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PROJECT

BASEMENT FLOOR (PART) + STILT FLOOR (PIT - PUZZLE PARKING) + 4 FLOORS (HEIGHT - 18.30M) IT/ITES BUILDING, AT SHED NO. B-12, THIRU-VI-KA INDUSTRIAL ESTATE, GUINDY, CHENNAI 600032. COMPOSED IN T.S. NO. 59 (PT) & 63 (PT), BLOCK NO.6 OF ALANDUR VILLAGE WITHIN THE LIMITS OF GREATER CHENNAI CORPORATION.

CLIENT

M/s SKN GHANPUR LLP,
NO. 4, JAYALAKSHMIPURAM FIRST STREET,
NUNGAMBAKKAM,
CHEENAI – 600 034

PROJECT NAME:

SKCL AURA

TITLE

GEOTECHNICAL INVESTIGATION REPORT

Dr.C.V. VENKATA PRASAD
Recognised Geotechnical Engineer (RGTE)
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REPORT NO.: GT- 2410

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DATE	REVISON	DESCRIPTION		AUTHORISED SIGNATORY
05/08/2022	FIRST SUBMISSION	SUBMISSION OF GEOTECHNICAL REPORT	SIGN	
14/11/2024	1.0	CHANGE IN PROJECT TITLE	DATE	05/08/2022
			DESIGNATION	**MANAGING DIRECTOR**
			NAME	**DR. C.V.PRASAD**

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REPORT TEXT

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CHAPTER-1

INTRODUCTION

1.0 PROJECT INFORMATION MATRIX:

NATURE OF PROJECT	: COMMERCIAL DEVELOPMENT SKCL AURA (IT/ITES BUILDING)
STRUCTURE	: BASEMENT (PART) + STILT + 4 FLOORS
PROJECT OWNER	: M/s SKN GHANPUR LLP
PROJECT LOCATION	: GUINDY, CHENNAI
JOB CODE	: GT-2410

1.1 SCOPE OF WORK:

1.1.1 FIELD WORK:

- Conducting two soil investigation bore holes of 100mm/ 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 15.0m, SPT is conducted at every 1.5m depth interval
  - In case of rock formation core drilling shall be conducted and checked at every 1.5m or 1.0m depth interval
- 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 water samples if groundwater table met within the investigation depth

1.1.2 LABORATORY WORK:

- Natural Moisture Content
- Atterberg's limits
- Grain Size Analysis
- Consolidation test on undisturbed samples if applicable
- 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:

Two soil investigation boreholes were put as per the planning of the engineer in-charge and these locations are shown in Fig.2.0.The equipment used and the methodology adopted to carry out the fieldwork is described below.

2.1 METHODOLOGY OF FIELD WORK:

2.1.1 EQUIPMENT USED AND METHOD OF DRILLING:

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

2.1.2 STANDARD PENETRATION TESTS:

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

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

2.1.3 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.

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NOTE ON GROUNDWATER TABLE RECORD:

- Groundwater table observation in geotechnical report is predominantly to arrive at foundation design criteria and shall not be construed as design guidelines for the design of dewatering systems
- The groundwater level indicated in the bore logs is specific to the duration of investigation and intensity of the monsoon rains during the time of investigation. Hence, the level shall be taken as guidelines only to plan the investigation for the dewatering system
- No foundation excavation or basement excavations if anticipated within the groundwater table zone shall be carried out without implementing groundwater lowering schemes

2.2 LABORATORY TESTING:

2.2.1 ON COARSE GRAINED SOIL:

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

2.2.2 ON FINE GRAINED SOIL:

On the SPT sample index property tests were conducted to estimate consistency. These test results are presented in Tables-2.1 & 2.2. The graphical representation of hydrometer analyses curve for the representative samples in each bore is presented in Fig. 2.5 to 2.8.

2.2.3 CHEMICAL ANALYSIS TESTS:

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

2.3 SUMMARY:

The locations of the field investigation boreholes are shown in site plan given in Fig.2.0. The average sub soil profiles encountered at each location along with their classification and engineering properties are presented in Figs.2.1 & 2.2.

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SITE PLAN

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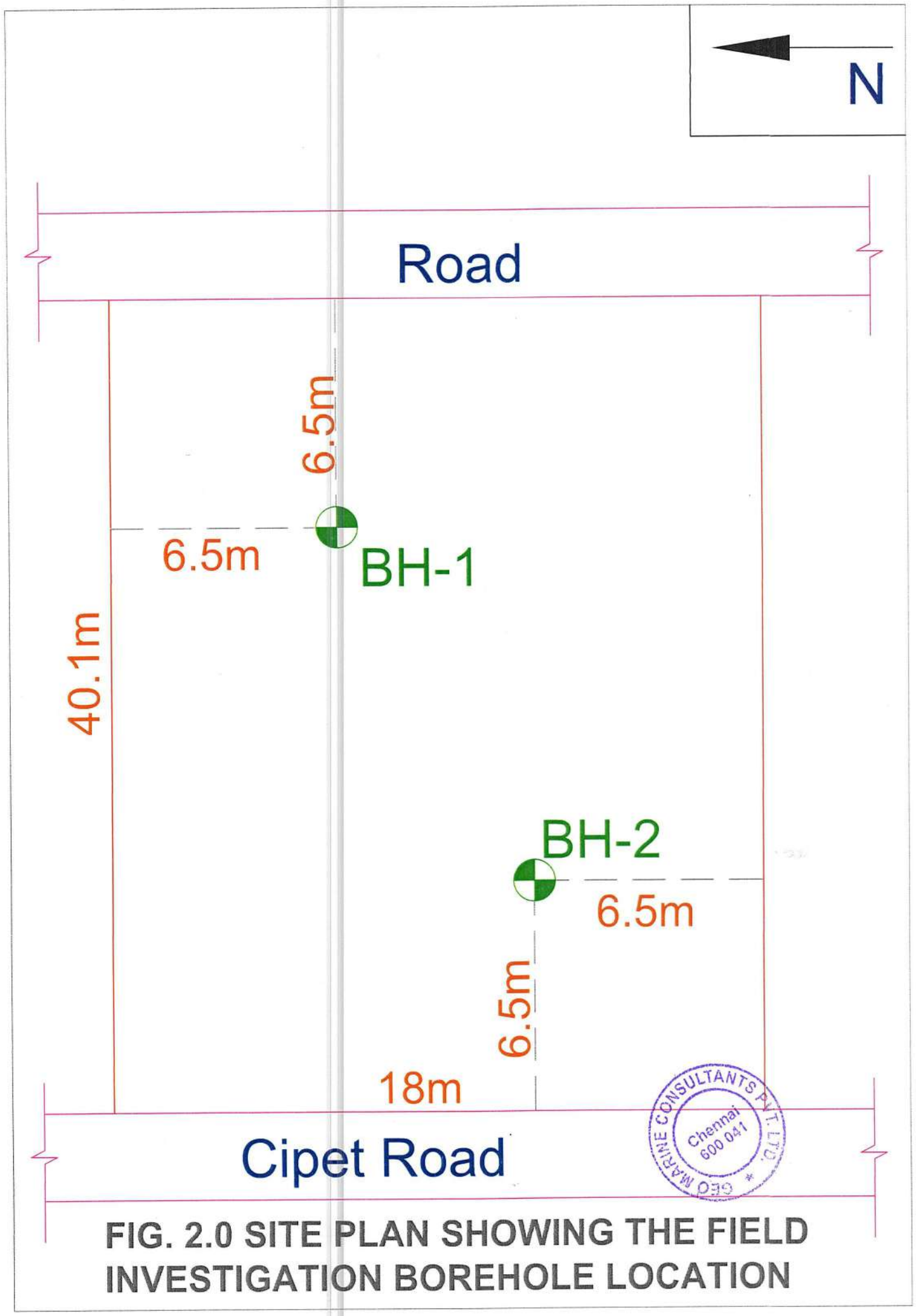


FIG. 2.0 SITE PLAN SHOWING THE FIELD INVESTIGATION BOREHOLE LOCATION

SOIL PROFILES

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SITE INVESTIGATION RECORD

BORE HOLE No.	BH-01						
SHEET	1	OF	2				
PROJECT NAME	PROPOSED CONSTRUCTION OF A COMMERCIAL BUILDING			DIA OF BORE HOLE	150mm ✓		
					NX ✓		
LOCATION	Guindy, Chennai	MACHINE No.	-	CHAINAGE (m)	-	BORE START DATE	26/07/2022
STRUCTURE	Basement (Part) + Stilt + 4 Floors	DRILLING METHOD	Rotary	CO-ORDINATES	N -	BORE END DATE	27/07/2022
JOB CODE	GT-2410	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
1	26/07/2022	16	00	SC	-	-												
		To																
		16	10				4	5	6	11	1.00	1	SS	-1.0				
		16	40								1.45							
		To		SC	-	-												Brown,Moist,Stiff,**Silty CLAY (CH)** Clay of High Plasticity
2		16	50				-	-	-	-	2.00	2	UDS	-2.0				
		09	00															
		To		SC	-	-												
		09	11															
3		09	30				8	33	35	68	3.00	3	SS	-3.0		L1	3.2	
		To		SC	-	-					3.45				+ + + + + + + +			Brown Grey,Moist,Fine to Coarse Grain Structure,Very Dense,**Residual Soil/ Clayey Silty SAND (SC)**
		09	44															
4		10	05				33	55	10cm penet for 50 blows	>100	4.00	4	SS	-4.0		L2	4.0	Disintegrated Hypersthene Granitic Rock
		To		SC	-	-					4.40							
		10	20															
5		10	30				SPT Hammer Rebound			>100	5.00	-	WS	-5.0				
		To		DB	0	0												
	27/07/2022	11	00															
6							SPT Hammer Rebound			>100	6.00	-	WS	-6.0				
		11	15															
		To		DB	0	0												Brown Grey,Moist,Fine & Medium Grains Sand Size Fraction,Very Dense, **Completely Weathered Rock - Grade W5 Rock** Disintegrated Hypersthene Granitic Rock Formation
7		11	50															
							SPT Hammer Rebound			>100	7.50	-	WS	-7.5				
8		12	05															
		To		DB	0	0												
		12	40															
9							SPT Hammer Rebound			>100	9.00	-	WS	-9.0				
		14	00															
		To		DB	0	0												
10		14	40															

CS - Core Sample	DS - Disturbed Sample	LOGGED	S.Stephenraj	PROJECT SITE DETAILS	REMARKS
SS - Split Spoon Sample	SC - Soil Cutter	DATE	27/07/2022	GROUND LEVEL (m) 0.00	
UDS- Undisturbed Sample	TCB - Tungsten Carbide Bit	CHECKED	Sharmila.G	WATER TABLE (m) 2.30	
WS - Wash Sample	DB - Diamond Bit	DATE	28/07/2022	CASING DEPTH (m) 0.00	

