sriperumpudur. The formation mechanism of the sediments is chiefly due to transportation of surface water and marine deposition.

The above geological characteristics are also observed in the direct borehole investigation, which confirms that the present site does not depict any surprising geological features that are different from that of the region.

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.

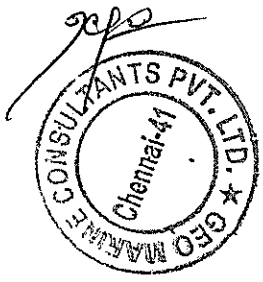
- For Coarse Grained Material, Ref. IS: 6403 to estimate Angle of Shearing Resistance (Reproduced and shown in Fig.A1)
- For Fine Grained Material, Ref. Terzaghi & Peck, 1948, to estimate Unconfined Compressive Strength (Reproduced and shown in Fig.A2)

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

REFERENCE BORE HOLE-BH:					1	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							(C_u) kPa	(ϕ) Deg.
1	0.00	1.70	1.70	-	-	0	Very Loose	-	12	-	19.61
2	1.70	9.00	7.30	Silty Sand	Brown	31	Dense	- -	19.5	-	36.28
3	9.00	12.00	3.00	Silty Clay	Grey	19	-	Very Stiff	20	127	-
4	12.00	14.00	2.00	Silty Clay	Grey	6	-	Medium Stiff	15.5	40	-
5	14.00	16.00	2.00	Silty Sand	Brownish Grey	59	Very Dense	-	20.5	-	42.35
6	16.00	25.00	9.00	Silty Clay	Grey	10	-	Stiff	17.5	67	-
7	25.00	27.00	2.00	Silty Clay	Grey	19	-	Very Stiff	20	127	-
8	27.00	29.50	2.50	Shale	Greenish Grey	CRR 17 % to 32 %, RQD 0 %					

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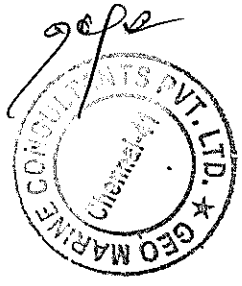
REFERENCE BORE HOLE-BH:					2	Ref R.L. of G.L. (m):			0.00		
Layer No.	Layer Thk. (m)			Type of Strata	Colour	Ave. Design SPT	Relative Density	Consistency	(γ) kN/m³	Shear Parameters	
	Top BGL	Bottom BGL	Thickness							(C_u) kPa	(ϕ) Deg.
1	0.00	2.00	2.00	Silty Sand	Brown	10	Loose	-	15	-	30
2	2.00	7.20	5.20	Silty Sand	Brown	34	Dense	-	19.5	-	37.1
3	7.20	12.00	4.80	Silty Clay	Grey	12	-	Stiff	18.5	80	-
4	12.00	14.00	2.00	Sandy Silt	Grey	49	-	Hard	21	327	-
5	14.00	20.00	6.00	Silty Clay	Grey	7	-	Medium Stiff	16	47	-
6	20.00	25.00	5.00	Silty Clay	Grey	12	-	Stiff	18.5	80	-
7	25.00	26.50	1.50	Sandy Silty Clay	Grey	63	-	Hard	22	400	-
8	26.50	27.50	1.00	Sandstone	Brownish Grey	CRR 97 %, RQD 39 %					



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REFERENCE BORE HOLE-BH:					3	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							(C_u) kPa	(ϕ) Deg.
1	0.00	1.30	1.30	Building Debris							
2	1.30	3.00	1.70	Poorly Graded Sand	Brown	17	Medium Dense	-	18	-	32.1
3	3.00	7.60	4.60	Silty Sand	Brown	37	Dense	-	19.5	-	37.93
4	7.60	10.50	2.90	Silty Clay	Grey	9	-	Stiff	17	60	-
5	10.50	12.00	1.50	Silty Clay	Grey	18	-	Very Stiff	20	120	-
6	12.00	14.00	2.00	Silty Clay	Grey	31	-	Hard	21	207	-
7	14.00	18.00	4.00	Silty Clay	Grey	7	-	Medium Stiff	16	47	-
8	18.00	20.00	2.00	Silty Clay	Grey	6	-	Medium Stiff	15.5	40	-
9	20.00	22.50	2.50	Silty Clay	Grey	11	-	Stiff	18	73	-
10	22.50	25.00	2.50	Silty Clay	Grey	10	-	Stiff	17.5	67	-
11	25.00	27.00	2.00	Clayey Silty Sand	Grey	56	Very Dense	-	20.5	-	41.9
12	27.00	28.00	1.00	Sandstone	Brownish Grey	CRR 99 %, RQD 90 %					

REFERENCE BORE HOLE-BH:					4	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/m^3	Shear Parameters	
	Top BGL	Bottom BGL	Thickness							(C_u) kPa	(ϕ) Deg.
1	0.00	0.80	0.80	Building Debris							
2	0.80	5.00	4.20	Silty Sand	Brown	18	Medium Dense	-	18	-	32.4
3	5.00	9.00	4.00	Silty Sand	Brown	46	Dense	-	20	-	40.1
4	9.00	14.00	5.00	Silty Clay	Grey	11	-	Stiff	18	73	-
5	14.00	20.00	6.00	Silty Clay	Grey	6	-	Medium Stiff	15.5	40	-
6	20.00	25.00	5.00	Silty Clay	Grey	9	-	Stiff	17	60	-
7	25.00	27.00	2.00	Silty Clay	Brownish Grey	>100	-	Hard	22	400	-
8	27.00	28.00	1.00	Sandstone	Brownish Grey	CRR 99 %, RQD 46 %					



CHAPTER-4

LIQUEFACTION EVALUATION

4.0 PHENOMENA:

Liquefaction has historically been used in conjunction with a variety of phenomena that involve soil deformations caused by monotonic, transient, or repeated disturbance of saturated cohesion-less soils under un-drained conditions. The generation of excess pore water pressure under un-drained loading conditions is a hallmark of all liquefaction phenomena. When saturated cohesion-less soils subjected to rapid loading resulting in undrained conditions undergo densification generates excess pore pressures and decreases effective stresses, eventually leading to excess deformation failures, commonly known as liquefaction. Liquefaction phenomena that result from this process is generally divided in two main groups: flow liquefaction and cyclic mobility. Both flow liquefaction and cyclic mobility are very important and any evaluation of liquefaction hazards should carefully consider both.

4.1 LIQUEFACTION SUSCEPTIBILITY:

Not all soils susceptible to liquefaction; consequently, the first step in a liquefaction hazard evaluation is the evaluation of liquefaction susceptibility. There are several criteria by which liquefaction susceptibility can be judged, and some are different for flow liquefaction and cyclic mobility. These include Historical, Geologic, Compositional, and State Criteria (Initial stress state before liquefaction).

Of the above four criteria, except the state criteria, the other three provide a qualitative evaluation of the liquefaction susceptibility of a deposit. The state criteria provide an analytical approach to quantify the liquefaction susceptibility with respect to the stress-strain response of the deposit against the environmental loading conditions.

The evaluation of liquefaction susceptibility based on state criteria is an independent and involved elaborate laboratory monotonic and cyclic loading testing programme and this is beyond the scope of present investigation. However, the liquefaction susceptibility pertinent to the present site sub surface characteristics are qualitatively outlined in the following sections. Further, based on the published correlation with respect to the corrected SPT-values, an attempt is made to provide a basic and guideline analysis on the liquefaction potential pertinent to ZONE-III earthquake coefficient.

4.2 QUALITATIVE APPROACH:

4.2.1 HISTORICAL CRITERIA:

Historically, the present site location never documented any post-earthquake generated soil flows or local liquefaction related effects.

4.2.2 GEOLOGIC CRITERIA:

Geologic process that sort soils into uniform grain size distribution and deposit them in loose states produce soil deposits with high liquefaction susceptibility. Similarly, the older geological formations are less susceptible to liquefaction compared to the recent deposits like Fluvial, Colluvium and Aeolian deposits.

FORMATION CHARACTERISTICS:

The sub soil in the present investigation location consists of following layers of stratification:

0.0m to 8.0m or 9.0m	Dense, Silty Sand to Poorly Graded Sand
9.0m to 12.0m	Stiff to Very Stiff, Silty Clay
12.0m to 25.0m	Medium Stiff, Silty Clay & Dense, Sand to Silt at Locations
25.0m to 27.5m	Hard, Clay to Very Dense, Clayey Sand
26.5m/27.m and beyond	Fissile,Hard, Shale

4.2.3 COMPOSITION CRITERIA:

Since liquefaction requires the development of excess pore pressure, liquefaction susceptibility is influenced by the compositional characteristics that influence volume change behaviour. These characteristics include particle size, shape and gradation. No specific Indian Standards are available to arrive at the potential particle size that chiefly contributes to the liquefaction. Further, well graded soils are less susceptible to liquefaction than poorly graded soils. Similarly rounded particles are more susceptible than angular particles as they tend to density.

In general, the composition of particles that is susceptible to liquefaction is encountered in loose state of deposition in alluvial and fluvial environment. In the present case, the sub soil from the existing ground level being dense soil followed by rock formation of different degree of weathering which indicates the deposit is non-susceptible to liquefaction phenomena.

4.3 QUANTITATIVE APPROACH:

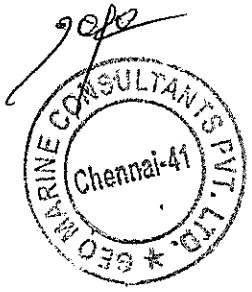
4.3.1 FLOW LIQUEFACTION:

Flow liquefaction can occur, when the shear stress required for static equilibrium of a soil mass (the static shear stress) is greater than the shear strength of the soil in its liquefied state. Flow liquefaction can occur either under monotonic or under cyclic loading conditions. In this failure, the cyclic stresses bring the soil to an unstable state at which its strength drops sufficiently to allow the static stresses to produce the flow. The flow liquefaction is characterised by sudden nature of occurrence and speed of occurrence.

The cyclic mobility can develop when the static shear stress is smaller than the steady-state shear strength and can occur in both loose and dense soils. A combination of static and cyclic loading generally produces cyclic mobility. However, no cyclic testing programme is carried out as it is beyond the scope of present investigation.

In the absence of cyclic testing programme a basic analysis based on the published data using in situ test results (SPT) is presented below to characterize the Liquefaction Resistance of the sub surface deposits encountered in the present site.

Further, as a first order of approximation and in the absence of rigours testing programme focusing on liquefaction steady, it is pressured that the clayey strata are non-susceptible to liquefaction and analysis is limited to sandy strata.



4.3.1.1 LIQUEFACTION RESISTANCE CHARACTERIZATION USING IN SITU TEST RESULTS:

(Ref."GEOTECHNCIAL EARTHQUAKE ENGINEERING" by Steven L. Kramer, University of Washington, Prentice-Hall International Series in Civil Engineering and Engineering Mechanic, 2005, Page77-381.

Seed et al (1975) developed a relationship between cyclic stress ratios (CSR) causing liquefaction and corrected SPT-values $(N_1)_{60}$ for silty sands in M=7.5 earthquakes. Further a magnitude correction factor for cyclic stress approach for different earthquake magnitudes is also developed.

The above relationships are reproduced in Figs.4.1 and Table-4.1. Based on this method, for the present site, the following approach is adopted to arrive at Liquefaction Resistance Characterization of the sub surface deposits encountered in the present site.

Step-I: Using the Zone Factor (Z), Importance Factor (I),Response reduction factor and Average response acceleration coefficient (S_a/g) pertinent to Zone-III, the design horizontal and vertical seismic coefficients are estimated as per IS:1893.

Step-2: Using the design seismic coefficient, compute the design seismic shear for corresponding to effective vertical stress (cyclic shear stress) due to overburden is computed.

Stet-3: Using the average corrected design SPT-value arrive at the design angle of shearing resistance compute the effective shear strength (static strength)

Step-4: Arrive at the CSR value of the deposit by dividing the cyclic shear stress with the effective shear strength.

Step-4: Based on the CSR-N_{160} relation from Fig.4.1 and using the magnitude correction factor corresponding to Zone-III (M=6), the probable liquefaction/no-liquefaction characterization is arrived at and the details are given below:

Table 9-2 Magnitude Correction Factors for Cyclic Stress Approach

Magnitude, M	$CSR_M/CSR_{M=7.5}$
$5\frac{1}{4}$	1.50
6	1.32
$6\frac{3}{4}$	1.13
$7\frac{1}{2}$	1.00
$8\frac{1}{2}$	0.80

TABLE-4.1 MAGNITUDE CORRECTION FACTORS FOR CYCLIC STRESS APPROACH

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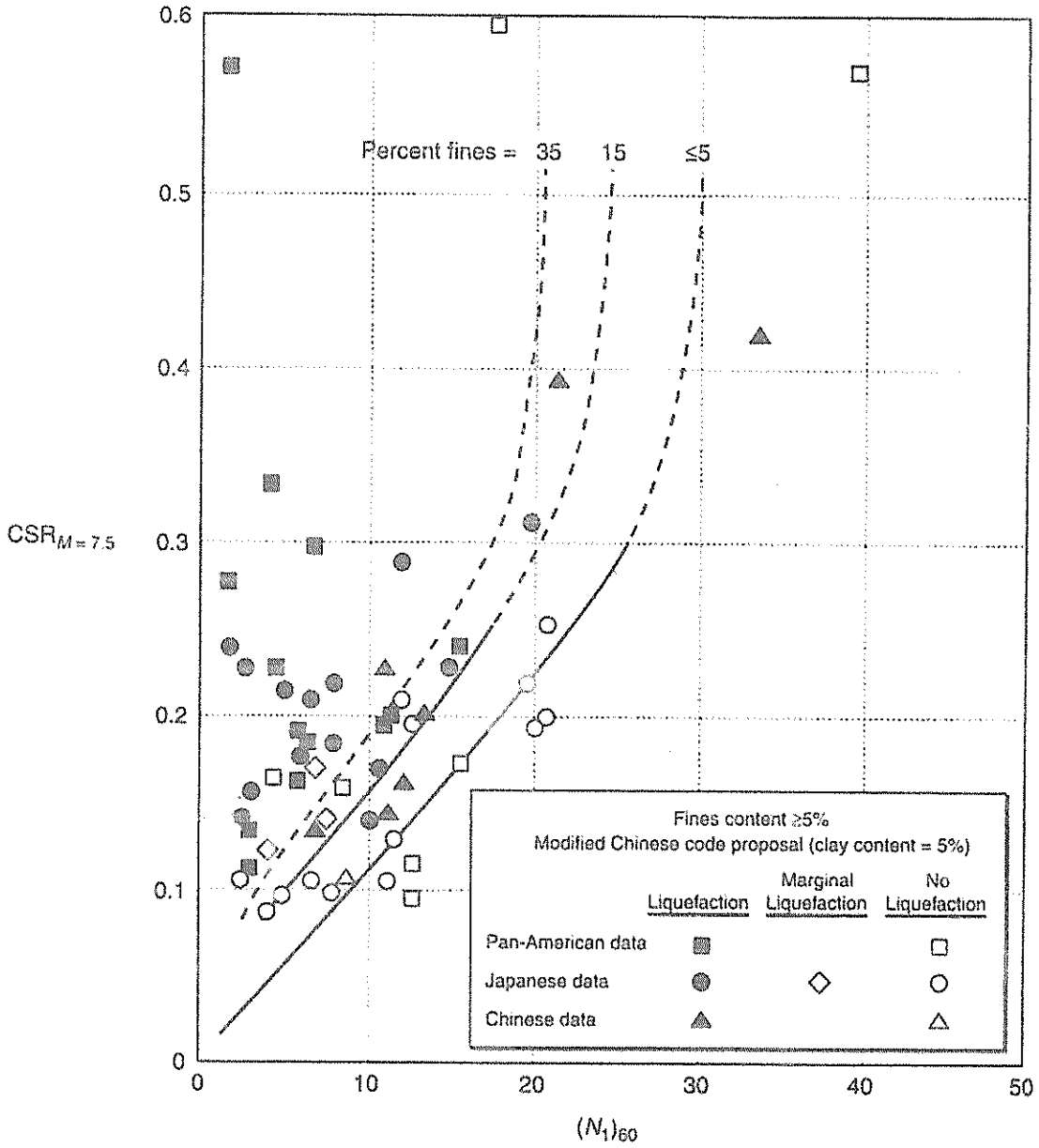


Figure 9.31 Relationship between cyclic stress ratios causing liquefaction and $(N_1)_{60}$ values for silty sands in $M = 7.5$ earthquakes. (After Seed et al. (1975). Influence of SPT procedures in soil liquefaction resistance evaluations, *Journal of Geotechnical Engineering*, Vol. 111, No. 12. Reprinted by permission of ASCE.)

