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GEO ENGINEERINGCONSULTANTS

(An ISO 9001:2015 Certified Company)

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PROJECT NAME

PROPOSED CONSTRUCTION OF RESIDENTIAL & COMMERCIAL NON HIGH RISE GROUP DEVELOPMENT CONSISTS OF 15 BLOCKS, BLOCK 1 TO 12A : GROUND + FIRST FLOOR + SECOND FLOOR, 13 D/U, BLOCK : 14 COMBINED BASEMENT + GROUND + 5 UPPER FLOORS, 35 D/U, TOTALLY 48 D/U WITH SWIMMING POOL ON THE GROUND FLOOR LEVEL & BLOCK 15 (COMMERCIAL BLOCK) : COMBINED BASEMENT + GROUND + 4 UPPER FLOORS

CLIENT NAME

CASA GRANDE COIMBATORE LLP,
COIMBATORE.

PROJECT ADDRESS

CASAGRAND AVARAMPALAYAM,
(OLD SURVEY NO.381 PT) TS NOS: 1/2, WARD AA, BLOCK-2,
SOWRIPALAYAM, COIMBATORE SOUTH,
COIMBATORE.

GEO ENGINEERING CONSULTANTS Chennai 600 042

TITLE

GEOTECHNICAL INVESTIGATION REPORT

PROJECT NO: GEC-JC-GT-4110/2022-2023

GEO ENGINEERING CONSULTANTS
G. MANOJ KUMAR
DDTC - No: GTE/TVLR/01/2019
CMDA No: GTE/19/03/012
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DATE: 14/01/2023

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REPORT TEXT

CHAPTER-1

INTRODUCTION

1.0 Project Information Matrix

Nature of project : Proposed Residential Apartment & Commercial Building (1B+Ground+5 Upper Floors/1B+Ground+4 Upper floors and G+2 Villas)

Project Owner : **Casa Grande Coimbatore LLP,**

Project Location : Ward AA, Block-2, Sowripalayam, Coimbatore South, Coimbatore

Job Code : GEC-JC-GT-4110

1.1 Scope of Work

1.1.1 Field Work

- Conducting five soil investigation bore holes of 150 mm & NX diameter up to 7.0m 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 termination depth.
- Collection of Soil Samples and undisturbed samples from the clayey strata with SPT-value less than 15.
- Collection of water samples if groundwater table met within the investigation depth

.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:

Five 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 2.5. The graphical representation of grain size distribution curve for the representative samples in each bore is presented in Fig. 2.6 to 2.10.

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 2.5. The graphical representation of hydrometer analyses curve for the representative samples in each bore is presented in Fig.2.11 to 2.15.

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 - 2.6.

2.3 Summary:

The seven 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 2.5.

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SITE PLAN

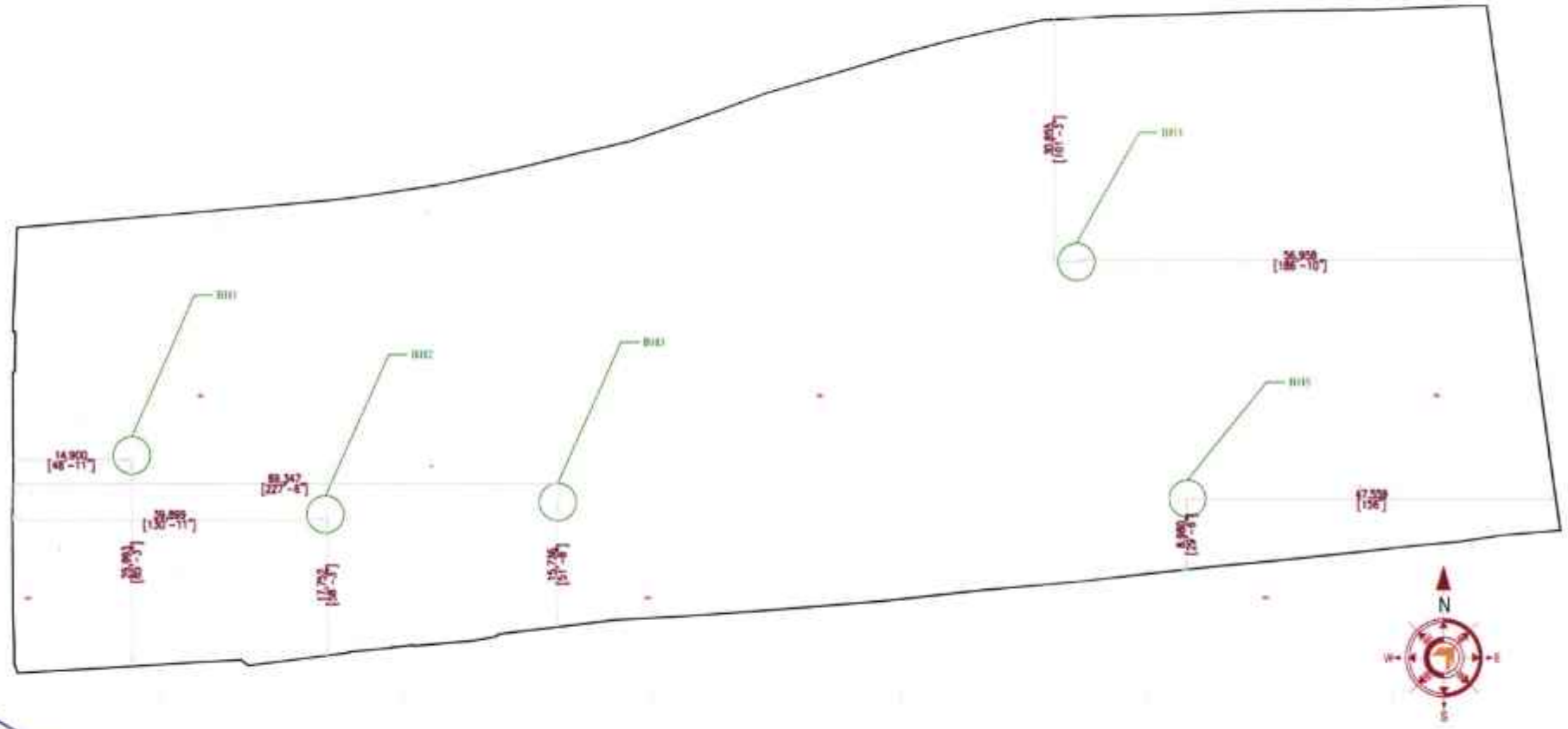


FIG:- 2.0 SITE PLAN SHOWING FIELD BORE HOLE INVESTIGATION POINT AT AVARAMPALAYAM, COIMBATORE.

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SOIL PROFILE

SITE INVESTIGATION RECORD

BORE HOLE No.	BH-01		
SHEET	1	OF	1
DIA OF BORE HOLE	150mm ✓ / 100mm		
BORE START DATE	01/01/2023		
BORE END DATE	01/01/2023		
TOTAL DRILL DAYS	1		

PROJECT NAME	PROPOSED CONSTRUCTION OF RESIDENTIAL & COMMERCIAL BUILDING AND VILLAS				
LOCATION	Avarampalayam, Coimbatore	MACHINE No.	CR-01	CHAINAGE (m)	-
STRUCTURE	(1B+G+5 Floors/1B+G+4 Floors/G+2 Villas)	DRILLING METHOD	Rotary	CO-ORDINATES	N
JOB CODE	GEC-JC-GT-4110	FLUSHING MEDIUM	Bentonite		E

Depth below E.G.L (m)	Drilling progress per metre: Date	Time: Hr.	Time: Min.	Type of Drill Bit (SC / TCB / DB)	Core Details: Total Core Recovery %	Core Details: R.Q.D %	SPT Details: Blows/cm. 0-15	SPT Details: Blows/cm. 15-30	SPT Details: Blows/cm. 30-45	SPT 'N' Value	Sample Details: Depth	Sample Details: No.	Sample Details: Type	Sample Details: RL (m)	Layer Data: Legend	Layer Data: No	Layer Data: Depth	Layer Data: Geotechnical Description
0	01/01/2023	10	01													L1	0.5	**Filled Up Soil** (Clayey Sand)
		To		SC	-	-												
		10	03															
1							3	3	4	7	1.00	1	SS	-1.0				Brown, Moist, Medium Stiff, **Sandy Silty CLAY (CH)**, Silty Clay of High Plasticity
		10	15								1.45							
		To		SC	-	-												
		10	20													L2	2.0	
2							5	9	15	24	2.00	2	SS	-2.0				Brown, Moist, Very Stiff, **Sandy Silty CLAY (CI)**, Silty Clay of Medium Plasticity with Lime Particles
		10	40															
		To		SC	-	-												
		11	00													L3	3.0	
3							SPT Hammer Rebounded			>100	3.00	3	WS	-3.0				
		11	20															
		To		DB	19	0												
4		12	01				-	-	-	-	4.50	4	CS	-4.5				White,Fine Grains, Massive,Moderately Weathered **Limestone Rock**
		12	15															
		To		DB	23	9												
5		13	15				-	-	-	-	5.50	5	CS	-5.5				
		13	30															
		To		DB	26	16												
6		14	40				-	-	-	-	6.50	6	CS	-6.5		L4	6.5	
7																		
8																		
9																		
10																		