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SITE INVESTIGATION RECORD

BORE HOLE No.	BH-01						
SHEET	2	OF	2				
PROJECT NAME	PROPOSED CONSTRUCTION OF A COMMERCIAL BUILDING			DIA OF BORE HOLE	150mm		
					NX	✓	
LOCATION	Guindy, Chennai	MACHINE No.	-	CHAINAGE (m)	-	BORE START DATE	26/07/2022
STRUCTURE	Basement (Part) + Stilt + 4 Floors	DRILLING METHOD	Rotary	CO-ORDINATES	N -	BORE END DATE	27/07/2022
JOB CODE	GT-2410	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	27/07/2022	15	00	DB	0	0	SPT Hammer Rebound			>100	10.50	-	WS	-10.5	+ + +			
		To													+ + +			
12		15	45				SPT Hammer Rebound			>100	12.00	-	WS	-12.0	+ + +			No Penetration of SPT, Very Dense, **Completely Weathered Rock - Grade W5 Rock** Disintegrated Hypersthene Granitic Rock Formation
		16	00												+ + +			
13		To		DB	0	0									+ + +	L3	13.5	
		16	49				-	-	-	-	13.50	5	CS	-13.5	+ + +			Grey Brown, Medium to Coarse Grain Structure, Highly & Completely Fractured, Discoloured Parent Rock, **Highly Weathered Rock - Grade W4 Rock** Hypersthene Granitic Rock Formation
14		17	00												+ + +			
		To		DB	10	0									+ + +			
15		17	50				-	-	-	-	15.00	12	CS	-15.0	+ + +	L4	15.0	
16																		
17																		
18																		
19																		
20																		

						REMARKS
CS - Core Sample	DS - Disturbed Sample	LOGGED	S.Stephenraj	PROJECT SITE DETAILS		
SS - Split Spoon Sample	SC - Soil Cutter	DATE	27/07/2022	GROUND LEVEL (m)	0.00	
UDS- Undisturbed Sample	TCB - Tungsten Carbide Bit	CHECKED	Sharmila.G	WATER TABLE (m)	2.30	
WS - Wash Sample	DB - Diamond Bit	DATE	28/07/2022	CASING DEPTH (m)	0.00	

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

FIG.2.1 Sub Soil Profile at BH-01 Location

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SITE INVESTIGATION RECORD

BORE HOLE No.	BH-02						
SHEET	1	OF	2				
PROJECT NAME	PROPOSED CONSTRUCTION OF A COMMERCIAL BUILDING			DIA OF BORE HOLE	150mm ✓		
					NX ✓		
LOCATION	Guindy, Chennai	MACHINE No.	-	CHAINAGE (m)	-	BORE START DATE	23/07/2022
STRUCTURE	Basement (Part) + Stilt + 4 Floors	DRILLING METHOD	Rotary	CO-ORDINATES N	-	BORE END DATE	25/07/2022
JOB CODE	GT-2410	FLUSHING MEDIUM	Bentonite	CO-ORDINATES 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
1	23/07/2022	14	30	SC	-	-												
		To																
		14	35				2	2	3	5	1.00	1	SS	-1.0				Brown,Moist,Medium Stiff,**Silty CLAY (CH)** Clay of High Plasticity
		16	00								1.45 ↓							
		To		SC	-	-												
2		16	10				6	7	11	18	2.00	2	SS	-2.0		L1	2.0	
		17	30								2.45 ↓							
		To		SC	-	-												
3		17	40				-	-	-	-	3.00	3	UDS	-3.0				Brown,Moist,Very Stiff,**Silty CLAY (CH)** Clays of High Plasticity
		09	00															
		To		SC	-	-												
4		09	10				15	55	SPT Hammer Rebounded	>100	4.00	4	SS	-4.0		L2	4.0	
		09	40								4.30 ↓				+ + + / + + / + + + / + + / + + +			
		To		SC	-	-												Brown Grey,Moist,Fine & Medium Grains Sand Fraction With Traces of Coarse Sand & Gravels,Very Dense, **Residual Soil - Grade W5 Rock Formation**
5		09	50				35	8cm penet for 50 blows		>100	5.00	5	SS	-5.0		L3	5.0	
		10	30								5.23 ↓				+ + + / + + / + + + / + + / + + +			
		To		SC	-	-												
		10	45															
6	25/07/2022						SPT Hammer Rebound			>100	6.00	-	WS	-6.0				
		11	00															
		To		DB	0	0												
7		11	30															Brown Grey,Moist,Fine & Medium Grains Sand Size Fraction,Very Dense, **Completely Weathered Rock - Grade W5 Rock** Disintegrated Hypersthene Granitic Rock Formation
							SPT Hammer Rebound			>100	7.50	-	WS	-7.5				
		11	45															
8		To		DB	0	0												
		12	17															
9							SPT Hammer Rebound			>100	9.00	-	WS	-9.0				
		12	30															
		To		DB	0	0												
10		13	05															

				PROJECT SITE DETAILS		REMARKS
CS - Core Sample	DS - Disturbed Sample	LOGGED	S.Stephen Raj	GROUND LEVEL (m)	0.00	
SS - Split Spoon Sample	SC - Soil Cutter	DATE	25/07/2022	WATER TABLE (m)	2.50	
UDS- Undisturbed Sample	TCB - Tungsten Carbide Bit	CHECKED	Sharmila.g	CASING DEPTH (m)	0.00	
WS - Wash Sample	DB - Diamond Bit	DATE	29-07-2022			

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SITE INVESTIGATION RECORD

PROJECT NAME	PROPOSED CONSTRUCTION OF A COMMERCIAL BUILDING					BORE HOLE No.	BH-02
						SHEET	2 OF 2
						DIA OF BORE HOLE	150mm ✓
							NX ✓
LOCATION	Guindy, Chennai	MACHINE No.	-	CHAINAGE (m)	-	BORE START DATE	23/07/2022
STRUCTURE	Basement (Part) + Stilt + 4 Floors	DRILLING METHOD	Rotary	CO-ORDINATES	N -	BORE END DATE	25/07/2022
JOB CODE	GT-2410	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	25/07/2022	14	00	DB	0	0	SPT Hammer Rebound			>100	10.50	-	WS	-10.5				
		To																
12		14	36				SPT Hammer Rebound			>100	12.00	-	WS	-12.0				No Penetration of SPT, Very Dense, **Completely Weathered Rock - Grade W5 Rock** Disintegrated Hypersthene Granitic Rock Formation
13		15	00	DB	0	0												
		To					SPT Hammer Rebound			>100	13.50	-	WS	-13.5				
14		15	35															
		16	00	DB	0	0												
		To																
15		16	45				SPT Hammer Rebound			>100	15.00	-	WS	-15.0				
															L4	15.0		
16																		
17																		
18																		
19																		
20																		

CS - Core Sample	DS - Disturbed Sample	LOGGED	S.Stephen Raj
SS - Split Spoon Sample	SC - Soil Cutter	DATE	25/07/2022
UDS- Undisturbed Sample	TCB - Tungsten Carbide Bit	CHECKED	Sharmila.g
WS - Wash Sample	DB - Diamond Bit	DATE	44771

PROJECT SITE DETAILS	
GROUND LEVEL (m)	0.00
WATER TABLE (m)	2.50
CASING DEPTH (m)	0.00

REMARKS

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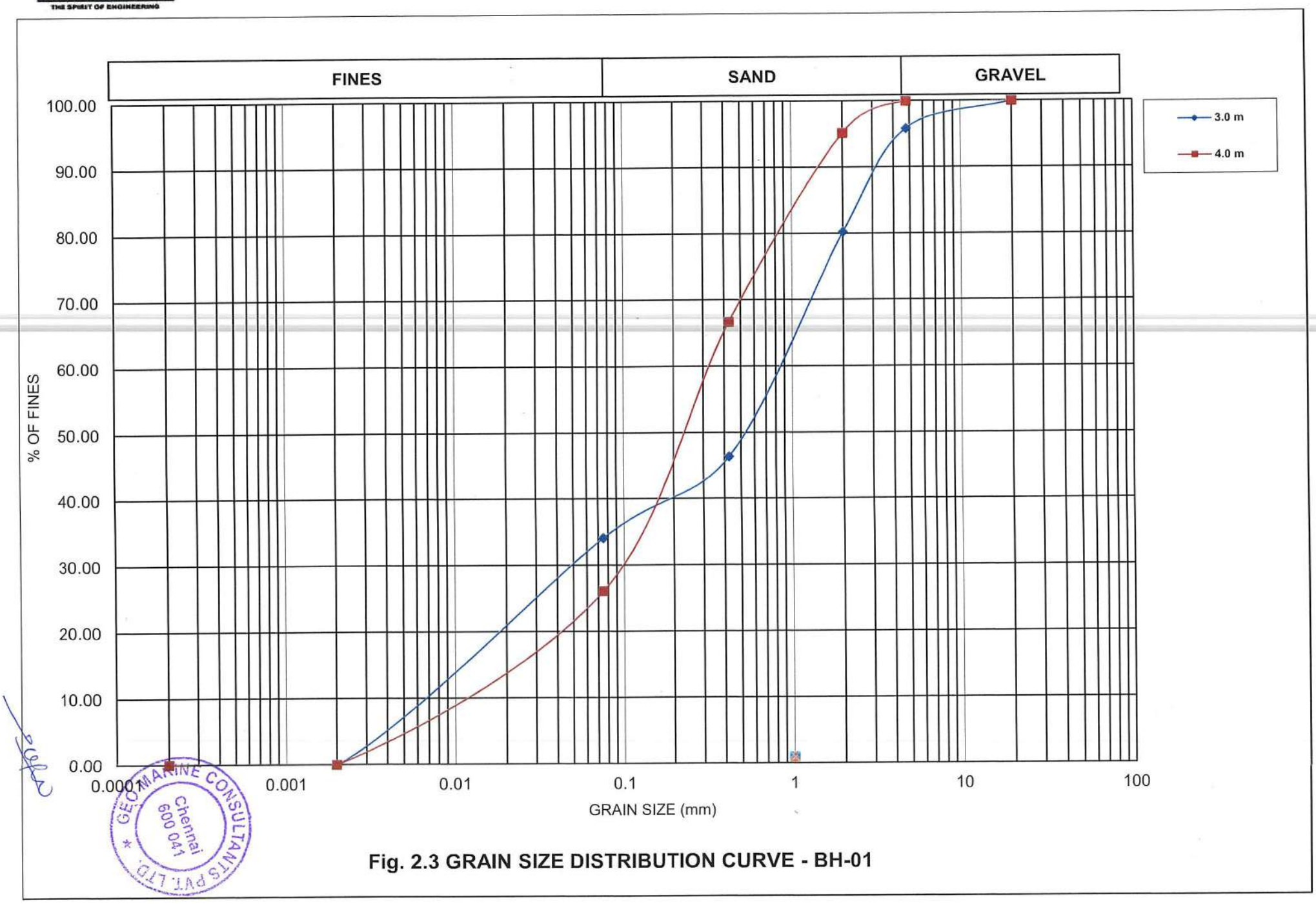
Borehole terminated at 15 m depth below E.G.L

