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PROJECT NAME

PROPOSED CONSTRUCTION OF VILLAS (G+ 1 UPPER FLOORS)
Survey No. 136 & 137, MAMBAKKAM VILLAGE, TAMBARAM TALUK
CHENGALPET DISTRICT

CLIENT NAME

AKSHAYA ESTATES REALTY LLP.,
RO NO 22, 2nd STREET, NEHRU
NAGAR, ADYAR, CHENNAI - 600 020.

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TITLE

GEOTECHNICAL INVESTIGATION REPORT

PROJECT NO: GEC-JC-GT-4111/2022-2023

REPORTING DATE: 20/01/2023

GEO ENGINEERING CONSULTANTS
G. MANOJ KUMAR
DDTC - No: GTE/TVLR/01/2019
CMDA No: GTE/19/03/012
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CONTENTS

	SEC. NO.	CONTENTS	PAGE NO.
			i-ii
CHAPTER-1		INTRODUCTION	
	1.0	Project Information Matrix	1
	1.1	Scope of Work	1
	1.1.1	Field Work	1
	1.1.2	Laboratory Work	1
	1.2	Structure of the Report	1
CHAPTER-2		INVESTIGATION METHODOLOGY & TEST RESULTS	
	2.0	Preamble	2
	2.1	Methodology of Field Work	2
	2.1.1	Equipment Used and Method of Drilling	2
	2.1.2	Standard Penetration Test	2
	2.1.3	Collection of Soil Samples	2
	2.1.4	Collection of Ground Water Samples	2-3
	2.2	Laboratory Testing	3
	2.2.1	On Coarse Grained Soil	3
	2.2.2	On Fine Grained Soil	3
	2.2.3	Chemical Analysis Tests	3
	2.3	Summary	3
FIGURES	2.0	Site Plan showing the Location of Field Investigation Points	4
	2.1 to 2.4	Soil Profile	5-8
	2.5 to 2.8	Graphical Representation of Grain Size Analyses Curve	9-12
	2.9 to 2.12	Graphical Representation of Hydrometer Analyses Curve	13-16
TABLES	2.1 to 2.4	Laboratory Test Results	17-20
	2.5	Chemical Test Results	21
CHAPTER-3		GEOLOGY & SUB-SURFACE STRATIFICATION	
	3.0	Preamble	22
	3.1	Geology of Study Area	22
	3.2	Design Sub Soil Profile	22-24
CHAPTER-4		FOUNDATION SYSTEM	
	4.0	Preamble	25
	4.1	Proposed Structures	25

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	4.2	Foundation System	25
FIGURE	4.1	Schematic diagrams for shallow foundation	26
CHAPTER-5		**RECOMMENDATIONS**	27
ANNEXURE		Typical Bearing Capacity Computations for Foundations	28
	A1	Relationship Between Angle of Internal Friction & N-Value	29
	A2	Relationship Between UCC & SPT -Value (N) of Saturated Clay	29

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REPORT TEXT

CHAPTER-1

INTRODUCTION

1.0 Project Information Matrix

Nature of project	: Proposed Construction of Villas (G+1 Upper Floors)
Project Client	: **M/s Akshaya Estates Realty LLP.,**
Project Location	: Mambakkam Village, Tambaram Taluk, Chengalpet District.
Job Code	: GEC-JC-GT-4111

1.1 Scope Of Work

1.1.1 Field Work

- Conducting two soil investigation bore holes of 150 mm up to 30.0m 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 depth interval up to 20.0m depth and after that at every 2.0m depth interval up to 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:

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

2.1 Methodology of Field Work:

2.1.1 Equipment Used and Method of Drilling:

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

2.1.2 Standard Penetration Tests:

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

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

2.1.3 Collection of Soil Samples:

2.1.3.1 Disturbed Samples:

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

2.1.4 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.

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 2.4. The graphical representation of grain size distribution curve for the representative samples in each bore is presented in Fig. 2.5 to 2.8.

2.2.2 On Fine Grained Soil

On the SPT sample index property tests were conducted to estimate consistency. These test results are presented in Tables-2.1 to 2.4. The graphical representation of hydrometer analyses curve for the representative samples in each bore is presented in Fig.2.9 to 2.12.

2.2.3 Chemical Analysis Tests

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

2.3 Summary:

The four 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 to 2.4.



SOIL PROFILE

SITE INVESTIGATION RECORD

PROJECT NAME	PROPOSED CONSTRUCTION OF VILLAS AT MAMBAKKAM					BORE HOLE No.	BH-01
						SHEET	1 OF 1
LOCATION	Mambakkam,Chennai	MACHINE No.	CR-01	CHAINAGE (m)	-	DIA OF BORE HOLE	150mm ✓ / NX
STRUCTURE	G+1 Upper Floors	DRILLING METHOD	Rotary	CO-ORDINATES	N -	BORE START DATE	10/01/2023
JOB CODE	JC-GT-4111	FLUSHING MEDIUM	Bentonite		E -	BORE END DATE	10/01/2023
						TOTAL DRILL DAYS	1

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	10/01/2023	12	16	SC	-	-										L1	0.5	Filled Up Soil (Clayey Sand)
		To																
		12	18															
1		12	28	SC	-	-	11	14	17	31	1.00 ↓	1	SS	-1.0				Brownish, Moist, Dense, Poorly Graded, **Clayey SAND (SC)** Sand - Clay Mixture
		To									1.45 ↓							
		12	29															
2		12	39	SC	-	-	11cm Penet. For 50 Blows			>100	2.00 ↓	2	SS	-2.0		L2	2.0	
		To									2.11 ↓							
		12	43															
3		12	53	SC	-	-	2cm Penet. For 50 Blows			>100	3.00 ↓	3	WS	-3.0				Whitish Brown/Brown, Moist, Very Dense, **Completely Weathered Rock** Descent from Rock Charnockite
		To									3.02 ↓							
		12	58															
4		13	55	SC	-	-	SPT Hammer Rebounded			>100	4.00	4	WS	-4.0				
		To																
		14	00															
5		14	11	SC	-	-	SPT Hammer Rebounded			>100	5.00	5	WS	-5.0				
		To																
		14	15															
6							SPT Hammer Rebounded			>100	6.00	6	WS	-6.0		L3	6.0	
7																		
8																		
9																		
10																		

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CS - Core Sample	DS - Disturbed Sample	LOGGED	Vinod Pradap	PROJECT SITE DETAILS		REMARKS
SS - Split Spoon Sample	SC - Soil Cutter	DATE	10/01/2023	GROUND LEVEL (m)	0.00	
UDS- Undisturbed Sample	TCB - Tungsten Carbide Bit	CHECKED	JALEEL YASIN	WATER TABLE (m)	1.00	
WS - Wash Sample	DB - Diamond Bit	DATE	20/01/2023	CASING DEPTH (m)	0.00	

