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(An ISO 9001:2015 Certified Company)
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PROJECT

PROPOSED CONSTRUCTION OF RESIDENTIAL APARTMENT BUILDING (STILT+5 UPPER FLOORS) AT OLD DOOR NO.54, NEW DOOR NO.14 & 16, BHEEMANNA MUDALI GARDEN STREET, ALWARPET, CHENNAI – 600 018.

CLIENT

SRESHTA SUMANTH BUILDERS PVT. LTD.,
NO.8 (57), LUZ AVENUE,
MYLAPORE,
CHENNAI-600 004.

TITLE

GEOTECHNICAL INVESTIGATION REPORT

PROJECT NO: GEC-JC-GT-512/2023-2024

DATE: 31/05/2023

GEO ENGINEERING CONSULTANTS
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REPORT TEXT

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CHAPTER-1

INTRODUCTION

1.0 Project Information Matrix

Nature of project	: Proposed Residential building (Stilt + 5 Upper Floors)
Project Client	: **M/s Sreshta Sumanth Builders Pvt. Ltd.,**
Project Location	:Old Door No.54, New Door No.14 & 16, Bheemanna Mudali Garden Street, ALWARPET, Chennai.-600018
Job Code	: JC-GT-5012

1.1 Scope Of Work

1.1.1 Field Work

- Conducting two soil investigation bore holes of 150 mm & NX diameter up to 26.0m depth or up to the refusal strata with SPT>100
- Conducting Standard Penetration Test (SPT) within the borehole at every 1.0m depth interval up to 5.0m and thereafter at every 1.5m interval up to 20.0m after that 2.0m interval up to the termination depth
- Collection of soil samples 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
- 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
- Geology &Sub-Surface Stratification
- 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.

2.1.4 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.

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.

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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-2.1to 2.2. The graphical representation of grain size distribution curve for the representative samples in each bore is presented in Fig. 2.3 to 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 to 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.2.1to 2.2.

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SOIL PROFILE

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SITE INVESTIGATION RECORD

BORE HOLE No.	BH-01						
SHEET	1	OF	3				
PROJECT NAME	Old No,54 New No14&16 Bheemanna Mudali Garden St, Alwarpet chennai-18			DIA OF BORE HOLE	150mm ✓ / NX		
LOCATION	Alwarpet Chennai	MACHINE No.	CR-01	CHAINAGE (m)	-	BORE START DATE	22/05/2023
STRUCTURE	Still +5 Upper Floors	DRILLING METHOD	Rotary	CO-ORDINATES	N -	BORE END DATE	23/05/2023
JOB CODE	GEC-JC-GT-5012	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
0		16	10													L1	0.5	**Filled Up Soil** (Sand and Concrete)
		To		SC	-	-												
		16	11															
1		16	21				3	5	5	10	1.00	1	SS	-1.0				Brown, Moist, Loose, Poorly Graded, **Clayey Silty SAND (SC)** Sand -Clay Mixture
		To		SC	-	-					1.45							
		16	22													L2	2.0	
2		16	32				2	3	3	6	2.00	2	SS	-2.0				
		To		SC	-	-					2.45							Brown, Moist, Medium Stiff, **Sandy Silty CLAY (CL),** Clays of Low Plasticity
		16	33													L3	3.0	
3		16	43				8	10	12	22	3.00	3	SS	-3.0				
		To		SC	-	-					3.45							
		16	44															
4		16	54				7	9	11	20	4.00	4	SS	-4.0				
		To		SC	-	-					4.45							
		16	55															
5	22/05/2023	17	05				6	12	13	25	5.00	5	SS	-5.0				Brown, Moist, Medium Dense, Poorly Graded, **Silty SAND (SM/SP-SM)** Sand-Silt Mixture
		To		SC	-	-					5.45							
		17	06															
6																		
							6	7	9	16	6.50	6	SS	-6.5				
		17	16								6.95							
7		To		SC	-	-										L4	7.0	
		17	17															
8		17	16				1	1	1	2	8.00	7	SS	-8.0				Greyish Black, Moist, Very Soft, **Silty CLAY (CI),** Clays of Medium Plasticity
		To		SC	-	-					8.45							
		17	17															
9																L5	9.5	
							1	1	1	2	9.50	8	SS	-9.5				
											9.95							
10																		Greyish Black, Moist, Very Loose, Poorly Graded, **Clayey Silty SAND (SC),** Sand Clay Mixture

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CS - Core Sample	DS - Disturbed Sample	LOGGED	N.PANDIARAJAN	PROJECT SITE DETAILS	REMARKS
SS - Split Spoon Sample	SC - Soil Cutter	DATE	22/05/2023	GROUND LEVEL (m) 0.00	
UDS- Undisturbed Sample	TCB - Tungsten Carbide Bit	CHECKED	JALEEL YASIN	WATER TABLE (m) 2.00	
WS - Wash Sample	DB - Diamond Bit	DATE	28/05/2023	CASING DEPTH (m) 0.00	

SITE INVESTIGATION RECORD

BORE HOLE No.	BH-01				
SHEET	2	OF	3		
PROJECT NAME	Old No,54 New No14&16 Bheemanna Mudali Garden St ,Alwarpet chennai-18			DIA OF BORE HOLE	150mm ✓ / NX
LOCATION	Alwarpet, Chennai	MACHINE No.	CR-01	CHAINAGE (m)	-
STRUCTURE	Still +5 Upper Floors	DRILLING METHOD	Rotary	CO-ORDINATES N	-
JOB CODE	GEC-JC-GT-5012	FLUSHING MEDIUM	Bentonite	CO-ORDINATES E	-
BORE START DATE	22/05/2023				
BORE END DATE	23/05/2023				
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)	Legend	Layer Data: No	Depth	Geotechnical Description
11	23/05/2023	08	30 To 31	SC	-	-	1	1	1	2	11.00 / 11.45	9	SS	-11.0		L6	11.0	Greyish Black, Moist, Very Loose, Poorly Graded, **Clayey Silty SAND (SC),** Sand - Clay Mixture
12		08	46 To 47	SC	-	-	1	1	1	2	12.50 / 12.95	10	SS	-12.5				Greyish Black, Moist, Very Soft, **Silty CLAY/Sandy CLAY (CI),** Clays of Medium Plasticity
13		09	02 To 05	SC	-	-												
14		09					1	1	2	3	14.00 / 14.45	11	SS	-14.0		L7	12.5	
15		09	20 To 25	SC	-	-	1	2	2	4	15.50 / 15.95	12	SS	-15.5				
16																		
17		09	45 To 52	SC	-	-	1	1	2	3	17.00 / 17.45	13	SS	-17.0				Blackish Grey, Moist, Soft, **Silty Clay (CH),** Silty Clay of High Plasticity
18		10	12 To 16	SC	-	-	1	2	1	3	18.50 / 18.95	14	SS	-18.5				
19																		
20		10	36 To 43	SC	-	-	6	10	12	22	20.00 / 20.45	15	SS	-20.0		L8	20.0	Greenish Grey, Moist, Medium Dense, Poorly Graded, **Clayey Silty SAND (SC)**

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CS - Core Sample	DS - Disturbed Sample	LOGGED	N.PANDIARAJAN	PROJECT SITE DETAILS	REMARKS
SS - Split Spoon Sample	SC - Soil Cutter	DATE	23/05/2023	GROUND LEVEL (m) 0.40	
UDS- Undisturbed Sample	TCB - Tungsten Carbide Bit	CHECKED	JALEEL YASIN	WATER TABLE (m) 2.00	
WS - Wash Sample	DB - Diamond Bit	DATE	28/05/2023	CASING DEPTH (m) 0.00	

SITE INVESTIGATION RECORD

BORE HOLE No.	BH-01		
SHEET	3	OF	3
PROJECT NAME	Old No,54 New No14&16 Bheemanna Mudali Garden St ,Alwarpet chennai-18	DIA OF BORE HOLE	150mm ✓ / NX
LOCATION	ALWARPET Chennai	MACHINE No.	CR-01
CHAINAGE (m)	-	BORE START DATE	22/05/2023
STRUCTURE	Still +5 Upper Floors	DRILLING METHOD	Rotary
CO-ORDINATES	N -	BORE END DATE	23/05/2023
JOB CODE	GEC-JC-GT-5012	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	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	23/05/2023	11	31	SC	-	-												Greenish Grey, Moist, Medium Dense, Poorly Graded, **Clayey Silty SAND (SC)** Sand-Clay Mixture
		To																
22		11	40				11	14	13	27	22.00	16	SS	-22.0				
											22.45							
23																L9	23.0	
		12	20	SC	-	-												Greenish Grey, Moist, Very Dense, Poorly Graded, **Clayey Silty SAND (SC)** Sand-Clay Mixture
		To							9cm Penet. Fo 50Blows									
24		12	26				11	24		>100	24.00	17	SS	-24.0				
											24.39					L10	24.4	
25																		Reddish Brown, Moist, Very Dense, **Completely Weathered Rock,** Descented from Charnockite
		13	10	SC	-	-												
		To																
26		13	15				SPT Hammer Rebounded			>100	26.00	18	WS	-26.0		L11	26.0	
27																		
28																		
29																		
30																		