FIG.2.2 Sub Soil Profile at BH-02 Location

GRAIN SIZE DISTRIBUTION CURVE

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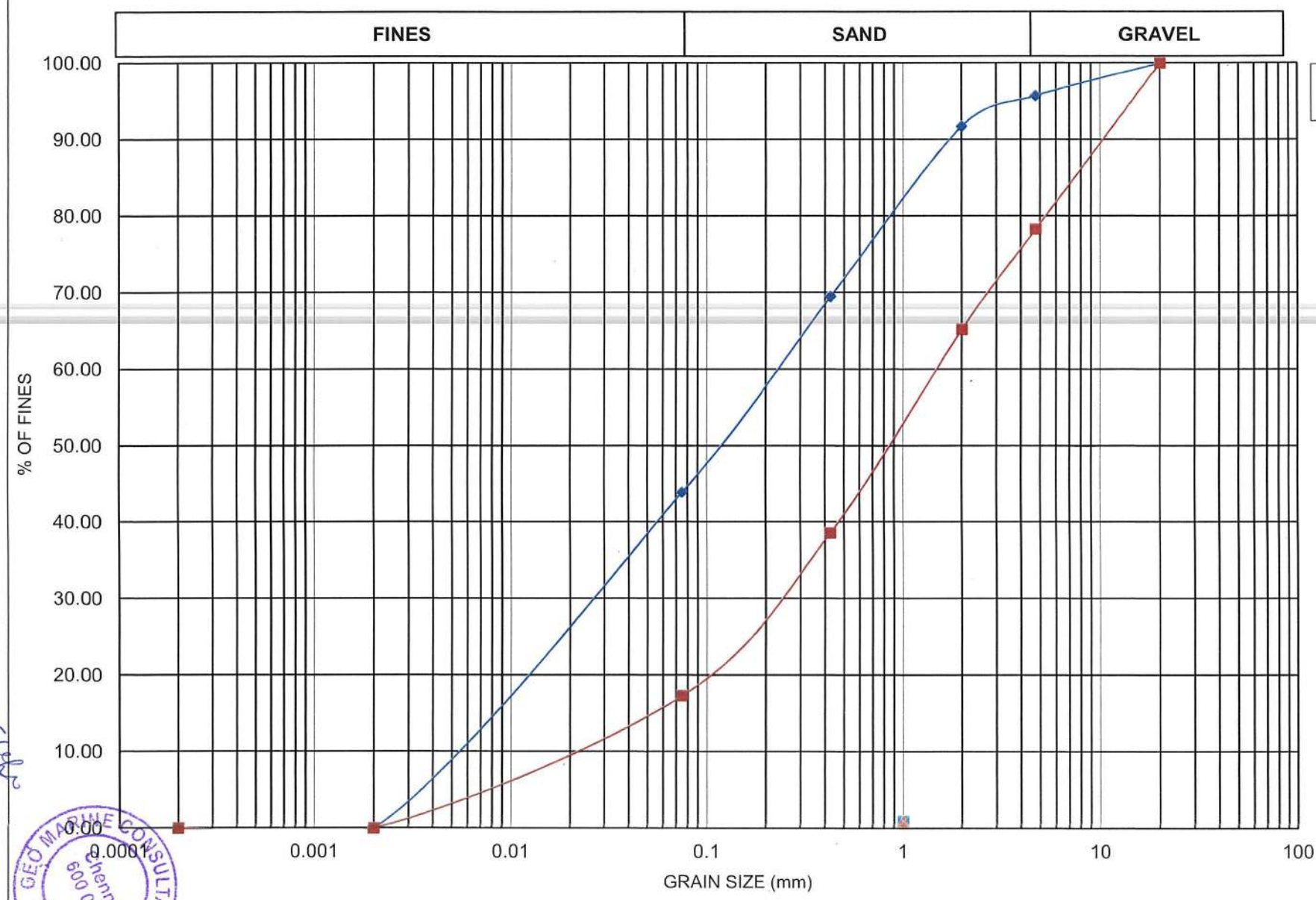
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Fig. 2.3 GRAIN SIZE DISTRIBUTION CURVE - BH-01

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Fig. 2.4 GRAIN SIZE DISTRIBUTION CURVE - BH-02

HYDROMETER ANALYSIS CURVE

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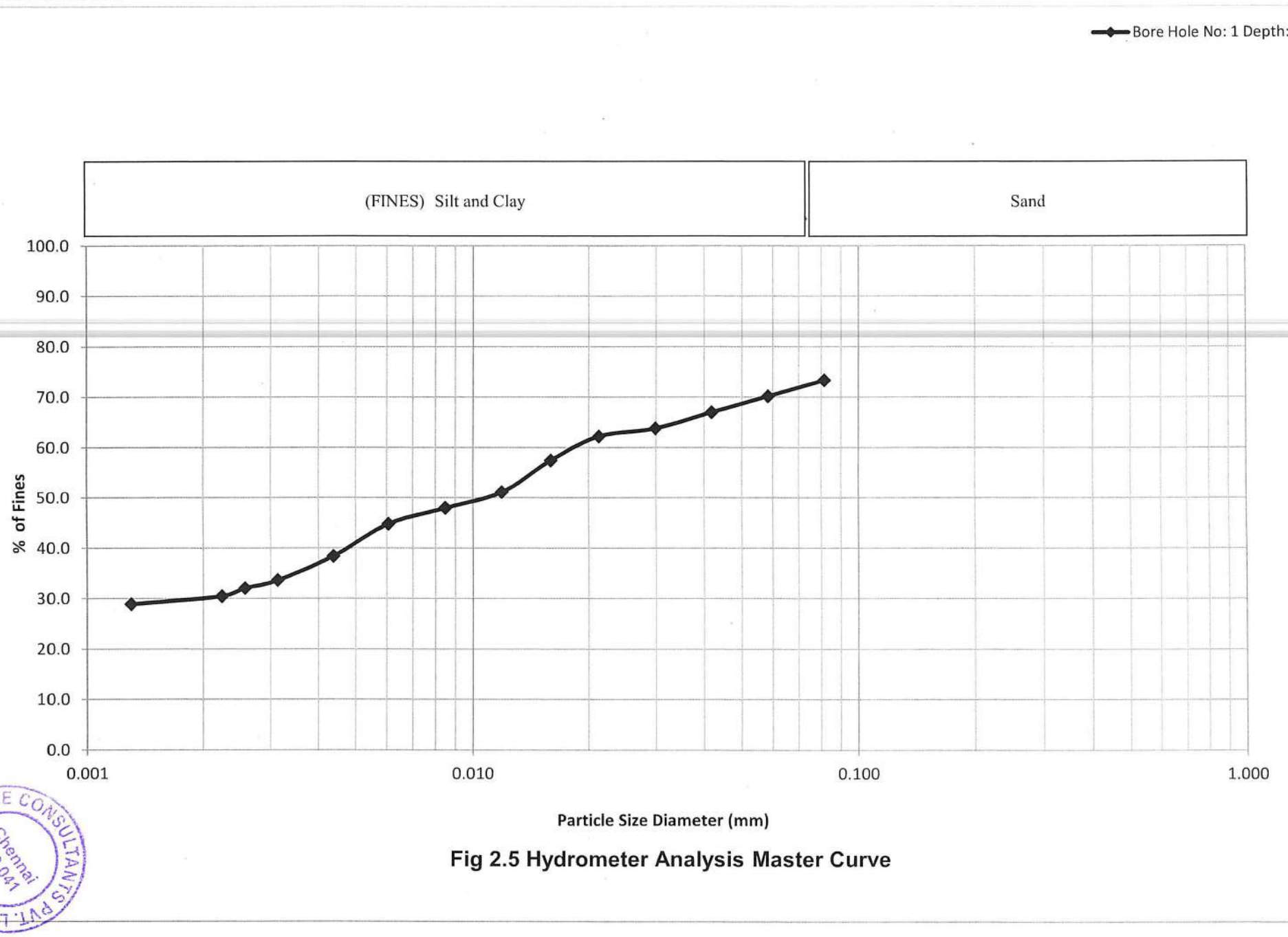


Fig 2.5 Hydrometer Analysis Master Curve

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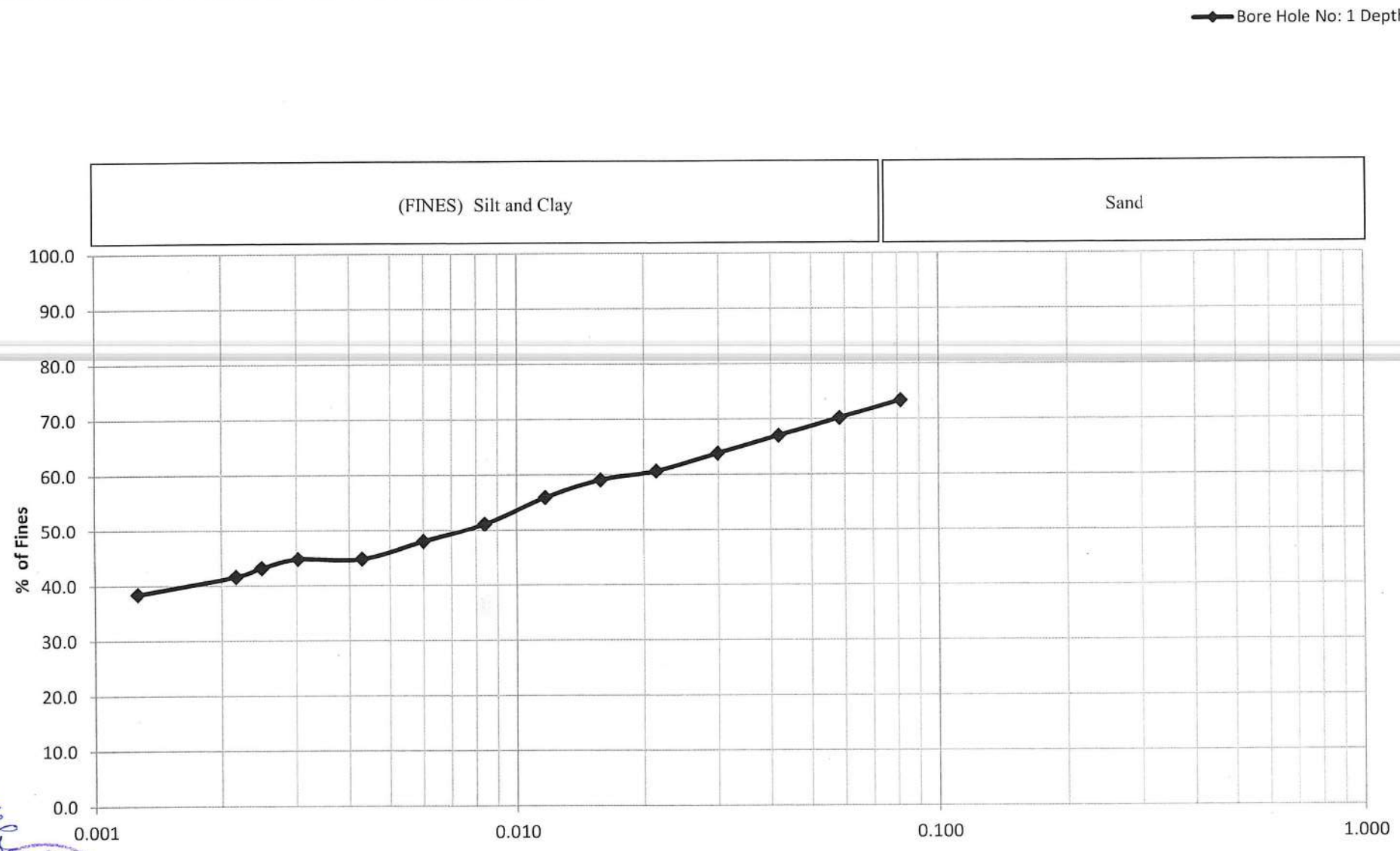