FIG 4.1: RELATIONSHIP BETWEEN CYCLIC STRESS RATIOS OF LIQUEFACTION

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4.4 SUSCEPTIBILITY TO LIQUEFACTION:

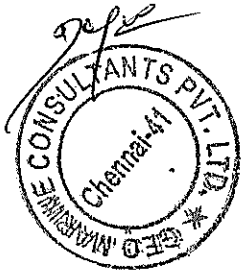
Liquefaction is a phenomenon occurs in sand and silts having relative density loose to very loose formation. Further the phenomenon can occurs in soft to very soft, clays of low plastic nature. The low plastic nature indirectly infers the predominant percentage of silt size particle which are highly susceptible to liquefaction.

In the project site no silt and sand with relative density having neither very loose nor very soft to soft low plastic clay strata exits within the investigation depth.

- ***The present project site falls in Seismic Zone-III, as per IS 1893 (Part-I).***
- ***In the project site, the sub soil formation encountered being dense sand formation followed by stiff to very stiff clay, the formation is not susceptible to liquefaction as per Zone-III seismic intensity.***

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FOUNDATION SYSTEM



CHAPTER-5

FOUNDATION SYSTEM

5.0 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.

5.1 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 two basement floors and nineteen upper floors, and is meant for residential occupancy. For this kind of structure, the column loads could vary between 5000kN to 7500 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.

5.2 SUB SURFACE CHARACTERISTICS:

The general sub soil stratification in the project site consists of the following formation:

Layer-I	0.0m to 8.0m or 9.0m	Dense, Silty Sand to Poorly Graded Sand
Layer-II	9.0m to 12.0m	Stiff to Very Stiff, Silty Clay
Layer-III	12.0m to 25.0m	Medium Stiff, Silty Clay & Dense, Sand to Silt at Locations
Layer-IV	25.0m to 27.5m	Hard, Clay to Very Dense, Clayey Sand
Layer-V	26.5m/27.m and beyond	Fissile, Hard, Shale

5.3 FOUNDATION SYSTEM:

5.3.1 PREAMBLE:

It is proposed to construct multi-storey structure with two basement floor. Considering each basement floor height of 3.5m the overall depth of excavation up to the top of lower basement floor is informed as 7.0m below the existing ground level. Taking into consideration of thickness of pile cap the overall depth required could be about 8.0m below the existing ground level.

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5.3.2 FOUNDATION SYSTEM:

For the kind of proposed configuration and sub soil condition, it is not possible to adopt any kind of open foundation system from settlement considerations. Hence, it is advisable to 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 taken to a depth of 28.0m below the existing ground level 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-5.1.

Typical computations are presented in Annexure-I.

TABLE:- 5.1 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-04	28.0	8.0	20.00	500	1100	550	50
2.0					600	1400	650	60
3.0					750	1800	800	75
4.0					800	2100	900	80
5.0					900	2500	1000	90
6.0					1000	3000	1100	100

5.4 DEEP EXCAVATION:

5.4.1 PREAMBLE:

All deep excavations need shoring system that fulfils the functionality irrespective of the cycles of season that is experienced during its life time. The primary functions of the shoring system are:

- To maintain the stability and safety of the excavation line.
- To prevent possible subsidence in the neighborhood either due to ground water lowering or due to release of overburden pressure
- To prevent soil flow or erosion from the excavation line.

To achieve the above, different shoring systems have been developed and are in practice based on the suitability of the system pertinent to the subsoil characteristics as described below:

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- ❖ Anchored Sheet Piles
- ❖ Anchored R.C.C. diaphragm walls
- ❖ Contiguous Piles (Anchored or Free Standing/Cantilever)
- ❖ Secant Piles (Anchored or Free Standing/Cantilever)
- ❖ Soil Nailing
- ❖ Open slope with Geo-grids

However, in Rocks, many a time deep excavations may not need any protection, as they stand stably, but for in case of intruded boulders, where in rock bolting is needed to achieve the stability. Further, the tie back anchors shall be located in passive zone, which requires sufficient space behind the excavation line for the implementation of anchored systems mentioned above.

Thus, for the design of deep excavation in soils, an insight of the soil behavior under seasonal cycles, knowledge subsurface hydrogeology along with Topography details of the excavation region are pre-requisites for the successful design of deep excavations.

The above aspects of deep excavation pertinent to the present site conditions are discussed below:

5.4.2 EXCAVATION DESIGN PHILOSOPHY (SHORING SYSTEM- DIAPHRAGM WALL):

In the project site the sub sol formation up to the bottom of excavation is predominantly fine & medium grains sand formation.

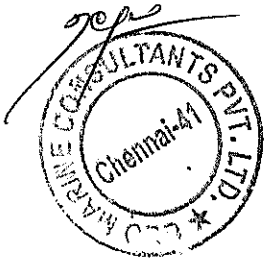
For soil retention and to prevent dewatering & uplift pressures it is ideal to adopt diaphragm wall taken to a minimum depth of 18.0m. Since the strata below the lower basement is clayey formation the ***diaphragm wall acts as cut-off wall and hence the lower basement raft need not be designed for uplift.***

5.5 DEWATERING/ GROUND WATER LOWERING DESIGN:

For ground water lowering, since diaphragm wall is recommended as shoring for ground water lowering dewatering bore-wells installed inside the diaphragm is needed. Hence, after the installation of diaphragm wall four boreholes shall be installed within the excavation zone up to depth of 12.0m with slotted pipes up to 9.0m depth. The internal bore-wells functions effectively for dewatering the green field zone confined within the diaphragm wall.

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RECOMMENDATIONS



CHAPTER-6

RECOMMENDATIONS

6.1 RECOMMENDATION FOR DEEP PILE FOUNDATION SYSTEM:

- For the kind of proposed structure and sub soil condition deep pile foundation is the suitable foundation to adopt. In the present case, 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-5.1.can be adopted as provisional design loads, as the load carrying capacity of piles not only depends upon the sub soil properties, but also depends on the care and experience of installation of 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.

6.2 CONSTRUCTION METHOD STATEMENT OF PILE FOUNDATION:

- 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 be more than 5%.
- The mud should be prepared using sodium bentonite with a density of range 1.03 g/cc to 1.10 g/cc. However, while flushing before concreting the density should not be more than 1.12 g/cc.

6.3 RECOMMENDATIONS FOR EXCAVATION:

- As discussed in chapter-5, Section 5.4 it is recommended to adopt shoring system of diaphragm wall for excavation.

6.4 GENERAL RECOMMENDATION:

- The chlorides content in ground water & 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 and ground water use Table 4.0 of IS 456 Clause 2.0 for minimum cement content and maximum water cement ratio. Hence ordinary Portland cement can be used.

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- *Before excavation is started a workshop shall be conducted including the Owner, Architect, Structural Engineer, Geotechnical Engineer and Execution agency to ensure the proposal given by the contractor is workable and safe.*
- *Before construction activities are initiated, a scientific due-diligence of the condition of the neighbouring structures shall be carried out and authenticated. This is required to ensure that no undue claims or interpretations are made by the neighbourhood that the construction activities cause damages to their structures*

AUTHORISED SIGNATORY

GEOMARINE CONSULTANTS PVT. LTD. Chennai-41

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

ANNEXURE-I



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THE SPIRIT OF ENGINEERING

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)	28.0	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	8.0	8.0	Cut-Off Level													
2.0	8.0	12.0	4.0	Clay	19	20.0	20.0	127	-	0.0	40.0	20.0	0.4	-	qf	2	279.3
3.0	12.0	14.0	2.0	Clay	6	15.5	17.8	40	-	40.0	51.0	45.5	1.0	-	qf	3	125.7
4.0	14.0	16.0	2.0	Sand	50	20.5	18.0	-	41.0	51.0	72.0	61.5	-	1.5	qf	4	251.9
5.0	16.0	25.0	9.0	Clay	10	17.5	19.0	67	-	72.0	139.5	105.8	0.7	-	qf	5	691.4
6.0	25.0	27.0	2.0	Clay	19	20.0	18.8	127	-	139.5	159.5	149.5	0.4	-	qf	6	139.6
7.0	27.0	28.0	1.0	Shale	100	22.0	21.0	600	-	159.5	171.5	165.5	0.3	-	qf	7	245.0

Summation of Positive Skin Resitance (kN) Q_f= 1733.02

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

Computation of End Bearing Resistance

		SPT	ϕ	C_u	N_q	N_c			
Bearing Stratum	Shale	100	-	600	-	9	Eff.Ht.of Overburden	8	m
							Effective Overburden Pressure	90.00	kN/m²

End Bearing Resistance (kN) Q_p= 1060.29

Skin Resistance in Clay Layer is $\pi*d*T_l*C_u*\alpha$	Ultimate Load Carrying Capacity (Q_{ult})	**$Q_u=Q_f-Q_f+Q_p$ (kN)** 2793.31
Skin Resistance in Sand Layer is $\pi*d*T_l*q_l*K*Tan(\phi)$	Safe Load Carrying Capacity (Q_{safe})	**$Q_u/2.5$ (kN)** 1117.32
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)** 1117.32
End Bearing Resistance in Sand Layer is $\pi*d^2/4*Q*N_q$	Allowable Safe Pull out Capacity	**$Q_{A\text{-}pull}$: Qf/3 (kN)** 577.67

Where

Cu=Undrained Shear Strength of Clay
ϕ=Angle of Shearing Resistance
N_c=Bearing Capacity Factor = 9
K=Coef. Earth Pressure at Rest
q_l=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=Adhession Factor
T_l=Thickness of Layer
Q (i.e) Effecitve Overburden Pressure at pile tip=Effective height of overburden X (γ-10)

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THE SPIRIT OF ENGINEERING

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)	28.0	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	8.0	8.0	Cut-Off Level													
2.0	8.0	12.0	4.0	Clay	12	18.5	18.5	80	-	0.0	34.0	17.0	0.6	-	qf	2	276.5
3.0	12.0	14.0	2.0	Silt	49	20.0	19.3	-	36.0	34.0	54.0	44.0	-	1.5	qf	3	150.6
4.0	14.0	16.0	2.0	Clay	9	17.0	18.5	60	-	54.0	68.0	61.0	0.7	-	qf	4	137.6
5.0	16.0	20.0	4.0	Clay	7	16.0	16.5	47	-	68.0	92.0	80.0	0.9	-	qf	5	265.8
6.0	20.0	25.0	5.0	Clay	11	18.0	17.0	73	-	92.0	132.0	112.0	0.6	-	qf	6	355.5
7.0	25.0	26.5	1.5	Clay	60	22.0	20.0	400	-	132.0	150.0	141.0	0.3	-	qf	7	245.0
8.0	26.5	28.0	1.5	Shale	100	22.0	22.0	600	-	150.0	168.0	159.0	0.3	-	qf	8	367.6

Summation of Positive Skin Resitance (kN) Q_f= 1798.57

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

Computation of End Bearing Resistance

		SPT	ϕ	C_u	N_q	N_c			
Bearing Stratum	Shale	100	-	600	-	9	Eff.Ht.of Overburden	8	m
							Effective Overburden Pressure	90.00	kN/m²

End Bearing Resistance (kN) Q_p= 1060.29

Skin Resistance in Clay Layer is $\pi*d*T_l*C_u*\alpha$	Ultimate Load Carrying Capacity (Q_{ult})	**$Q_u=Q_f-Q_f+Q_p$ (kN)** 2858.85
Skin Resistance in Sand Layer is $\pi*d*T_l*q_l*K*Tan(\phi)$	Safe Load Carrying Capacity (Q_{safe})	**$Q_u/2.5$ (kN)** 1143.54
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)** 1143.54
End Bearing Resistance in Sand Layer is $\pi*d^2/4*Q*N_q$	Allowable Safe Pull out Capacity	**$Q_{A\text{-}pull}$: Qf/3 (kN)** 599.52

Where

Cu=Undrained Shear Strength of Clay
ϕ=Angle of Shearing Resistance
N_c=Bearing Capacity Factor = 9
K=Coef. Earth Pressure at Rest
q_l=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=Adhession Factor
T_l=Thickness of Layer

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

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GEO MARINE
THE SPIRIT OF ENGINEERING

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)	28.0	As Per IS:2911-(P-I,S-2)-2010
Reference Bore Hole	BH-03		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	8.0	8.0	Cut-Off Level													
2.0	8.0	10.5	2.5	Clay	9	17.0	17.0	60	-	0.0	17.5	8.8	0.7	-	qf	2	172.0
3.0	10.5	12.0	1.5	Clay	18	20.0	18.5	120	-	17.5	32.5	25.0	0.4	-	qf	3	107.4
4.0	12.0	14.0	2.0	Clay	31	21.0	20.5	207	-	32.5	54.5	43.5	0.3	-	qf	4	169.1
5.0	14.0	20.0	6.0	Clay	7	16.0	18.5	47	-	54.5	90.5	72.5	0.9	-	qf	5	398.7
6.0	20.0	25.0	5.0	Clay	10	17.5	16.8	67	-	90.5	128.0	109.3	0.7	-	qf	6	384.1
7.0	25.0	27.0	2.0	Sand	50	20.5	19.0	-	41.0	128.0	149.0	138.5	-	1.5	qf	7	567.4
8.0	27.0	28.0	1.0	Shale	100	22.0	21.3	600	-	149.0	161.0	155.0	0.3	-	qf	8	245.0

Summation of Positive Skin Resitance (kN) Q_f= 2043.73

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

Computation of End Bearing Resistance

		SPT	ϕ	C_u	N_q	N_c			
Bearing Stratum	Shale	100	-	600	-	9	Eff.Ht.of Overburden	8	m
							Effective Overburden Pressure	78.75	kN/m²

End Bearing Resistance (kN) Q_p= 1060.29

Skin Resistance in Clay Layer is $\pi*d*T_l*C_u*\alpha$	Ultimate Load Carrying Capacity (Q_{ult})	**$Q_u=Q_f-Q_f+Q_p$ (kN)** 3104.02
Skin Resistance in Sand Layer is $\pi*d*T_l*q_l*K*Tan(\phi)$	Safe Load Carrying Capacity (Q_{safe})	**$Q_u/2.5$ (kN)** 1241.61
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)** 1241.61
End Bearing Resistance in Sand Layer is $\pi*d^2/4*Q*N_q$	Allowable Safe Pull out Capacity	**$Q_{A\text{-}pull}$: Qf/3 (kN)** 681.24

Where

Cu=Undrained Shear Strength of Clay
K=Coef. Earth Pressure at Rest
d=Dia. Of Pile
ϕ=Angle of Shearing Resistance
q_l=Effecitve Overburden Pressure at middle of Layer
α=Adhession Factor
N_c=Bearing Capacity Factor = 9
N_q=Bearing Capacity Factor, Ref. Fig.1 of IS: Code Referred above
T_l=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)	28.0	As Per IS:2911-(P-I,S-2)-2010	
Reference Bore Hole	BH-04		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	8.0	8.0	Cut-Off Level													
2.0	8.0	14.0	6.0	Clay	11	18.0	18.0	73	-	0.0	48.0	24.0	0.6	-	qf	2	426.6
3.0	14.0	20.0	6.0	Clay	6	15.5	16.8	40	-	48.0	81.0	64.5	1.0	-	qf	3	377.0
4.0	20.0	25.0	5.0	Clay	9	17.0	16.3	60	-	81.0	116.0	98.5	0.7	-	qf	4	344.0
5.0	25.0	27.0	2.0	Clay	60	22.0	19.5	400	-	116.0	140.0	128.0	0.3	-	qf	5	326.7
6.0	27.0	28.0	1.0	Shale	100	22.0	22.0	600	-	140.0	152.0	146.0	0.3	-	qf	6	245.0

Summation of Positive Skin Resitance (kN) Q_f= 1719.33

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

Computation of End Bearing Resistance

Bearing Stratum	Shale	SPT	ϕ	C_u	N_q	N_c	Eff.Ht.of Overburden	8	m
		100	-	600	-	9	Effective Overburden Pressure	90.00	kN/m²

End Bearing Resistance (kN) Q_p= 1060.29

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 $\pi*d^2/4*Q*N_q$

Ultimate Load Carrying Capacity (Q_{ult})	$Q_u=Q_f-Q_f+Q_p$ (kN)	2779.62
Safe Load Carrying Capacity (Q_{safe})	$Q_u/2.5$ (kN)	1111.85
Allowable Safe Load Carrying Capacity	$Q_{A\text{-}safe}$ (kN)	1111.85
Allowable Safe Pull out Capacity	$Q_{A\text{-}pull}$: Qf/3 (kN)	573.11