Borehole terminated at 6 m depth below E.G.L

FIG.2.1 Sub Soil Profile at BH-01 Location

SITE INVESTIGATION RECORD

PROJECT NAME	PROPOSED CONSTRUCTION OF VILLAS AT MAMBAKKAM					BORE HOLE No.	BH-02
						SHEET	1 OF 1
						DIA OF BORE HOLE	150mm ✓ / NX
LOCATION	Mambakkam, Chennai	MACHINE No.	CR-01	CHAINAGE (m)	-	BORE START DATE	10/01/2023
STRUCTURE	G+1 Upper Floors	DRILLING METHOD	Rotary	CO-ORDINATES	N -	BORE END DATE	10/01/2023
JOB CODE	JC-GT-4111	FLUSHING MEDIUM	Bentonite		E -	TOTAL DRILL DAYS	1

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	10/01/2023	15	51	SC	-	-										L1	0.5	Filled Up Soil (Clayey Sand)
		To 15	52															
1		16	02	SC	-	-	6	7	7	14	1.00 / 1.45	1	SS	-1.0				Brownish, Moist, Stiff, **Sandy Silty CLAY (CH)** Sandy Clay of High Plasticity
		To 16	03															
2		16	13	SC	-	-	19	50	10cm Penet. For 50 Blows	>100	2.00 / 2.40	2	SS	-2.0		L2	2.0	
		To 16	17															Brownish White, Moist, Very Dense, **Residual Soil** Descent from Rock Charnockite
3		16	27	SC	-	-	7cm Penet. For 50 Blows			>100	3.00 / 3.07	3	SS	-3.0		L3	3.0	
		To 16	33															
4		16	43	SC	-	-	SPT Hammer Rebounded			>100	4.00	4	WS	-4.0				Brownish White, Moist, Very Dense, **Completely Weathered Rock** Descent from Rock Charnockite
		To 16	49															
5		16	59	SC	-	-	SPT Hammer Rebounded			>100	5.00	5	WS	-5.0				
		To 17	03															
6							SPT Hammer Rebounded			>100	6.00	6	WS	-6.0		L4	6.0	
7																		
8																		
9																		
10																		

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CS - Core Sample	DS - Disturbed Sample	LOGGED	Vinod Pradap	PROJECT SITE DETAILS	REMARKS
SS - Split Spoon Sample	SC - Soil Cutter	DATE	10/01/2023	GROUND LEVEL (m) 0.00	
UDS- Undisturbed Sample	TCB - Tungsten Carbide Bit	CHECKED	JALEEL YASIN	WATER TABLE (m) 1.00	
WS - Wash Sample	DB - Diamond Bit	DATE	20/01/2023	CASING DEPTH (m) 0.00	

Borehole terminated at 6 m depth below E.G.L

FIG.2.2 Sub Soil Profile at BH-02 Location

SITE INVESTIGATION RECORD

BORE HOLE No.	BH-03						
SHEET	1	OF	1				
PROJECT NAME	PROPOSED CONSTRUCTION OF VILLAS AT MAMBAKKAM					DIA OF BORE HOLE	150mm ✓ / NX
LOCATION	Mambakkam,Chennai	MACHINE No.	CR-01	CHAINAGE (m)	-	BORE START DATE	11/01/2023
STRUCTURE	G+1 Upper Floors	DRILLING METHOD	Rotary	CO-ORDINATES	N -	BORE END DATE	11/01/2023
JOB CODE	JC-GT-4111	FLUSHING MEDIUM	Bentonite		E -	TOTAL DRILL DAYS	1

Depth below E.G.L. (m)	Drilling progress per metre: Date	Time: Hr.	Time: Min.	Type of Drill Bit (SC / TCB / DB)	Core Details: Total Core Recovery %	Core Details: R.Q.D %	SPT Details: Blows/cm. 0-15	SPT Details: Blows/cm. 15-30	SPT Details: Blows/cm. 30-45	SPT 'N' Value	Sample Details: Depth	Sample Details: No.	Sample Details: Type	Sample Details: RL (m)	Layer Data: Legend	Layer Data: No	Layer Data: Depth	Geotechnical Description
0	11/01/2023	07	30	SC	-	-										L1	0.5	**Filled Up Soil** (Clayey Sand)
		To																
		07	31				4	10	14	24	1.00	1	SS	-1.0				
1		07	42								1.45							Brownish, Moist, Very Stiff, **Sandy Silty CLAY (CH)** Sandy Clay of High Plasticity
		To		SC	-	-												
		07	43															
2							3cm Penet. For 50 Blows			>100	2.00	2	SS	-2.0		L2	2.0	
		07	55								2.03							
		To		SC	-	-												
		07	59															
3							1cm Penet. For 50 Blows			>100	3.00	3	WS	-3.0				
		08	10								3.01							
		To		SC	-	-												Brownish White, Moist, Very Dense, **Completely Weathered Rock** Descent from Rock Charnockite
		08	16															
4							SPT Hammer Rebounded			>100	4.00	4	WS	-4.0				
		08	26															
		To		SC	-	-												
		08	35															
5							SPT Hammer Rebounded			>100	5.00	5	WS	-5.0		L3	6.0	
6																		
7																		
8																		
9																		
10																L4	10.0	



CS - Core Sample	DS - Disturbed Sample	LOGGED	Vinod Pradap	PROJECT SITE DETAILS	REMARKS
SS - Split Spoon Sample	SC - Soil Cutter	DATE	11/01/2023	GROUND LEVEL (m) 0.00	
UDS- Undisturbed Sample	TCB - Tungsten Carbide Bit	CHECKED	JALEEL YASIN	WATER TABLE (m) 1.00	
WS - Wash Sample	DB - Diamond Bit	DATE	20/01/2023	CASING DEPTH (m) 0.00	

Borehole terminated at 5 m depth below E.G.L

FIG.2.3 Sub Soil Profile at BH-03 Location

SITE INVESTIGATION RECORD

BORE HOLE No.	BH-04						
SHEET	1	OF	1				
PROJECT NAME	PROPOSED CONSTRUCTION OF VILLAS AT MAMBAKKAM					DIA OF BORE HOLE	150mm ✓ / NX
LOCATION	Mambakkam,Chennai	MACHINE No.	CR-01	CHAINAGE (m)	-	BORE START DATE	11/01/2023
STRUCTURE	G+1 Upper Floors	DRILLING METHOD	Rotary	CO-ORDINATES	N -	BORE END DATE	11/01/2023
JOB CODE	JC-GT-4111	FLUSHING MEDIUM	Bentonite		E -	TOTAL DRILL DAYS	1

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	Layer Data: Geotechnical Description
0	11/01/2023	12	03	SC	-	-										L1	0.5	**Filled Up Soil** (Clayey Sand)
		To 12	04															
1		12	15				3	4	5	9	1.00	1	SS	-1.0				Brownish, Moist, Loose, Poorly Graded, **ClayeySilty SAND (SC)** Sand - Clay Mixture
		To 12	16	SC	-	-					1.45							
2		12	28				5	9	11	20	2.00	2	SS	-2.0		L2	2.0	
		To 12	29	SC	-	-					2.45							Brown, Moist, Medium Dense, Poorly Graded, **Clayey Silty SAND (SC)**, Sand - Clay Mixture
3		12	40				30	8cm Penet. For 50 Blows		>100	3.00	3	SS	-3.0		L3	3.0	
		To 12	42	SC	-	-					3.23							
4		12	55				3cm Penet. For 50 Blows			>100	4.00	4	WS	-4.0				Brown, Moist, Very Dense, **Completely Weathered Rock** Descent from Rock Charnockite
		To 13	00	SC	-	-					4.03							
5		13	11				SPT Hammer Rebounded			>100	5.00	5	WS	-5.0		L4	5.0	
		To 13	33	DB	60	0												Brown, **Moderately Weathered Rock** Descent from Rock Charnockite
6							-	-	-	-	6.00	6	CS	-6.0		L5	6.0	
7																		
8																		
9																		
10																		