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CS - Core Sample	DS - Disturbed Sample	LOGGED	N.PANDIARAJAN	PROJECT SITE DETAILS	REMARKS
SS - Split Spoon Sample	SC - Soil Cutter	DATE	23/05/2023	GROUND LEVEL (m) 0.00	
UDS- Undisturbed Sample	TCB - Tungsten Carbide Bit	CHECKED	JALEEL YASIN	WATER TABLE (m) 2.00	
WS - Wash Sample	DB - Diamond Bit	DATE	28/05/2023	CASING DEPTH (m) 0.00	

Borehole terminated at 26 m depth below E.G.L

FIG.2.1 Sub Soil Profile at BH-01 Location

SITE INVESTIGATION RECORD

BORE HOLE No.	BH-02						
SHEET	1	OF	3				
PROJECT NAME	Old No,54 New No14&16 Bheemanna Mudali Garden St ,Alwarpet chennai-18			DIA OF BORE HOLE	150mm / NX	✓	
LOCATION	ALWARPET, Chennai	MACHINE No.	CR-01	CHAINAGE (m)	-	BORE START DATE	23/05/2023
STRUCTURE	Still +5 Upper Floors	DRILLING METHOD	Rotary	CO-ORDINATES N	-	BORE END DATE	24/05/2023
JOB CODE	GEC-JC-GT-5012	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
0		17	15													L1	0.5	**Filled Up Soil** (Sand, Concrete and Brick Waste)
		To		SC	-	-												
		17	16															
1	23/05/2023						2	3	3	6	1.00	1	SS	-1.0				
		17	26								1.45							
		To		SC	-	-												Brown, Moist, Loose, Poorly Graded, **Clayey Silty SAND (SC)** Sand-Clay Mixture
		17	27															
2							3	4	5	9	2.00	2	SS	-2.0				
		06	40								2.45							
		To		SC	-	-												
		06	41															
3							4	10	14	24	3.00	3	SS	-3.0		L2	3.0	
		06	51								3.45							
		To		SC	-	-												
		06	52															
4							7	10	13	23	4.00	4	SS	-4.0				
		07	02								4.45							
		To		SC	-	-												
		07	03															
5							9	10	11	21	5.00	5	SS	-5.0				
		07	13								5.45							Brown, Moist, Medium Dense, Poorly Graded, **Silty SAND (SM)** Sand-Silt Mixture
		To		SC	-	-												
		07	14															
6	24/05/2023						5	8	10	18	6.50	6	SS	-6.5				
		07	24								6.95							
7		To		SC	-	-										L3	7.0	
		07	26															
8							1	1	1	2	8.00	7	SS	-8.0				
		07	36								8.45							
		To		SC	-	-												
		07	38															
9																		Grey/Black, Moist, Very Soft, **Silty CLAY (CH)** Clay of Medium Plasticity
							1	1	1	2	9.50	8	SS	-9.5				
											9.95							
10																		

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CS - Core Sample	DS - Disturbed Sample	LOGGED	N.PANDIARAJAN	PROJECT SITE DETAILS		REMARKS
SS - Split Spoon Sample	SC - Soil Cutter	DATE	23/05/2023	GROUND LEVEL (m)	0.00	
UDS- Undisturbed Sample	TCB - Tungsten Carbide Bit	CHECKED	JALEEL YASIN	WATER TABLE (m)	2.00	
WS - Wash Sample	DB - Diamond Bit	DATE	28/05/2023	CASING DEPTH (m)	0.00	

SITE INVESTIGATION RECORD

BORE HOLE No.	BH-02						
SHEET	2	OF	3				
PROJECT NAME	Old No,54 New No14&16 Bheemanna Mudali Garden St ,Alwarpet chennai-18			DIA OF BORE HOLE	150mm ✓ / NX		
LOCATION	ALWARPET, Chennai	MACHINE No.	CR-01	CHAINAGE (m)	-	BORE START DATE	23/05/2023
STRUCTURE	Still +5 Upper Floors	DRILLING METHOD	Rotary	CO-ORDINATES	N -	BORE END DATE	24/05/2023
JOB CODE	GEC-JC-GT-5012	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	24/05/2023	07	48 To 07 49	SC	-	-	1	1	1	2	11.00 / 11.45	9	SS	-11.0				Greyish Black, Moist, Very Soft, **Silty CLAY (CI)**, Clays of Medium Plasticity
12		08	04 To 08 05	SC	-	-	1	1	2	3	12.50 / 12.95	10	SS	-12.5		L4	12.5	
13		08	20															Greyish Black, Moist, Very Soft, **Sandy Silty CLAY (CI)**, Clays of Mredium Plasticity
14		To 08	23	SC	-	-	1	1	2	3	14.00 / 14.45	11	SS	-14.0		L5	14.0	
15		08	38 To 08 42	SC	-	-	1	2	1	3	15.50 / 15.95	12	SS	-15.5				
16																		
17		09	12 To 09 19	SC	-	-	1	2	2	4	17.00 / 17.45	13	SS	-17.0				Greyish Black, Moist, Soft, **Silty Clay (CH)**, Silty Clay of High Plasticity
18		09	49 To 09 53	SC	-	-	1	2	2	4	18.50 / 18.95	14	SS	-18.5				
19																		
20		10	23 To 10 30	SC	-	-	5	11	12	23	20.00 / 20.45	15	SS	-20.0		L6	20.0	Greenish Grey, Moist, Medium Dense,Poorly Graded, **Silty SAND (SM)**

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CS - Core Sample
SS - Split Spoon Sample
UDS- Undisturbed Sample
WS - Wash Sample
DS - Disturbed Sample
SC - Soil Cutter
TCB - Tungsten Carbide Bit
DB - Diamond Bit

LOGGED	N.PANDIARAJAN	PROJECT SITE DETAILS	REMARKS
DATE	24/05/2023	GROUND LEVEL (m) 0.00	
CHECKED	JALEEL YASIN	WATER TABLE (m) 2.00	
DATE	28/05/2023	CASING DEPTH (m) 0.00	

SITE INVESTIGATION RECORD

BORE HOLE No.	BH-02						
SHEET	3	OF	3				
PROJECT NAME	Old No,54 New No14&16 Bheemanna Mudali Garden St ,Alwarpet chennai-18					DIA OF BORE HOLE	150mm ✓ / NX
LOCATION	ALWARPET, Chennai	MACHINE No.	CR-01	CHAINAGE (m)	-	BORE START DATE	23/05/2023
STRUCTURE	Still +5 Upper Floors	DRILLING METHOD	Rotary	CO-ORDINATES	N -	BORE END DATE	24/05/2023
JOB CODE	GEC-JC-GT-5012	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
21	24/05/2023	11	00	SC	-	-												Greenish Grey, Moist, Medium Dense, Poorly Graded, **Clayey Silty SAND (SC)** Sand-Clay Mixture
		To																
22		11	09				9	15	14	**29**	22.00	16	SS	-22.0				
											22.45							
23																L7	23.0	
		11	39	SC	-	-												Greenish Grey, Moist, Very Dense, Poorly Graded, **Clayey Silty SAND (SC)** Sand-Clay Mixture
		To																
24		11	45				13	26	10cm Penet. For 50Blows	**>100**	24.00	17	SS	-24.0				
											24.40					L8	24.4	
25																		Reddish Brown, Moist, Very Dense, **Completely Weathered Rock,** Descented from Charnockite
		12	15	SC	-	-												
		To																
26		12	20				SPT Hammer Rebounded			**>100**	26.00	18	WS	-26.0		L9	26.0	
27																		
28																		
29																		
30																		

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CS - Core Sample	DS - Disturbed Sample	LOGGED	N.PANDIARAJAN	PROJECT SITE DETAILS	REMARKS
SS - Split Spoon Sample	SC - Soil Cutter	DATE	24/05/2023	GROUND LEVEL (m) 0.00	
UDS- Undisturbed Sample	TCB - Tungsten Carbide Bit	CHECKED	JALEEL YASIN	WATER TABLE (m) 2.00	
WS - Wash Sample	DB - Diamond Bit	DATE	28/05/2023	CASING DEPTH (m) 0.00	