Where

Cu=Undrained Shear Strength of Clay

ϕ=Angle of Shearing Resistance

N_c=Bearing Capacity Factor = 9

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=Adhession Factor

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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LATERAL LOAD CARRYING CAPACITY OF BORED CAST- SITU PILES

Reference Bore Hole : BH-04

1.0 Geometrical Data

Type of Pile Head Considered		Fixed	
Diameter of Pile (d)	:	1.00	m
Free standing Length of Pile (e)	:	0	m
Length of Pile below E.G.L (Le)	:	28.0	m
Cut-Off Level From E.G.L	:	8.0	
Length of Pile below Cut-Off Level (Le)	:	20.0	m
Grade of Concrete (M)	:	25	MN/m^2
Young's Modulus of Concrete (E)	:	25000000	kN/m^2
Momemnt of Inertia (I)	:	0.049087	m^4

2.0 Determination of Depth of Fixity

Type of Soil Strata	:	Clay	
Ground Water Condition	:	Submerged	
Design SPT "N" Value	:	9	
K=((k1/1.5)*(0.3/B))			
(n can be read as h in the above and below equation in case of Sand)			
K1=	:	22500	kN/m^3
K=	:	4500	kN/m^4
R=	:	4.06	m
L1/R	:	0.00	
Lf/R	:	2.20	
Depth of Fixity below Cut off (z_f)	:	8.94	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	:	103.04	kN
Recommended Design Lateral Load carrying Capacity	:	**103**	**kN**
Fixed End Moment,M_F=H(e+z_f)/2		461	
Reduction Factor (L_1/T)	:	0.83	m
Actual Moment (Fixed End Moment/Reduction Factor),M_F		**382**	kN-m

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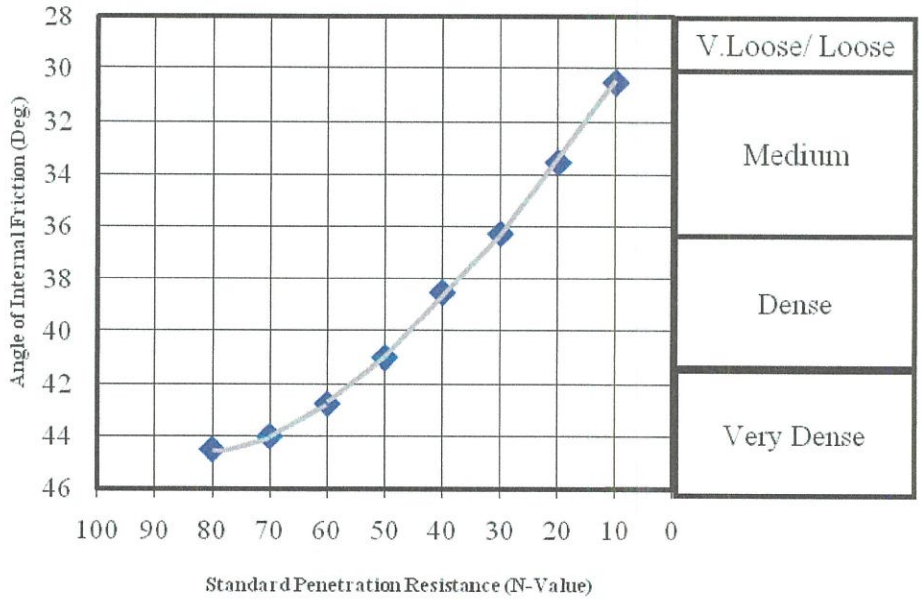


FIG. A1 Relation Ship between Angle of Internal Friction & N-value (Reproduced from IS:6403-1981)

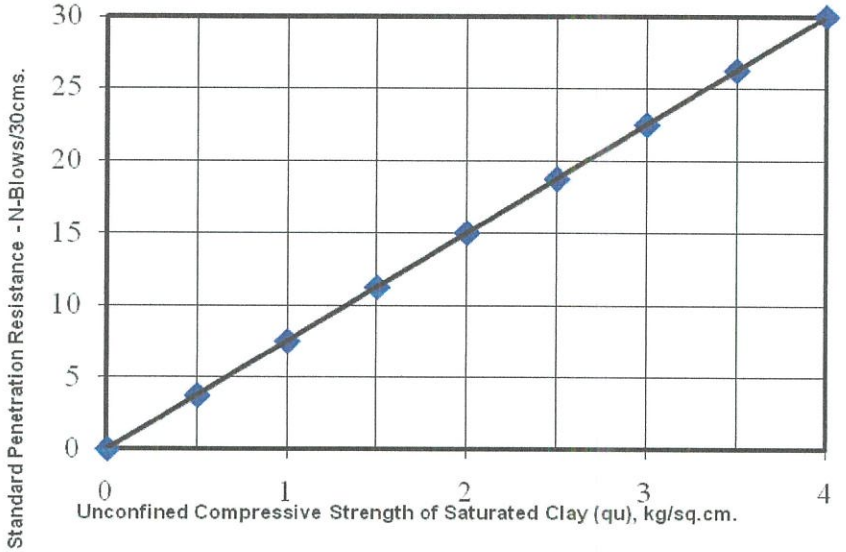
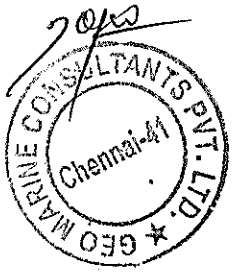


FIG. A2 : Relationship between UCC & SPT-Value (N) of Saturated Clay (AfterTerzhagi & Peck, 1948)

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ANNEXURE-II



GEOMARINE
THE SPIRIT OF ENGINEERING

SITE INVESTIGATION RECORD

BORE HOLE No.	01
PAGE No.	01
DIA OF BORE HOLE	150mm: 4 / 100mm: 1
BORE START DATE	30/11/2021
BORE END DATE	01/12/2021
TOTAL DRILLING DAYS	2

PROJECT NAME	APPASWAMY - VADAPALANI				
LOCATION		MACHINE No.		CHAINAGE (m)	
STRUCTURE	2B+stilt+12F	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
1	30	10	00												Filled up soil Building materials & sand
		10	05	SC			1	0	0	1	1.00	1	SS		
		10	15												
2		10	17	SC			8	10	12	22	2.00	2	SS		Brownish Medium Dense Silty fine sand
		10	30												
3		10	32	SC			11	17	20	37	3.00	3	SS		Brownish Dense Silty fine sand
		10	50												
4	/	10	52	SC			8	9	12	21	4.00	4	SS		Brownish medium Dense Silty fine to M. coarse sand
	11	11	06												
5		11	07	SC			12	14	20	34	5.00	5	SS		Brownish Dense fine to medium coarse sand
		11	23												
6		11	25	SC			17	20	21	41	6.00	6	SS		Brownish Dense Silty fine sand
		11	38												
7	/	11	40												
	2021			SC			12	15	16	31	7.50	7	SS		
8		11	58												
		12	01												
9				SC			4	7	8	15	9.00	8	SS		Greyish stiff Silty clay
		12	19												
10		12	25	SC			6	10	12	22	10.50	9	SS		Greyish very stiff Silty

GEOMARINE CONSULTANTS PVT. LTD. Chennai-41

CS - Core Sample	DS - Disturbed Sample	SUPERVISOR NAME	B. Loganathan	PROJECT SITE DETAILS	
SS - Split Spoon Sample	SC - Soil Cutter	SIGNATURE		GROUND LEVEL (m)	+0.50m
UDS-Undisturbed Sample	TCB - Tungsten Carbide Bit	DATE	30/11/2021	WATER TABLE (m)	1.00m
WS - Wash Sample	DB - Diamond Bit	CLIENT IN-CHARGE		CASING DEPTH (m)	—

GEOMARINE
THE SPIRIT OF ENGINEERING

SITE INVESTIGATION RECORD

BORE HOLE No.	01
PAGE No.	02
DIA OF BORE HOLE	150mm / 100mm: 4
BORE START DATE	30/11/2021
BORE END DATE	01/12/2021
TOTAL DRILLING DAYS	2

PROJECT NAME	APPASWAMY - VADAPALANI						
LOCATION		MACHINE No.	HR	CHAINAGE (m)			
STRUCTURE	2B+S+11+12F	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
1		12	44												
		12	53												
2	30			SC			2	2	4	6	12.00	10	SS		Greyish Medium Stiff Silty Clay
3		2	26												
		2	30												
4				SC			16	21	38	59	14.00	11	SS		Brownish Grey Dense Silty Fine Sand
5	11	3	01												
		3	03												
6				SC			3	4	5	9	16.00	12	SS		Greyish Stiff Silty Clay
7		3	41												
	2021	3	43												
8				SC			3	4	5	9.	18.00	13	SS		—Do—
9		4	08												
		4	11												
10				SC			5	5	8	13	20.00	14	SS		—Do—

CONSULTANTS PVT. LTD. Chennai-41

CS - Core Sample	DS - Disturbed Sample	SUPERVISOR NAME	K. Gopinathan	PROJECT SITE DETAILS	
SS - Split Spoon Sample	SC - Soil Cutter	SIGNATURE		GROUND LEVEL (m)	+0.50
UDS-Undisturbed Sample	TCB - Tungsten Carbide Bit	DATE	30/11/2021	WATER TABLE (m)	1.00
WS - Wash Sample	DB - Diamond Bit	CLIENT IN-CHARGE		CASING DEPTH (m)	—

GEOMARINE
THE SPIRIT OF ENGINEERING

SITE INVESTIGATION RECORD

BORE HOLE No.	01
PAGE No.	03
DIA OF BORE HOLE	150mm 5 / 100mm
BORE START DATE	30/11/2021
BORE END DATE	01/12/2021
TOTAL DRILLING DAYS	2

PROJECT NAME	APPASWAMY - VADAPALANI						
LOCATION		MACHINE No.	HR-01	CHAINAGE (m)			
STRUCTURE	2B + Stilt + 12F	DRILLING METHOD	Rotery	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
1	1	9	33												
	01	9	36												
2				SC			4	4	6	10	2.50	15	SS		Greyish Stiff Silty clay
3															
4		10	11												
	12	10	15												
5				SC			11	10	9	19	5.00	16	SS		Greyish Medium Dense Silty fine sand with clay pockets
6		11	00												
		11	04												
7	2021														
		11	46	SC			15cm/72blow				27.50	17	SS		Greenish Grey very Hard Shale with silt Stone
		12	47				HR N > 100								
8		1	33												
		2	25												
	1			DB	17%	0%					28.50	18	CS		Greenish Grey very Hard Shale
9		2	58												
		4	30												
				DB	32%	0%					29.50	19	CS		Greenish Grey very Hard Shale
0															

Bore hole Terminated at 29.50m Depth below NGL.

CS - Core Sample	DS - Disturbed Sample	SUPERVISOR NAME	B. Loganathan	PROJECT SITE DETAILS	
SS - Split Spoon Sample	SC - Soil Cutter	SIGNATURE		GROUND LEVEL (m)	+2.50m
UDS-Undisturbed Sample	TCB - Tungsten Carbide Bit	DATE	01/12/2021	WATER TABLE (m)	1.00m
WS - Wash Sample	DB - Diamond Bit	CLIENT IN-CHARGE		CASING DEPTH (m)	—

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GEOMARINE
THE SPIRIT OF ENGINEERING

SITE INVESTIGATION RECORD

BORE HOLE No.	02
PAGE No.	01
DIA OF BORE HOLE	150mm 4 / 100mm
BORE START DATE	25/11/2021
BORE END DATE	29/11/2021
TOTAL DRILLING DAYS	3

PROJECT NAME	Appaswamy - Vadapalani						
LOCATION		MACHINE No.		CHAINAGE (m)		N	
STRUCTURE	2B+S+12F	DRILLING METHOD	Rotary	CO-ORDINATES		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	15-30	30-45	SPT 'N' Value	Sample Details: Depth	No.	Type	Layer Data: Depth (m)	Geotechnical Description
1		2	40												
		2	42	SC			3	4	6	10	1.00	1	SS		Brownish loose fine to m. coarse sand
	25	2	54												
2		2	58	SC			13	20	22	42	2.00	2	SS		Brownish Dense fine to m. coarse sand
		3	12												
		3	14	SC			13	14	17	31	3.00	3	SS		Brownish Dense silty fine to m. coarse sand
3	11														
		3	29												
		3	31	SC			6	12	21	33	4.00	4	SS		Brownish Dense silty fine to m. coarse sand
4															
		3	46												
		3	48	SC			16	13	18	31	5.00	5	SS		Brownish Dense silty fine sand
5	30/4														
		4	01												
		4	03	SC			12	16	16	32	6.00	6	SS		Brownish Dense silty fine sand
6															
		9	30												
7	26	9	32												
				SC			4	5	5	10	7.50	7	SS		Greyish stiff silty clay
8															
	11	9	46												
		9	49	SC			4	6	8	14	9.00	8	SS		Greyish stiff silty clay
9															
	30/4														
		10	10												
10		10	21	SC			45 cm / 3			55	10.58	9	UDS		Greyish silty clay

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CS - Core Sample	DS - Disturbed Sample	SUPERVISOR NAME	G. Loganathan	PROJECT SITE DETAILS	
SS - Split Spoon Sample	SC - Soil Cutter	SIGNATURE	G. Cutter	GROUND LEVEL (m)	GL
UDS-Undisturbed Sample	TCB - Tungsten Carbide Bit	DATE	26/11/2021	WATER TABLE (m)	0.30m
WS - Wash Sample	DB - Diamond Bit	CLIENT IN-CHARGE		CASING DEPTH (m)	—

GEOMARINE
THE SPIRIT OF ENGINEERING

SITE INVESTIGATION RECORD

BORE HOLE No.	02
PAGE No.	02
DIA OF BORE HOLE	150mm: 4 / 100mm:
BORE START DATE	25/11/2024
BORE END DATE	29/11/2024
TOTAL DRILLING DAYS	3

PROJECT NAME	APPASWAMY – VADAPALANI						
LOCATION		MACHINE No.	HR·01	CHAINAGE (m)			
STRUCTURE	2B + 8T + 12 F	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
1		10	49												
		10	53												
2				SC			18	30	19	49	12.00	10	SS		Greyish Dense Sandy Silt
	26														
3		11	25												
		11	27												
4				SC			7	5	4	9	14.00	11		Sample Loss	Greyish Loose Sand
5		11	50												
		11	54												
6	11			SC			2	3	4	7	16.00	12	SS		Greyish medium Stiff Silty Clay
7		12	21												
		12	24												
8	202			SC			3	3	3	6	18.00	13	SS		-Do-
9		12	55												
		12	58												
10				SC			3	5	5	10	20.00				Greyish Stiff Silty Clay

GEOMARINE CONSULTANTS PVT. LTD. Chennai-41

CS - Core Sample	DS - Disturbed Sample	SUPERVISOR NAME	S. Loganathan	PROJECT SITE DETAILS	
SS - Split Spoon Sample	SC - Soil Cutter	SIGNATURE		GROUND LEVEL (m)	GL
UDS-Undisturbed Sample	TCB - Tungsten Carbide Bit	DATE	26/11/2021	WATER TABLE (m)	0.30
WS - Wash Sample	DB - Diamond Bit	CLIENT IN-CHARGE		CASING DEPTH (m)	—

GEOMARINE
THE SPIRIT OF ENGINEERING

SITE INVESTIGATION RECORD

BORE HOLE No.	04
PAGE No.	03
DIA OF BORE HOLE	150mm 4 / 100mm
BORE START DATE	25/11/2021
BORE END DATE	29/11/2021
TOTAL DRILLING DAYS	5

PROJECT NAME	APPASWAMY - VADAPALANI						
LOCATION		MACHINE No.		CHAINAGE (m)		CO-ORDINATES	N
STRUCTURE	28+ST+12F	DRILLING METHOD	Rotary				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
1	26	3	38												
		3	43												
2				SC			5	6	7	13	22.50	15	SS		Greyish stiff silty clay
3	11														
		4	18												
4		4	25												
5	2021			SC			15	23	40	63	25.00	16	SS		Greyish Very Hard / Dense Cemented Sand (clayey)
6	29	12	17												
		12	31												
	11														
7	2021			SC			Hammer Release NO/PENT N'100				26.50	17	[illegible]		Sample Nil
		2	01												
		3	29												
8				DB	97%	39%					27.50	18	CS		Reddish Grey Very Hard Silt Stone (with Shell)
9	Bore hole Terminated at 27.50 m Depth below n.g.l														
0															