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CS - Core Sample	DS - Disturbed Sample	LOGGED	Vinod Pradap	PROJECT SITE DETAILS		REMARKS
SS - Split Spoon Sample	SC - Soil Cutter	DATE	11/01/2023	GROUND LEVEL (m)	0.00	
UDS- Undisturbed Sample	TCB - Tungsten Carbide Bit	CHECKED	JALEEL YASIN	WATER TABLE (m)	1.00	
WS - Wash Sample	DB - Diamond Bit	DATE	20/01/2023	CASING DEPTH (m)	0.00	

Borehole terminated at 6 m depth below E.G.L

FIG.2.4 Sub Soil Profile at BH-04 Location

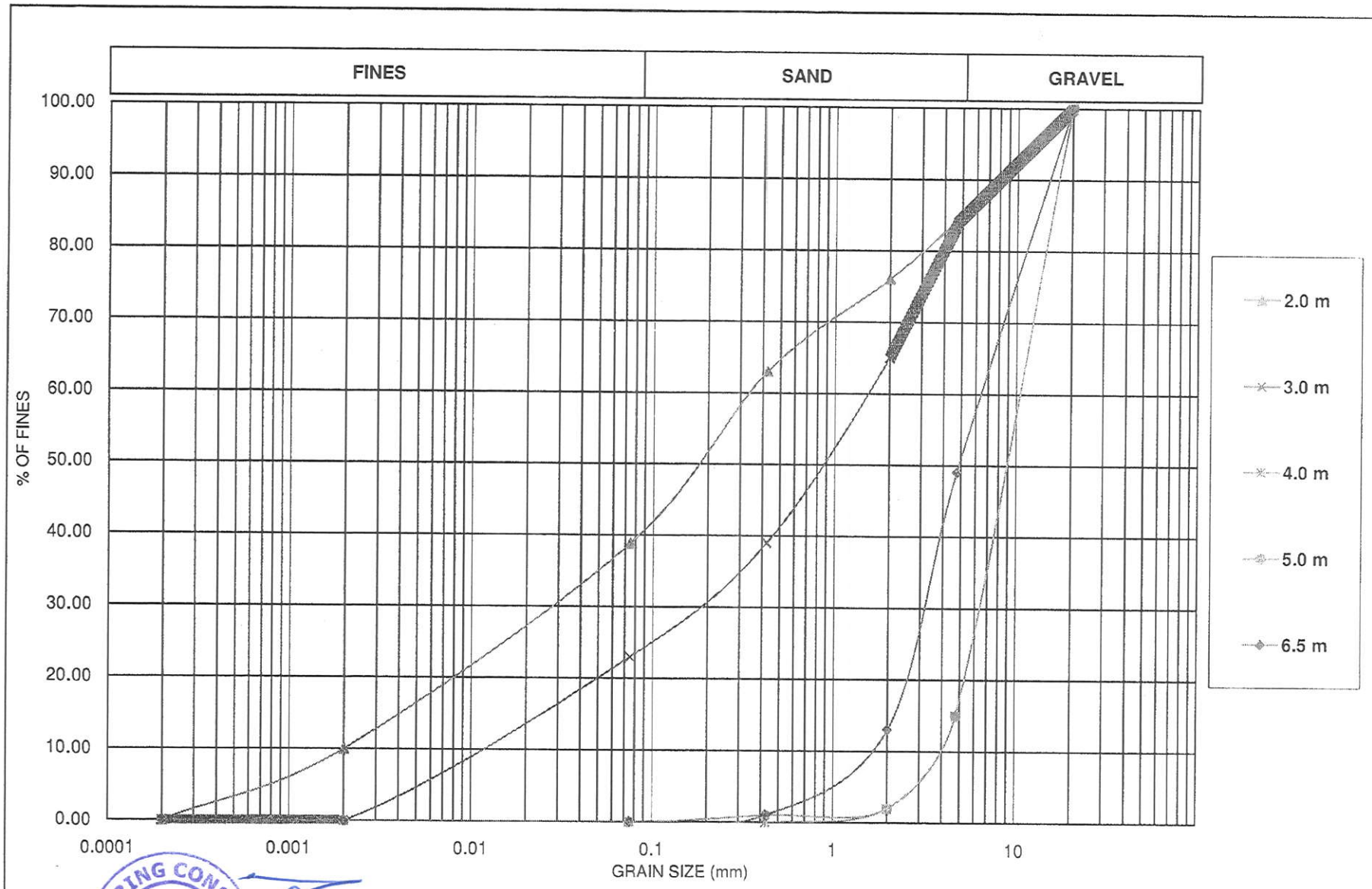


Fig. 2.6 GRAIN SIZE DISTRIBUTION CURVE - BH-02

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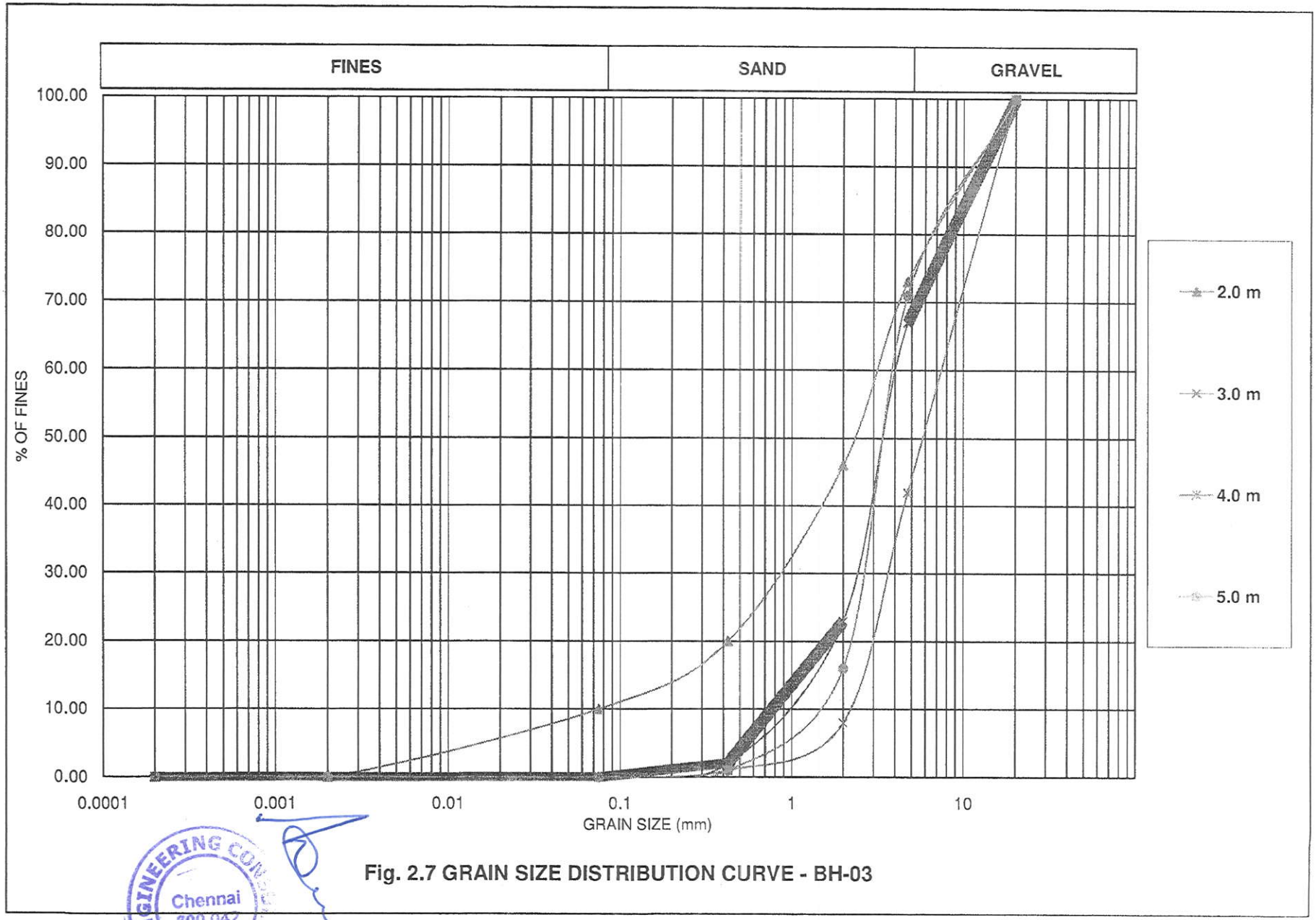