Fig 2.6 Hydrometer Analysis Master Curve

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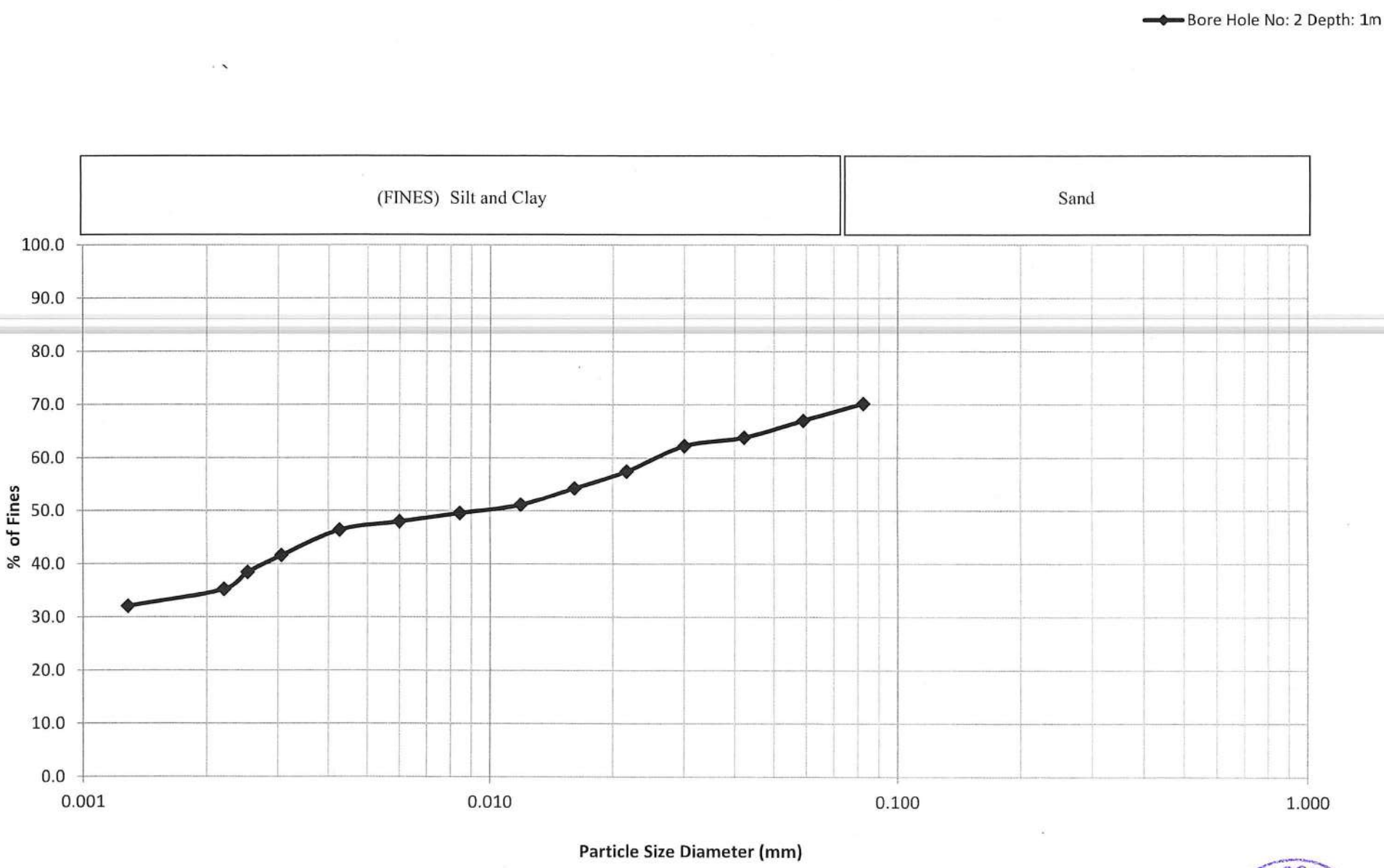


Fig 2.7 Hydrometer Analysis Master Curve

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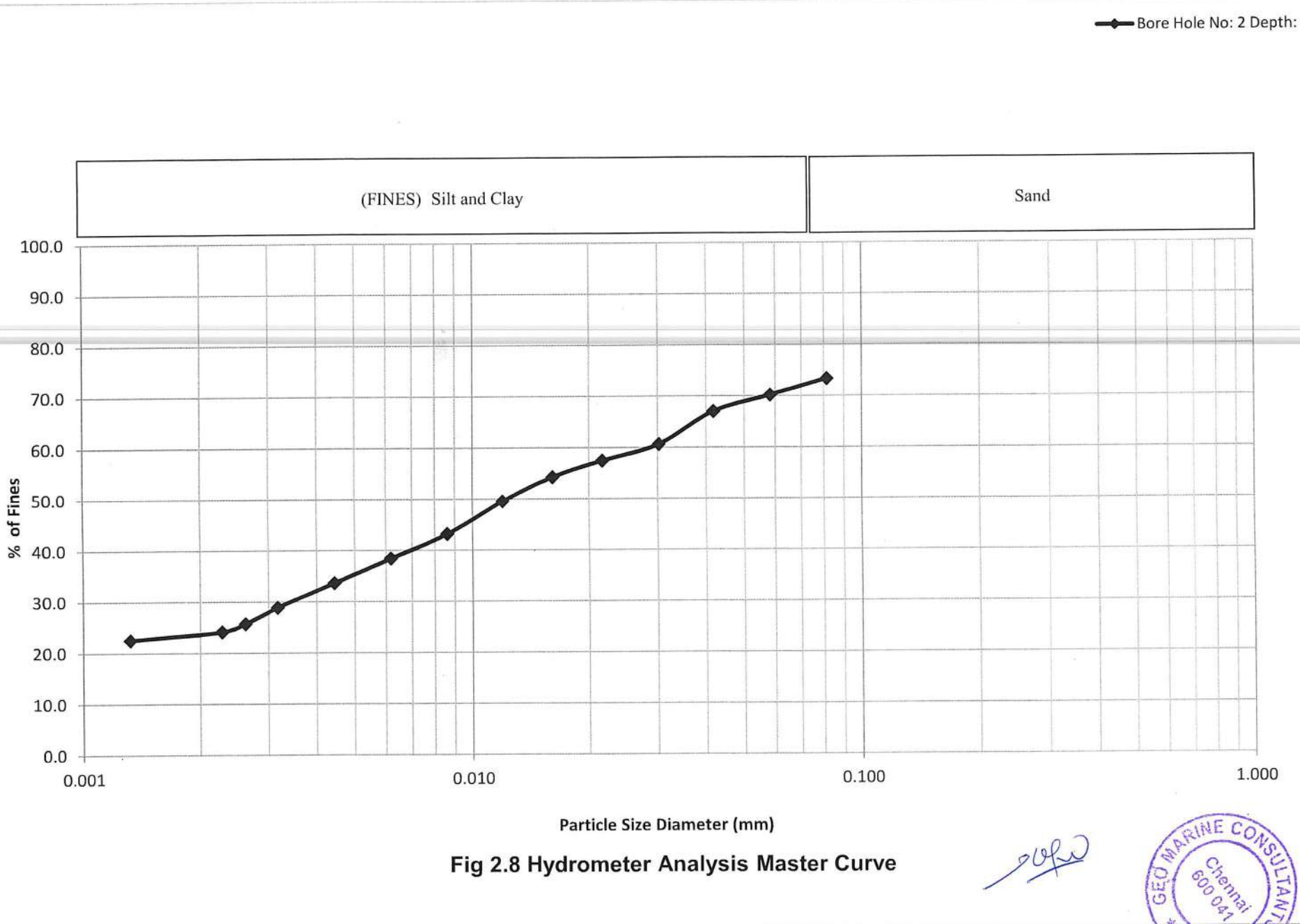


Fig 2.8 Hydrometer Analysis Master Curve

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LABORATORY TEST RESULTS

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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 SRI KAUSALYA CONSTRUCTIONS LIMITED**	**Customer Reference**	:	By Email
Sample Description	:	Soil Sample	**Period of Testing**	:	29/07/2022 to 05/08/2022
Source of Sample	:	Customer Supplied- Borehole No. BH-01	**Sample Identification Number**	:	SS/GMC/072022/506/BH01
Sample Condition	:	Satisfactory	**Test Report No.**	:	GT-2410/BH-01
Test Method	:	As per Bureau of Indian Standards	**Report Date**	:	05/08/2022
Sample Receipt Date	:	25/07/2022	**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)												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	SPECIFIC GRAVITY AS PER IS 2720 (P-III, SEC-1) - 1980, RA-2010	GRAIN SIZE ANALYSIS AS PER IS 2720 (P-IV) - 1985, RA-2015						D_{10} (mm)	D_{30}(mm)	D_{60} (mm)	Uniformity Co-Efficient $C_U=D_{60}/D_{10}$	Co-Efficient of Curvature $C_c=D_{30}^2/(D_{10}xD_{60})$	Relative Density		
													Gravel (%)	Coarse (%)	Medium (%)	Fine (%)	Silt (%)	Clay (%)							Gravel	Sand
1.0	11	SS	31.0	50.2	27.5	22.7	0.8	12.9	27.3	Stiff	Above	CH	-	-	-	-	-	69.5	30.5	-	-	-	-	-	FG>50%	FG>50%	FG>50%
3.0	68	SS	31.0	43.5	24.2	19.2	0.7	12.9	25.0	CG>50%	Above	-	-	4.16	15.62	33.78	12.32	27.0	7.1	-	-	-	-	-	V.Dense		
4.0	>100	SS	Clay Binder						20.0	CG>50%	Above	-	-	0	4.862	28.44	40.59	26.1		-	-	-	-	-	V.Dense		
5.0	>100	WS	-	-	-	-	-	-	-	CG>50%	-	-	-	62.39	18.54	14.96	3.54	0.6		-	-	-	-	-	V.Dense		
6.0	>100	WS	-	-	-	-	-	-	-	CG>50%	-	-	-	85.78	7.57	3.4	1.34	1.9		-	-	-	-	-	V.Dense		
7.5	>100	WS	-	-	-	-	-	-	-	CG>50%	-	-	-	16.94	29.76	49.34	3.84	0.1		-	-	-	-	-	V.Dense		
9.0	>100	WS	-	-	-	-	-	-	-	CG>50%	-	-	-	22.46	26.12	48.4	3.01	0.0		-	-	-	-	-	V.Dense		
10.5	>100	WS	-	-	-	-	-	-	-	CG>50%	-	-	-	39.04	26.79	30.93	2.97	0.3		-	-	-	-	-	V.Dense		
12.0	>100	WS	-	-	-	-	-	-	-	CG>50%	-	-	-	42.2	27.1	28.1	2.62	0.0		-	-	-	-	-	V.Dense		