CS - Core Sample	DS - Disturbed Sample	LOGGED	Vinod Pradap	PROJECT SITE DETAILS		REMARKS
SS - Split Spoon Sample	SC - Soil Cutter	DATE	01/01/2023	GROUND LEVEL (m)	0.00	
UDS- Undisturbed Sample	TCB - Tungsten Carbide Bit	CHECKED	Jaleel Yasin	WATER TABLE (m)	1.40	
WS - Wash Sample	DB - Diamond Bit	DATE	13/01/2023	CASING DEPTH (m)	0.00	

Borehole terminated at 6.5 m depth below E.G.L

FIG.2.1 Sub Soil Profile at BH-01 Location

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SITE INVESTIGATION RECORD

BORE HOLE No.	BH-02
SHEET	1 OF 1
DIA OF BORE HOLE	150mm ✓ / 100mm
BORE START DATE	31/12/2022
BORE END DATE	01/01/2023
TOTAL DRILL DAYS	2

PROJECT NAME	PROPOSED CONSTRUCTION OF RESIDENTIAL & COMMERCIAL BUILDING AND VILLAS
LOCATION	Avarampalayam, Coimbatore
STRUCTURE	(1B+G+5 Floors/1B+G+4 Floors/G+2 Villas)
JOB CODE	GEC-JC-GT-4110
MACHINE No.	CR-01
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	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	31/12/2022	17	30	SC	-	-										L1	0.5	**Filled Up Soil** (Clayey Sand)
		To 17	31															
1		17	40				2	3	3	6	1.00	1	SS	-1.0				Brown, Moist, Medium Stiff, **Sandy Silty CLAY (Cl)**, Silty Clay of Medium Plasticity
		To 17	41	SC	-	-					1.45							
2		17	53				15	30	10cm Penet. For 50 Blows	>100	2.00	2	SS	-2.0		L2	2.0	
		To 17	56	SC	-	-					2.40							Brown, Moist, Very Dense, **Clayey SAND(SC)** with Lime Particles
3							SPT Hammer Rebounded			>100	2.50	3	WS	-2.5		L3	2.5	
		18	09															
		To 18	36	DB	19	7												
4							-	-	-	-	4.00	4	CS	-4.0				White, Fine Grains, Massive, Moderately Weathered **Limestone Rock**
5		18	40															
		To 19	15	DB	24	13												
	01/01/2023						-	-	-	-	5.50	5	CS	-5.5				
6		07	40															
		To 08	36	DB	26	18												
							-	-	-	-	6.50	6	CS	-6.5		L4	6.5	
7																		
8																		
9																		
10																		

CS - Core Sample	DS - Disturbed Sample	LOGGED	Vinod Pradap	PROJECT SITE DETAILS	REMARKS
SS - Split Spoon Sample	SC - Soil Cutter	DATE	31/12/2022	GROUND LEVEL (m) 0.00	
UDS - Undisturbed Sample	TCB - Tungsten Carbide Bit	CHECKED	Jaleel Yasin	WATER TABLE (m) 1.50	
WS - Wash Sample	DB - Diamond Bit	DATE	13/01/2023	CASING DEPTH (m) 0.00	

Borehole terminated at 6.5 m depth below E.G.L

FIG.2.2 Sub Soil Profile at BH-02 Location

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SITE INVESTIGATION RECORD

BORE HOLE No.	BH-03		
SHEET	1	OF	1
DIA OF BORE HOLE	150mm ✓		
	100mm		
BORE START DATE	31/12/2022		
BORE END DATE	31/12/2022		
TOTAL DRILL DAYS	1		

PROJECT NAME	PROPOSED CONSTRUCTION OF RESIDENTIAL & COMMERCIAL BUILDING AND VILLAS				
LOCATION	Avarampalayam, Coimbatore	MACHINE No.	CR-01	CHAINAGE (m)	-
STRUCTURE	(1B+G+5 Floors/1B+G+4 Floors/G+2 Villas)	DRILLING METHOD	Rotary	CO-ORDINATES	N
JOB CODE	GEC-JC-GT-4110	FLUSHING MEDIUM	Bentonite		E

Depth below E.G.L (m)	Drilling progress per metre: Date	Time: Hr.	Time: Min.	Type of Drill Bit (SC / TCB / DB)	Core Details: Total Core Recovery %	Core Details: R.Q.D %	SPT Details: Blows/cm. 0-15	SPT Details: Blows/cm. 15-30	SPT Details: Blows/cm. 30-45	SPT 'N' Value	Sample Details: Depth	Sample Details: No.	Sample Details: Type	Sample Details: RL (m)	Layer Data: Legend	Layer Data: No	Layer Data: Depth	Geotechnical Description
0	31/12/2022	13	50	SC	-	-										L1	0.5	**Filled Up Soil** (Clayey Sand)
		To																
		13	53															
1							4	4	6	10	1.00	1	SS	-1.0				Brown, Moist, Stiff, **Sandy Silty CLAY (CH)**, Silty Clay of High Plasticity
		14	05								1.45							
		To		SC	-	-												
		14	09															
2		14	20				14	16	20	38	2.00	2	SS	-2.0		L2	2.0	
		To									2.45							Brown, Moist,Hard, **Sandy Silty CLAY (CI)** with Lime Particles
		14	23	SC	-	-										L3	2.5	
							SPT Hammer Rebounded			>100	2.50	3	WS	-2.5				
3		14	33															
		To		DB	16	8												
		15	00															
4							-	-	-	-	4.00	4	CS	-4.0				White,Fine Grains, Massive,Moderately Weathered **Limestone Rock**
		15	10															
5		To		DB	24	14												
		15	43				-	-	-	-	5.50	5	CS	-5.5				
		15	55															
6		To		DB	28	15												
		16	09				-	-	-	-	6.50	6	CS	-6.5		L4	6.5	
7																		
8																		
9																		
10																		

CS - Core Sample	DS - Disturbed Sample	LOGGED	Vinod Pradap	PROJECT SITE DETAILS		REMARKS
SS - Split Spoon Sample	SC - Soil Cutter	DATE	31/12/2022	GROUND LEVEL (m)	0.00	
UDS- Undisturbed Sample	TCB - Tungsten Carbide Bit	CHECKED	Jaleel Yasin	WATER TABLE (m)	1.50	
WS - Wash Sample	DB - Diamond Bit	DATE	13/01/2023	CASING DEPTH (m)	0.00	

Borehole terminated at 6.5 m depth below E.G.L

FIG.2.3 Sub Soil Profile at BH-03 Location

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SITE INVESTIGATION RECORD

BORE HOLE No.	BH-04
SHEET	1 OF 1
PROJECT NAME	PROPOSED CONSTRUCTION OF RESIDENTIAL & COMMERCIAL BUILDING AND VILLAS
DIA OF BORE HOLE	150mm ✓ / 100mm
LOCATION	Avarampalayam, Coimbatore
MACHINE No.	CR-01
CHAINAGE (m)	-
BORE START DATE	31/12/2022
STRUCTURE	(1B+G+5 Floors/1B+G+4 Floors/G+2 Villas)
DRILLING METHOD	Rotary
CO-ORDINATES	N
BORE END DATE	31/12/2022
JOB CODE	GEC-JC-GT-4110
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	31/12/2022	08	35	SC	-	-										L1	0.5	**Filed Up Soil** (Clayey Sand)
		To																
		08	39															
1							5	6	9	15	1.00	1	SS	-1.0				Brown, Moist, Stiff, **Sandy Silty CLAY (CH)** Silty Clay of High Plasticity
		08	50								1.45							
		To		SC	-	-			Bore Refusal, For 50/Blows									
		08	56															
2		09	10	SC	-	-	8	15		>100	2.00	2	SS	-2.0		L2	2.0	
		To									2.38							Brown, Moist,Hard, **Sandy Silty CLAY (CH)** with Lime Particles
		09	17													L3	2.5	
							SPT Hammer Rebounded			>100	2.50	3	WS	-2.5				
3																		
		09	34															
		To		DB	20	9												
4		10	20				-	-	-	-	4.00	4	CS	-4.0				White,Fine Grains, Massive,Moderately Weathered **Limestone Rock**
		10	30															
		To		DB	25	17												
5		11	33				-	-	-	-	5.00	5	CS	-5.0				
		11	50															
		To		DB	28	19												
6		12	49				-	-	-	-	6.00	6	CS	-6.0		L4	6.0	
7																		
8																		
9																		
10																		

CS - Core Sample	DS - Disturbed Sample	LOGGED	Vinod Pradap	PROJECT SITE DETAILS	REMARKS
SS - Split Spoon Sample	SC - Soil Cutter	DATE	31/12/2022	GROUND LEVEL (m) 0.00	
UDS- Undisturbed Sample	TCB - Tungsten Carbide Bit	CHECKED	Jaleel Yasin	WATER TABLE (m) 1.50	
WS - Wash Sample	DB - Diamond Bit	DATE	13/01/2023	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