Fig. 2.7 GRAIN SIZE DISTRIBUTION CURVE - BH-03

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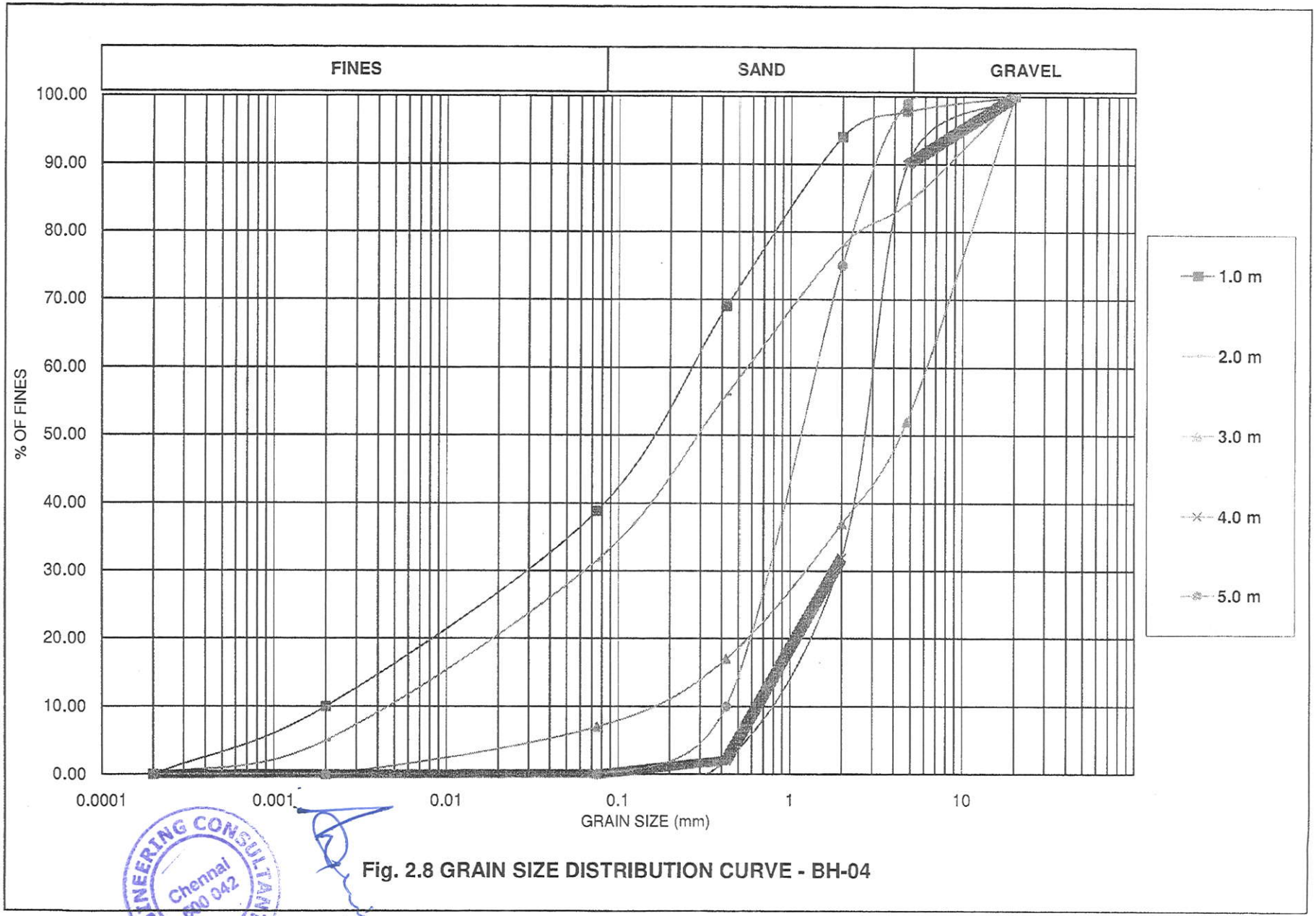