Borehole terminated at 26 m depth below E.G.L

FIG.2.2 Sub Soil Profile at BH-02 Location

Grain Size Distribution Curves

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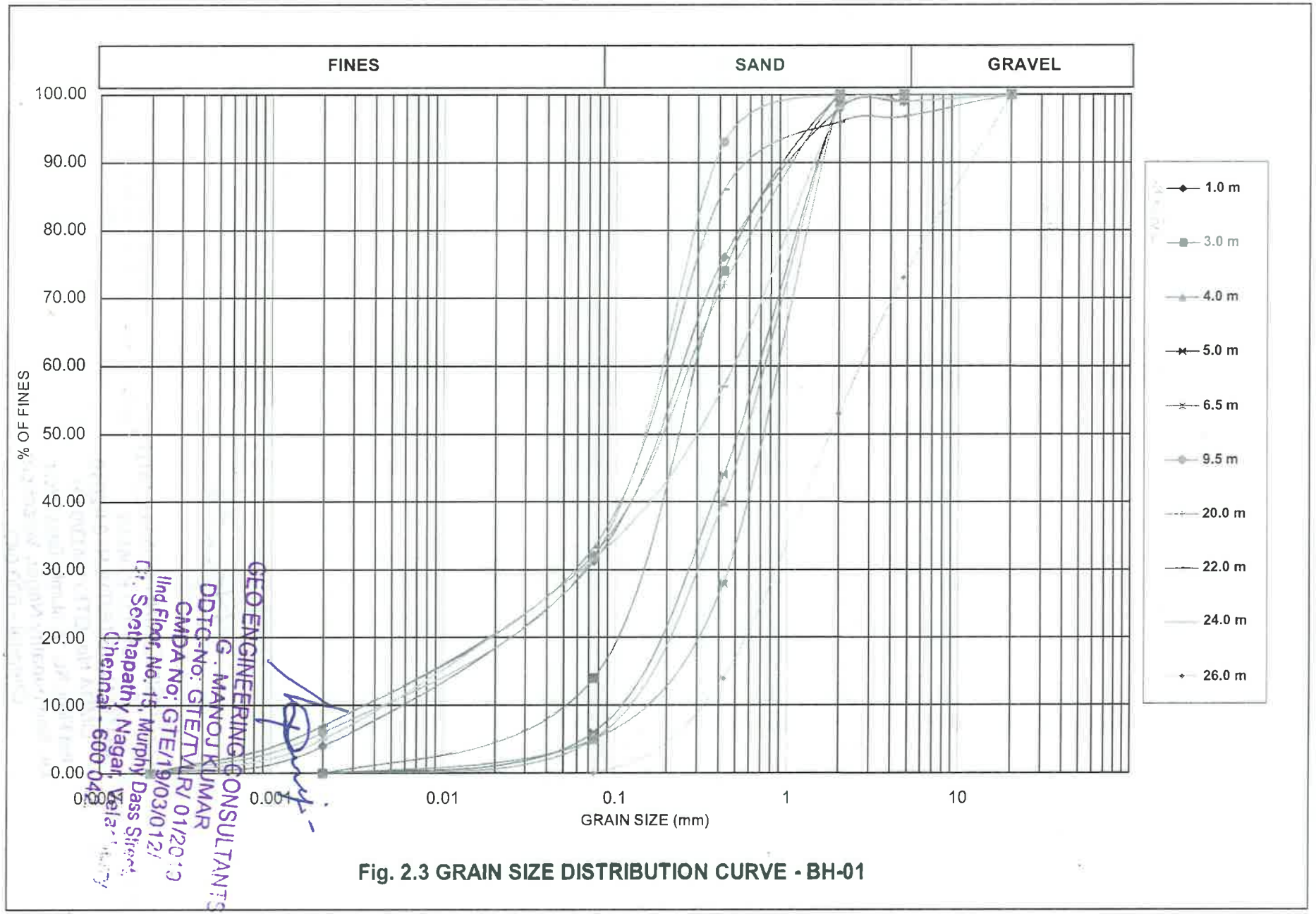
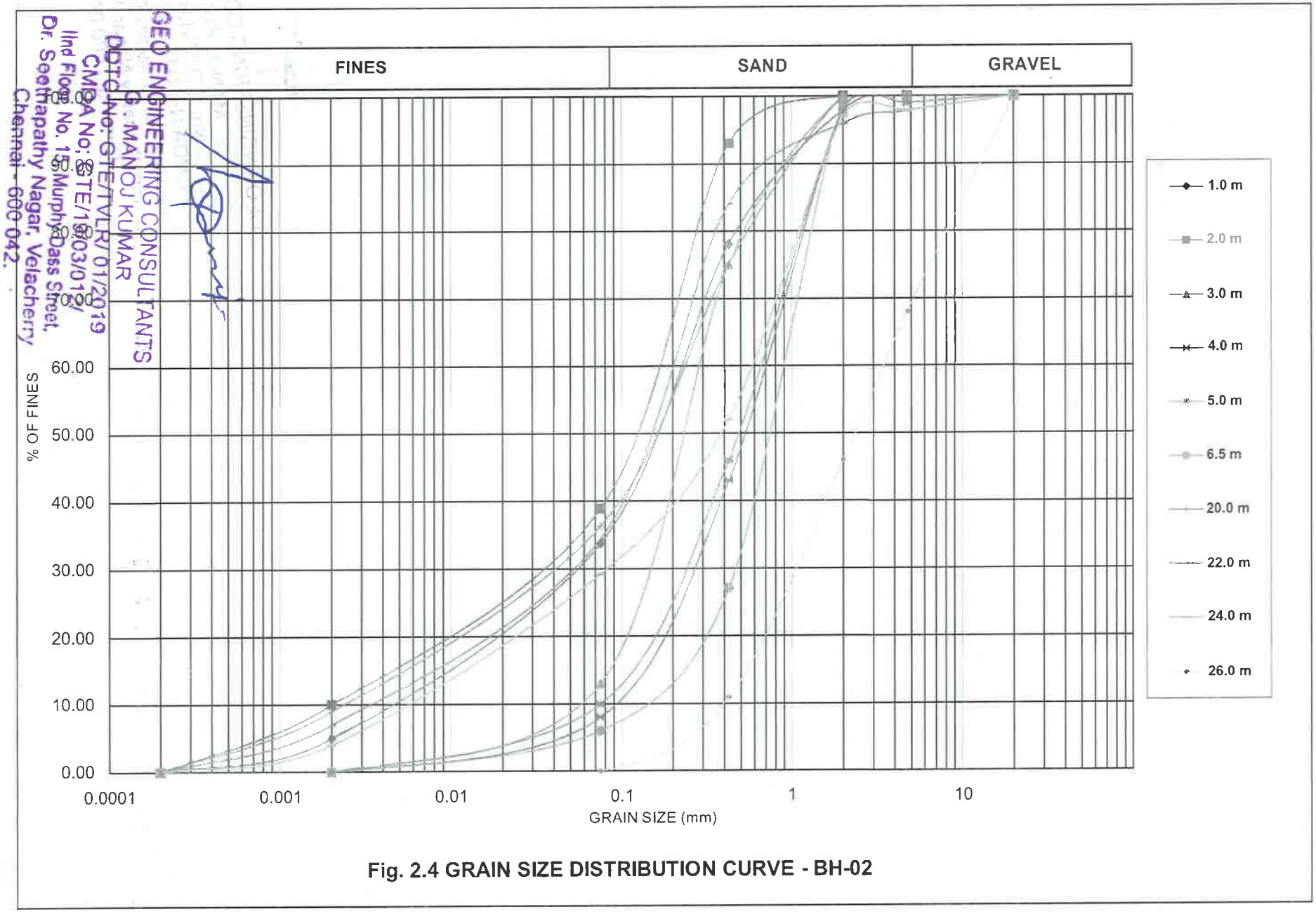


Fig. 2.3 GRAIN SIZE DISTRIBUTION CURVE - BH-01



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Fig. 2.4 GRAIN SIZE DISTRIBUTION CURVE - BH-02