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SITE INVESTIGATION RECORD

BORE HOLE No.	BH-05		
SHEET	1	OF	1
PROJECT NAME	PROPOSED CONSTRUCTION OF RESIDENTIAL & COMMERCIAL BUILDING AND VILLAS	DIA OF BORE HOLE	150mm ✓ / 100mm
LOCATION	Avarampalayam, Coimbatore	MACHINE No.	CR-01
CHAINAGE (m)	-	BORE START DATE	30/12/2022
STRUCTURE	(1B+G+5 Floors/1B+G+4 Floors/G+2 Villas)	DRILLING METHOD	Rotary
CO-ORDINATES	N	BORE END DATE	30/12/2022
JOB CODE	GEC-JC-GT-4110	FLUSHING MEDIUM	Bentonite
CO-ORDINATES	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	30/12/2022	12	20	SC	-	-										L1	0.5	**Filled Up Soil** (Clayey Sand)
		To																
		12	21															
1							3	3	4	7	1.00	1	SS	-1.0				Brown, Moist, Medium Stiff, **Sandy Silty CLAY (Cl)**, Silty Clay of Medium Plasticity
		12	40						14cm Penet. For 50 Blows		1.45							
		To		SC	-	-												
		12	46															
2		13	05				4	28		>100	2.00	2	SS	-2.0		L2	2.0	
		To		SC	-	-					2.44							Brown, Moist, Very Hard, **Sandy Silty CLAY (Cl)** with Lime Particles
		13	10				SPT Hammer Rebounded			>100	2.50	3	SS	-2.5		L3	2.5	
3		13	20															
		To		DB	19	8												
		13	55															
4							-	-	-	-	4.00	4	CS	-4.0				
																		White, Fine Grains, Massive, Moderately Weathered **Limestone Rock**
5		14	10															
		To		DB	21	12												
		15	30				-	-	-	-	5.50	5	CS	-5.5				
6																		
		15	40															
		To		DB	25	16												
		17	00															
7							-	-	-	-	7.00	6	CS	-7.0		L4	7.0	
8																		
9																		
10																		

CS - Core Sample	DS - Disturbed Sample	LOGGED	Vinod Pradap	PROJECT SITE DETAILS	REMARKS
SS - Split Spoon Sample	SC - Soil Cutter	DATE	30/12/2022	GROUND LEVEL (m) 0.00	
UDS- Undisturbed Sample	TCB - Tungsten Carbide Bit	CHECKED	Jaleel Yasin	WATER TABLE (m) 1.50	
WS - Wash Sample	DB - Diamond Bit	DATE	13/01/2023	CASING DEPTH (m) 0.00	