Fig. 2.8 GRAIN SIZE DISTRIBUTION CURVE - BH-04

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HYDROMETER ANALYSIS CURVE

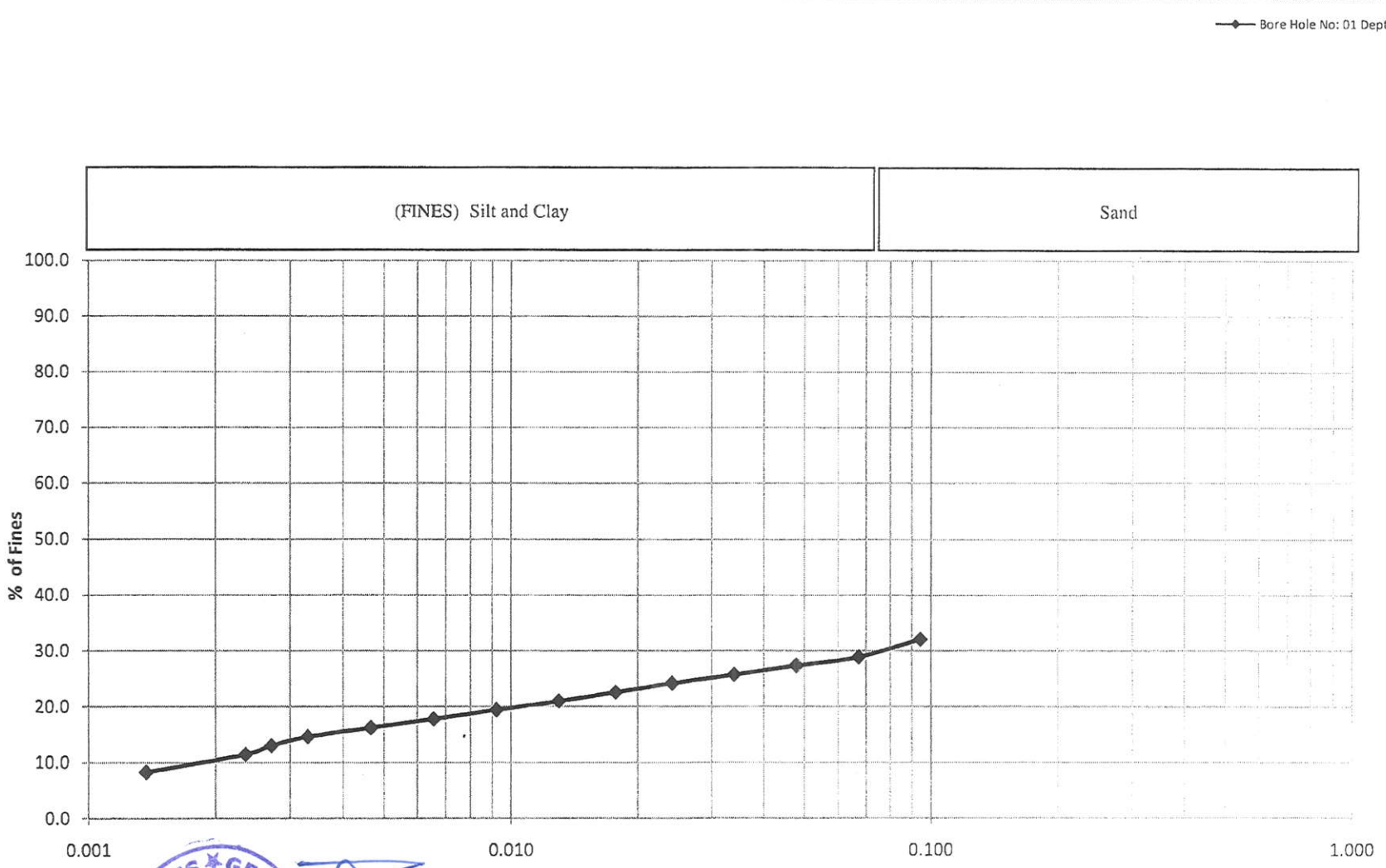


Fig 2.9 Hydrometer Analysis Master Curve

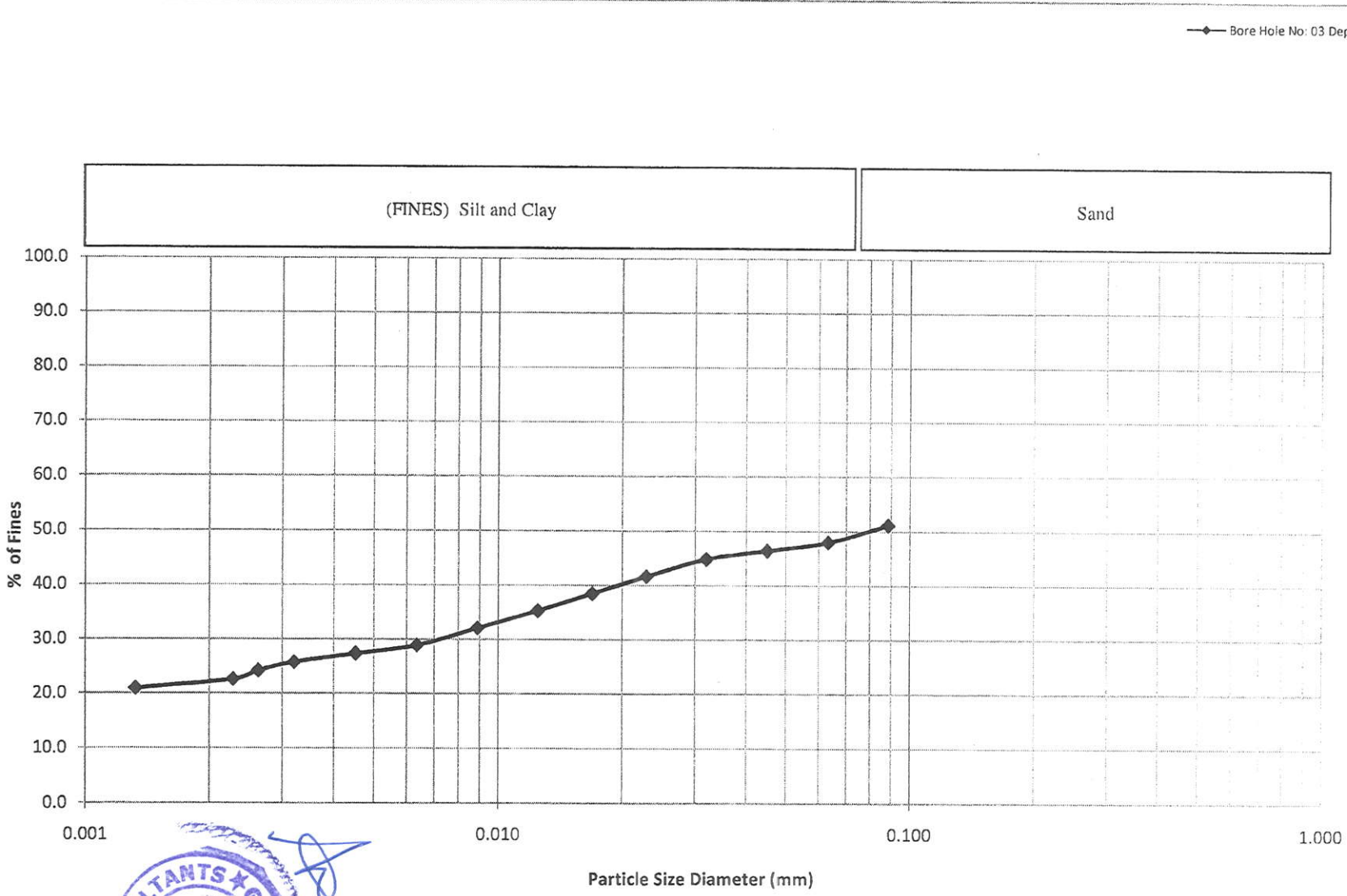


Fig 2.11 Hydrometer Analysis Master Curve

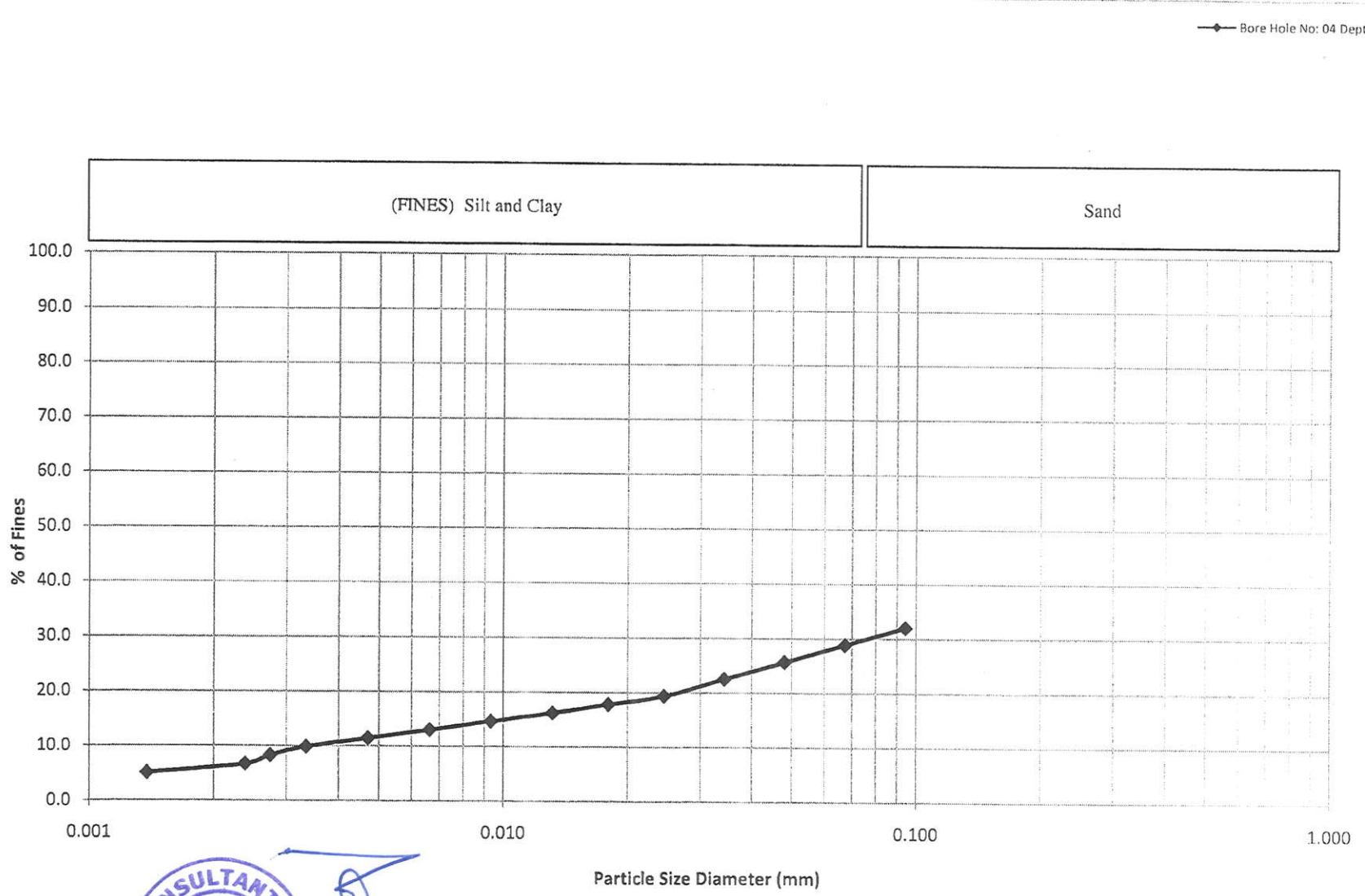


Fig 2.12 Hydrometer Analysis Master Curve

LABORATORY TEST RESULTS

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

Depth of Sample below E.G.L. (m)	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 Respect to A-Aline	IS:Notation	Gravel (%)	Coarse (%)	Medium (%)	Fine (%)	Silt (%)	Clay (%)	D_{10} (mm)	D_{30}(mm)	D_{60} (mm)	$C_U=D_{60}/D_{10}$	$C_c=D_{30}^2/(D_{10}xD_{60})$	Relative Density	Gravel	Sand
1.0	31	SS	14	39	18	21	1.19	16	41	CG>50%	Above	-	12	16	20	10	34	8	-	-	-	-	-	Dense	<50%	SC
2.0	>100	SS	-	-	-	-	-	-	-	CG>50%	-	-	19	22	35	15	9	0	-	-	-	-	-	V.Dense	<50%	SP-SM
3.0	>100	WS	-	-	-	-	-	-	-	CG>50%	-	-	83	10	4	3	0	0	-	-	-	-	-	V.Dense	GP	<50%
4.0	>100	WS	-	-	-	-	-	-	-	CG>50%	-	-	70	6	9	15	0	0	-	-	-	-	-	V.Dense	GP	<50%
5.0	>100	WS	-	-	-	-	-	-	-	CG>50%	-	-	83	14	2	1	0	0	-	-	-	-	-	V.Dense	GP	<50%
6.5	>100	WS	-	-	-	-	-	-	-	CG>50%	-	-	41	38	21	0	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 below E.G.L. (m)	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 Respect to A-Aline	IS:Notation	Gravel (%)	Coarse (%)	Medium (%)	Fine (%)	Silt (%)	Clay (%)	D_{10} (mm)	D_{30}(mm)	D_{60} (mm)	$C_U=D_{60}/D_{10}$	$C_c=D_{30}^2/(D_{10}xD_{60})$	Relative Density	Gravel	Sand