Residual Soil to Completely Weathered Rock

**** 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

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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 SRI KAUSALYA CONSTRUCTIONS LIMITED**	**Customer Reference**	:	By Email
Sample Description	:	Soil Sample	**Period of Testing**	:	29/07/2022 to 05/08/2022
Source of Sample	:	Customer Supplied- Borehole No. BH-02	**Sample Identification Number**	:	SS/GMC/072022/506/BH02
Sample Condition	:	Satisfactory	**Test Report No.**	:	GT-2410/BH-02
Test Method	:	As per Bureau of Indian Standards	**Report Date**	:	05/08/2022
Sample Receipt Date	:	28/07/2022	**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	SPECIFIC GRAVITY AS PER IS 2720 (P-III, SEC-1) - 1980, RA-2010	GRAIN SIZE ANALYSIS AS PER IS 2720 (P-IV) - 1985, RA-2015						D_{10} (mm)	D_{30}(mm)	D_{60} (mm)	Uniformity Co-Efficient $C_U=D_{60}/D_{10}$	Co-Efficient of Curvature $C_c=D_{30}^2/(D_{10}xD_{60})$	Relative Density	IS-Notation	
													Gravel (%)	Coarse (%)	Medium (%)	Fine (%)	Silt (%)	Clay (%)							Gravel	Sand
1.0	5	SS	37.6	61.4	28.0	33.4	0.7	10.8	33.3	M.Stiff	Above	CH	-	-	-	-	-	64.8	35.2	-	-	-	-	-	FG>50%	FG>50%	FG>50%
2.0	18	SS	26.6	58.4	28.8	29.6	1.1	11.5	14.3	V.Stiff	Above	CH	-	-	-	-	-	100.0		-	-	-	-	-	FG>50%	FG>50%	FG>50%
4.0	>100	SS	25.5	34.1	23.3	10.8	0.8	12.9	8.3	CG>50%	Above	-	-	4.28	4.02	22.18	25.58	38.6	5.3	-	-	-	-	-	V.Dense		
5.0	>100	SS	-	-	-	-	-	-	-	CG>50%	-	-	-	21.68	13.08	26.62	21.26	17.4		-	-	-	-	-	V.Dense		
6.0	>100	WS	-	-	-	-	-	-	-	CG>50%	-	-	-	42.93	28.25	26.01	2.24	0.6		-	-	-	-	-	V.Dense		
7.5	>100	WS	-	-	-	-	-	-	-	CG>50%	-	-	-	36.64	28.9	32.12	2.36	0.0		-	-	-	-	-	V.Dense	Residual Soil to Completely Weathered Rock	
9.0	>100	WS	-	-	-	-	-	-	-	CG>50%	-	-	-	14.85	29.79	49.32	5.04	1.0		-	-	-	-	-	V.Dense		
10.5	>100	WS	-	-	-	-	-	-	-	CG>50%	-	-	-	17.89	16.89	56.94	6.89	1.4		-	-	-	-	-	V.Dense		
12.0	>100	WS	-	-	-	-	-	-	-	CG>50%	-	-	-	26.84	28.64	42.13	2.35	0.0		-	-	-	-	-	V.Dense		
13.5	>100	WS	-	-	-	-	-	-	-	CG>50%	-	-	-	22.34	27.22	46.42	4.04	0.0		-	-	-	-	-	V.Dense		

**** END OF REPORT****

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Authorised Signatory

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GEO MARINE CONSULTANTS PVT. LTD. Chennai 600 041

Table-2.3 Results of Chemical Analysis

SL No.	Bore HoleNo.	Water				Soil (2:1)			
		Depth of Sample (m)	pH	Chlorides (ppm)	Sulphates (ppm)	Depth of Sample (m)	pH	Chlorides (ppm)	Sulphates (ppm)
1.0	BH-01	2.30	7.29	136.1	363.0	3.0	7.71	22.7	331.2
2.0	BH-02	2.50	7.23	125.5	328.4	1.0	7.38	27.2	480.6

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CHAPTER-3

GEOLOGY & SUB-SURFACE STRATIFICATION

3.0 PREAMBLE:

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

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

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

3.1 CLIMATE AND RAINFALL:

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

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

3.2 GEOMORPHOLOGY:

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

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

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

3.3 GEOLOGY OF CHENNAI DISTRICT:

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

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

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

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3.4 GEOLOGICAL ORDER OF THE STUDY AREA:

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

Deposits of Recent Age

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

Archaean Basement Rock (Charnockite Rock / Hypersthene Granite)

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

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

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

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

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REFERENCE BORE HOLE					BH-01	Ref R.L. of G.L. (m):			0.00		
Layer No.	Layer Thk. (m)			Type of Strata	Colour	Ave. Design SPT	Relative Density	Consistency	(γ) kN/m³	Shear Parameters	
	Top BGL	Bottom BGL	Thickness							(C_u) kPa	(ϕ) Deg.
1.0	0.00	3.20	3.20	Silty Clay	Brown	11	-	Stiff	18	73	-
2.0	3.20	4.00	0.80	Residual Soil	Brown Grey	68	Very Dense	-	21	-	42.5
3.0	4.00	13.50	9.50	Completely Weathered Rock	Brown Grey	>100	Very Dense	-	21	-	42.5
4.0	13.50	15.00	1.50	Highly Weathered Rock	Grey,Grey Brown	CRR-10%, RQD-0%					

REFERENCE BORE HOLE					BH-02	Ref R.L. of G.L. (m):			0.00		
Layer No.	Layer Thk. (m)			Type of Strata	Colour	Ave. Design SPT	Relative Density	Consistency	(γ) kN/m³	Shear Parameters	
	Top BGL	Bottom BGL	Thickness							(C_u) kPa	(ϕ) Deg.
1.0	0.00	2.00	2.00	Silty Clay	Brown	5	-	Medium Stiff	15	33	-
2.0	2.00	4.00	2.00	Silty Clay	Brown	18	-	Very Stiff	20	120	-
3.0	4.00	5.00	1.00	Residual Soil	Brown Grey	>100	Very Dense	-	21	-	42.5
4.0	5.00	15.00	10.00	Completely Weathered Rock	Grey Brown	>100	Very Dense	-	21	-	42.5

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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, Colluvial and Aeolian deposits.

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FORMATION CHARACTERISTICS:

In the project location, the sub soil formation based on the investigation location consists of two layers of stratification and the same is presented below:

Layer-I: Layer-I is Silty Clay formation of consistency varying from Medium Stiff to Very Stiff and the layer thickness is 3.5m from the existing ground level

Layer-II: Weathered Rock Formation with degree of weathering varies form W5 (Residual Soil/ Completely Weathered Rock) to Grade W4 (Highly Weathered Rock Formation)

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.

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.

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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
$8\frac{1}{2}$	0.89

TABLE-4.1 MAGNITUDE CORRECTION FACTORS FOR CYCLIC STRESS APPROACH

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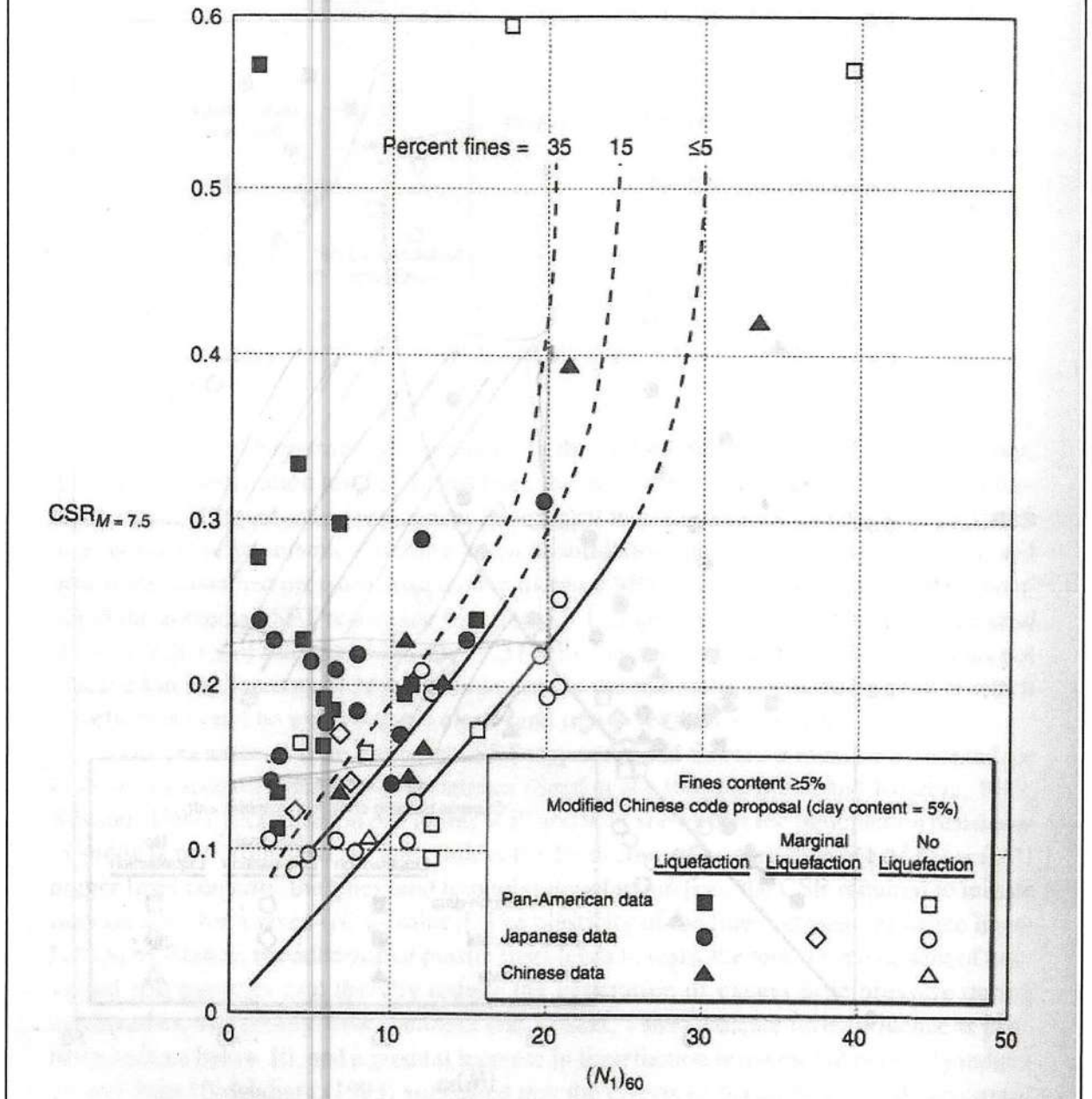


Figure 9.31 Relationship between cyclic stress ratios causing liquefaction and $(N_1)_{60}$ values for silty sands in $M = 7.5$ earthquakes. (After Seed et al. (1975). Influence of SPT procedures in soil liquefaction resistance evaluations, *Journal of Geotechnical Engineering*, Vol. 111, No. 12. Reprinted 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 Medium Stiff to Very Stiff, Clay followed by dense to very dense formation from the existing ground level the formation is not susceptible to liquefaction as per Zone-III seismic intensity.***

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FOUNDATION SYSTEM

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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 one basement + five upper floors, and is meant for commercial (IT/ITES) occupancy. For this kind of structure, the column loads could vary between 3000kN to 4000kN.

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 SOIL FORMATION:

The sub soil formation in the study location is generalized into three layer of stratification:

0.0m to 3.5m	Medium Stiff Followed by Very Stiff, Silty Clay
3.5m to 5.0m	Very Dense, Residual Soil
5.0m to 15.0m	Very Dense, Completely to Highly Weathered Rock Formation (Grade W5 to Grade W4)

5.3 FOUNDATION SYSTEM:

For the kind of proposed commercial building with one basement floor, the clear height is considered as 3.5m below the existing ground level.

LOAD TRANSFER THROUGH BEARING STRATUM AND FOUNDATION SETTLEMENT:

The bearing stratum at 4.5m and beyond is predominantly completely weathered rock and it is modelled as coarse grain soil (very dense granular soil). Since the bearing stratum is rock formation and initial elastic settlement governs the settlement criteria.