Borehole terminated at 7 m depth below E.G.L

FIG.2.5 Sub Soil Profile at BH-05 Location

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...thy N... Vela...
...2

Grain Size Distribution Curves

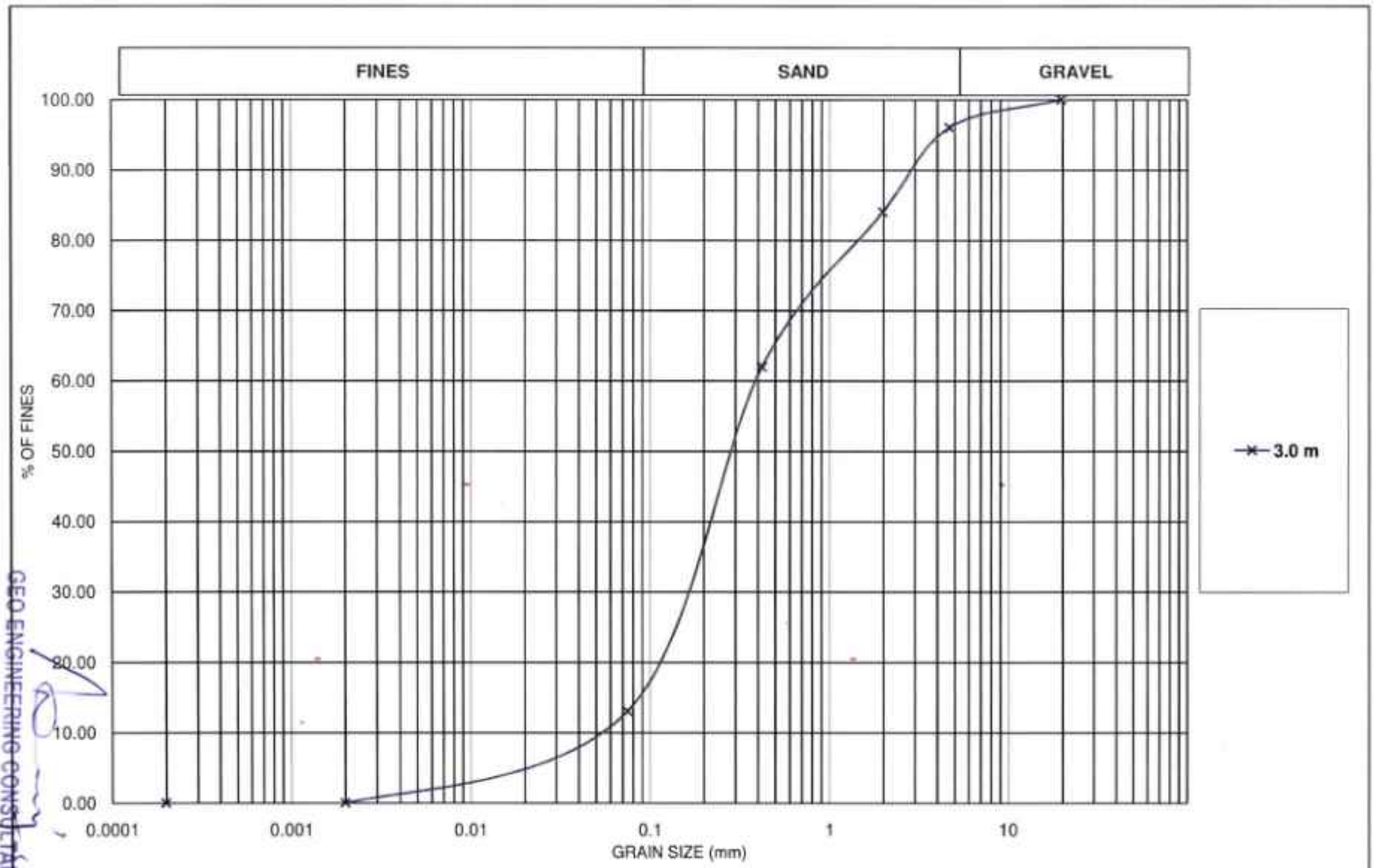


Fig. 2.6 GRAIN SIZE DISTRIBUTION CURVE - BH-01

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Chennai - 600 042

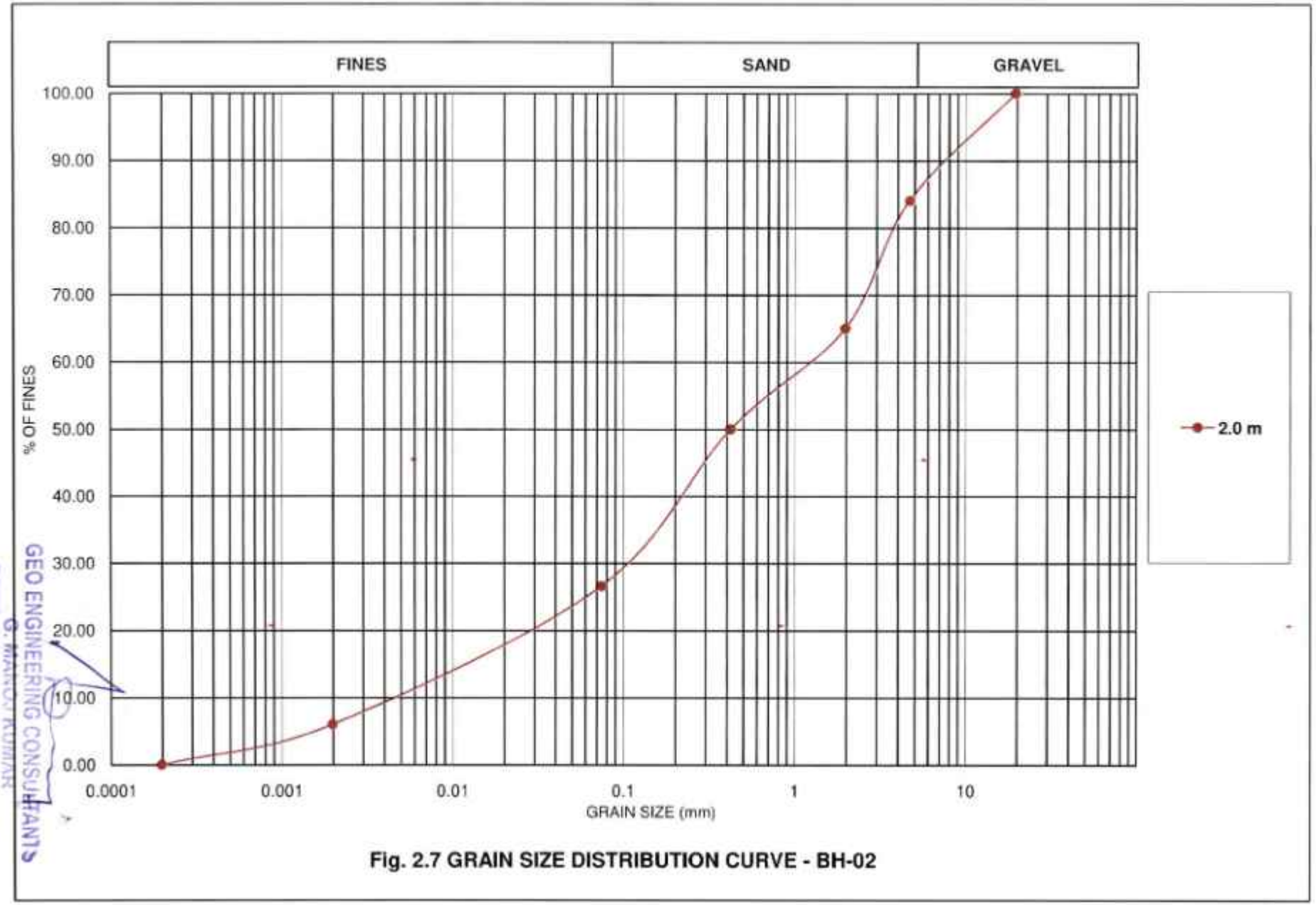


Fig. 2.7 GRAIN SIZE DISTRIBUTION CURVE - BH-02

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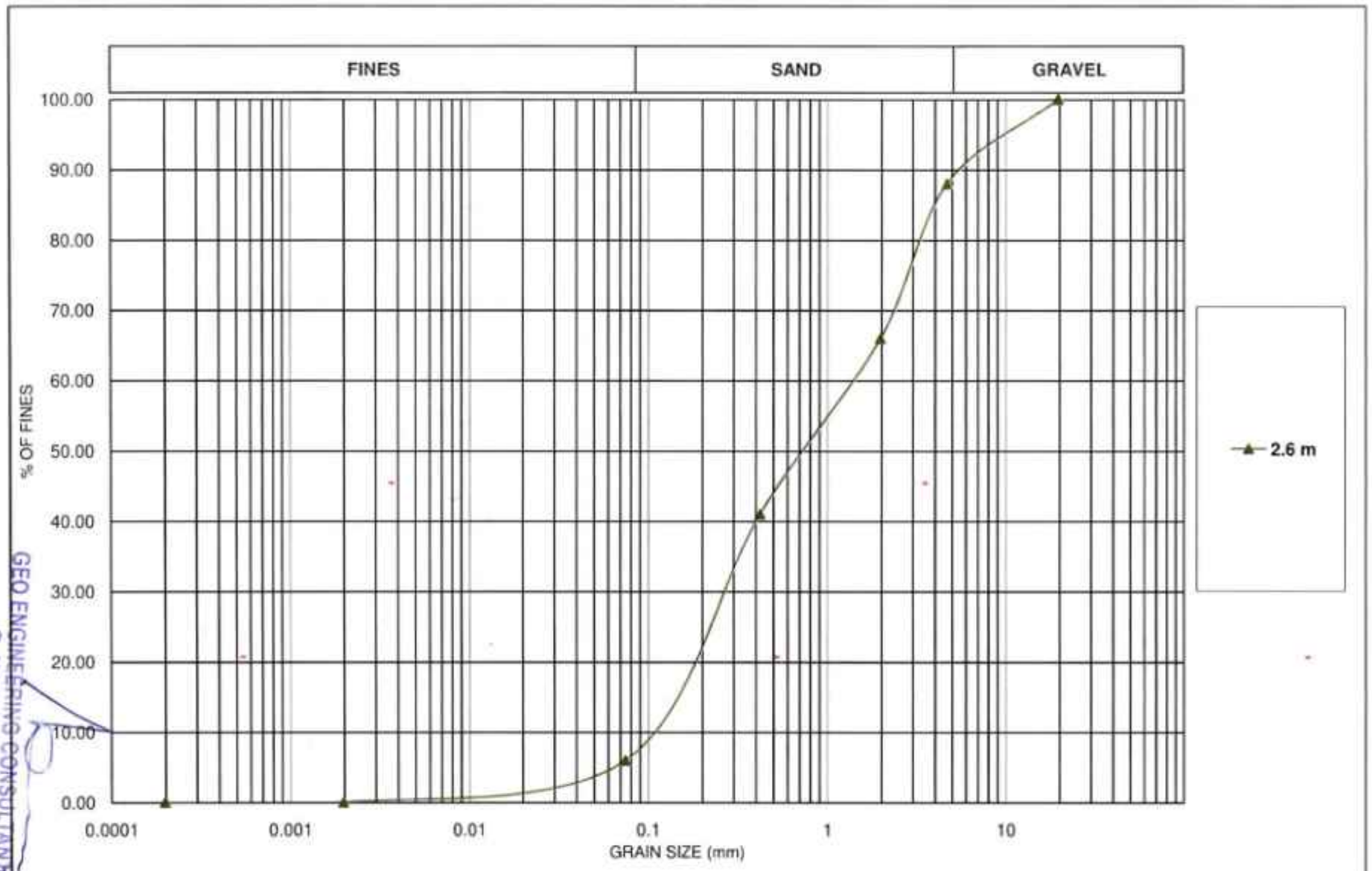


Fig. 2.8 GRAIN SIZE DISTRIBUTION CURVE - BH-03

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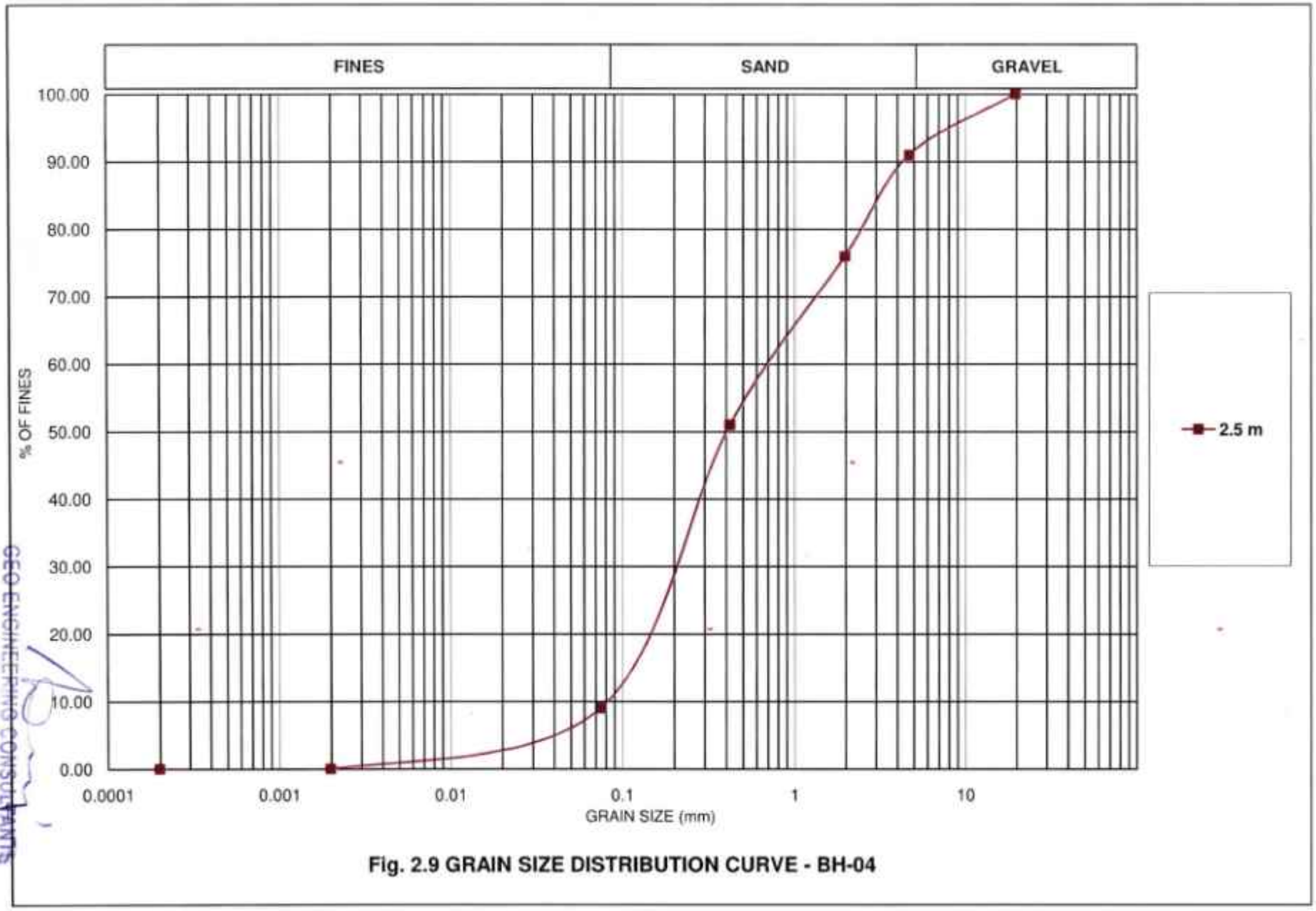