1.0	14	SS	28	64	26	38	0.95	14	58	Stiff	Above	CH	5	9	20	9	40	17	-	-	-	-	-	FG>50%	FG>50%	FG>50%
2.0	>100	SS	14	30	16	14	1.14	17	22	CG>50%	Above	-	14	10	13	8	35	10	-	-	-	-	-	V.Dense	<50%	SC
3.0	>100	SS	-	-	-	-	-	-	-	CG>50%	-	-	16	19	26	16	23	0	-	-	-	-	-	V.Dense	<50%	SM
4.0	>100	WS	-	-	-	-	-	-	-	CG>50%	-	-	85	13	2	0	0	0	-	-	-	-	-	V.Dense	GP	<50%
5.0	>100	WS	-	-	-	-	-	-	-	CG>50%	-	-	85	13	1	1	0	0	-	-	-	-	-	V.Dense	GP	<50%
6.5	>100	WS	-	-	-	-	-	-	-	CG>50%	-	-	51	36	12	1	0	0	-	-	-	-	-	V.Dense	GP	<50%

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

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

Depth of Sample below E.G.L. (m)	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 Respect to A-Aline	IS:Notation	Gravel (%)	Coarse (%)	Medium (%)	Fine (%)	Silt (%)	Clay (%)	D_{10} (mm)	D_{30}(mm)	D_{60} (mm)	$C_U=D_{60}/D_{10}$	$C_c=D_{30}^2/(D_{10}xD_{60})$	Relative Density	Gravel	Sand
1.0	24	SS	18	44	24	20	1.30	15	27	V.Stiff	Above	CI	8	9	13	8	42	20	-	-	-	-	-	FG>50%	FG>50%	FG>50%
2.0	>100	SS	-	-	-	-	-	-	-	CG>50%	-	-	27	27	26	10	10	0	-	-	-	-	-	V.Dense	<50%	SP-SM
3.0	>100	WS	-	-	-	-	-	-	-	CG>50%	-	-	33	44	21	2	0	0	-	-	-	-	-	V.Dense	<50%	SP
4.0	>100	WS	-	-	-	-	-	-	-	CG>50%	-	-	58	34	7	1	0	0	-	-	-	-	-	V.Dense	GP	<50%
5.0	>100	WS	-	-	-	-	-	-	-	CG>50%	-	-	29	55	15	1	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