FOUNDATION SYSTEM:

For the kind of configuration of proposed structure and the sub soil condition, either isolated column footings or raft foundation system are suitable for effective load transfer to the bearing stratum.

Table 5.1 presents the allowable net safe bearing pressure for different sizes of footing. All the footing shall rest on 100mm thick M10 levelling coarse bed or P.C.C

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In case of raft the allowable net safe bearing pressure is 750 kPa. Adopt Modulus of Sub grade value, of k_s 1,50,000 kN/m²/m for soil structure interaction analysis.

Typical computation is presented in the Annexure-I

TABLE 5.1 RECOMMENDED ALLOWABLE NET SAFE BEARING PRESSURE

DEPTH OF BASEMENT FLOOR BELOW EGL (m)	FOUNDATION THICKNESS/ EMBEDMENT DEPTH (m)	OVERALL DEPTH OF EXCAVATION (m)	WIDTH OF FOUNDATION (m)	ALLOWABLE NET SAFE BEARING PRESSURE (kPa)	ELASTIC SETTLEMENT (mm)
3.5	1.0	4.5	1.0	450	2.53
			2.0	500	5.61
			3.0	600	10.1
			4.0	750	16.84
			5.0	750	21.05
			6.0	750	25.26

5.4 EXCAVATION & EXCAVATABILITY:

The top 3.0m is medium stiff to very stiff clay and stands vertically as 3.0m falls in tension zone. However, for practical consideration adopt a minimum slope of 1 Horizontal : 3 Vertical to withstand all weather condition. Cover the exposed cut slope with HDPE sheet duly anchored at top and toe with 1.0m wide PCC of 75mm thickness.

5.5 DEWATERING/ GROUND WATER LOWERING DESIGN:

Adopt open pit dewatering system in case, water seepage takes place during excavation.

5.6 BASEMENT FLOOR UPLIFT DESIGN:

The top 3.0m clay formation acts as a impervious layer hence, for design of uplift consider ground water table at 3.0m below the existing ground as a critical condition.

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RECOMMENDATIONS

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CHAPTER-6

RECOMMENDATIONS

- For the kind of proposed construction open foundation system of either isolated column footing or RCC raft foundation can be adopted.
- In case of isolated column footings, for different sizes of footing the allowable net safe bearing is presented in Table 5.1.
- In case of raft foundation is adopted, the raft can be designed for an allowable net safe bearing pressure of 750 kPa. For the design of raft the recommended modulus of sub grade reaction beyond 4.5m depth (k_s) is 1,50,000 kN/m^3.

RECOMMENDATION FOR EXCAVATION & GROUNDWATER LOWERING:

- For the proposed excavation, open/vertical cut can be adopted. However it is recommended to adopt a minimum slope of 1Horizontal: 3 Vertical.
- It is suggested to cover the slope with 1000 micron HDPE sheet duly anchored in the top and toe with 1.0m wide PCC of 75mm thickness.
- For lowering the ground water, conventional collection pit pumping system, with water training shallow ditches connecting the collection pit at the bottom of excavation in case of seepage is observed during the course of excavation.

GENERAL RECOMMENDATIONS:

- 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 steel 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 is suitable for the construction.
- The present project site fall in seismic zone-III as per IS 1893-P-I and based on the liquefaction analysis the sub soil formation exists at site is non-liquefiable considering the zone-III seismic intensity.

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AUTHORISED SIGNATORY

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DR. C. V. PRASAD
GEOMARINE CONSULTANTS PRIVATE LIMITED

ANNEXURE-I

GEO MARINE CONSULTANTS PVT. LTD. Chennai 600 041

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TYPICAL BEARING CAPACITY COMPUTATIONS FOR SHALLOW FOUNDATIONS

1.0 COMPUTATION OF BEARING CAPACITY AS PER IS:6403

Reference Borehole No. **BH-02**

1.1 Geometrical Data

Shape of the Foundation	Sqaure
Depth of One Basement floor Height Below EGL (m):	3.50
Assumed Thickness of Foundation or Depth of Embedment (m):	1.00
The over all foundation excavation depth below EGL (m):	4.50
Breadth of Footing "B" (m):	1.00
Length of Footing "L" (m):	1.00
L/B:	1.00
Inclination of Vertical Load with the Vertical (a)	0.00

1.2 Soil Data

Type of Effective Bearing Strata :	Residual Soil
Average SPT "N" of the bearing strata located beyond 4.0m below EGL:	>100
Design SPT-value of the Bearing Strata :	50.00
Type of Shear Failure:	General
Angle of Shearing Resistance	41.00

1.3 Design Parameters

Bulk Density of Soil above the foundation depth (g_{bulk})	18.00
Effective Overburden pressure at foundation level (q)	8.00
Water Table Correction Factor (w')	0.50
Bearing Capacity Factors:	
N_c =	N/A
N_q =	78.34
N_g =	141.88
Shape Factors:	
S_c =	-
S_q =	1.20
S_g =	0.60
Depth Factors :	
D_c =	-
D_q =	1.02
D_g =	1.02
Inclination Factor:	
I_c =	1.00
I_q =	1.00
I_g =	1.00

1.4 Ultimate Bearing Capacity (Qu)

Qu=q'(Nq-1)*Sq*Dq*Iq + 0.5*B*g*Ng*Sg*Dg*Ig*w' **1153.05 kPa**
(g should be read as gama)

1.5 Safe Bearing Capacity (Qsafe) :

Factor of Safety (FOS) :	2.50
Qsafe :	461.22 kPa
However limit Q_{safe}	**450 kPa**

2.0 Computation of Settlement for Maximum Pressure and Size of Footing: (as per IS:8009-Part-I-Ref. Eq.11) (Elastic Analysis)

Type of compressible strata	Completely Weathered Rock
Immediate Settlement (S_i)=	$qB(1-m^2)*I/E_s$
Bearing Capacity (q)	450.00
Poission's Ratio (μ)	0.20
Modulus of Elasticity (E_s)(Ref. Joseph E Bowels,1996,page316,Table5.6, Japanese design standards)	
Modulus of Elasticity (E_s)	130000
Size of footing/Raft considered for maximum settlement(m)	1.00
Influence factor	0.95
Rigidity Factor	0.80
Elastic Settlement (DH_i)	2.53 mm
	<75 mm

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THE SPIRIT OF ENGINEERING

TYPICAL BEARING CAPACITY COMPUTATIONS FOR SHALLOW FOUNDATIONS

1.0 COMPUTATION OF BEARING CAPACITY AS PER IS:6403

Reference Borehole No. **BH-02**

1.1 Geometrical Data

Shape of the Foundation	Raft
Depth of One Basement floor Height Below EGL (m):	3.50
Assumed Thickness of Foundation or Depth of Embedment (m):	1.00
The over all foundation excavation depth below EGL (m):	4.50
Breadth of Footing "B" (m):	10.00
Length of Footing "L" (m):	10.00
L/B:	1.00
Inclination of Vertical Load with the Vertical (a)	0.00

1.2 Soil Data

Type of Effective Bearing Strata :	Residual Soil
Average SPT "N" of the bearing strata located beyond 4.0m below EGL:	>100
Design SPT-value of the Bearing Strata :	50.00
Type of Shear Failure:	General
Angle of Shearing Resistance	41.00

1.3 Design Parameters

Bulk Density of Soil above the foundation depth (g_{bulk})	18.00
Effective Overburden pressure at foundation level (q)	8.00
Water Table Correction Factor (w')	0.50
Bearing Capacity Factors:	
N_c =	N/A
N_q =	78.34
N_g =	141.88
Shape Factors:	
S_c =	-
S_q =	1.20
S_g =	0.60
Depth Factors :	
D_c =	-
D_q =	1.00
D_g =	1.00
Inclination Factor:	
I_c =	1.00
I_q =	1.00
I_g =	1.00

1.4 Ultimate Bearing Capacity (Qu)

Qu=q*(Nq-1)*Sq*Dq*Iq + 0.5*B*g*Ng*Sg*Dg*Ig*w' **4584.38 kPa**
(g should be read as gama)

1.5 Safe Bearing Capacity (Qsafe) :

Factor of Safety (FOS) :	2.50
Qsafe :	1833.75 kPa
However limit Q_{safe}	**750 kPa**

2.0 Computation of Settlement for Maximum Pressure and Size of Footing: (as per IS:8009-Part-I-Ref. Eq.11) (Elastic Analysis)

Type of compressible strata	Completely Weathered Rock
Immediate Settlement (S_i)=	$qB(1-m^2)*I/E_s$
Bearing Capacity (q)	750.00
Poission's Ratio (μ)	0.20
Modulus of Elasticity (E_s)(Ref. Joseph E Bowels,1996,page316,Table5.6, Japanese design standards)	
Modulus of Elasticity (E_s)	130000
Size of footing/Raft considered for maximum settlement(m)	10.00
Influence factor	0.95
Rigidity Factor	0.80
Elastic Settlement (DH_i)	42.09 mm
	<100 mm

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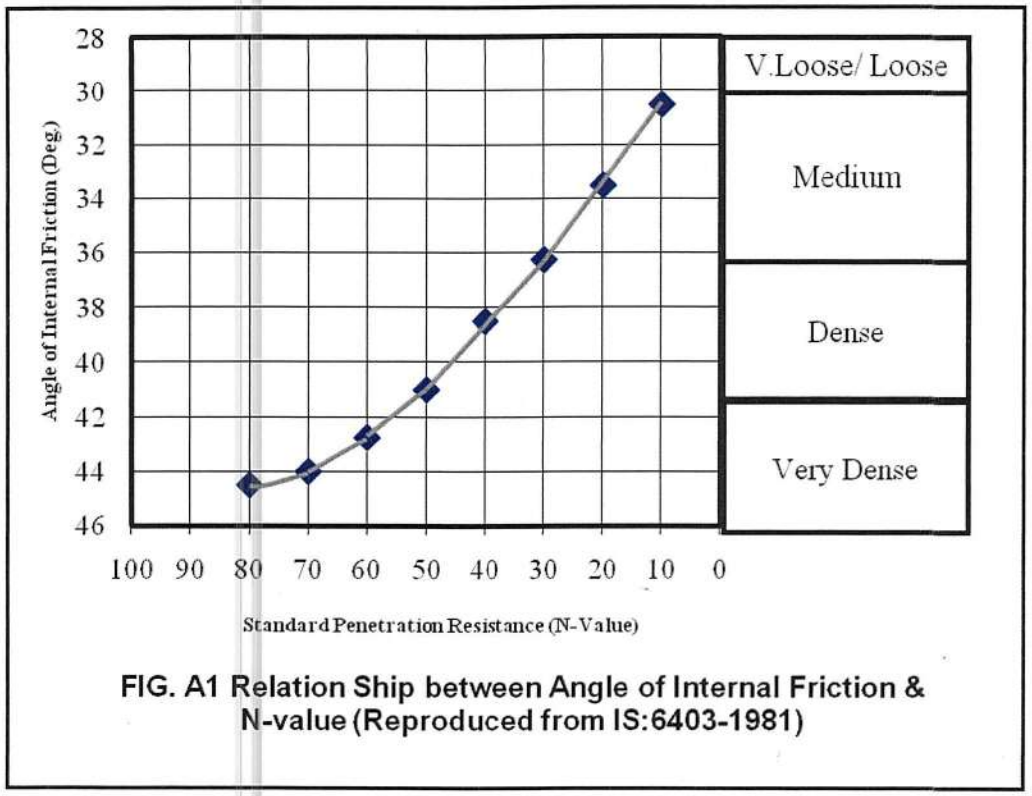