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CS - Core Sample	DS - Disturbed Sample	SUPERVISOR NAME	K. Gopinathan	PROJECT SITE DETAILS	
SS - Split Spoon Sample	SC - Soil Cutter	SIGNATURE		GROUND LEVEL (m)	G.L
UDS-Undisturbed Sample	TCB - Tungsten Carbide Bit	DATE	29/11/2021	WATER TABLE (m)	0.30 m
WS - Wash Sample	DB - Diamond Bit	CLIENT IN-CHARGE		CASING DEPTH (m)	

[APPASWAMY]

GEOMARINE
THE SPIRIT OF ENGINEERING

SITE INVESTIGATION RECORD

BORE HOLE No.	BH-03
PAGE No.	1
DIA OF BORE HOLE	150mm 7 / 100mm
BORE START DATE	30-11-2021
BORE END DATE	01-12-2021
TOTAL DRILLING DAYS	2

PROJECT NAME	PROPOSED FOR HIGH RISE BUILDING				
LOCATION	VADAPALANI	MACHINE No.	HB:02	CHAINAGE (m)	
STRUCTURE	2B+S+12 Flrs	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)	Layer Data: Geotechnical Description
	30-11-2021										Trial Pit taken			0.70	Bricks, Sand & Concrete pieces
1														1.30	FILLED UP MATERIALS
2		10	26												
		10	41	SC			7	9	8	17	2.00	1	SS		Medium Dense, Brownish SAND
3		10	56												
		10	57	SC			11	18	19	37	3.00	2	SS		Dense, Brownish SAND
4		11	15												
		11	17	SC			12	19	21	40	4.00	3	SS		Dense, Brownish, Silty SAND
5		11	40												
		11	41	SC			13	19	19	38	5.00	4	SS		Dense, Brownish SAND
6		11	57												
		11	58	SC			8	12	19	31	6.00	5	SS		Dense, Brownish SAND
7		12	19												
		12	21	SC			7	5	4	9	7.50	6	SS	7.60	Stiff, Greyish Black, CLAY
8															
		12	45												
9		12	47	SC			–	–	–	—	9.00	7	UDS		Greyish-Black, CLAY
0		14	12												
		14	21	SC			5	8	10	18	10.50	8	SS		Very Stiff, Greyish Black CLAY

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CS - Core Sample	DS - Disturbed Sample	SUPERVISOR NAME	Bashar. J	PROJECT SITE DETAILS	
SS - Split Spoon Sample	SC - Soil Cutter	SIGNATURE	J. Bashar	GROUND LEVEL (m)	
UDS-Undisturbed Sample	TCB - Tungsten Carbide Bit	DATE	30-11-2021	WATER TABLE (m)	1.20
WS - Wash Sample	DB - Diamond Bit	CLIENT IN-CHARGE		CASING DEPTH (m)	

[APPASWAMY]

GEOMARINE
THE SPIRIT OF ENGINEERING

SITE INVESTIGATION RECORD

BORE HOLE No.	BH-03
PAGE No.	2
DIA OF BORE HOLE	150mm / 100mm
BORE START DATE	30-11-2021
BORE END DATE	01-12-2021
TOTAL DRILLING DAYS	2

PROJECT NAME	PROPOSED FOR HIGH RISE BUILDING				
LOCATION	VADAPALANI	MACHINE No.	HR :02	CHAINAGE (m)	
STRUCTURE	GB+St.12 floors	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
1															
2		14	41												
		15	00	SC			2	7	24	31	12.00	9	SS		Hard, Greyish Black, Silty CLAY
3															
		15	29												
4		15	31	SC			2	2	4	6	14.00	10	SS		Medium Stiff, Greyish Black, CLAY
5															
		16	04												
6		16	08	SC			2	3	5	8	16.00	11	SS		Stiff, Greyish Black, CLAY
7															
		16	35												
8		16	38	SC			2	2	4	6	18.00	12	SS		Medium Stiff, Greyish Black, Silty mix CLAY
9	01-12-2021														
		9	22												
0		9	25	SC			3	5	6	11	20.00	13	SS		Stiff, Greyish Black, Silty CLAY

GEOMARINE CONSULTANTS PVT. LTD. Chennai-41

CS - Core Sample	DS - Disturbed Sample	SUPERVISOR NAME	Baskar. I	PROJECT SITE DETAILS	
SS - Split Spoon Sample	SC - Soil Cutter	SIGNATURE		GROUND LEVEL (m)	
UDS-Undisturbed Sample	TCB - Tungsten Carbide Bit	DATE	30-11-2021	WATER TABLE (m)	1.20
WS - Wash Sample	DB - Diamond Bit	CLIENT IN-CHARGE		CASING DEPTH (m)	

[APPASWAMY]

GEOMARINE
THE SPIRIT OF ENGINEERING

SITE INVESTIGATION RECORD

BORE HOLE No.	BH-03
PAGE No.	3
DIA OF BORE HOLE	150mm / 100mm
BORE START DATE	30-11-2021
BORE END DATE	01-12-2021
TOTAL DRILLING DAYS	2

PROJECT NAME	PROPOSED FOR HIGH RISE BUILDING				
LOCATION	VADAPALANI	MACHINE No.	HR-02	CHAINAGE (m)	
STRUCTURE	2B+ S + 12 flrs	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
1															
2		10	01												
		10	05	SC			2	4	6	10	22.50	14	SS		Stiff, Greyish Black, CLAY
3															
4															
		11	19												
5		11	25	SC			12	20	36	56	25.00	15	SS		Hard, Greyish Black, Sandy CLAY
6															
		14	07												
		14	51				7cm / 50blw			N/100	27.00	16	—	27.00	SAMPLE NILL —
7				SC											
		15	19												
8		16	27	DB	90	99					28.00	16	CS		Strong, Greyish Brown, SILT STONE.
9															
															BORE HOLE TERMINATED AT 28.00 mts DEPTH.
0															

INE CONSULTANTS PVT. LTD. Chennai-41

CS - Core Sample	DS - Disturbed Sample	SUPERVISOR NAME	Bashab.J	PROJECT SITE DETAILS	
SS - Split Spoon Sample	SC - Soil Cutter	SIGNATURE		GROUND LEVEL (m)	
UDS-Undisturbed Sample	TCB - Tungsten Carbide Bit	DATE	01-12-2021	WATER TABLE (m)	1.20
WS - Wash Sample	DB - Diamond Bit	CLIENT IN-CHARGE		CASING DEPTH (m)	

[APPASWAMY]

GEOMARINE
THE SPIRIT OF ENGINEERING

SITE INVESTIGATION RECORD

BORE HOLE No. 04
PAGE No. 01
DIA OF BORE HOLE 150mm 4 / 100mm
BORE START DATE 26-11-2021
BORE END DATE 29-11-2021
TOTAL DRILLING DAYS 3

PROJECT NAME: PROPOSED FOR HIGH RISE BUILDING
LOCATION: VADAPALANI
MACHINE No.: HR-02
CHAINAGE (m):
STRUCTURE: 2B+S+12F
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	15-30	30-45	SPT 'N' Value	Sample Details: Depth	No.	Type	Layer Data: Depth (m)	Geotechnical Description
		9	30											0.10	CONCRETE
														0.70	Sandy clay
														0.80	CONCRETE
1		9	32	SC			2	4	4	8	1.00	1	SS		Brownish Loose M. coarse to fine Sand
	26	9	41												
2		9	43	SC			6	9	10	19	2.00	2	SS		Brownish Medium Dense Silty fine Sand
		9	53												
3		9	55	SC			9	10	14	24	3.00	3	SS		Brownish Medium Dense Silty fine Sand
		10	06												
4		10	07	SC			8	10	12	22	4.00	4	SS		Brownish Medium Dense Silty fine to M. coarse Sand
		10	21												
5	11	10	23	SC			14	21	25	46	5.00	5	SS		Brownish Dense Silty fine to M. coarse Sand
		10	35												
6		10	36	SC			11	19	20	39	6.00	6	SS		Brownish Dense fine to M. coarse Sand
		10	57												
7		10	52	SC			21	25	27	52	7.50	7	SS		Greyish Dense Silty M. coarse to fine Sand
8	20														
		11	25												
9		11	31	SC			3	4	5	9	9.00	8	SS		Greyish Stiff Clay
		11	52												
10		12	02	SC			45cm/33blows				10.50	9	UDS		Greyish Silty clay

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CS - Core Sample	DS - Disturbed Sample	SUPERVISOR NAME	M. Loganathan	PROJECT SITE DETAILS	
SS - Split Spoon Sample	SC - Soil Cutter	SIGNATURE		GROUND LEVEL (m)	
UDS-Undisturbed Sample	TCB - Tungsten Carbide Bit	DATE	26/11/2021	WATER TABLE (m)	
WS - Wash Sample	DB - Diamond Bit	CLIENT IN-CHARGE		CASING DEPTH (m)	

[APPASWAMY]

GEOMARINE
THE SPIRIT OF ENGINEERING

SITE INVESTIGATION RECORD

BORE HOLE No.	04
PAGE No.	02
DIA OF BORE HOLE	150mm: 4 / 100mm:
BORE START DATE	26/11/2021
BORE END DATE	29-11-2021
TOTAL DRILLING DAYS	3

PROJECT NAME	PROPOSED FOR HIGH RISE BUILDING						
LOCATION	VADAPALANI	MACHINE No.	HR:02	CHAINAGE (m)			
STRUCTURE	2B+S+12 Flrs	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
1		12	27												
	26	12	33											12.00	
2				SC			7	4	9	13	12.00	10	SS		Greyish Medium Dense Sandy Silt
3		3	09												
	11	3	12												
4				SC			2	2	4	6	14.00	11	SS		Greyish Medium Stiff Silty Clay
5	2024	3	55												
		4	00												
6				SC			2	3	4	7	16.00	12	SS		Greyish Medium Stiff Silty Clay
7	27-11-2021														
		9	49												
8		9	54	SC			1	2	3	5	18.00	13	SS		Medium Stiff, Greyish Black, Silty CLAY
9															
		10	44												
10		10	48	SC			1	3	5	8	20.00	14	SS		Stiff, Greyish Black, CLAY

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CS - Core Sample	DS - Disturbed Sample	SUPERVISOR NAME	MR. LOGANATHAN & BASKAR. T	PROJECT SITE DETAILS	
SS - Split Spoon Sample	SC - Soil Cutter	SIGNATURE		GROUND LEVEL (m)	
UDS-Undisturbed Sample	TCB - Tungsten Carbide Bit	DATE	26/11/2021	WATER TABLE (m)	
WS - Wash Sample	DB - Diamond Bit	CLIENT IN-CHARGE		CASING DEPTH (m)	

[APPASWAMY]

GEOMARINE
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SITE INVESTIGATION RECORD

BORE HOLE No.	BH-01
PAGE No.	3
DIA OF BORE HOLE	150mm / 100mm
BORE START DATE	26-11-2021
BORE END DATE	29-11-2021
TOTAL DRILLING DAYS	3

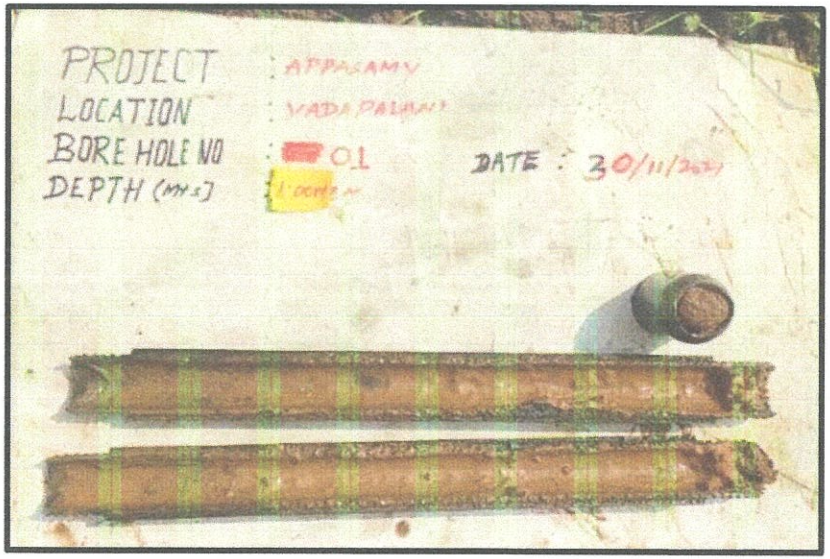
PROJECT NAME	PROPOSED FOR HIGH RISE BUILDING						
LOCATION	VADAPALANI	MACHINE No.	HR:02	CHAINAGE (m)			
STRUCTURE	2B + G + 12 Flrs	DRILLING METHOD	Rotary	CO-ORDINATES	N		
JOB CODE		FLUSHING MEDIUM	Bentonite		E		

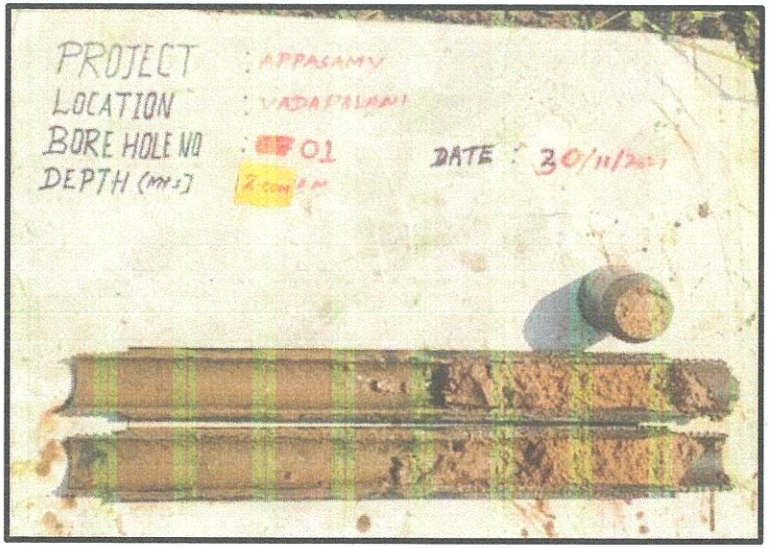
Depth below E.G.L. (m)	Drilling progress per metre: Date	Time: Hr.	Time: Min	Type of Drill Bit (SC / TCB / DB)	Core Details: Total Core Recovery %	Core Details: R.Q.D %	SPT Details: Blows/cm. 0-15	SPT Details: Blows/cm. 15-30	SPT Details: Blows/cm. 30-45	SPT 'N' Value	Sample Details: Depth	Sample Details: No.	Sample Details: Type	Layer Data: Depth (m)	Geotechnical Description
1															
2		11.28	11.32	SC			2	4	5	9	22.50	15	SS		Stiff, Greyish Black, CLAY
3															
4															
5		12.07	12.15	SC			13	12cm / 50bls		NV100	25.00	16	SS	25.30	Hard, Brownish Grey, SHALE
6							No penetration								
7		14.37	15.45	SC			5cm / 50bls			NV100	27.00	17	—	27.00	Sample NILL
8		10.29	11.57	DB	99	46					28.00	18	CS		Strong, Greenish - Brownish Grey, SANDSTONE
9															
0															BORE HOLE TERMINATED AT 28.00 mts DEPTH

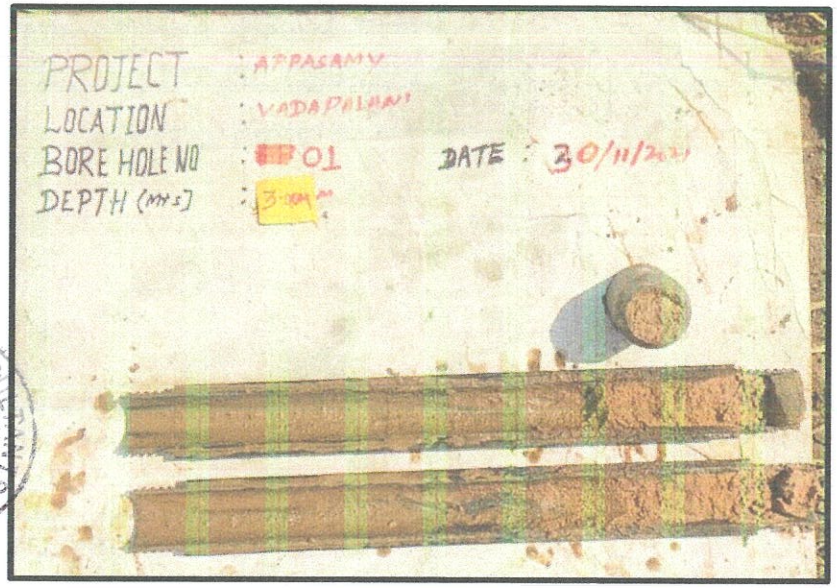
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CS - Core Sample	DS - Disturbed Sample	SUPERVISOR NAME	BASKAR. I	PROJECT SITE DETAILS	
SS - Split Spoon Sample	SC - Soil Cutter	SIGNATURE		GROUND LEVEL (m)	
UI S-Undisturbed Sample	TCB - Tungsten Carbide Bit	DATE	27/11/2021	WATER TABLE (m)	
WS - Wash Sample	DB - Diamond Bit	CLIENT IN-CHARGE		CASING DEPTH (m)	