Fig. 2.9 GRAIN SIZE DISTRIBUTION CURVE - BH-04

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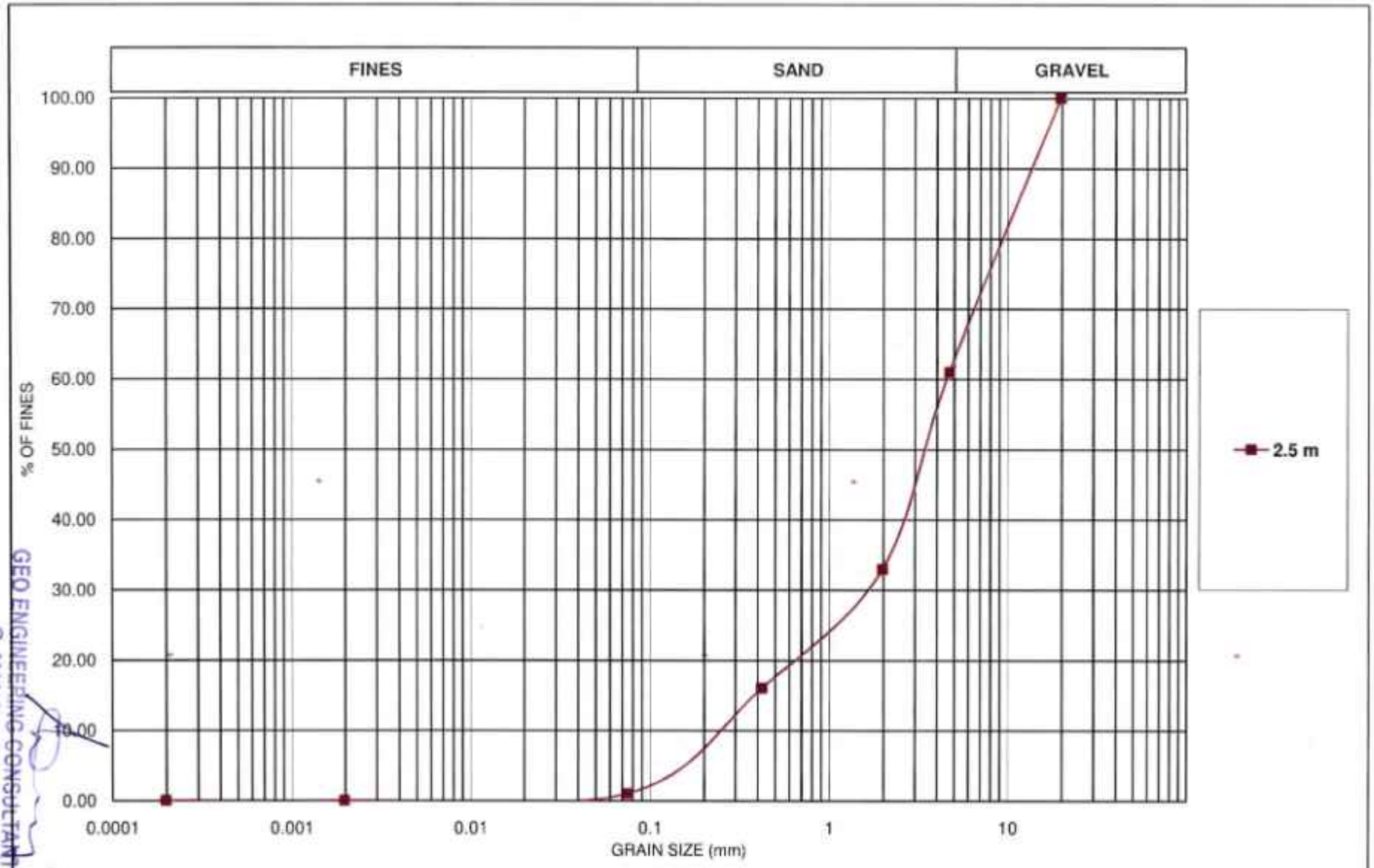