FIG. A1 Relation Ship between Angle of Internal Friction & N-value (Reproduced from IS:6403-1981)

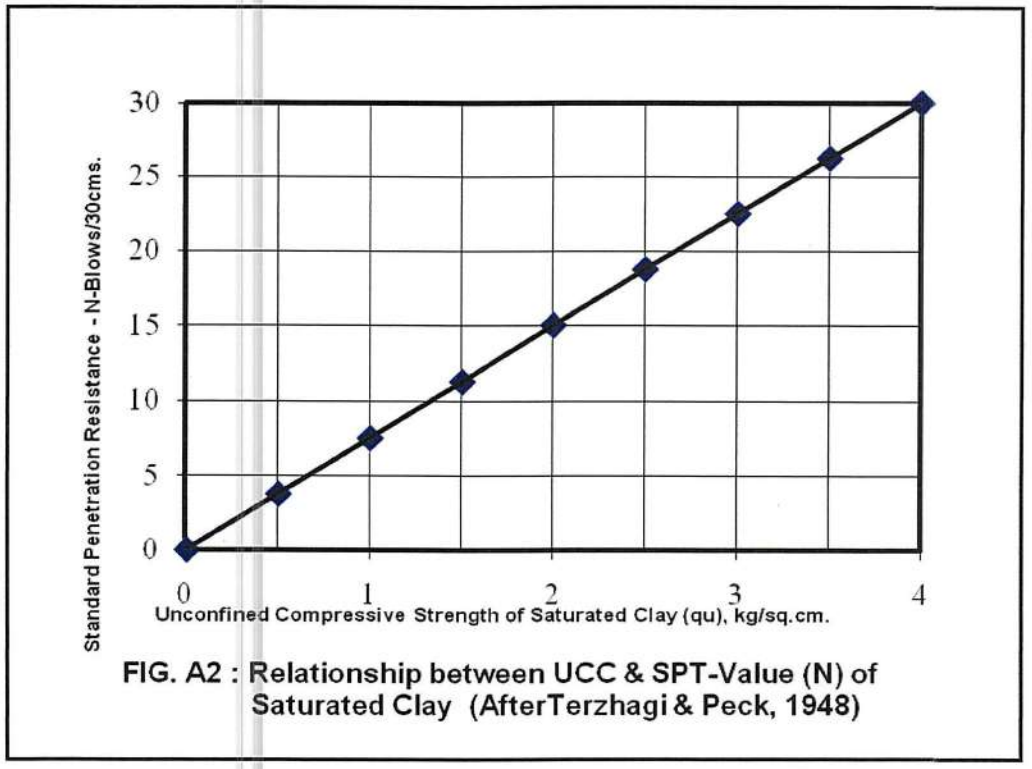


FIG. A2 : Relationship between UCC & SPT-Value (N) of Saturated Clay (AfterTerzhagi & Peck, 1948)

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ANNEXURE-II

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SITE INVESTIGATION RECORD

BORE HOLE No. 01
PAGE No. 01

PROJECT NAME: GUINDY - CHENNAI
DIA OF BORE HOLE: 150mm ✓ / 100mm
LOCATION:
MACHINE No.:
CHAINAGE (m):
BORE START DATE: 26/07/2022
STRUCTURE:
DRILLING METHOD: Rotary
CO-ORDINATES: N / E
BORE END DATE: 27/07/2022
JOB CODE:
FLUSHING MEDIUM: Bentonite
TOTAL DRILLING DAYS:

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	26/07/2022	15	00				4	5	6	11	1.0	1	S.S.	1.0	Brownish Medium Stiff clay
2		16	40				UDS				2.0	2	UDS	2.0	-DO-
3		9	00				8	33	35	68	3.0	3	SS.	3.0	-DO-
														3.20	
4		9	30												Brown, Grey Weathered Rock
		9	44				33	55	10cm / 50/4 N>100		4.0	4	SS	4.0	Brown, Grey Weathered Rock
5		10	05				Hammer Blow				5.05	WS		5.0	Brown, Grey Weathered Rock
		10	20				N>100								
6		10	30				Hammer Blow				6.06	WS		6.0	Brown, Grey Weathered Rock
		11	00				N>100								
7	27/07/2022	11	15												
		11	50				Hammer Blow				7.07	WS		7.50	Brown, Grey Weathered Rock
8							N>100								
9		12	05				Hammer Blow				9.08	WS		9.0	Brown, Grey Weathered Rock
		12	40				N>100								
0															

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CS - Core Sample	DS - Disturbed Sample	SUPERVISOR NAME	S. STEPHEN RAJ	PROJECT SITE DETAILS	
SS - Split Spoon Sample	SC - Soil Cutter	SIGNATURE		GROUND LEVEL (m)	
UDS-Undisturbed Sample	TCB - Tungsten Carbide Bit	DATE	27/07/2022	WATER TABLE (m)	2.30m
WS - Wash Sample	DB - Diamond Bit	CLIENT IN-CHARGE		CASING DEPTH (m)	

GEOMARINE
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SITE INVESTIGATION RECORD

BORE HOLE No.	01		
PAGE No.	01		
DIA OF BORE HOLE	150mm	✓	
	100mm		
BORE START DATE	26/07/2022		
BORE END DATE	27/07/2022		
TOTAL DRILLING DAYS			

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

Depth below E.G.L. (m)	Drilling progress per metre: Date	Time: Hr.	Time: Min	Type of Drill Bit (SC / TCB / DB)	Core Details: Total Core Recovery %	Core Details: R.Q.D %	SPT Details: Blows/cm. 0-15	SPT Details: Blows/cm. 15-30	SPT Details: Blows/cm. 30-45	SPT 'N' Value	Sample Details: Depth	Sample Details: No.	Sample Details: Type	Layer Data: Depth (m)	Geotechnical Description
1		14 00					Hammer Blow				1.00	9	WS	1.00	Brown, Gray Weathered Rock
		14 45					N > 100								
2		15 00					Hammer Blow				2.00	10	WS	2.00	— DO —
		15 45					N > 100								
3															
4		16 00									3.50	11	C.S.	3.50	Gray, Brown Weathered Rock (Broken Pieces Recorded)
		16 49													
5		17 00									4.50	12	C.S.	4.50	Gray Weathered Rock
		17 50			100	0									
6	Bore Hole Terminated at 5.00m Below the Ground Level														
7															
8															
9															
0															

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CS - Core Sample	DS - Disturbed Sample	SUPERVISOR NAME	S. STEPHENRAJ	PROJECT SITE DETAILS	
SS - Split Spoon Sample	SC - Soil Cutter	SIGNATURE		GROUND LEVEL (m)	
UDS-Undisturbed Sample	TCB - Tungsten Carbide Bit	DATE	29/07/2022	WATER TABLE (m)	2.30 m
WS - Wash Sample	DB - Diamond Bit	CLIENT IN-CHARGE		CASING DEPTH (m)	

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SITE INVESTIGATION RECORD

BORE HOLE No. 02
PAGE No. 01
DIA OF BORE HOLE 150mm ✓ / 100mm
BORE START DATE 23/07/2022
BORE END DATE 25/07/2022
TOTAL DRILLING DAYS

PROJECT NAME: PROPOSED OFFICE BUILDING
LOCATION: GUINDY
STRUCTURE: BASEMENT + S
JOB CODE:
MACHINE No.:
DRILLING METHOD: Rotary
FLUSHING MEDIUM: Bentonite
CHAINAGE (m):
CO-ORDINATES: N / 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	Layer Data: Depth (m)	Geotechnical Description
1	23/07/2022	14	30	SC			2	2	3	5	1.0	1	S.S.	1.0	BROWNISH MEDIUM STIFF CLAY
		14	35												
2		16	00	SC			6	7	11	18	2.0	2	S.S.	2.0	BROWNISH STIFF CLAY
		16	10												
3		17	30	SC			U	D	S		3.0	3	UDS	3.0	
		17	40												
4		9	00	SC			15	55	5/7	NT/10	4.0	4	S.S.	4.0	Brown, Grey very dense sand with clay binder
		9	10												
5		9	40	SC			35	80/7 / 50/5		NT/10	5.0	5	S.S	5.0	Brown, Grey Soft Rock
		9	50												
6	25/07/2022	10	30	SC			Hammer Blow			6.0	6	W.S	6.0	Brown, Grey weathered Rock	
		10	45				N7/10								
7		11	00	DB							7.50				
		11	30				Hammer Blow					7	WS	7.50	
8							N7/10.								
9		11	45	DB							9.0	8	WS.	9.0	
		12	17				Hammer Blow								
0							N7/10								

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				PROJECT SITE DETAILS	
CS - Core Sample	DS - Disturbed Sample	SUPERVISOR NAME	S. STEPHENRAJ	GROUND LEVEL (m)	
SS - Split Spoon Sample	SC - Soil Cutter	SIGNATURE		WATER TABLE (m)	
UDS-Undisturbed Sample	TCB - Tungsten Carbide Bit	DATE	25/07/2022	CASING DEPTH (m)	
WS - Wash Sample	DB - Diamond Bit	CLIENT IN-CHARGE			

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SITE INVESTIGATION RECORD

BORE HOLE No. 02
PAGE No. 02

PROJECT NAME: PROPOSED OFFICE BUILDING AT
DIA OF BORE HOLE: 150mm ✓ / 100mm

LOCATION: GUINDY | MACHINE No. | CHAINAGE (m) | BORE START DATE: 23/07/2022
STRUCTURE | DRILLING METHOD: Rotary | CO-ORDINATES N | BORE END DATE: 25/07/2022
JOB CODE | FLUSHING MEDIUM: Bentonite | E | TOTAL DRILLING DAYS

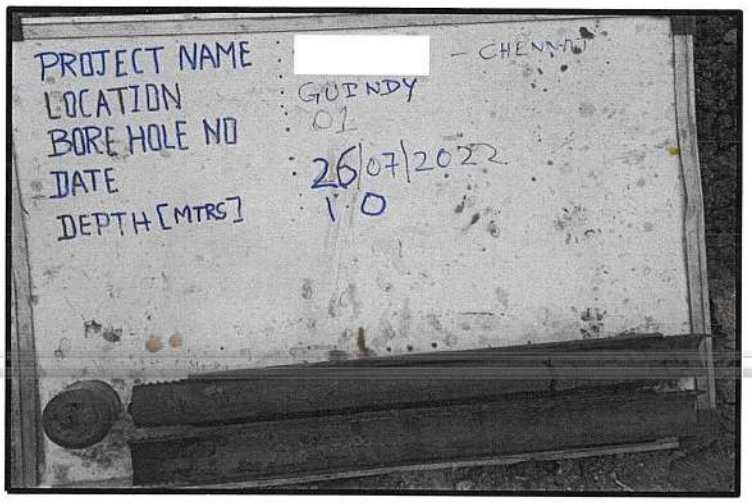
Depth below E.G.L. (m)	Drilling progress per metre: Date	Time: Hr.	Time: Min	Type of Drill Bit (SC / TCB / DB)	Core Details: Total Core Recovery %	Core Details: R.Q.D %	SPT Details: Blows/cm. 0-15	15-30	30-45	SPT 'N' Value	Sample Details: Depth	No.	Type	Layer Data: Depth (m)	Geotechnical Description
1		12	30				Hammer blows N > 100				10.50	9	W.S	10.50	Brown, Grey Weathered Rock
		13	05												
2		14	00				Hammer Rebound (R)				12.00	10	W.S	12.0	Brown, Grey Weathered Rock
		14	26												
3		15	00												
4		15	35				Hammer blows N > 100				13.50	11	W.S	13.50	———
5		16	00				Hammer blows N > 100				15.0	12	W.S. C.S.	15.0	Grey & weathered Rock (Broken pieces Recovered)
		16	45												
6															
7															
8															
9															
0															