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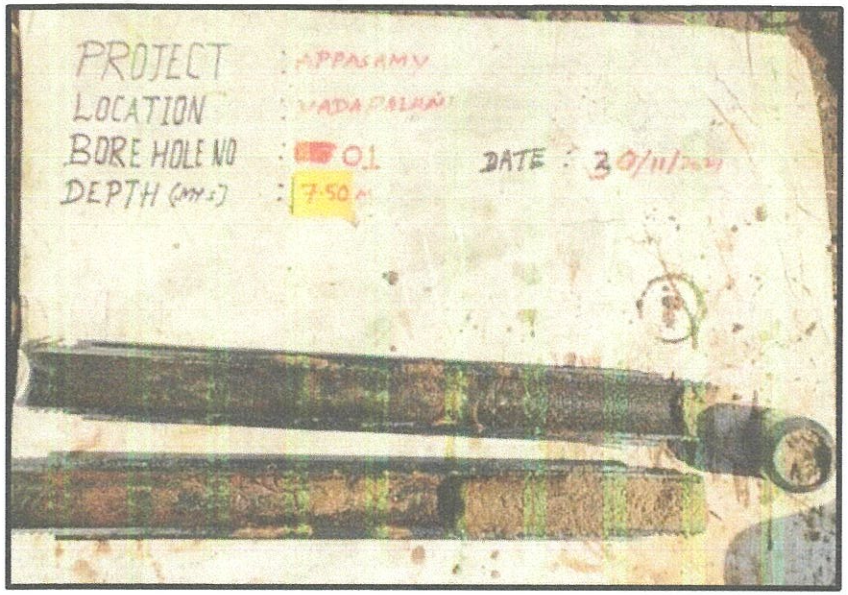


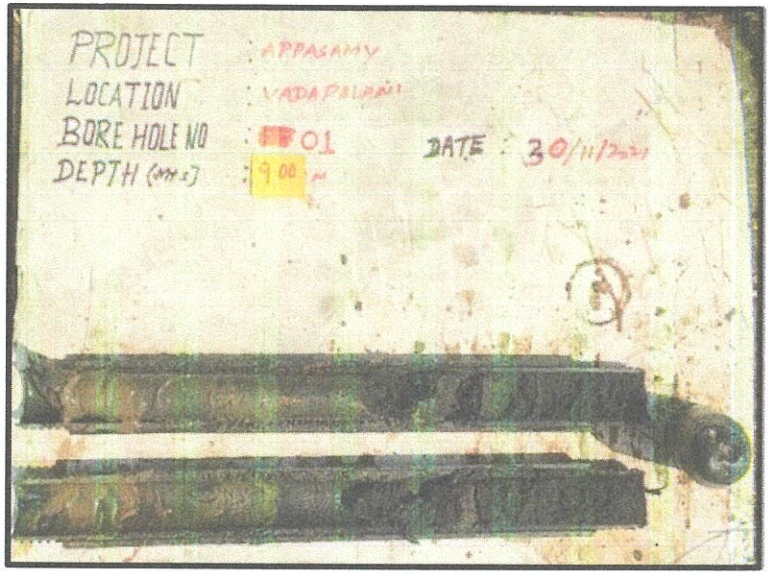
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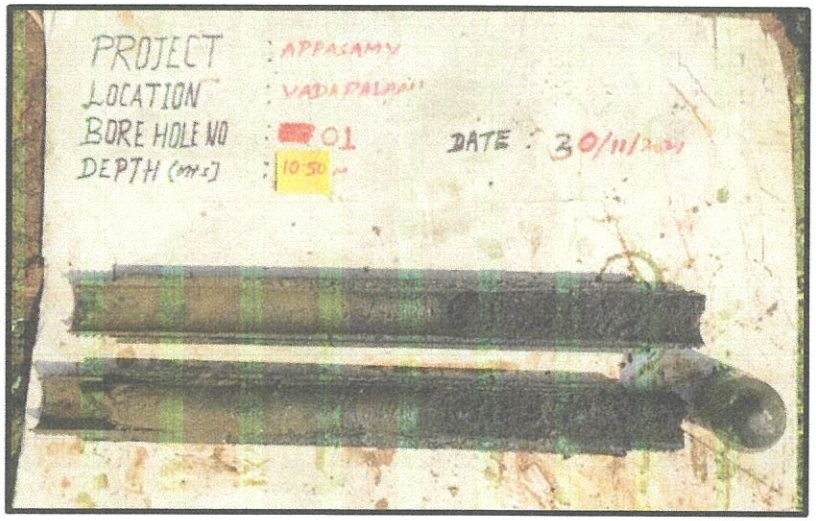


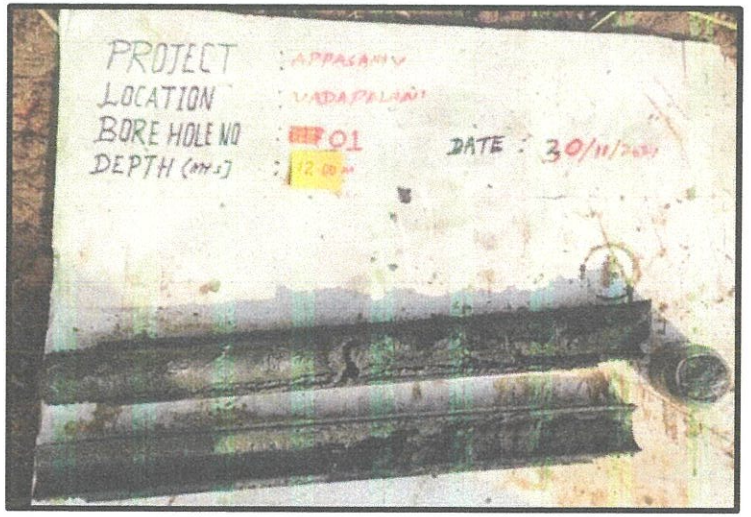


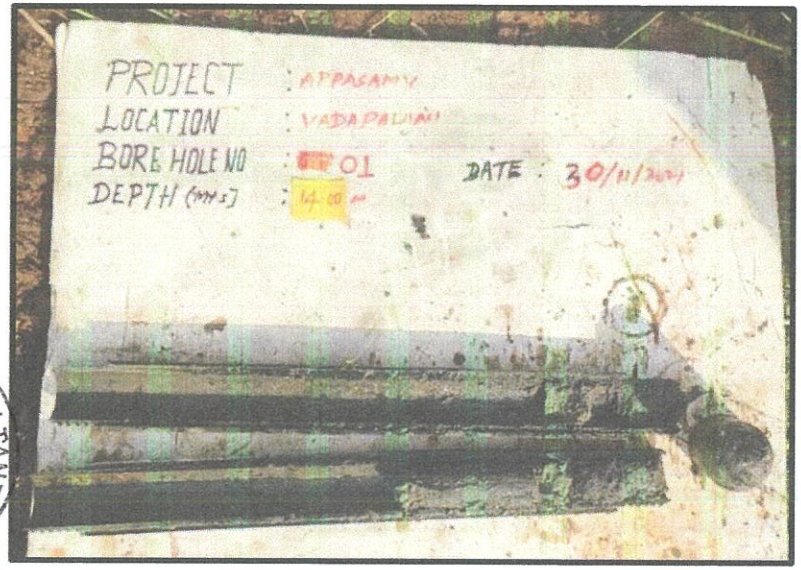


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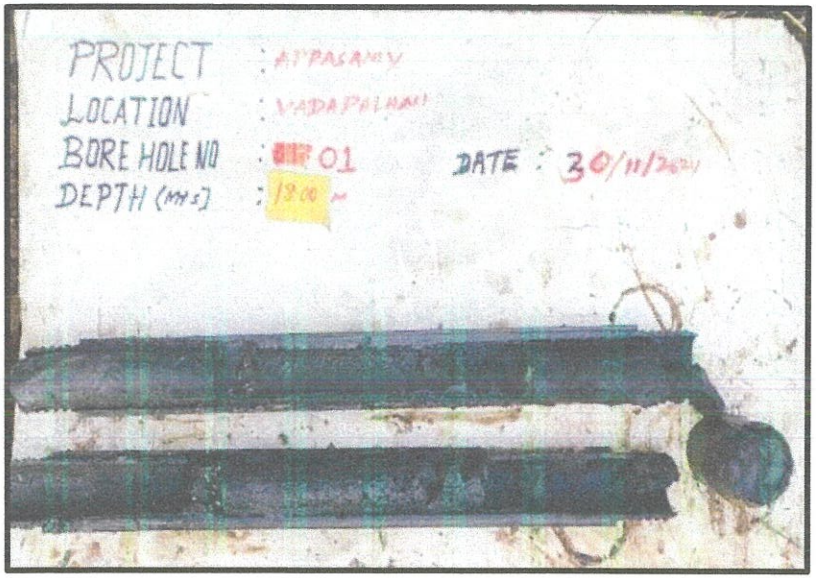






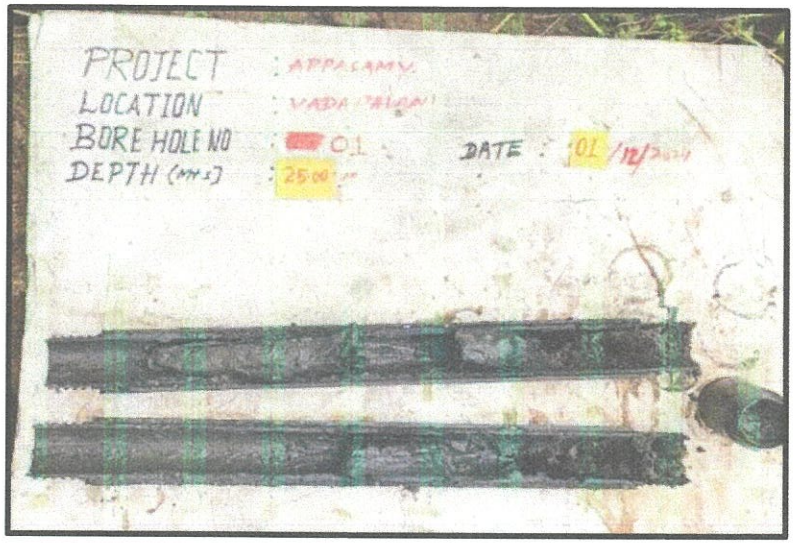
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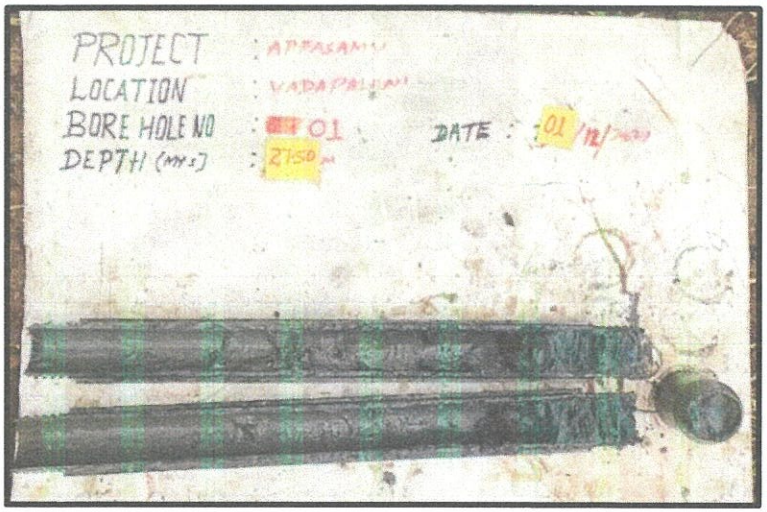


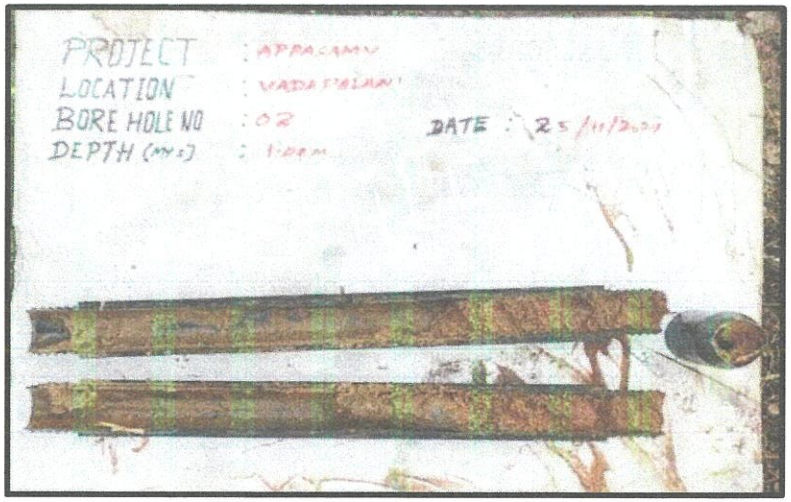


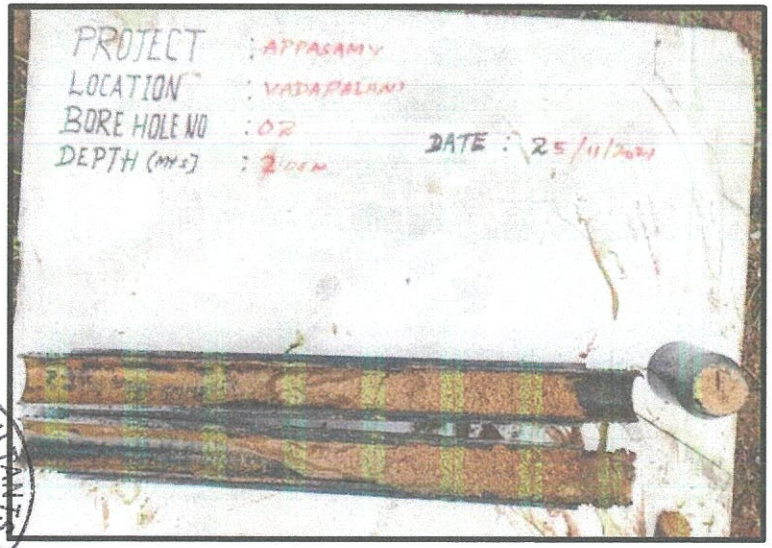


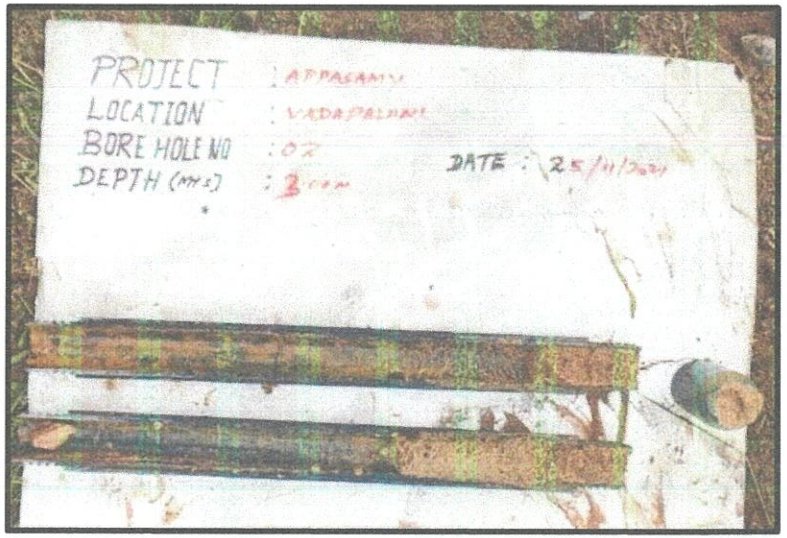
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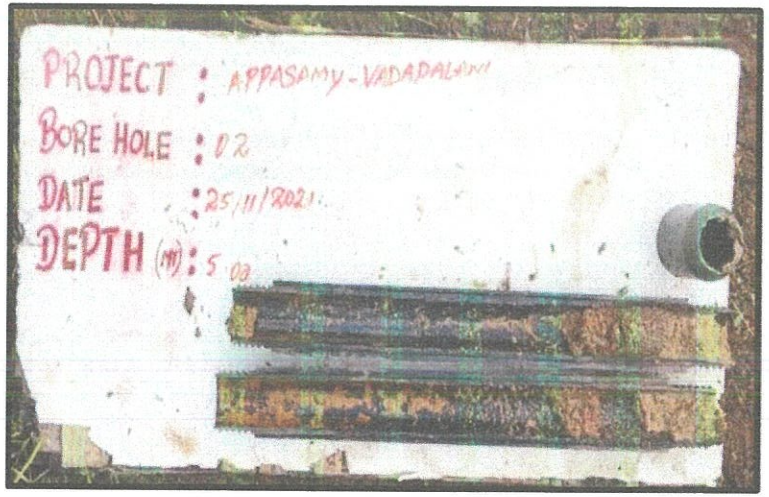