HYDROMETER ANALYSIS CURVE

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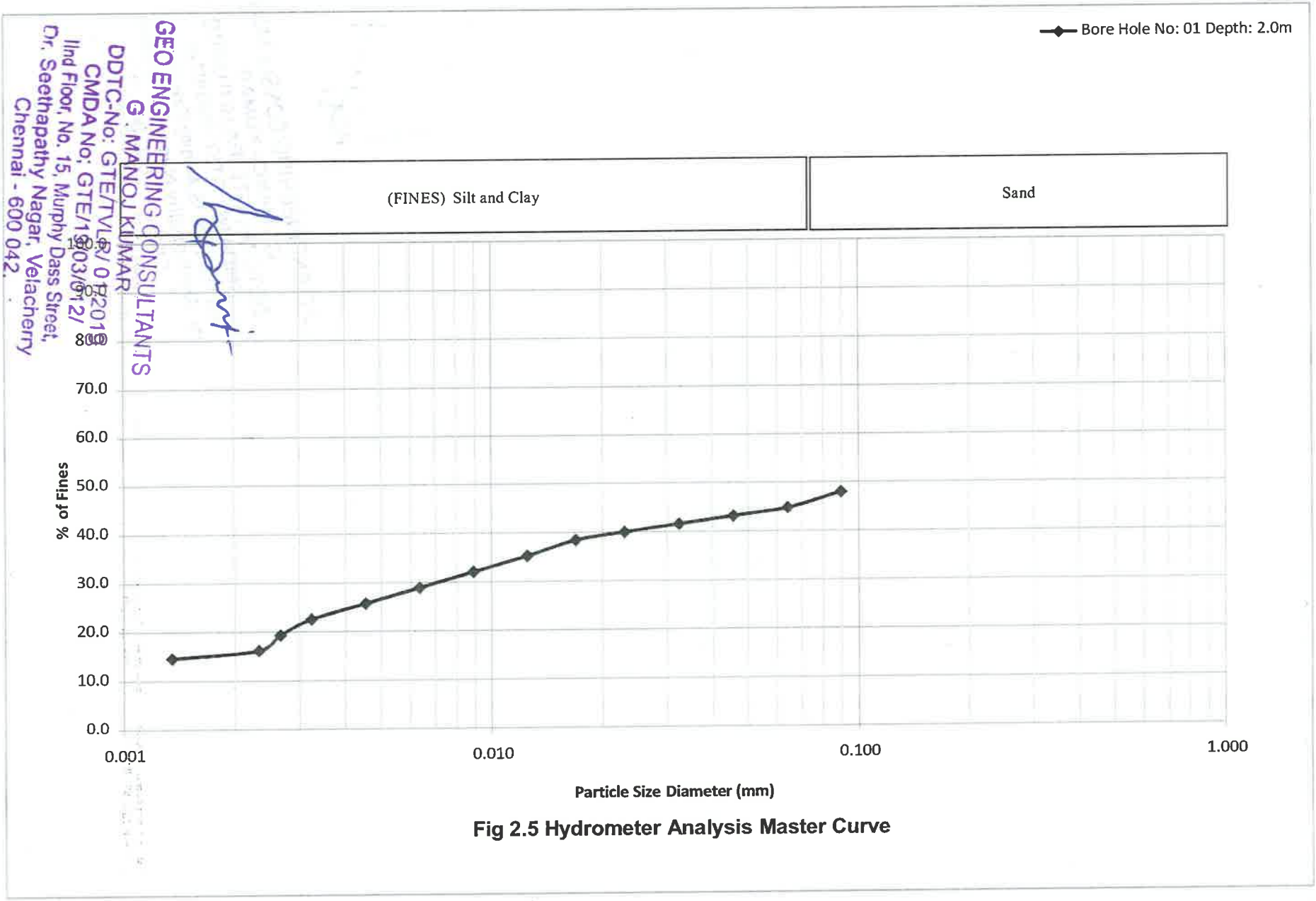


Fig 2.5 Hydrometer Analysis Master Curve

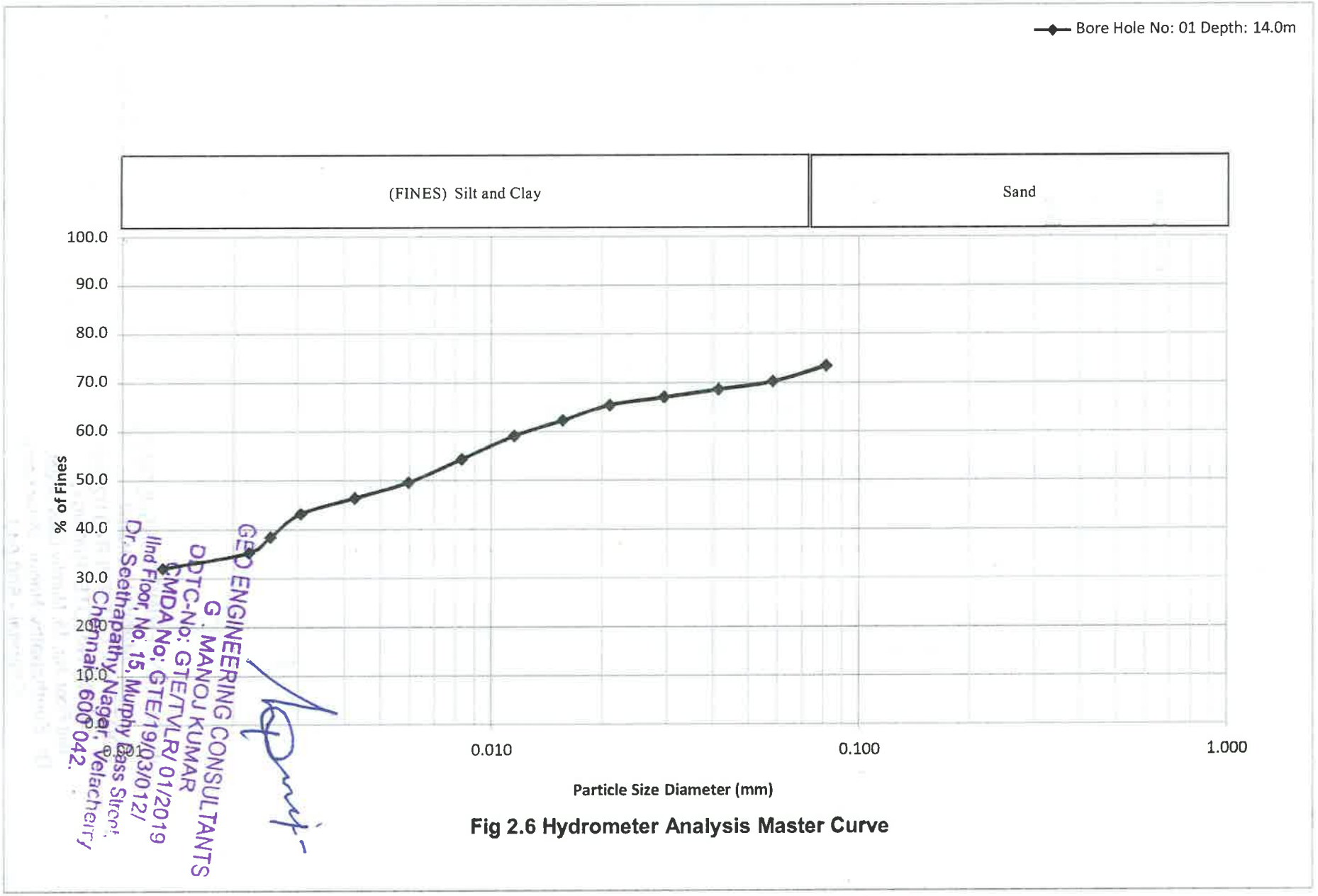


Fig 2.6 Hydrometer Analysis Master Curve

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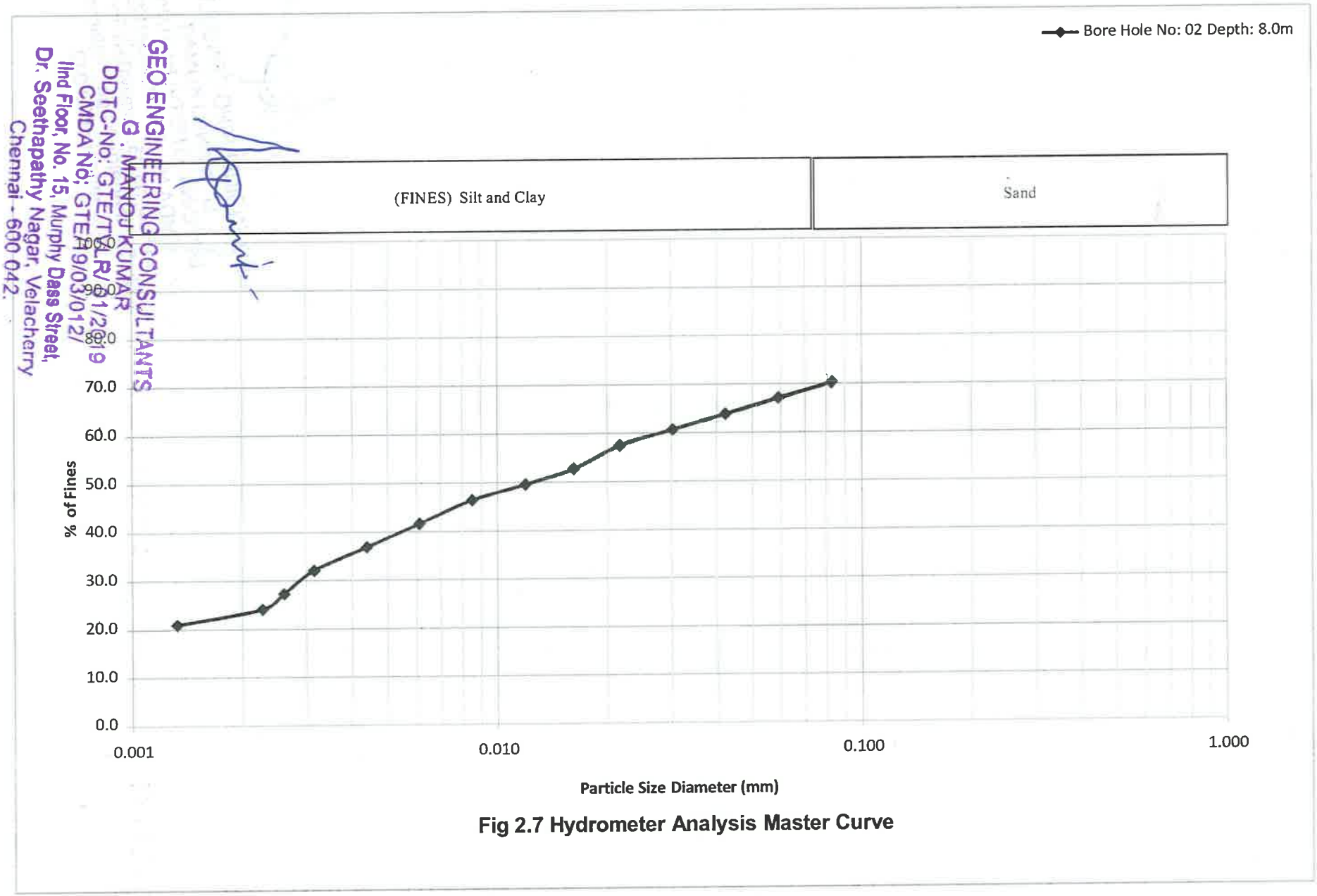