Fig. 2.10 GRAIN SIZE DISTRIBUTION CURVE - BH-05

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HYDROMETER ANALYSIS CURVE

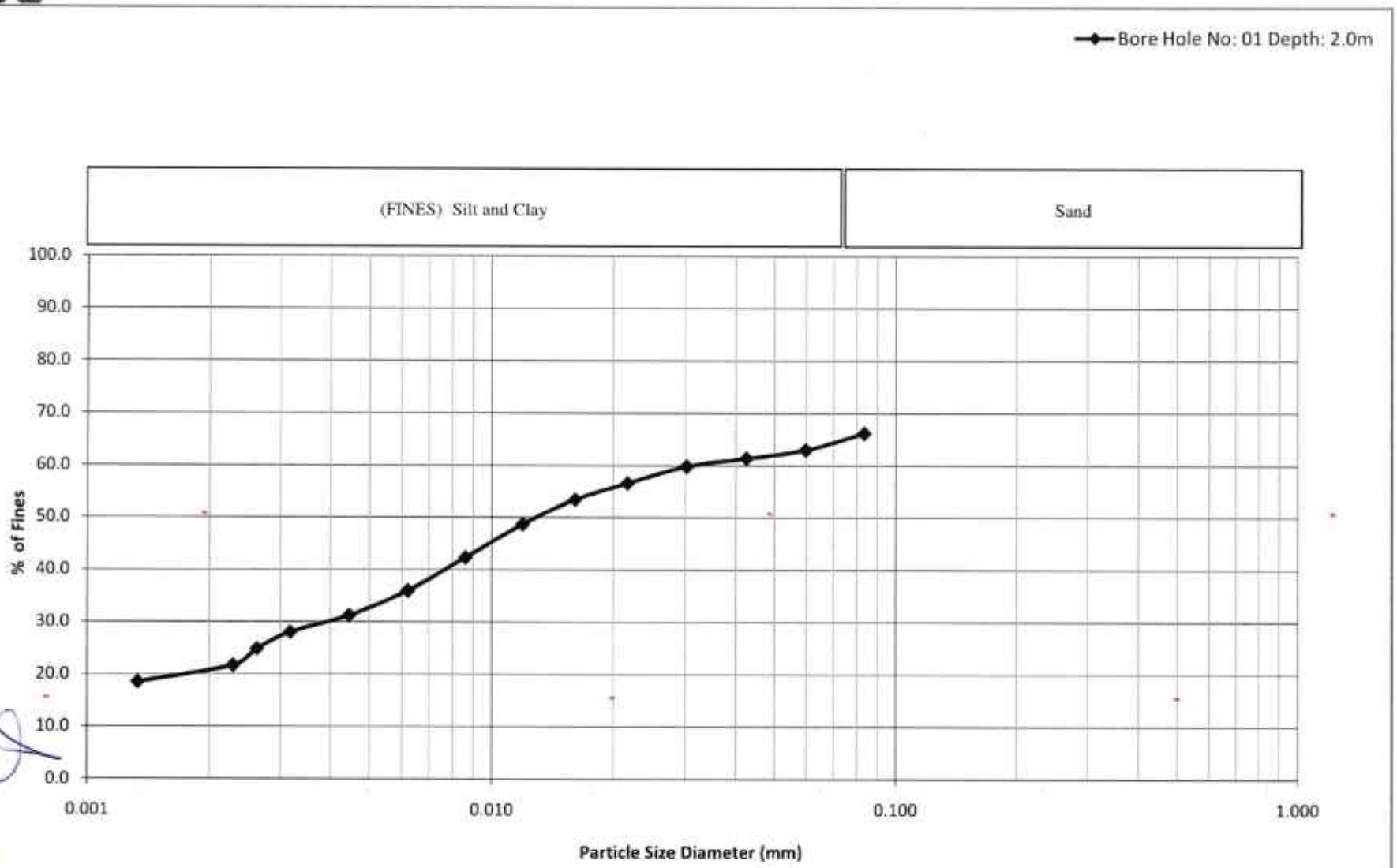


Fig 2.11 Hydrometer Analysis Master Curve

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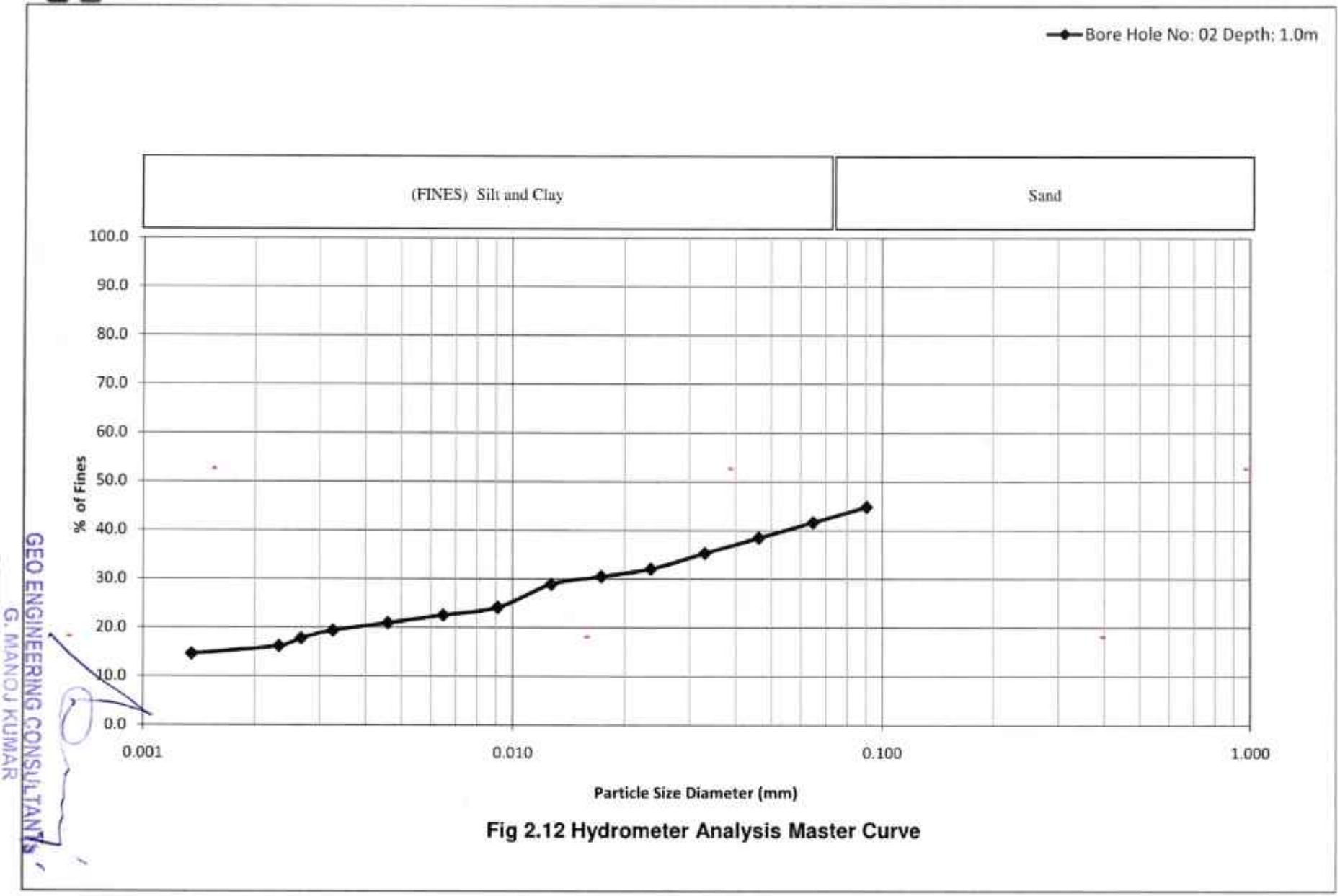


Fig 2.12 Hydrometer Analysis Master Curve

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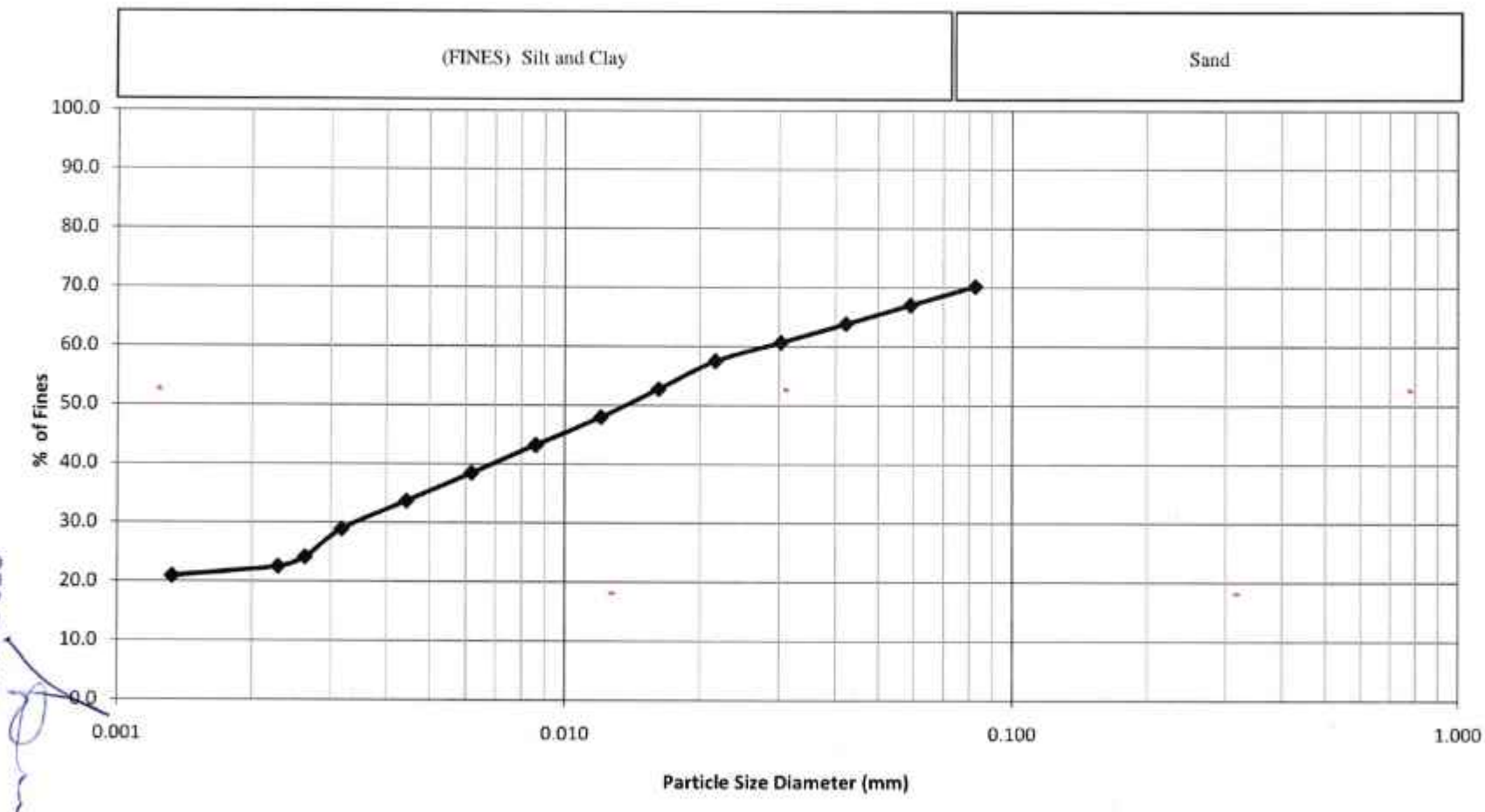


Fig 2.13 Hydrometer Analysis Master Curve

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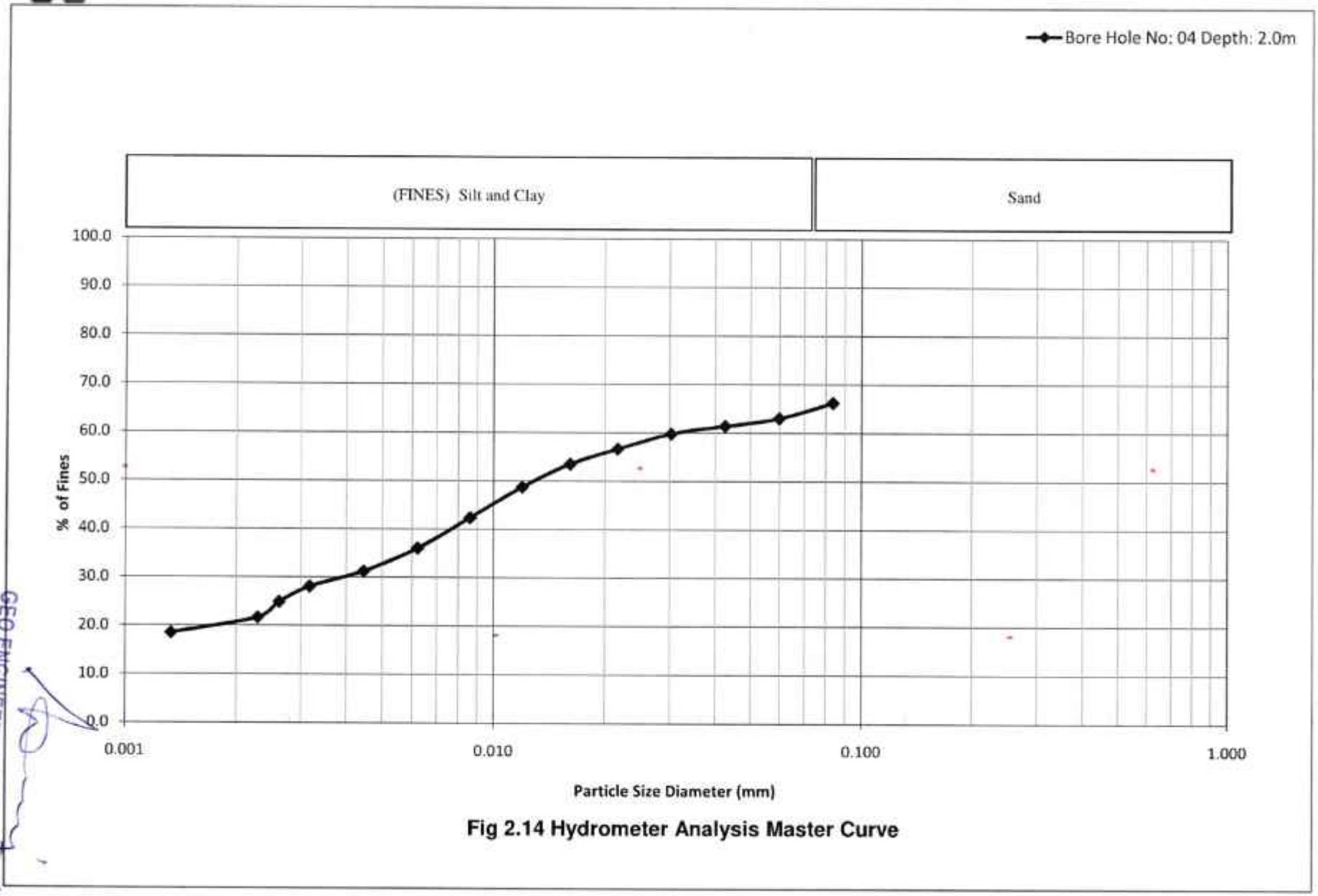