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

Depth of Sample below E.G.L. (m)	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 Respect to A-Aline	IS:Notation	Gravel (%)	Coarse (%)	Medium (%)	Fine (%)	Silt (%)	Clay (%)	D_{10} (mm)	D_{30}(mm)	D_{60} (mm)	$C_U=D_{60}/D_{10}$	$C_c=D_{30}^2/(D_{10}xD_{60})$	Relative Density	Gravel	Sand
1.0	9	SS	24	44	18	26	0.77	14	42	CG>50%	Above	-	2	4	25	24	35	10	-	-	-	-	-	Loose	<50%	SC
2.0	20	SS	15	37	17	20	1.10	17	27	CG>50%	Above	-	15	7	22	21	30	5	-	-	-	-	-	M.Dense	<50%	SC
3.0	>100	SS	-	-	-	-	-	-	-	CG>50%	-	-	48	15	20	10	7	0	-	-	-	-	-	V.Dense	GP-GC	<50%
4.0	>100	WS	-	-	-	-	-	-	-	CG>50%	-	-	10	58	30	2	0	0	-	-	-	-	-	V.Dense	<50%	SP
5.0	>100	WS	-	-	-	-	-	-	-	CG>50%	-	-	1	24	65	10	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
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Table-2.5 Results of Chemical Analysis									
SL No.	Bore HoleNo.	Water				Soil (2:1)			
		Depth of Sample (m)	pH	Chlorides (mg/l)	Sulphates (mg/l)	Depth of Sample (m)	pH	Chlorides (mg/l)	Sulphates (mg/l)
1	BH-01	1.00	7.35	375	395	2.0	7.45	411	439
2	BH-04	1.00	7.35	378	391	2.0	7.45	418	433

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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 the Region (based on the published data)

3.1.1 Formation Characteristics:

The present location falls under chengalpet district, which can be geologically classified as hard rock formation (Charnockite of Meta igneous origin) of Archaean Rock Group, overlain by recent alluvium deposits.The entire area is mostly covered by recent alluvium on the site. The rocks present in this site are of Archaean age undergone weathering to variable extent. The thickness of alluvium deposit is around 2 to 3 meter underlain by varying degree of weathering.

The present site is Mambakkam Village, Tambaram Taluk, geologically it is classified as recent alluvium deposits consisting of Sandy Silty Clay/Clayey Silty Sand, which is underlying by varying degree of weathering and basement rock.

Recent alluvium deposit

Archaean Basement Crystalline Rock

3.2 DESIGN SUB SOIL PROFILE: (from Foundation Engineering Application)

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

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

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

REFERENCE BORE HOLE-BH:					01	Ref R.L. of G.L. (m):			0.000		
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 Clayey Silty Sand	-	-	-	-	-	-	-
2	0.50	2.00	1.50	Clayey Silty Sand	Brownish	31	Dense	-	19.5	-	36.28
3	2.00	6.00	4.00	Completely Weathered Rock	Whitish Brown	>100	Very Dense	-	21	-	42.5

REFERENCE BORE HOLE-BH:					02	Ref R.L. of G.L. (m):			0.000		
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 Clayey Silty Sand	-	-	-	-	-	-	-
2	0.50	2.00	1.50	Clayey Silty Sand	Brownish	31	Dense	-	19.5	-	36.28
3	2.00	3.00	1.00	Residual Soil	Brownish White	>100	Very Dense	-	21	-	42.5
4	3.00	6.00	3.00	Completely Weathered Rock	Whitish Brown	>100	Very Dense	-	21	-	42.5



REFERENCE BORE HOLE-BH:					03	Ref R.L. of G.L. (m):			0.000		
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 Clayey Silty Sand	-	-	-	-	-	-	-
2	0.50	2.00	1.50	Sandy Silty Clay	Brownish	24	-	Very Stiff	20.5	160	-
3	2.00	6.00	4.00	Completely Weathered Rock	Whitish Brown	>100	Very Dense	-	21	-	42.5

REFERENCE BORE HOLE-BH:					04	Ref R.L. of G.L. (m):			0.000		
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 Clayey Silty Sand	-	-	-	-	-	-	-
2	0.50	2.00	1.50	Clayey Silty Sand	Brown	9	Loose	-	14.5	-	29.8
3	2.00	3.00	1.00	Clayey Silty Sand	Brown	20	Medium Dense	-	18	-	33
4	3.00	5.00	2.00	Completely Weathered Rock	Whitish Brown	>100	Very Dense	-	21	-	42.5
5	5.00	6.00	1.00	Moderately Weathered Rock	Brown	CRR-60%,RQD-0%					

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FOUNDATION SYSTEM

CHAPTER-4

FOUNDATION SYSTEM

4.0 Preamble:

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

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

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

4.1 Proposed Structures

An understanding of the proposed construction and the order of loads on the foundations is needed for choosing the appropriate foundation system. In the present case, the proposed structure is configured with ground floor + 1 upper floors, and is meant for residetial occupancy. For this kind of structure, the column loads could vary between 900 kN to 1200 kN. The above-mentioned loads have no bearing on the design of either sub or super structures and are mentioned just to provide an insight to choose an appropriate foundation system with respect to subsoil conditions.

4.2 Foundation System

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 Isolated column footings can be located at a depth of 1.5m 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 footings can be designed for an allowable safe bearing pressure of 200kPa.