Fig 2.7 Hydrometer Analysis Master Curve

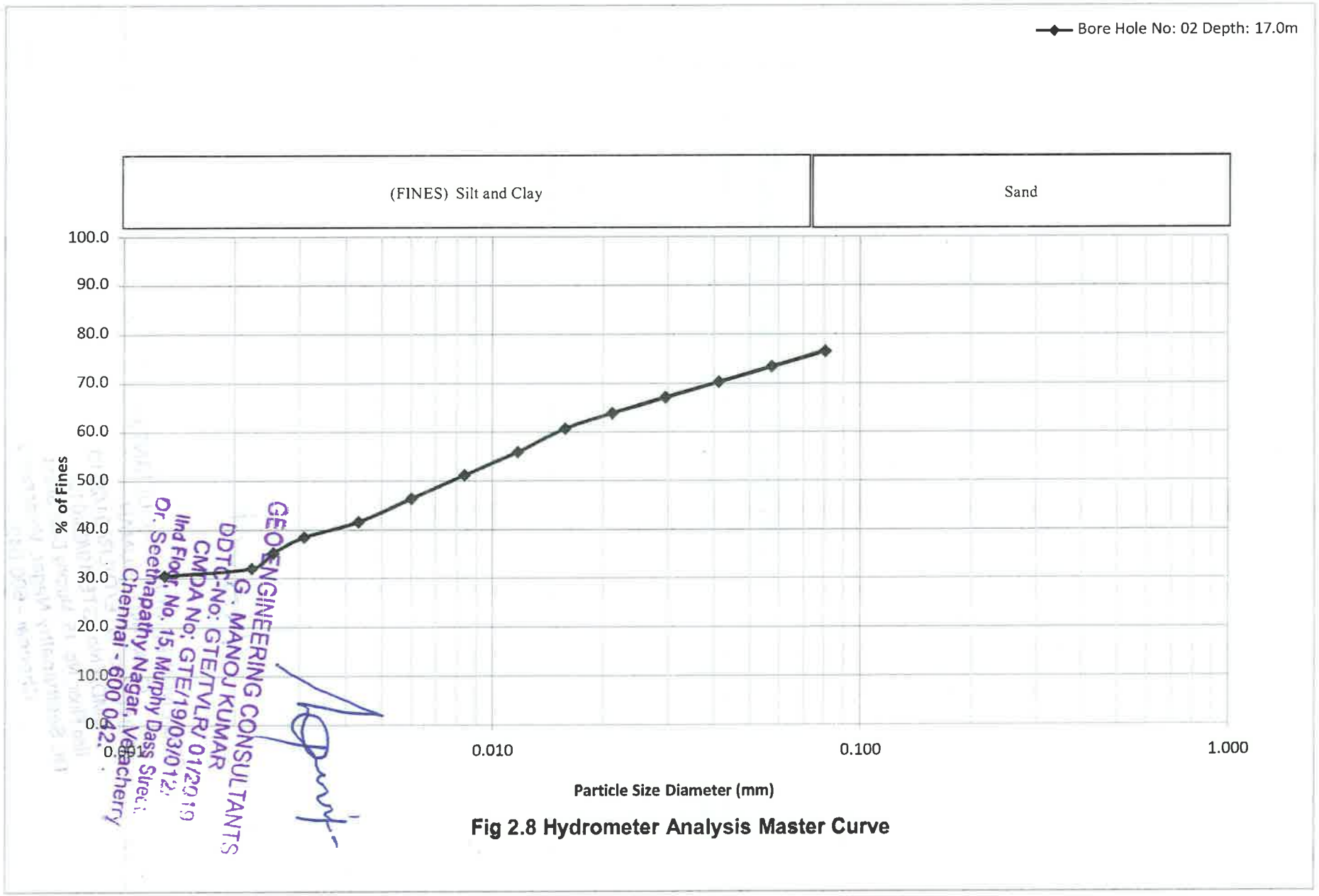


Fig 2.8 Hydrometer Analysis Master Curve

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LABORATORY TEST RESULTS

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

Depth of Sample below E.G.L.	SPT-Value	Type of Sample	Sub Soil Classification																								
			Fine Grained (FG)										Coarse Grained (CG)												IS-Notation	
			NMC(%)	LL (%)	PL (%)	I_P	Ic	SL (%)	FS (%)	Consistancy	Position With Respectto A-Aline	IS:Notation	Gravel (%)	Coarse (%)	Medium (%)	Fine (%)	Silt (%)	Clay (%)	D_{10} (mm)	D_{30}(mm)	D_{60} (mm)	$C_U=D_{60}/D_{10}$	$C=D^{2}/(D \times D)$	Relative Density	Gravel	Sand
1.0	10	SS	18	28	17	11	0.91	18	10	CG>50%	Above	-	1	1	22	42	30	4	-	-	-	-	-	Loose	<50%	SC
2.0	6	SS	25	35	19	16	0.63	17	14	M.Stiff	Above	CL	0	0	7	31	48	14	-	-	-	-	-	FG>50%	FG>50%	FG>50%
3.0	22	SS	-	-	-	-	-	-	-	CG>50%	-	-	0	0	26	60	14	0	-	-	-	-	-	M.Dense	<50%	SM
4.0	20	SS	-	-	-	-	-	-	-	CG>50%	-	-	0	1	59	35	5	0	-	-	-	-	-	M.Dense	<50%	SP-SM
5.0	25	SS	-	-	-	-	-	-	-	CG>50%	-	-	1	0	55	38	6	0	-	-	-	-	-	M.Dense	<50%	SP-SM
6.5	16	SS	-	-	-	-	-	-	-	CG>50%	-	-	0	1	71	23	5	0	-	-	-	-	-	M.Dense	<50%	SP-SM
8.0	2	SS	40	45	21	24	0.21	14	40	Very Soft	Above	CI	-	-	-	-	78	22	-	-	-	-	-	FG>50%	FG>50%	FG>50%
9.5	2	SS	31	33	16	17	0.12	18	32	CG>50%	Above	-	0	0	7	57	30	6	-	-	-	-	-	V.Loose	<50%	SC
11.0	2	SS	42	46	23	23	0.17	14	55	Very Soft	Above	CI	-	-	-	-	75	25	-	-	-	-	-	FG>50%	FG>50%	FG>50%
12.5	4	SS	41	45	22	23	0.17	16	44	Very Soft	Above	CI	0	0	18	30	34	18	-	-	-	-	-	FG>50%	FG>50%	FG>50%
14.0	4	SS	67	79	35	44	0.27	10	95	Soft	Above	CH	-	-	-	-	68	32	-	-	-	-	-	FG>50%	FG>50%	FG>50%
15.5	5	SS	55	66	30	36	0.31	11	54	Soft	Above	CH	-	-	-	-	70	30	-	-	-	-	-	FG>50%	FG>50%	FG>50%
17.0	4	SS	52	62	31	31	0.32	11	73	Soft	Above	CH	-	-	-	-	72	28	-	-	-	-	-	FG>50%	FG>50%	FG>50%
18.5	4	SS	60	77	35	42	0.33	10	108	Soft	Above	CH	-	-	-	-	68	32	-	-	-	-	-	FG>50%	FG>50%	FG>50%
20.0	20	SS	16	40	20	20	1.20	16	52	CG>50%	Above	-	0	0	28	35	30	7	-	-	-	-	-	M.Dense	<50%	SC
21.5	27	SS	16	39	19	20	1.15	17	38	CG>50%	Above	-	3	1	10	48	31	7	-	-	-	-	-	M.Dense	<50%	SC
24.0	>100	SS	17	41	22	19	1.26	15	27	CG>50%	Above	-	1	1	41	22	30	5	-	-	-	-	-	V.Dense	<50%	SC
26.0	>100	WS	-	-	-	-	-	-	-	CG>50%	-	-	27	20	39	14	0	0	-	-	-	-	-	V.Dense	<50%	SP

FG = Fine Grained
CG = Coarse Grained
NMC= Nature Moisture Content
LL = Liquid Limit
PL = Plastic Limit
Ip = Plasticity index
Ic = (LL-NMC)/Ip
SL = Shrinkage Limit
FS = Differential Frees Well Index
C_U = Uniformity Coefficient
C_C = Coefficient of Curvature
IP=LL-PL