Fig 2.14 Hydrometer Analysis Master Curve

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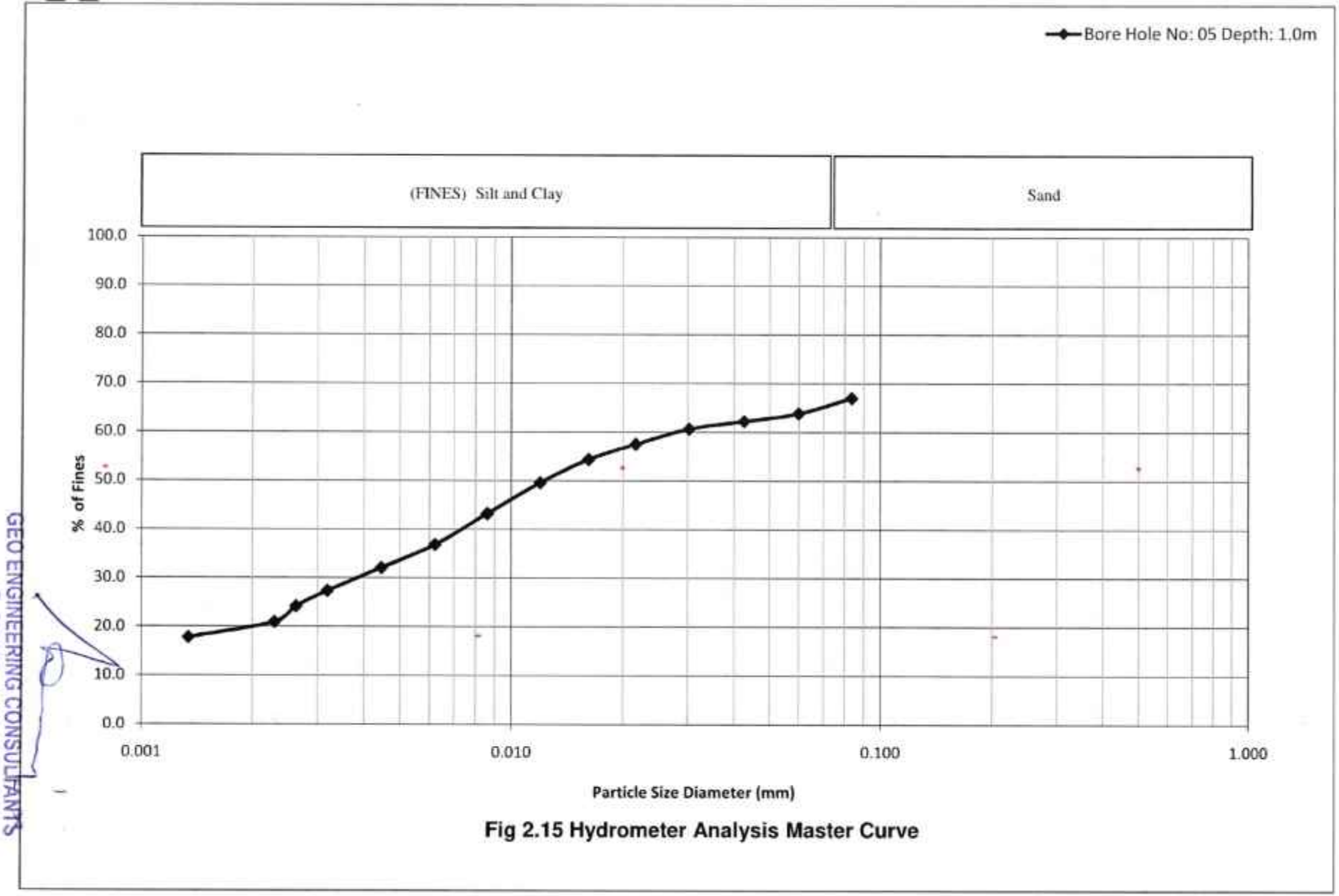


Fig 2.15 Hydrometer Analysis Master Curve

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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	7	SS	39	51	28	23	0.52	14	65	M.Stiff	Above	CH	3	1	7	22	45	22	-	-	-	-	-	FG>50%	FG>50%	FG>50%
2.0	24	SS	16	39	20	19	1.21	15	50	V.Stiff	Above	CI	7	8	10	15	42	18	-	-	-	-	-	FG>50%	FG>50%	FG>50%
3.0	>100	WS	-	-	-	-	-	-	-	CG>50%	-	-	4	12	22	49	13	0	-	-	-	-	-	V.Dense	<50%	SM

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	6	SS	33	46	26	20	0.65	14	38	M.Stiff	Above	CI	4	3	6	33	39	15	-	-	-	-	-	FG>50%	FG>50%	FG>50%
2.0	>100	SS	13	38	22	16	1.56	16	18	CG>50%	Above	-	15	20	15	19	25	6	-	-	-	-	-	V.Dense	<50%	SC

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-2.3 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	10	SS	25	51	24	27	0.96	12	95	Stiff	Above	CH	2	1	5	27	45	20	-	-	-	-	-	FG>50%	FG>50%	FG>50%
2.0	38	SS	18	42	20	22	1.09	14	68	Hard	Above	CI	19	8	8	13	38	14	-	-	-	-	-	FG>50%	FG>50%	FG>50%
2.6	>100	WS	-	-	-	-	-	-	-	CG>50%	-	-	12	22	25	35	6	0	-	-	-	-	-	V.Dense	<50%	SP-SM

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-2.4 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	15	SS	35	62	30	32	0.84	14	78	Stiff	Above	CH	6	4	11	27	35	17	-	-	-	-	-	FG>50%	FG>50%	FG>50%
2.0	>100	SS	18	52	22	30	1.13	12	85	Hard	Above	CH	0	6	8	27	41	18	-	-	-	-	-	FG>50%	FG>50%	FG>50%
2.5	>100	WS	-	-	-	-	-	-	-	CG>50%	-	-	9	15	25	42	9	0	-	-	-	-	-	V.Dense	<50%	SP-SM

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-2.5 Laboratory Classification of Soil Samples from BH-05

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	7	SS	28	47	21	26	0.73	14	45	M.Stiff	Above	CI	0	2	5	29	45	18	-	-	-	-	-	FG>50%	FG>50%	FG>50%
2.0	>100	SS	17	48	20	28	1.11	14	52	Hard	Above	CI	8	4	6	25	41	16	-	-	-	-	-	FG>50%	FG>50%	FG>50%
2.5	>100	WS	-	-	-	-	-	-	-	CG>50%	-	-	39	28	17	15	1	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-2.6 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	1.40	7.36	242	348	2.0	7.34	225	318
2	BH-03	1.50	7.36	248	351	2.0	7.34	229	321
3	BH-05	1.50	7.36	251	346	2.0	7.34	231	322

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

The present location falls under coimbatore District, geologically it is classified as recent alluvium deposits consisting of Sandy Silty Clay and /Clayey Silty Sand, which is underlying by basement rock.