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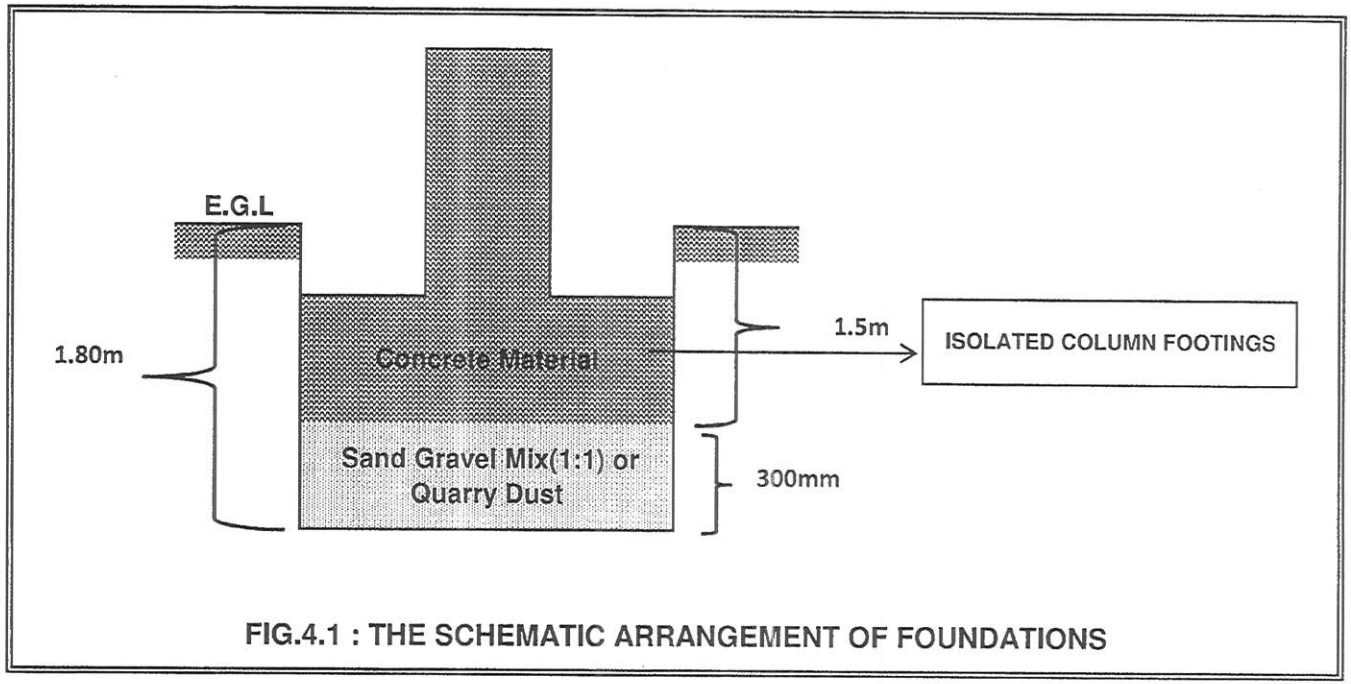


FIG.4.1 : THE SCHEMATIC ARRANGEMENT OF FOUNDATIONS

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RECOMMENDATIONS

CHAPTER-5

RECOMMENDATIONS

5.1 Recommendation for shallow foundation

- For the kind of sub soil conditions shallow foundation system coupled with soil replacement type of ground improvement technique within the foundation pit can be adopted
- The depth of foundation excavation will be 1.80m below the existing ground level and shall be back filled with either sand-gravel (1:1) mix 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 or hand rammer
- The **Isolated column footings** can be located at a depth of 1.50m over the prepared bed and can be designed for an allowable safe bearing pressure of 200kPa.
- 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 plinth 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.

5.2 General Recommendation:

- Since, chlorides and sulphates are well within the permissible limits, no special steel or cement is required for the construction of footings

For Geo Engineering Consultants, Chennai

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Authorized Signatory

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ANNEXURE

TYPICAL BEARING CAPACITY COMPUTATIONS FOR SHALLOW FOUNDATIONS

1.0 COMPUTATION OF BEARING CAPACITY AS PER IS:6403

Ref. BH-4

1.1 Geometrical Data :

Shape of the Foundation	square
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)	2.00
Length of Footing "L" (m)	2.00
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	20.00
Type of Shear Failure:	General
Angle of Shearing Resistance	33.00

1.3 Design Parameters:

Bulk Density of Soil above the foundation depth (g_{bulk})	18.50
Water Table Correction Factor (w')	0.50
Effective Overburden pressure at foundation level (q)	12.75
Bearing Capacity Factors:	
N_c =	N/A
N_q =	27.34
N_g =	37.78
Shape Factors:	
S_c =	-
S_q =	1.20
S_g =	0.80
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' 693.44 kPa

(g should be read as gama)

1.5 Safe Bearing Capacity (Qsafe) :

Factor of Safety (F.S.) :	2.50	
Qsafe :	277.38	kPa
Say Q_{safe}	**200**	**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	200.00
Poission's Ratio (m_1)	0.20

Modulus of Elasticity (E_s)(Ref. Joseph E Bowels,1996,page316,Table5.6, Japanese design standards)

Modulus of Elasticity (E_s)	52000.00	
Size of footing considered for maximum settlement(m)	2.00	
Influence factor	1.00	
Rigidity Factor	1.00	
Elastic Settlement (DH_i)	7.38	mm
	<50	mm

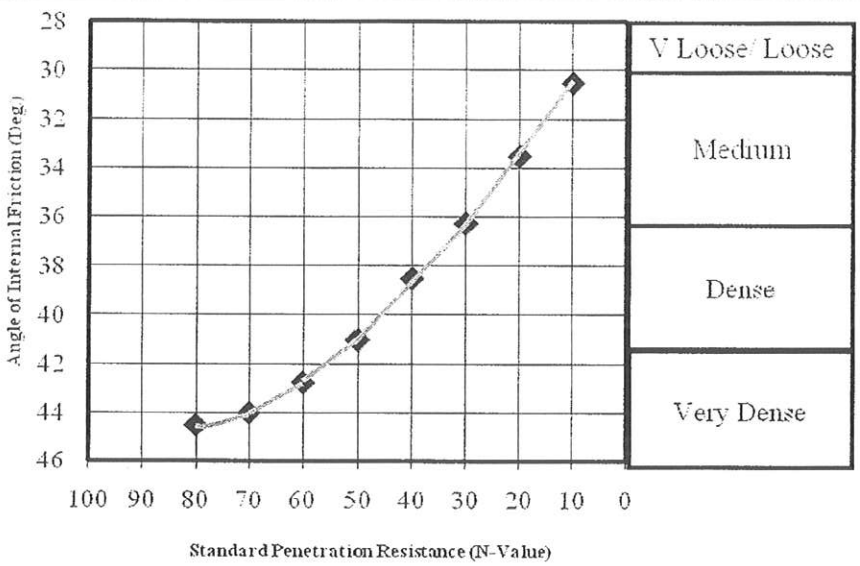


FIG. A1 Relation Ship between Angle of Internal Friction & N-value (Reproduced from IS:6403-1981)

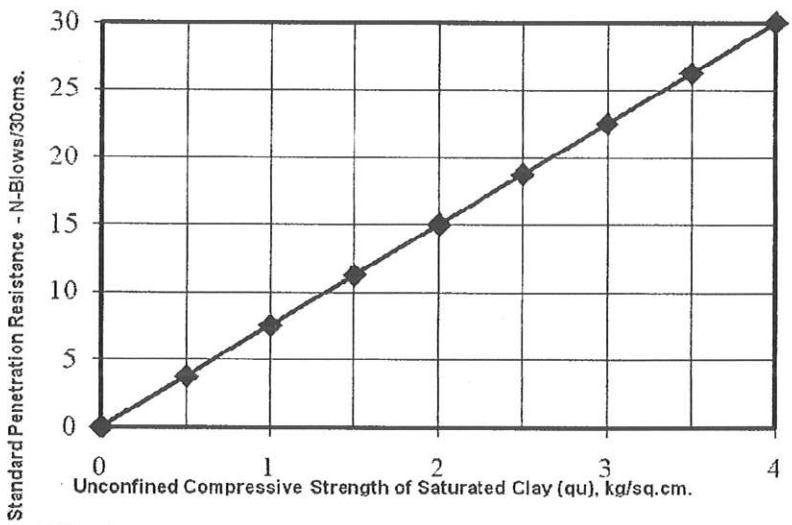


FIG. A2 : Relationship between UCC & SPT-Value (N) of Saturated Clay (AfterTerzhagi & Peck, 1948)

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