LAB IN-CHARGE	M.PRAVEEN
REVIEWED BY	JALEEL YASIN

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

Depth of Sample (m) below G.L	SPT 'N' Value	Type of Sample	Sub Soil Classification																										
			Fine Grained (FG)										Coarse Grained (CG)												IS-Notation		
			NMC(%)	LL (%)	PL (%)	I_P	Ic	SL (%)	FS (%)	Consistancy	Position With Respectto A-Line	IS:Notation	Gravel (%)	Coarse (%)	Medium (%)	Fine (%)	Silt (%)	Clay (%)	D_{10} (mm)	D_{30}(mm)	D_{60} (mm)	$C_U=D_{60}/D_{10}$	$C=D^2/(D_{60}\times D_{10})$	Relative Density	Gravel	Sand
1.0	8	SS	22	38	16	16	0.63	17	15	CG>50%	Above	-	0	2	20	41	32	5	-	-	-	-	-	Loose	<50%	SC
2.0	9	SS	20	38	18	15	0.87	17	18	CG>50%	Above	-	0	0	7	48	35	10	-	-	-	-	-	Loose	<50%	SC
3.5	24	SS	-	-	-	-	-	-	-	CG>50%	-	-	0	0	25	62	13	0	-	-	-	-	-	M.Dense	<50%	SM
4.0	23	SS	-	-	-	-	-	-	-	CG>50%	-	-	0	2	55	35	8	0	-	-	-	-	-	M.Dense	<50%	SP-SM
5.0	21	SS	-	-	-	-	-	-	-	CG>50%	-	-	1	1	52	36	10	0	-	-	-	-	-	M.Dense	<50%	SP-SM
6.5	18	SS	-	-	-	-	-	-	-	CG>50%	-	-	0	1	72	21	6	0	-	-	-	-	-	M.Dense	<50%	SP-SM
8.0	2	SS	41	42	20	22	0.05	14	42	Very Soft	Above	CI	-	-	-	-	80	20	-	-	-	-	-	FG>50%	FG>50%	FG>50%
9.5	2	SS	35	38	18	20	0.15	15	39	Very Soft	Above	CI	-	-	-	-	82	18	-	-	-	-	-	FG>50%	FG>50%	FG>50%
11.0	2	SS	40	44	22	22	0.18	14	52	Very Soft	Above	CI	-	-	-	-	78	22	-	-	-	-	-	FG>50%	FG>50%	FG>50%
12.5	3	SS	38	47	22	25	0.36	15	40	Soft	Above	CI	0	0	15	32	37	16	-	-	-	-	-	FG>50%	FG>50%	FG>50%
14.0	3	SS	65	80	34	46	0.33	11	85	Soft	Above	CH	-	-	-	-	67	33	-	-	-	-	-	FG>50%	FG>50%	FG>50%
15.5	3	SS	52	65	31	34	0.38	11	60	Soft	Above	CH	-	-	-	-	69	31	-	-	-	-	-	FG>50%	FG>50%	FG>50%
17.0	4	SS	50	63	30	33	0.39	11	75	Soft	Above	CH	-	-	-	-	70	30	-	-	-	-	-	FG>50%	FG>50%	FG>50%
18.5	4	SS	60	75	34	41	0.37	10	101	Soft	Above	CH	-	-	-	-	71	29	-	-	-	-	-	FG>50%	FG>50%	FG>50%
20.0	23	SS	18	43	21	22	1.14	15	55	CG>50%	Above	-	0	0	25	33	33	9	-	-	-	-	-	M.Dense	<50%	SC
22.0	29	SS	17	40	20	20	1.15	16	42	CG>50%	Above	-	2	2	12	45	32	7	-	-	-	-	-	M.Dense	<50%	SC
24.0	>100	SS	15	38	19	19	1.21	15	32	CG>50%	Above	-	2	1	45	20	28	4	-	-	-	-	-	V.Dense	<50%	SC
26.0	>100	WS	-	-	-	-	-	-	-	CG>50%	-	-	32	22	35	11	0	0	-	-	-	-	-	V.Dense	<50%	SP

FG = Fine Grained
CG = Coarse Grained
NMC= Nature Moisture Content
LL = Liquid Limit
PL = Plastic Limit
Ip = Plasticity Index
Ic = (LL-NMC)/Ip
SL = Shrinkage Limit
FS = Differential Frees Well Index
C_U = Uniformity Coefficient
C_C = Coefficient of Curvature
IP=LL-PL

LAB IN-CHARGE	M.PRAVEEN
REVIEWED BY	JALEEL YASIN

Table-2.3 Results of Chemical Analysis									
		Water				Soil (2:1)			
SL No.	Bore HoleNo.	Depth of Sample (m)	pH	Chlorides (ppm)	Sulphates (ppm)	Depth of Sample (m)	pH	Chlorides (ppm)	Sulphates (ppm)
1	BH-01	2.00	7.42	1651	844	2.0	7.40	1385	915
2	BH-02	2.00	7.42	1645	875	2.0	7.40	1356	919

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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 characteristics based on which the design of sub structures/foundations is generally carried out.However, the macro-level understanding of the sub surface is also needed for a comprehensive understanding of the sub structure/foundation response to naturally super imposed loads like earthquake forces etc., The macro level understanding of the sub surface is better provided through the knowledge of the Geology of the region. Since, it is beyond the scope of the present study to carry out geological investigation to establish the geology of the study region; published data are presented below along with the sub surface stratification observed through the direct borehole investigation carried out at the specified locations.

3.1 Geology of Study Area (based on the published data)

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 (Shale Formation).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 bore hole investigation, which confirms that the present site does not depict any surprising geological features that are different from that of the region

3.2 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/m^3	Shear Parameters	
	Top. R.L.	Bot. R.L.	Thickness							(C_u) kPa	(ϕ) Deg.
1	0.00	0.50	0.50	Filled Up Soil	-	-	-	-	-	-	-
2	0.50	2.00	1.50	Clayey Sand	Brownish	10	Loose	-	15	-	30
3	2.00	3.00	1.00	Sandy Silty Clay	Brownish	6	-	Medium Stiff	15.5	40	-
4	3.00	7.00	4.00	Silty Sand	Brownish	21	Medium Dense	-	18.5	-	33.3
5	7.00	9.50	2.50	Silty Clay	Greyish Black	2	-	Very Soft	14	13	-
6	9.50	11.00	1.50	Clayey Silty Sand	Greyish Black	2	Very Loose	-	13	-	19.91
7	11.00	14.00	3.00	Sandy Silty Clay	Greyish Black	2	-	Very Soft	14	13	-
8	14.00	20.00	6.00	Silty Clay	Blackish Grey	3	-	Soft	14	20	-
9	20.00	23.00	3.00	Clayey Silty Sand	Greenish Grey	23	Medium Dense	-	18.5	-	33.9
10	23.00	24.30	1.30	Clayey Silty Sand	Greenish Grey	>100	Very Dense	-	21	-	42.5
11	24.30	26.00	1.70	Completely Weathered Rock	Reddish Brown	>100	Very Dense	-	21	-	42.5

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REFERENCE BORE HOLE-BH:					02	Ref R.L. of G.L. (m):			0.00		
Layer No.	Layer Thk. (m)			Type of Strata	Colour	Ave. Design SPT	Relative Density	Consistency	(γ) kN/m^3	Shear Parameters	
	Top. R.L.	Bot. R.L.	Thickness							(C_u) kPa	(ϕ) Deg.
1	0.00	0.50	0.50	Filled Up Soil	-	-	-	-	-	-	-
2	0.50	3.00	2.50	Clayey Sand	Brownish	8	Loose	-	14.5	-	29.6
3	3.00	7.00	4.00	Silty Sand	Brownish	22	Medium Dense	-	18.5	-	33.6
4	7.00	12.50	5.50	Silty Clay	Greyish Black	2	-	Very Soft	14	13	-
5	12.50	14.00	1.50	Sandy Silty Clay	Greyish Black	3	-	Soft	14	20	-
6	14.00	20.00	6.00	Silty Clay	Blackish Grey	4	-	Soft	14.5	27	-
7	20.00	23.00	3.00	Clayey Silty Sand	Greenish Grey	29	Medium Dense	-	19	-	35.7
8	23.00	24.30	1.30	Clayey Silty Sand	Greenish Grey	>100	Very Dense	-	21	-	42.5
9	24.30	26.00	1.70	Completely Weathered Rock	Reddish Brown	>100	Very Dense	-	21	-	42.5

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FOUNDATION SYSTEM

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CHAPTER-4

FOUNDATION SYSTEM

4.0 Preamble:

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

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

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

4.1 Proposed Structures

An understanding of the proposed construction and the order of loads on the foundations is needed for choosing the appropriate foundation system.

In the present case, the proposed structure is configured with stilt and five upper floors, and is meant for residential use. For this kind of structure, the column loads could vary between 1500kN to 2500kN. The above mentioned loads have no bearing on the design of either sub or super structures and are mentioned just to provide an insight to choose an appropriate foundation system with respect to subsoil conditions.