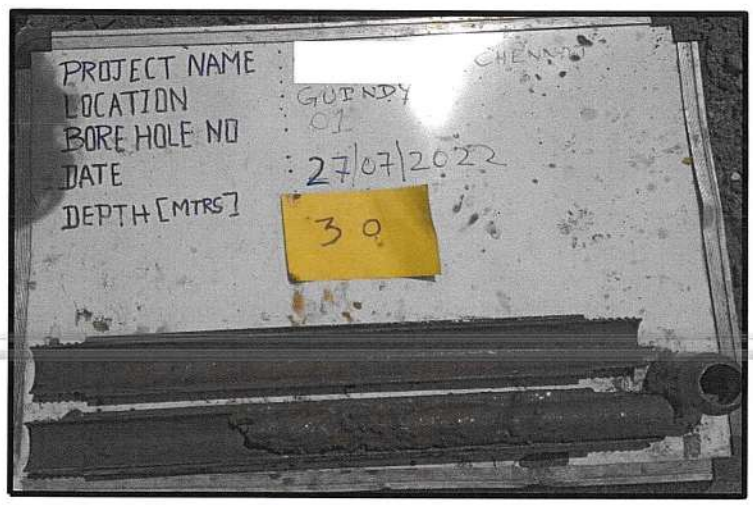
Bore Hole Terminated at 15.0m Below the Ground Level

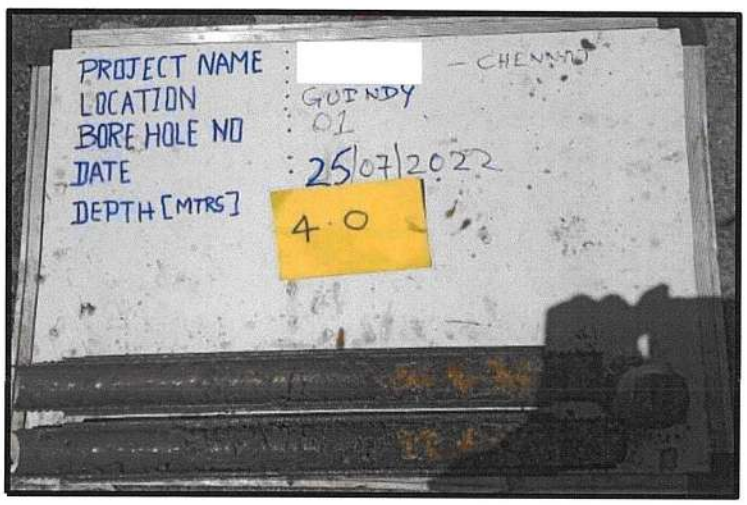
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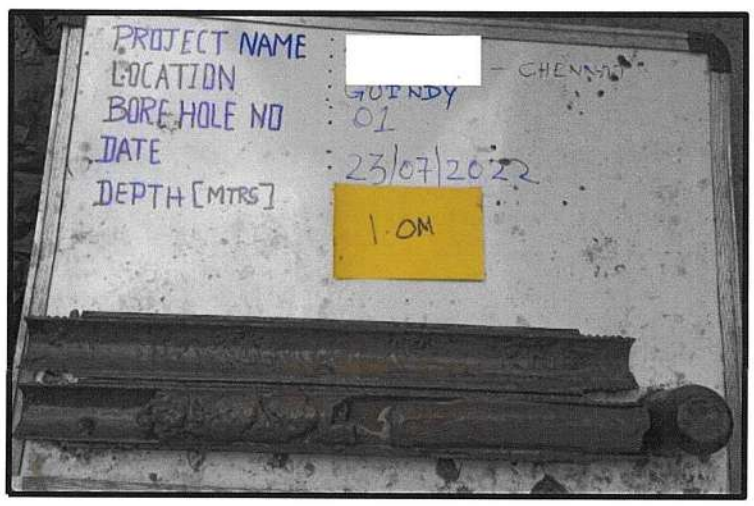
CS - Core Sample	DS - Disturbed Sample	SUPERVISOR NAME	S. STEPHEN RAJ	PROJECT SITE DETAILS
SS - Split Spoon Sample	SC - Soil Cutter	SIGNATURE		GROUND LEVEL (m)
UDS-Undisturbed Sample	TCB - Tungsten Carbide Bit	DATE	25/07/2022	WATER TABLE (m)
WS - Wash Sample	DB - Diamond Bit	CLIENT IN-CHARGE		CASING DEPTH (m)

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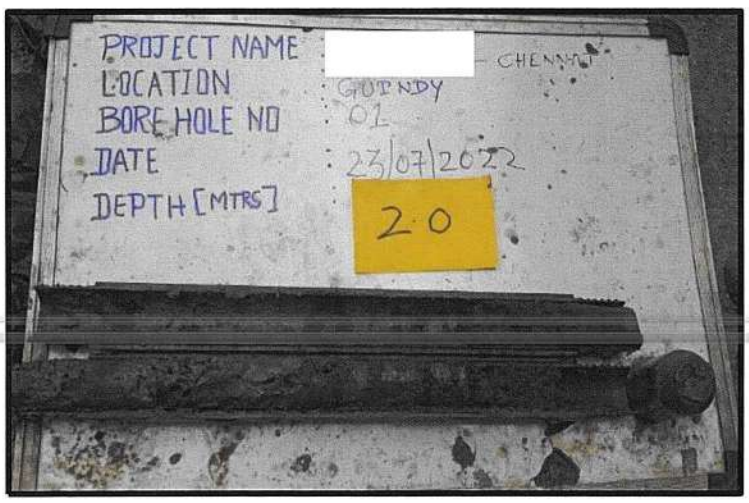


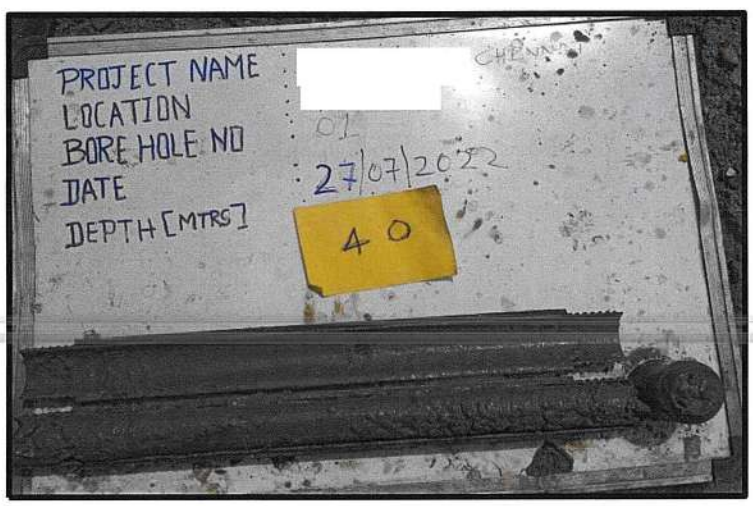


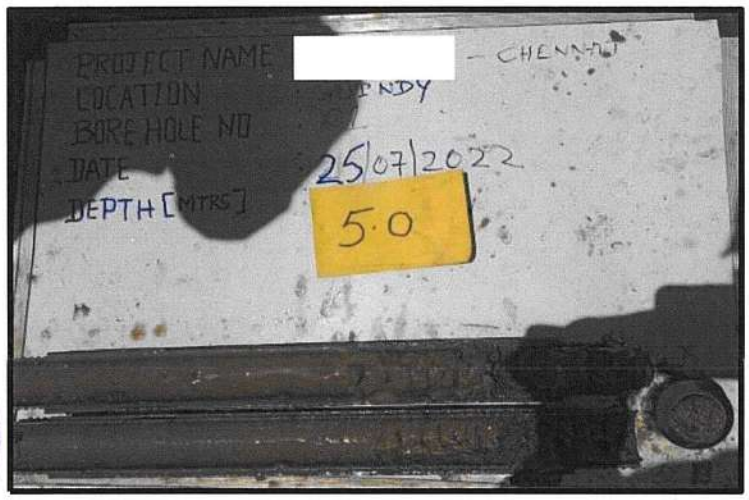


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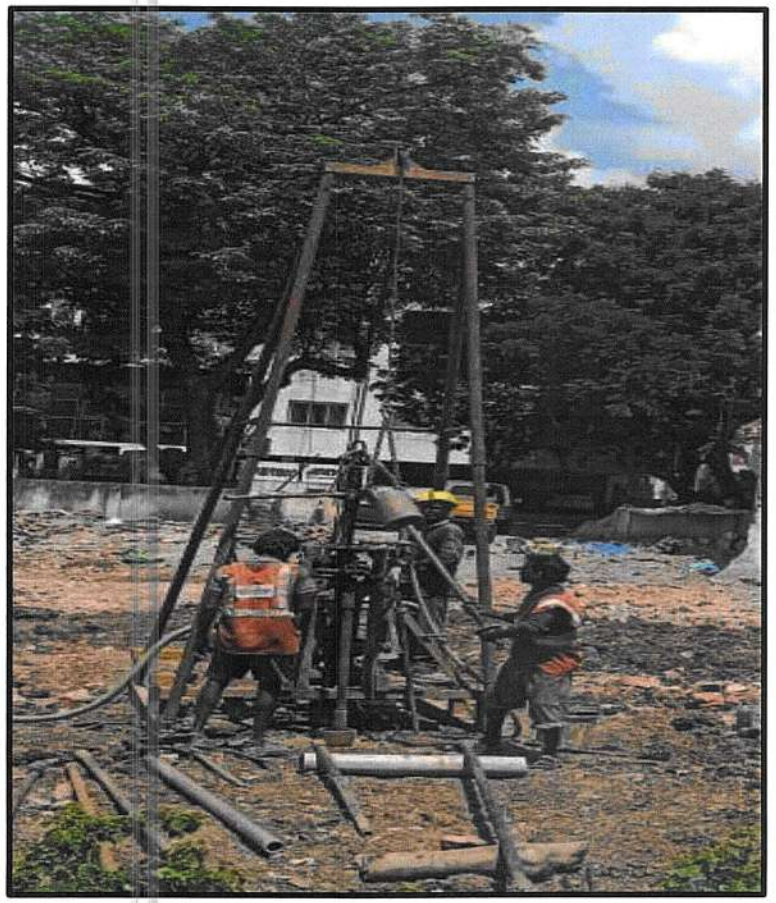




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Our services go beyond

Buying & Selling Services

Property Buying Assistance, Property Selling Support, Market Price Analysis, Owner Outreach and Negotiation.

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.

Smarter Tools, Stronger Decisions

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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