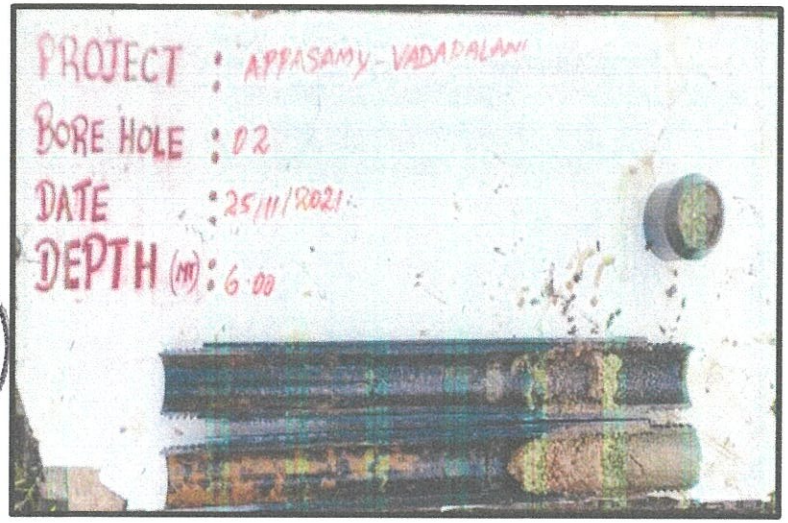


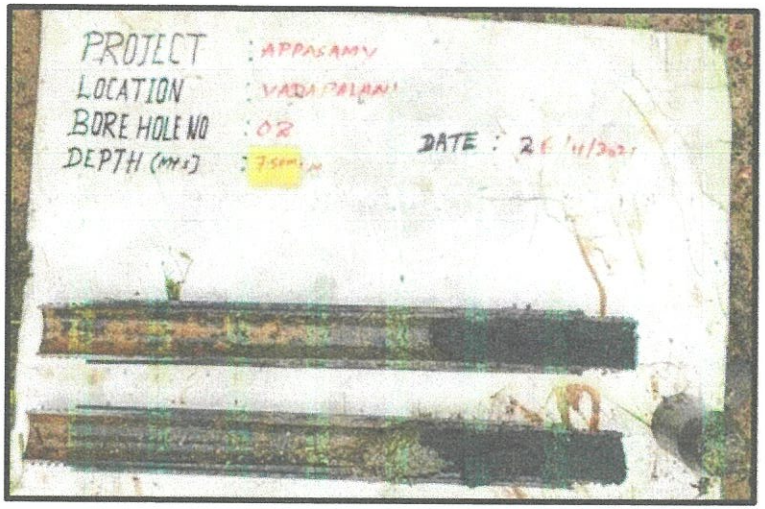
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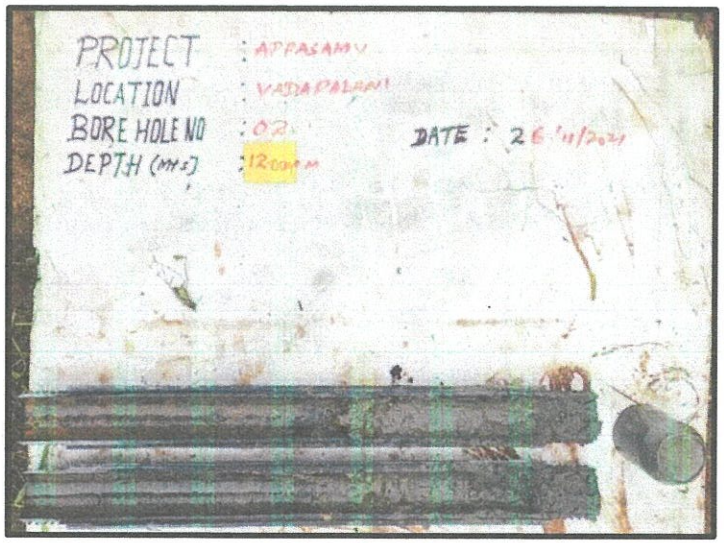


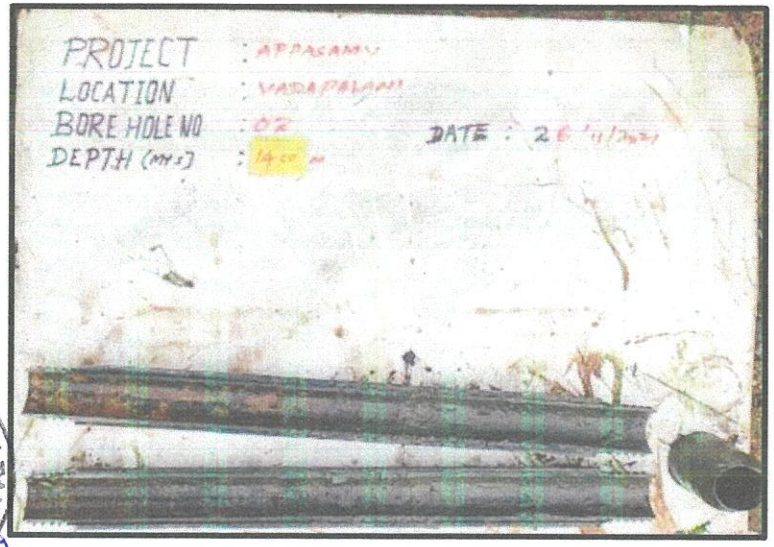


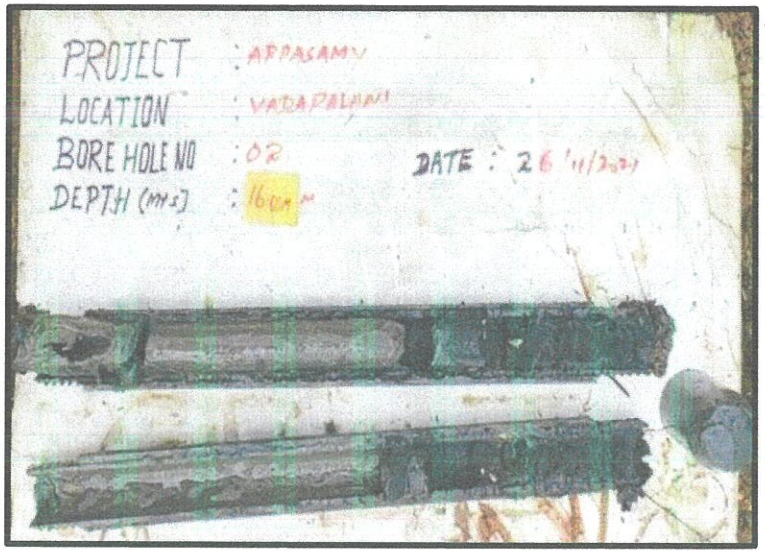
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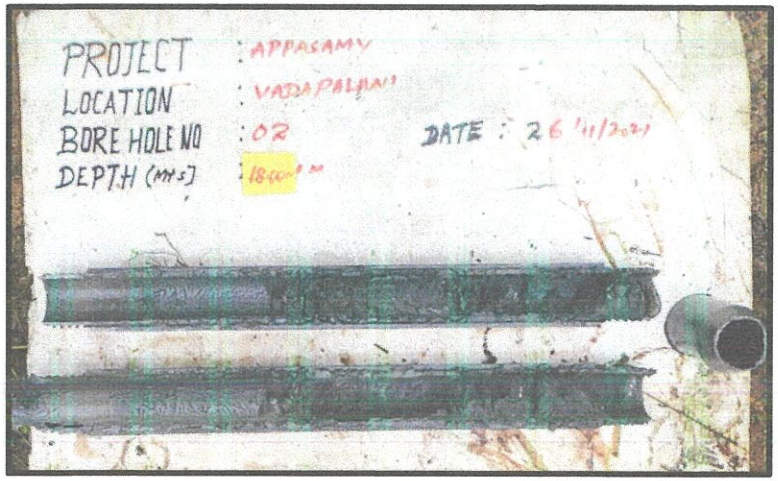


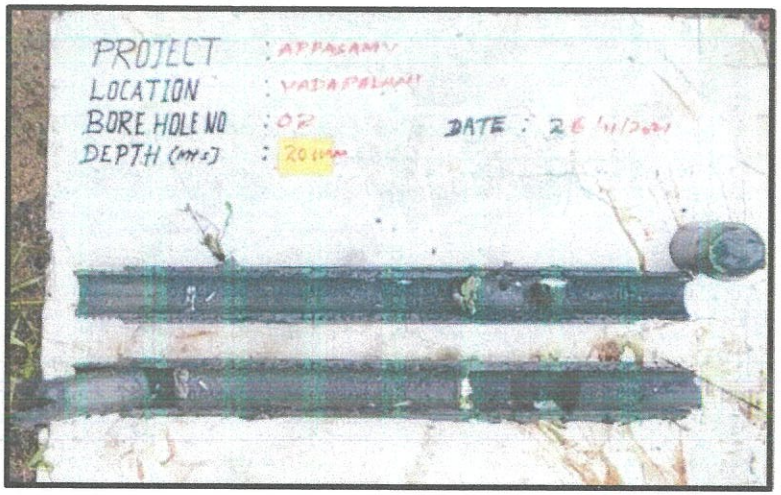


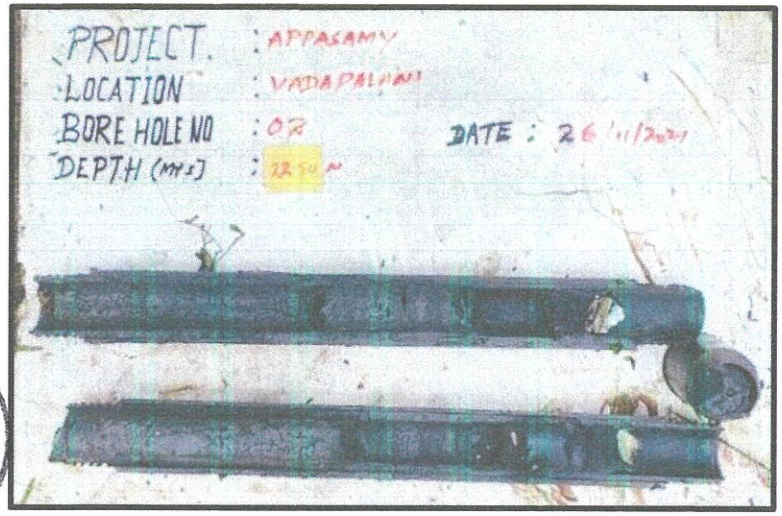


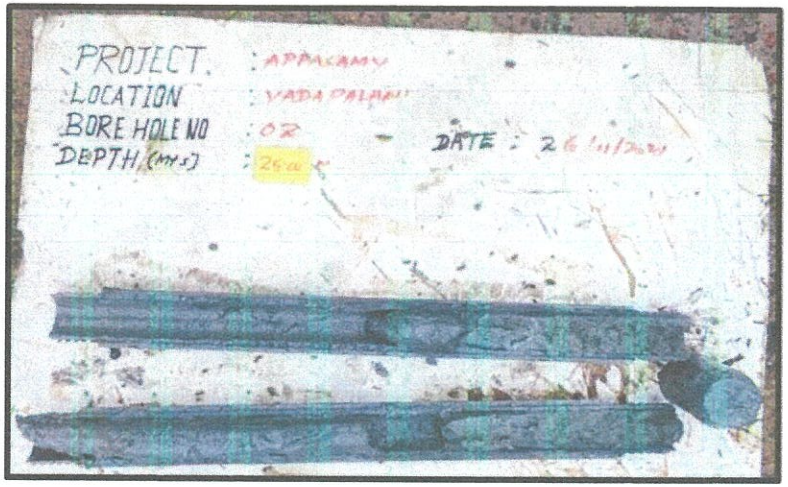
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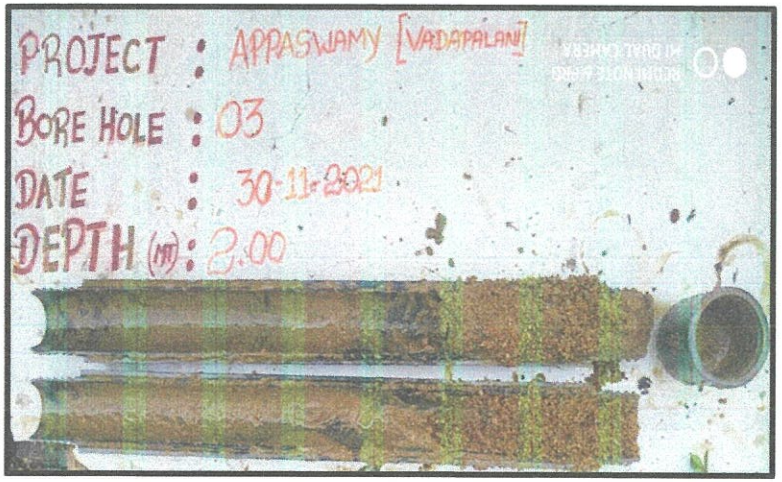


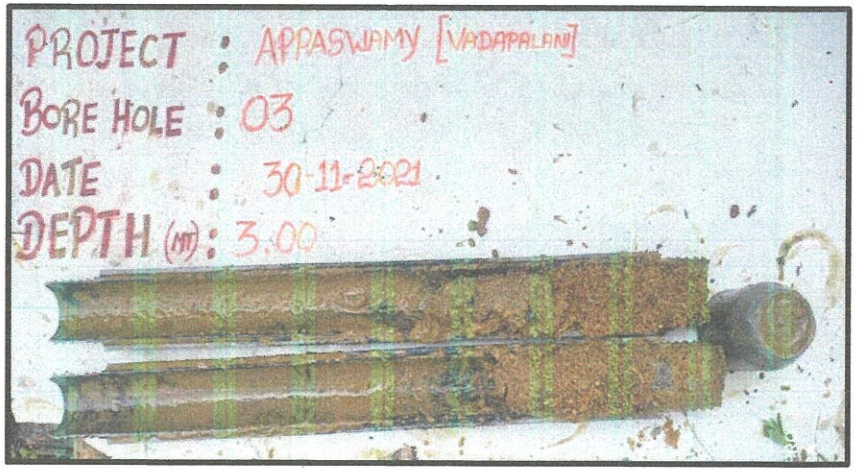


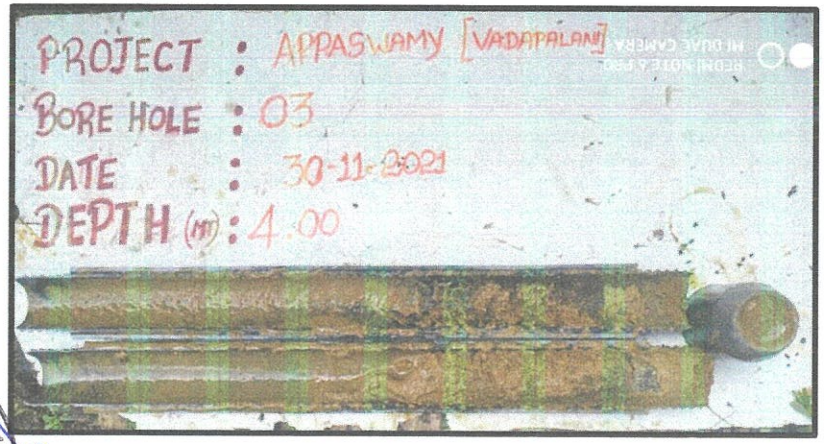


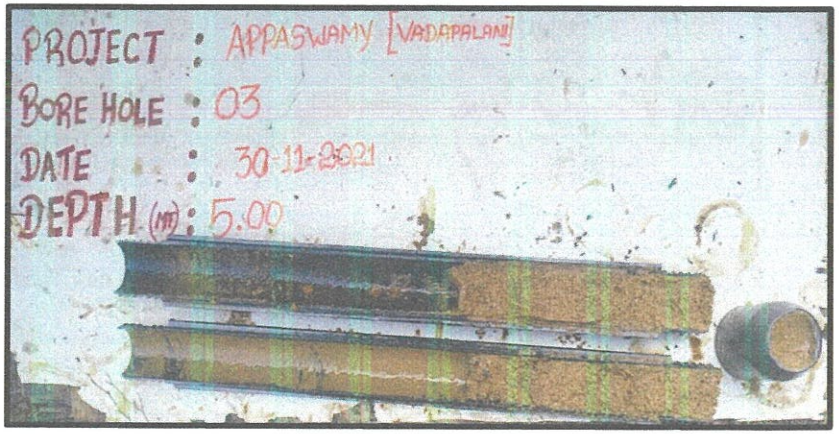
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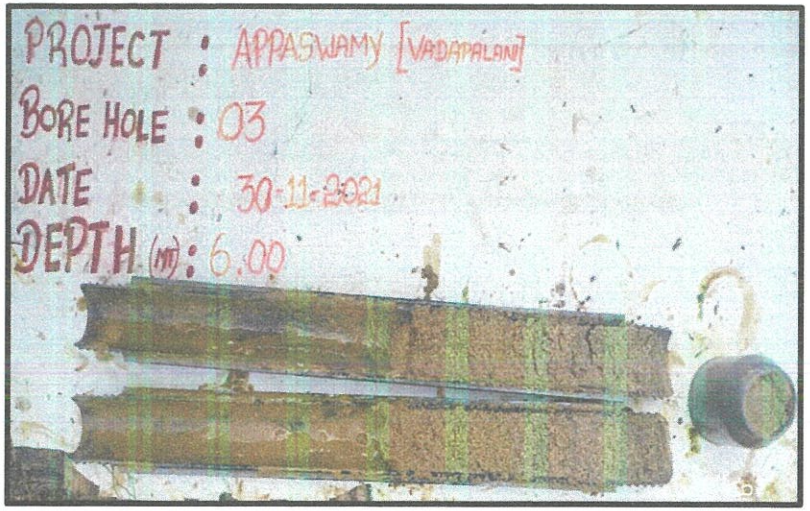