4.2 Foundation System

4.2.1 Option-I-Strip Raft

For the kind of proposed structure and sub soil conditions, shallow foundation system coupled with soil replacement within the foundation trench can be adopted. The R.C.C Strip Raft can be located at a depth of 1.50m over a well compacted sand-gravel (1:1) mix or quarry dust of 300mm thickness laid in non-compacted layers of 150mm at optimum moisture content and compacted using a plate compactor or hand ramming technique. Thus the overall depth of foundation excavation will be 1.80m below the existing ground level. The schematic arrangement of foundation system is presented in Fig. 4.1.

The R.C.C strip raft can be designed for an allowable safe bearing pressure of 100kPa. The maximum width of strip should be restricted to 1.5m

Typical computation is presented in the annexure

4.2.2 Option-II-Deep pile foundation

In case of bearing pressure is not feasible, alternatively deep pile foundation system can be adopted. The piles can be installed by drilling with direct mud circulation technique **(Bored Cast In-situ Piles)** and the recommended safe load carrying capacity of bored cast in-situ piles in compression, tension and lateral for different diameters is worked out as per IS 2911-Part-I-Section-2 and are presented in Table-4.2.Typical computations are presented in Annexure

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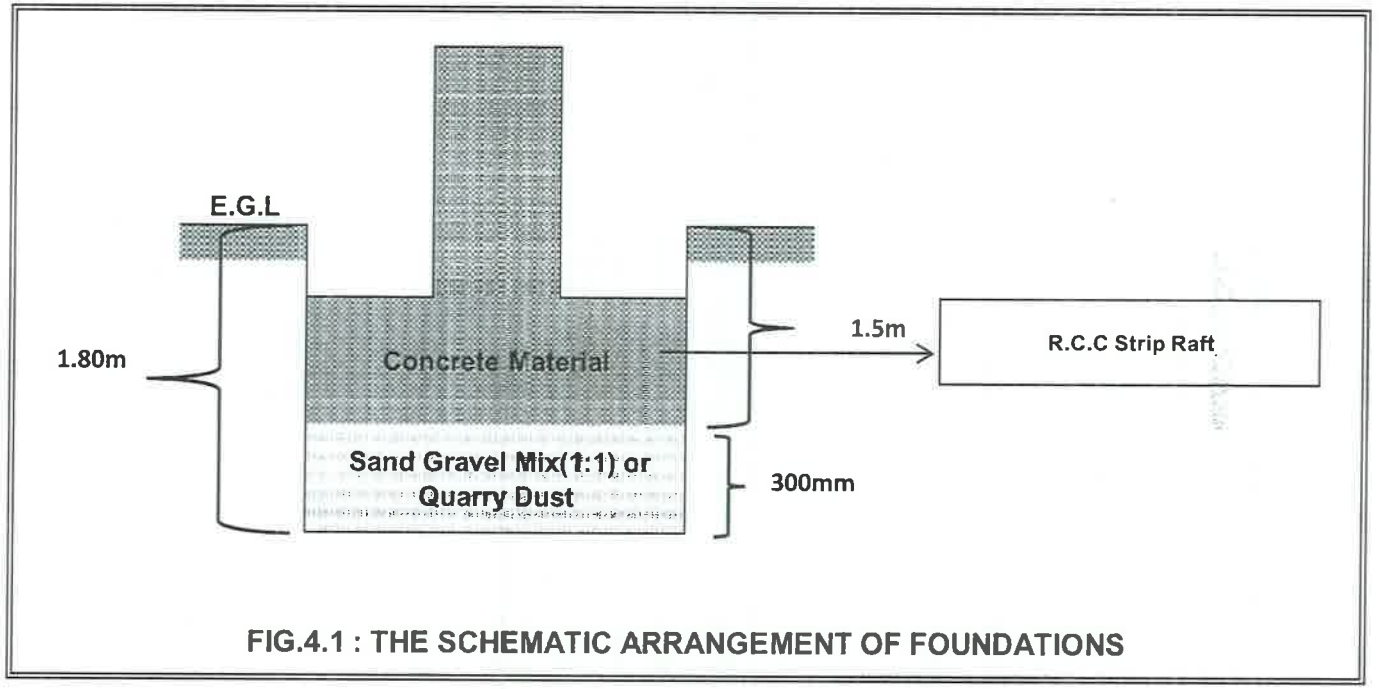


FIG.4.1 : THE SCHEMATIC ARRANGEMENT OF FOUNDATIONS

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Table:- 4.1 Recommended Safe Load Carrying Capacities of Bored Cast-in Situ Piles								
Sl.No	Reference Bore hole No.	Length of Pilebelow E.G.L	Assumed Length of Cut-Off Below	Length of Pilebelow Cut-off	Dia.of Pile in (mm)	SAFE LOAD CARRYING CAPACITY (kN)		
						Vertical Load Carrying Capacity	Pull Out Capacity	Lateral Load Carrying Capacity
1	BH-02	25.0	1.0	24.00	500	1100	500	30
2					550	1300	550	35
3					600	1500	600	40
4					650	1800	650	48
5					750	2300	750	60
6					800	2700	800	65
7					900	3300	900	80

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RECOMMENDATIONS

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CHAPTER-5

RECOMMENDATIONS

5.0 Recommendation for shallow foundation

- For the kind of sub soil conditions open foundation system coupled with soil replacement type of ground improvement technique can be adopted.
- The depth of foundation excavation shall be 1.80m below the ground level and shall be back filled with either sand-gravel mix (1:1) or quarry dust of 300mm thickness laid in non-compacted layers of thickness not more than 150mm and compacted at optimum moisture content using a plate vibrator.
- The R.C.C Strip raft footings can be located at 1.50m over the prepared bed and shall be designed for an allowable bearing pressure of 100 kPa.
- The maximum width of strip should be restricted to 1.5m
- The back filling of foundation trenches shall be carried out using either sand/gravel or quarry dust.
- All columns shall be connected with grade beams in both the directions irrespective of wall layout
- The ground floor shall be minimum 1.0m above the natural ground and the plingth shall be filled with sand/gravel/quarry dust. This height is recommended to contain the influence of soil volume change on the flooring. In case, floor is not raised, the ground floor shall be constructed as a suspended R.C.C. slab.

5.1 Recommendation for Bored Cast In-situ Pile Foundation:

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

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5.2 Construction method statement of pile foundation:

- For the bored cast in situ piles, a guide casing of 2.0 to 3.0m length can be adopted
- The mud used shall be made out of sodium bentonite with minimum frees swell index of more than 300% and liquid limit more than 100%. The silt content in bentonite shall not more than 5%.
- The mud was prepared using sodium bentonite with a density of 1.10 to 1.15 g/cc.

5.3 General Recommendation:

- The chlorides and the sulphate levels are within the permissible limits as per the standards hence no special cement or reinforcement is required for the construction of sub structure.

5.4 Special Recommendations

- Since, the sub soil strata are very loose and soft layer between 7.0m to 20.0m depth below ground level. The soft layer will affect when the pile boring of sub soil is necking and bulging factor upon the installation of pile, due to Lateral soil expansion. Hence, in order to assure quality of the pile, it is ideal to carryout pile integrity test on all piles.

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ANNEXURE

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TYPICAL BEARING CAPACITY COMPUTATIONS FOR SHALLOW FOUNDATIONS

1.0 COMPUTATION OF BEARING CAPACITY AS PER IS:6403

1.1 Geometrical Data :

	Ref.BH-01
Shape of the Foundation	strip
Depth of Foundation Below E.G.L"Df" (m)	1.50
Soil Replacement Thickness of CNS Layer (m)	0.30
Total Depth of Foundation (m)	1.80
Breadth of Footing "B" (m)	1.00
Length of Footing "L" (m)	1.00
B/L	1.00
Inclination of Vertical Load with the Vertical (a)	0.00

1.2 Soil Data :

Type of Effective Bearing Strata : sand
Average Design SPT-value of the Bearing Strata 9.00
Type of Shear Failure: General
Angle of Shearing Resistance 29.80 kPa

1.3 Design Parameters:

Bulk Density of Soil above the foundation depth (γ_{bulk}) 17.00 kN/m^3
Water Table Correction Factor (w') 0.50
Effective Overburden pressure at foundation level (q) 10.50 kPa

Bearing Capacity Factors:

N_c = N/A
N_q = 18.09
N_g = 21.94

Shape Factors:

S_c = -
S_q = 1.00
S_g = 1.00

Depth Factors :

D_c = -
D_q = 1.04
D_g = 1.04

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' 283.80 kPa
(g should be read as gama)

1.5 Safe Bearing Capacity (Qsafe) :

Factor of Safety (F.S.) : 2.50
Qsafe : 113.52 kPa
Say Q_{safe} 100 kPa

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

The immediate elastic settlement (S_i)= $qB(1-m^2)*I/E_s$
q= bearing pressure 100.00 kPa
Poission's Ratio (μ) 0.50
Modulus of Elasticity (E_s)(Ref. Joseph E Bowels,1996,page316,Table5.6, Japanese design standards)
Modulus of Elasticity (E) 23400.00 kPa
Size of footing considered for maximum settlement(m) 1.00
Influence factor 1.00
Rigidity Factor 1.00
Elastic Settlement (Di) 3.21 mm
<50 mm