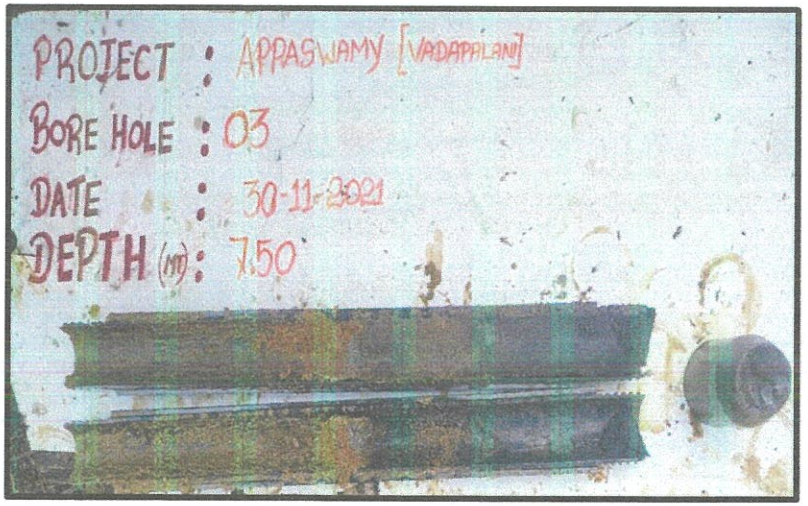


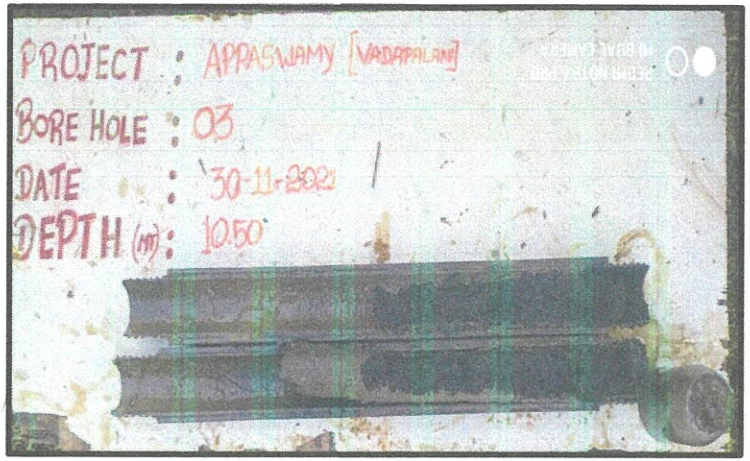


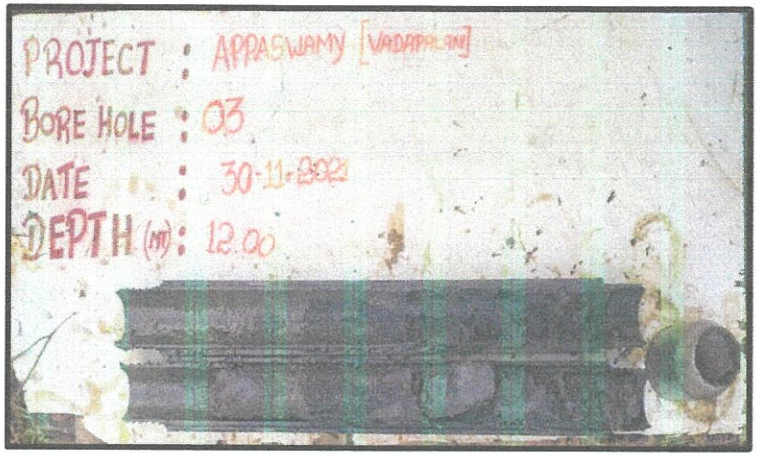
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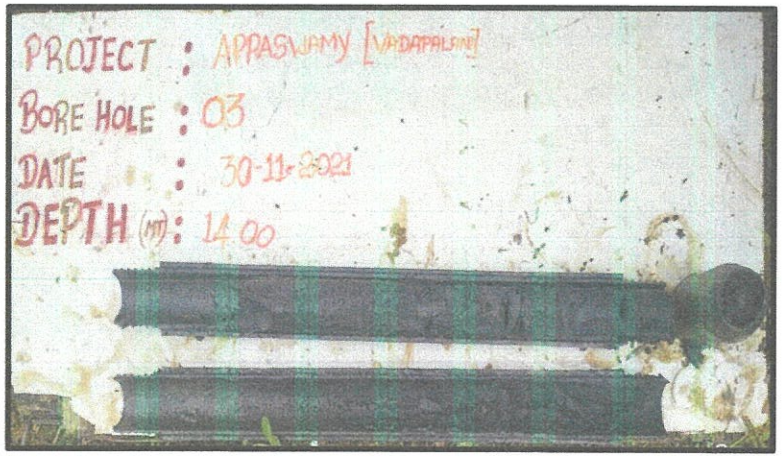


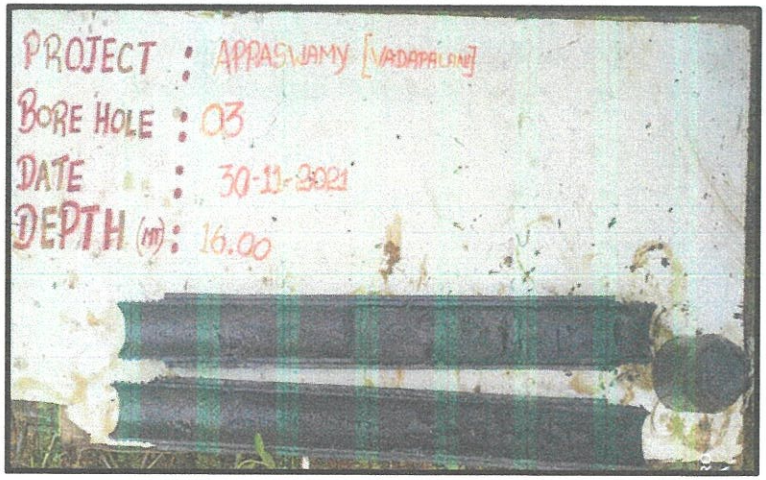


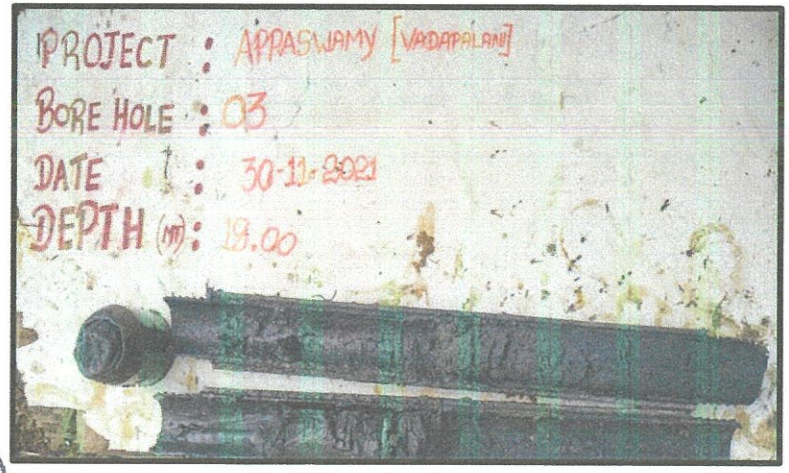


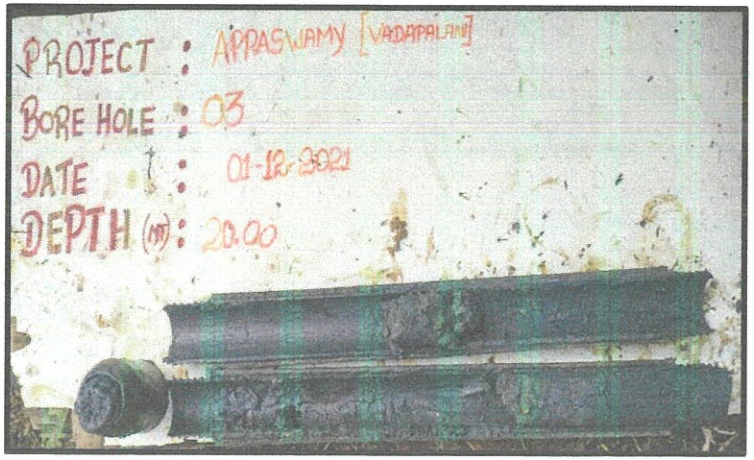
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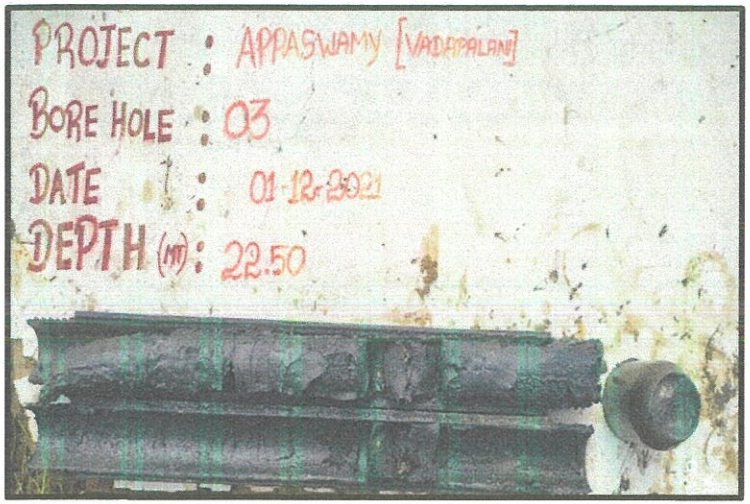


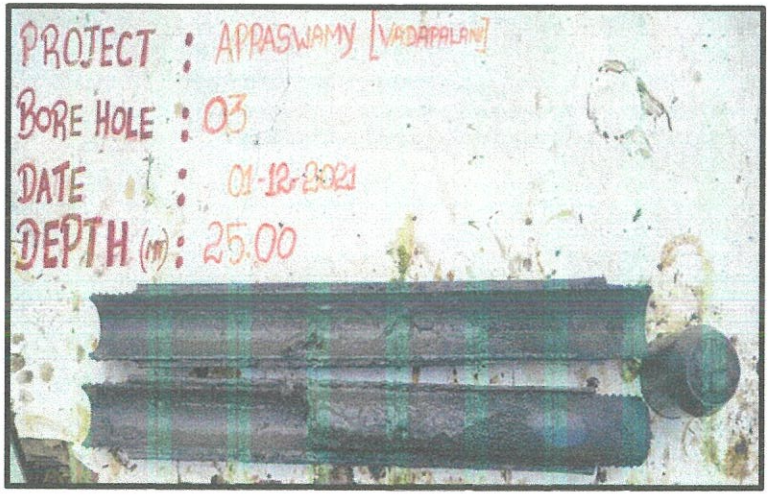




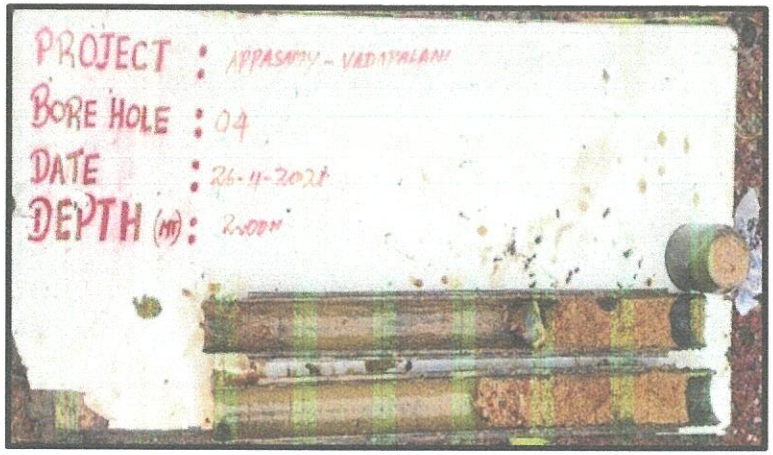
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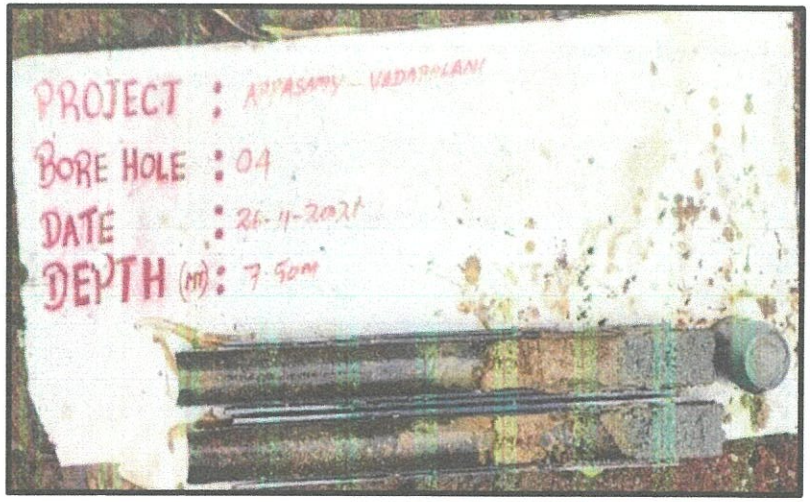


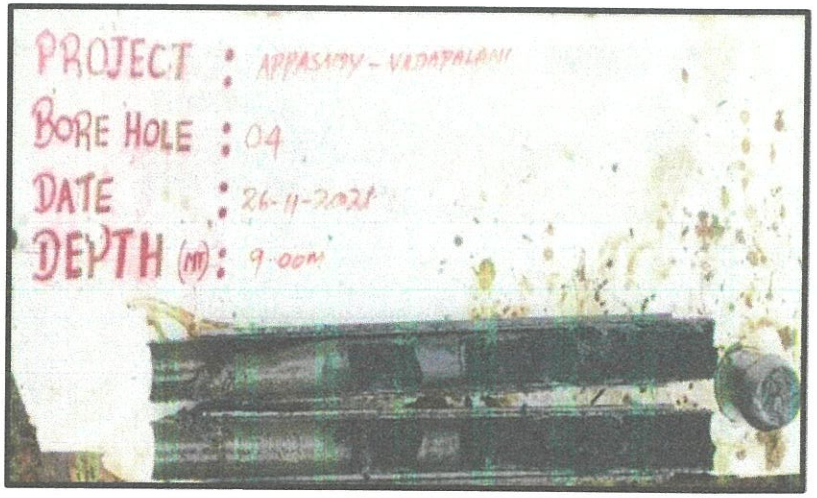




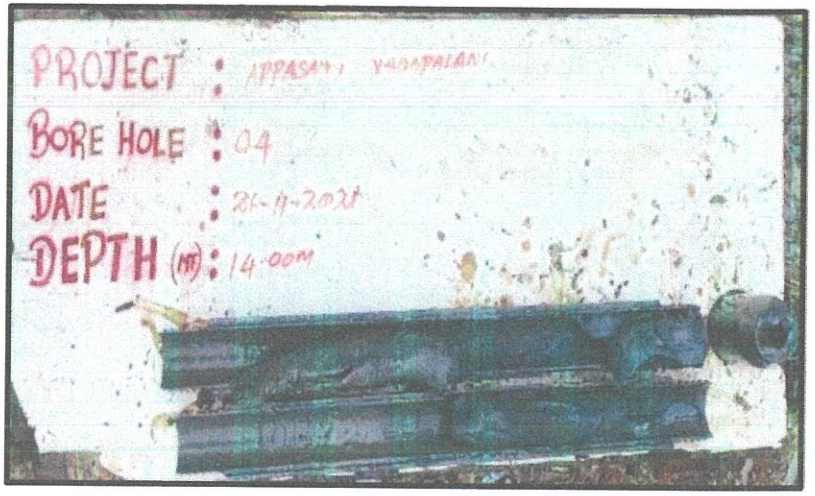
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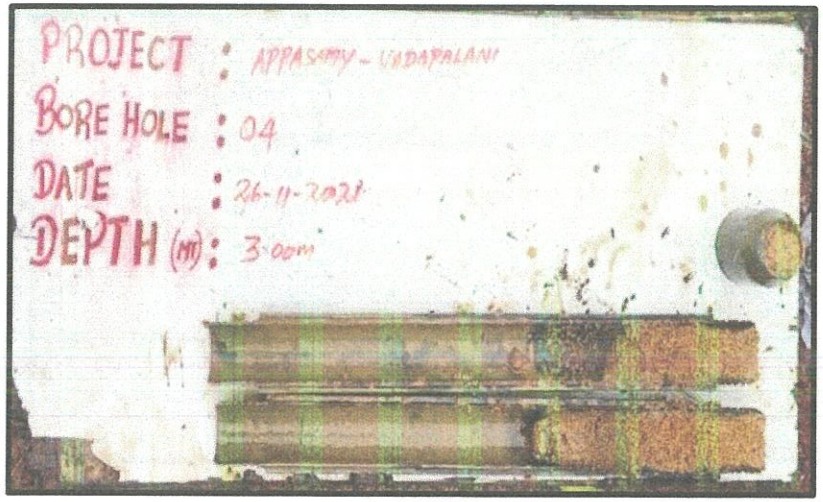




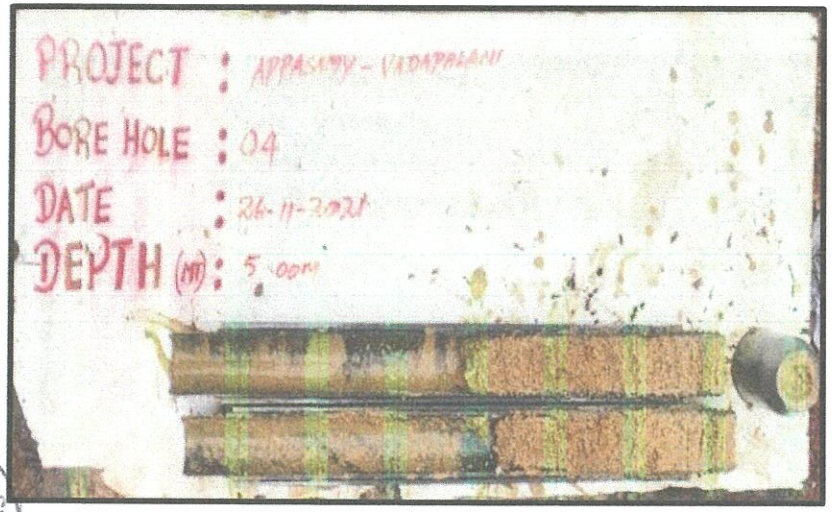


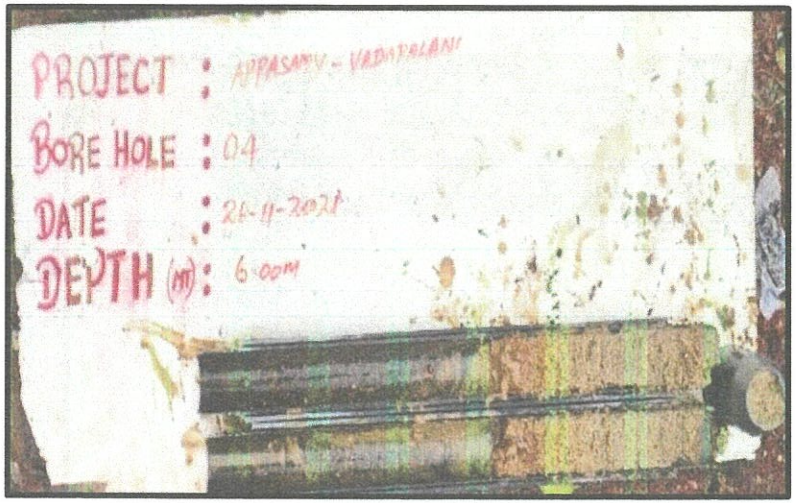
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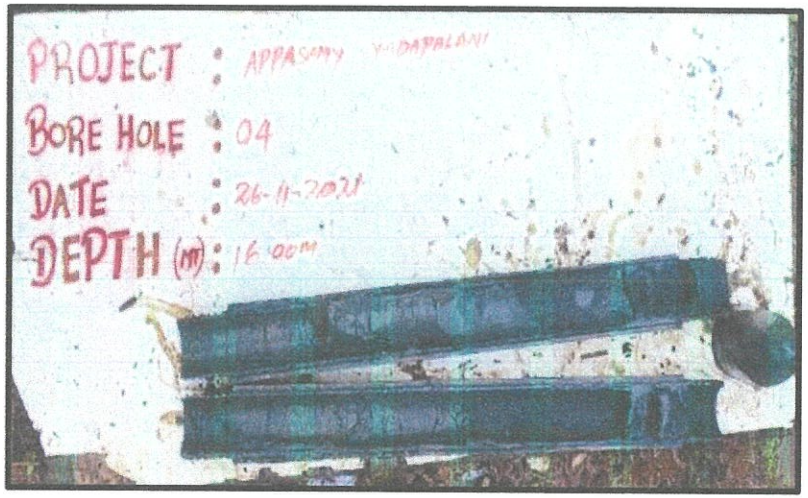


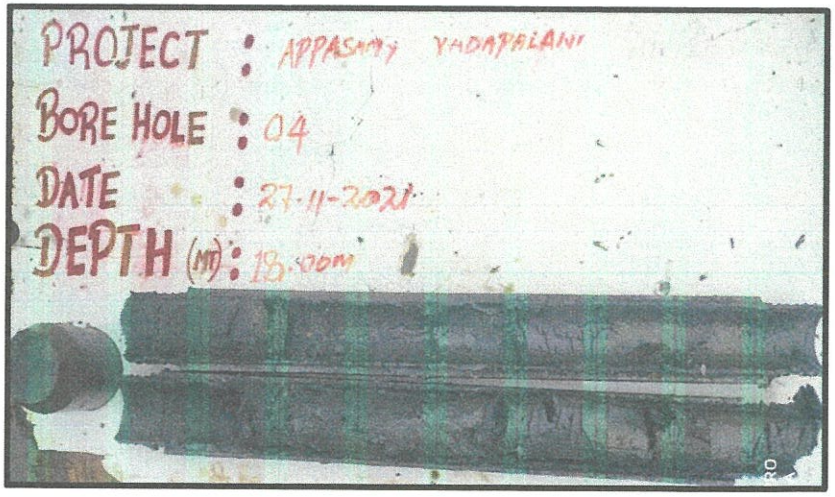


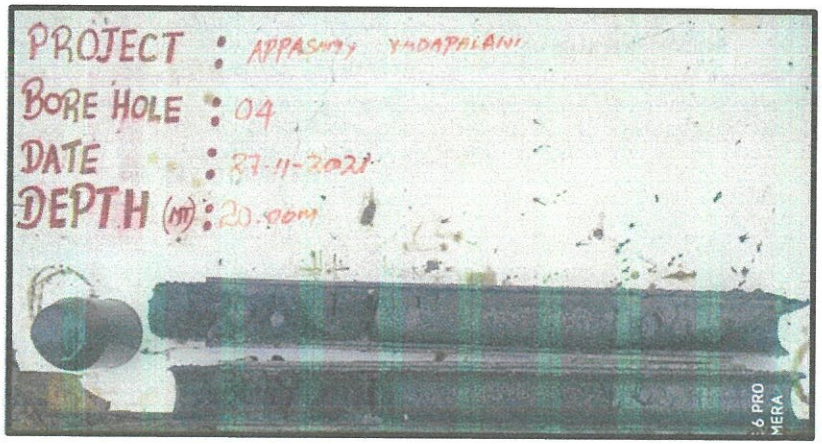


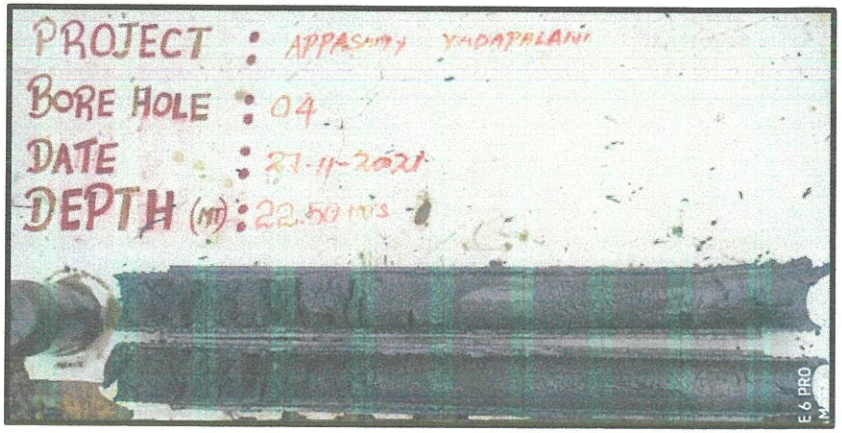
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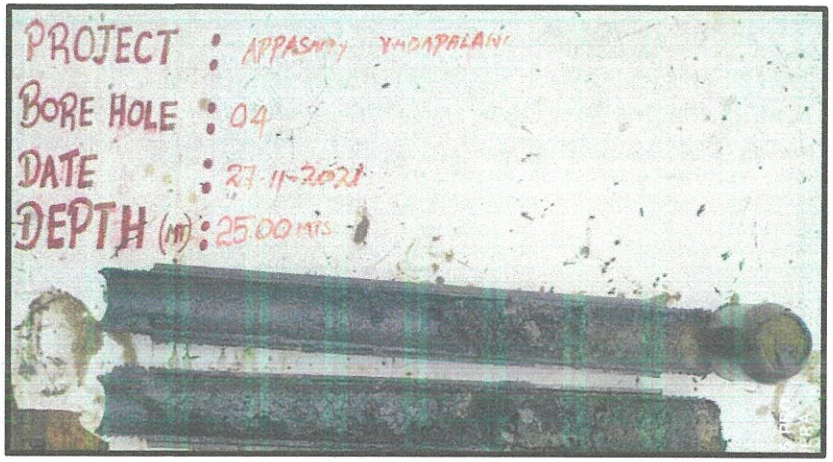






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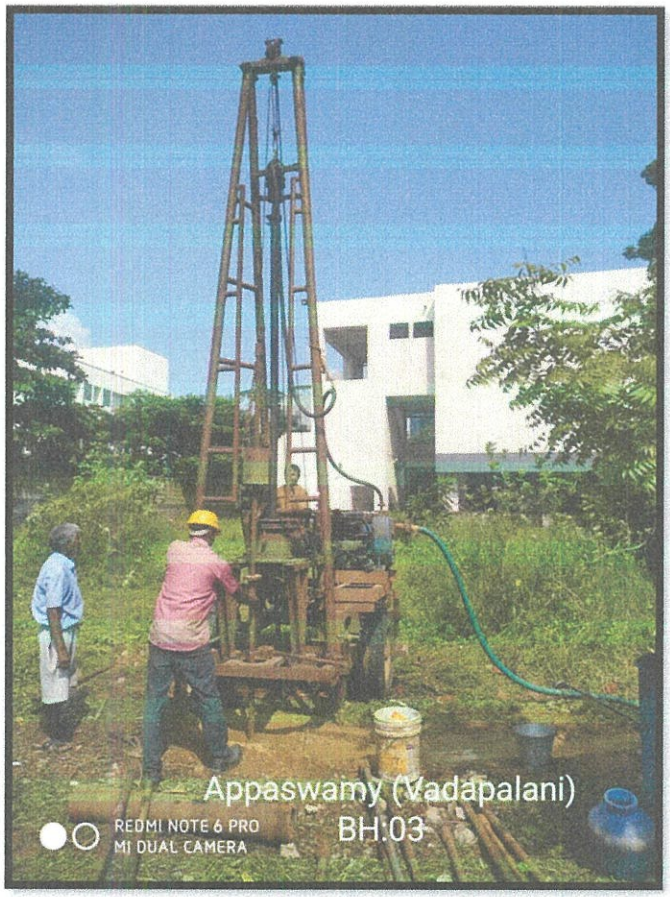
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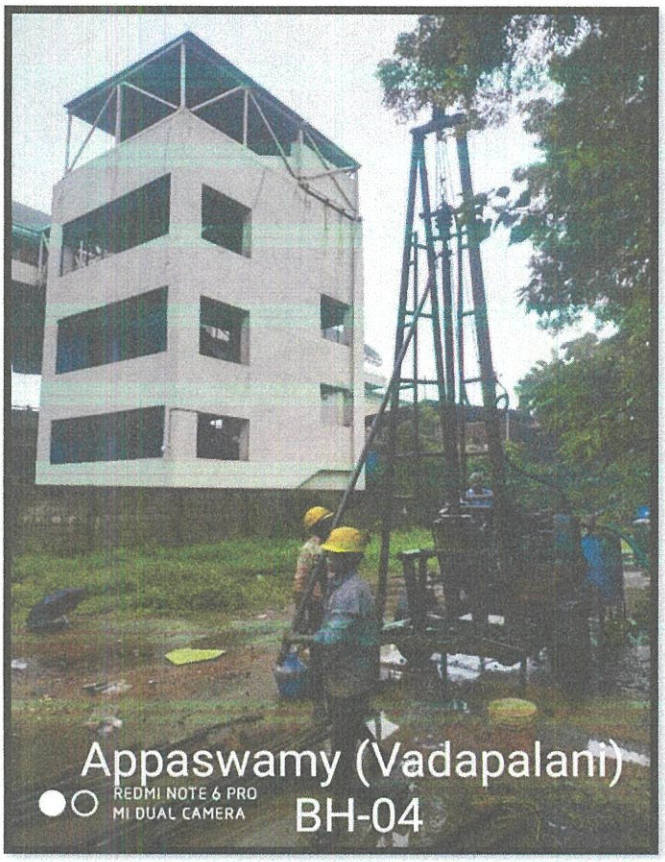




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Legal & Documentation Services

Certified EC, Patta, legal opinions, property verification, due diligence, litigation solutions, and legal heir certificates.

Property Development & Approvals

Building plan approvals, construction, layout and sub-division approvals, zone conversion, and occupancy certification.

NRI & Investment Services

Escrow Services, Rentals, Litigation Solutions, Property Valuation and Property Management

Compliance & Special Services

Demolition, Vaasthu checks, regularization of unauthorized buildings, and office space solutions.



empowering your real estate decisions with smart tools

Property Valuation & Cost Estimation

Guideline Value, Apartment Composite Value, Stamp Duty & Registration Fees Calculator, Building Value Calculator, Capital Gains Calculator, Area Unit Converter, Length Unit Converter

Ownership, Compliance & Legal Verification

Encumbrance Certificate (EC) Search, Find Your SRO, Temple Property Check, WAQF Property Check, View Patta/Chitta, View FMB, Patta Analyzer, EC Analyzer

Zoning & Land Use Analysis

Land Use Zone Finder, CRZ Zone Check, Aquifer Zone Check, CBA Check, EWS Check, Road Width Check, Proposed Road Widening Check, FSI Calculator

Property Documentation & Workflow Tools

Forms & Templates, Document Generator, Document Translation, Dictionary

Vastu & Property Management Tools

Home Vastu Shastra, Plot Vastu Shastra, Property Management

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