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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 E.G.L.(m)			25	As Per IS:2911-(P-I,S-2)-2010				
Reference Bore Hole				BH-02					600	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	1	1	Cut-Off Level														
2	1	3	2.0	Sand	8	14.5	14.5	-	29.6	0.0	9.0	4.5	-	1.0	qf	2	9.6	
3	3	7	4.0	Sand	22	18.5	16.5	-	33.6	9.0	43.0	26.0	-	1.2	qf	3	154.0	
4	7	14	7.0	Clay	2	14.0	16.3	13	-	43.0	71.0	57.0	1.0	-	qf	4	171.5	
5	14	20	6.0	Clay	4	14.5	14.3	27	-	71.0	98.0	84.5	1.0	-	qf	5	305.4	
6	20	23	3.0	Sand	26	19.0	16.8	-	34.8	98.0	125.0	111.5	-	1.2	qf	6	544.7	
7	23	24.4	1.4	Sand	50	20.5	19.8	-	41.0	125.0	139.7	132.4	-	1.5	qf	7	455.4	
11	24.4	25	0.6	Weathred Rock	50	20.5	20.5	-	41.0	139.7	146.0	142.9	-	1.5	qf	11	210.7	

Summation of Positive Skin Resitance (kN) Q_f= 1851.32

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

Computation of End Bearing Resistance

		SPT	ϕ	C_u	N_q	N_c			
Bearing Stratum	Weathred Rock	60	39.88	-	120.94	-	Eff.Ht.of Overburden	9	m
							Effective Overburden Pressure	62.36	kN/m²

End Bearing Resistance (kN) Q_p= 2132.25

Ultimate Load Carrying Capacity (Q_{ult})	$Q_u=Q_f-Q_f+Q_p$ (kN)	3983.57
Safe Load Carrying Capacity (Q_{safe})	$Q_u/2.5$ (kN)	1593.43
Allowable Safe Load Carrying Capacity	$Q_{A\text{-}safe}$ (kN)	1500.00
Allowable Safe Pull out Capacity	$Q_{A\text{-}pull}$: Qf/3 (kN)	617.11

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

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

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

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

Where

Cu=Undrained Shear Strength of Clay

ϕ=Angle of Shearing Resistance

N_c=Bearing Capacity Factor = 9

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 Refered 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)

Note: The End being is completely Weathered Rock modeld as Very Dense Sand with restricted to SPT-value of 60 corresponding phi angle 39.88

LATERAL LOAD CARRYING CAPACITY OF BORED CAST- SITU PILES

Reference Bore Hole : BH-02

1.0 Geometrical Data

Type of Pile Head Considered		Fixed	
Diameter of Pile (d)	:	**0.60**	m
Free standing Length of Pile (e)	:	**0**	m
Length of Pile below E.G.L (Le)	:	**25.0**	m
Cut-Off Level From E.G.L	:	1.0	
Length of Pile below Cut-Off Level (Le)	:	**24.0**	m
Grade of Concrete (M)	:	**25**	MN/m^2
Young's Modulus of Concrete (E)	:	25000000	kN/m^2
Momemnt of Inertia (I)	:	0.006362	m^4

2.0 Determination of Depth of Fixity

Type of Soil Strata	:	sand	
Ground Water Condition	:	Submerged	
Average Design SPT "N" Value	:	8	
T=(EI/nh)1/5			
(n can be read as η in the above and below equation in case of Sand)			
nh=	:	1000	kN/m^3
In Case of Sand	:	-	kN/m^2
T=	:	2.76	
L1/T	:	0.00	
Lf/T	:	2.20	
Depth of Fixity below Cut off (z_f)	:	6.06	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	:	42.80	kN
Recommended Design Lateral Load carrying Capacity	:	**42**	**kN**
Fixed End Moment,M_F=H(e+z_f)/2		130	
Reduction Factor (L_1/T)	:	0.83	m
Actual Moment (Fixed End Moment/Reduction Factor),M_F		**108**	kN-m

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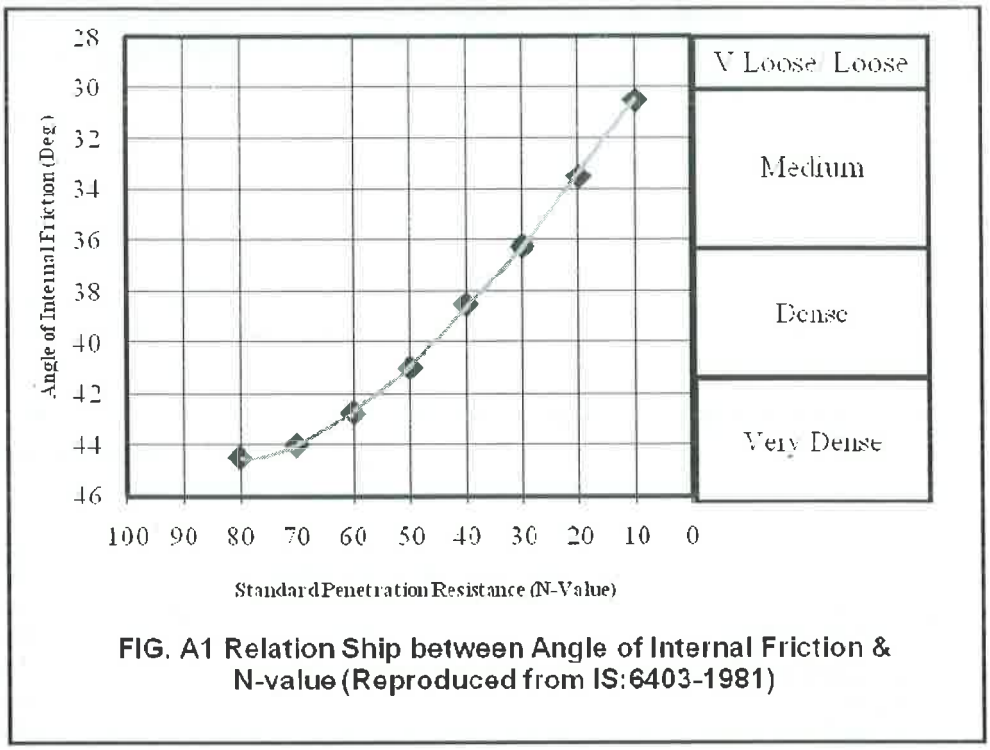


FIG. A1 Relation Ship between Angle of Internal Friction & N-value (Reproduced from IS:6403-1981)

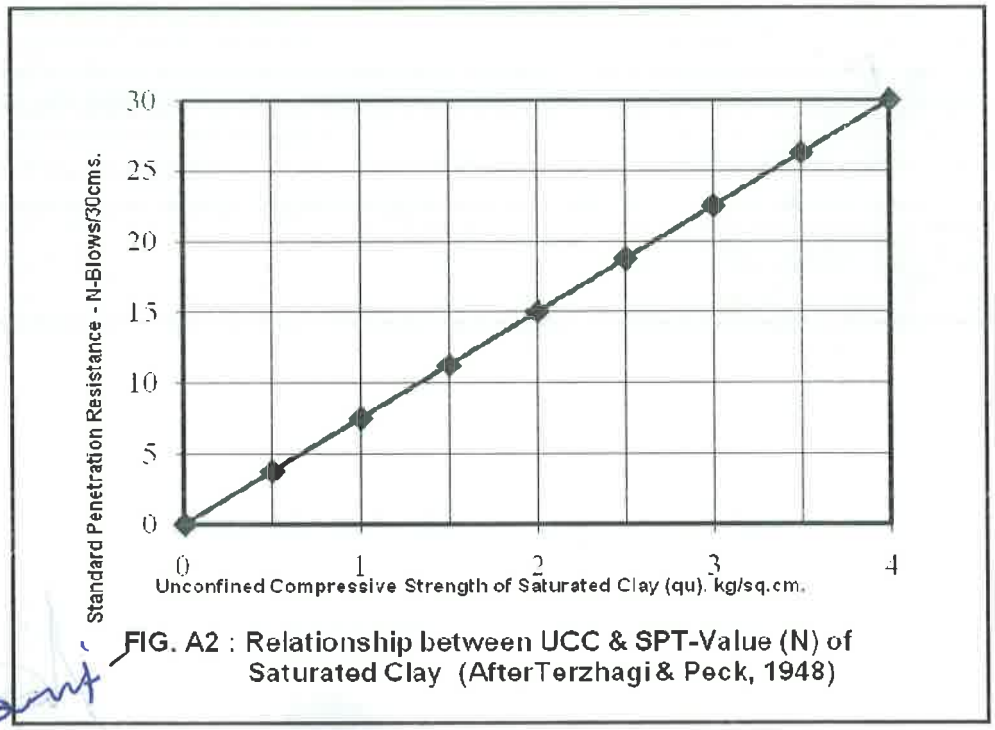


FIG. A2 : Relationship between UCC & SPT-Value (N) of Saturated Clay (AfterTerzhagi & Peck, 1948)

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