Recent alluvium deposit

Sedimentary formation (Limestone 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:

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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	Clayey Silty Sand	-	-	-	-	-	-	-
2	0.50	2.00	1.50	Sandy Silty Clay	Brown	7	-	Medium Stiff	16	47	-
3	2.00	3.00	1.00	Sandy Silty Clay	Brown	24	-	Very Stiff	20.5	160	-
4	3.00	6.50	3.50	Moderately Weathered Limestone	White	CRR-19 %,23% & 26%, RQD-9% & 16%					

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	Clayey Silty Sand	-	-	-	-	-	-	-
2	0.50	2.00	1.50	Sandy Silty Clay	Brown	6	-	Medium Stiff	15.5	40	-
3	2.00	2.50	0.50	Clayey Silty Sand	Brown	>100	Very Dense	-	21	-	42.5
4	2.50	6.50	4.00	Moderately Weathered Limestone	White	CRR-19 %,24% & 26%, RQD-7%,13% & 18%					

REFERENCE BORE HOLE-BH:					03	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	Clayey Silty Sand	-	-	-	-	-	-	-
2	0.50	2.00	1.50	Sandy Silty Clay	Brown	10	-	Stiff	17.5	67	-
3	2.00	2.50	0.50	Sandy Silty Clay	Brown	38	-	Hard	21	253	-
4	2.50	6.50	4.00	Moderately Weathered Limestone	White	CRR-16 %,24% & 28%, RQD-8%, 14% & 15%					

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REFERENCE BORE HOLE-BH:					04	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	Clayey Silty Sand	-	-	-	-	-	-	-
2	0.50	2.00	1.50	Sandy Silty Clay	Brown	15	-	Stiff	20	100	-
3	2.00	2.50	0.50	Sandy Silty Clay	Brown	>100	-	Hard	22	400	-
4	2.50	6.00	3.50	Moderately Weathered Limestone	White	CRR-20 %,25% & 28%, RQD-98%,17% & 19%					

REFERENCE BORE HOLE-BH:					05	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	Clayey Silty Sand	-	-	-	-	-	-	-
2	0.50	2.00	1.50	Sandy Silty Clay	Brown	7	-	Medium Stiff	16	47	-
3	2.00	2.50	0.50	Sandy Silty Clay	Brown	>100	-	Hard	22	400	-
4	2.50	7.00	4.50	Moderately Weathered Limestone	White	CRR-19 %,21% & 25%, RQD-8%,12% & 16%					

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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 1B+Ground+4/5 upper floors, and is meant for commercial /residential use. For this kind of structure, the column loads could vary between 2500 kN to 5000 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

4.2 Foundation System

4.2.1 Villas (Ground+2 Upper Floors)

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 300kPa.

4.2.2 Residential/ Commercial Building–1B+Ground+5 Upper Floors/1B+Ground+4 Upper Floors

In order to construct one basement floors an excavation of about 3.00m excluding the foundation depth is needed (as informed by the client incharge during the time of reporting). Hence, for the kind of proposed structure and the sub soil stratification, open foundation system (Isolated footing) can be adopted. In case the foundation area is more than 50% of the plan area it is ideal to adopt raft foundation system with shear block.

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The foundation system shall be Isolated Footing or Raft and it can be located at a depth of 1.00m (assumed thickness of raft or embedment thickness) below basement floor, hence the overall depth of foundation excavation shall be 4.0m below the existing ground level.

The Raft or Isolated Footing can be designed for an allowable safe bearing pressure of 850kPa.

Since the sub soil stratum below the founding level is rock formation with varying grade of weathering only immediate elastic settlement will takes place.

Typical bearing capacity computation is presented in the Annexure

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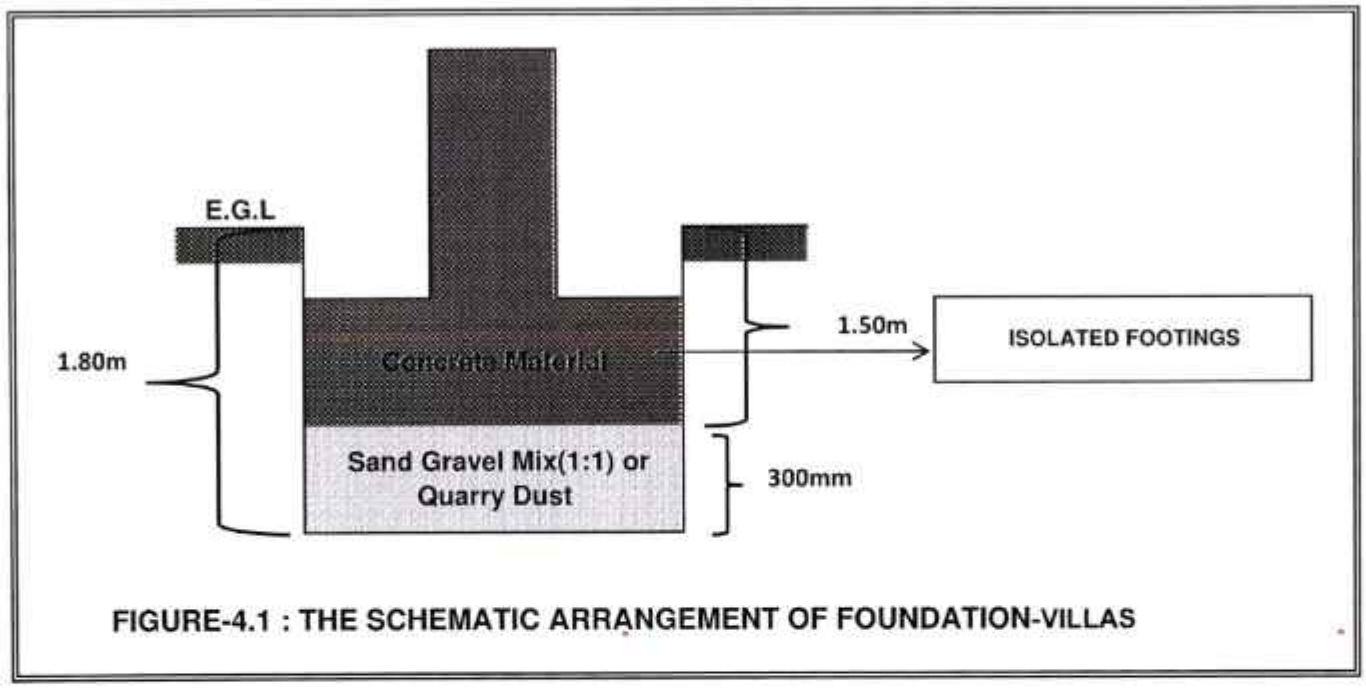


FIGURE-4.1 : THE SCHEMATIC ARRANGEMENT OF FOUNDATION-VILLAS

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DEEP EXCAVATION DESIGN

CHAPTER-5

DEEP EXCAVATION DESIGN

5.1 Preamble:

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

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

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

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

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

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

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

5.2 Geology of Site & Hydro-geological nature of sub strata:

The stratigraphy of the present location consists of alluvial formation overlying the Archean rocky formation. The thickness of alluvium soil/overburden soil is 3.00m.

The sub soil stratification consists of the following soil layers:

0.0m to 0.50m	:	Clayey Silty Sand
0.50m to 2.50m	:	Medium Stiff to Very Stiff Sandy Silty Clay/Very Dense Clayey Silty Sand
2.50m to 7.00m	:	Very Stiff Sandy Silty Clay/Moderately Weathered Rock

During the time of investigation (4th Week December 2022) the ground water table is observed at 1.50m the existing ground level.

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5.3 Dewatering Technique:

Since the excavation extending into the weathered rock formation (Moderately Weathered Rock) that is 2.5m depth below the existing ground level, for effective lowering of ground water it is ideal to provide ground water lowering bore wells in a grid pattern with grid spacing not exceeding 15m centre to centre outside the excavation line for a minimum depth of 10.0m depth below the existing ground level shall be installed and operated.

Further the borehole can be connected to a common header and the pumped water shall be connected to the source away from the excavation preferably to a storm drainage network or any unobjectionable location by ensuring that the pumped water will not recharge the same aquifer.

Before carrying out the basement excavation ground water shall be lowered 1.0m below the foundation depth and pumping shall not be stopped until the dead weight of the structures resists the ground water pressure.

5.4 Excavation Design Philosophy

From 0.0m to 2.5m depth:

The excavation in the top 2.5m depth shall be carried out by using mechanical excavator.

From 2.5m to 4.0m depth:

The formation between 2.5m and 4.0m depth being Moderately weathered rock formation (Grade III), mechanical excavator fitted with hydraulic breaks/ hammers can be adopted.

The sub soil strata in the excavation zone being sandy silty clay/clayey silty sand formation of consistency medium stiff to very stiff/very dense, open excavation by providing mild slope as discussed below shall be adopted.

In the present case, though vertical cut is possible to make, it is recommended to adopt a minimum slope of 2 Vertical: 1Horizontal for excavation.

However, considering the monsoon rains or unpredicted showers during the period of construction it is recommended to cover the surface of the slope with 1mm thick HDPE sheet suitably anchored at top and toe location with either sand bags or 100mm thick P.C.C of M10 grade for a minimum 1.0m width.

5.5 Design of Basement slab for Uplift

In the present case, the basement slab shall be designed for the uplift pressure corresponding to assumed ground water table at ground level. In order to optimize the basement slab design vertical anchors can be adopted. The fixed length of anchors can be provided in the moderately weathered rock layers which exits beyond 6.0m from the existing ground level.

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RECOMMENDATIONS

CHAPTER-6

RECOMMENDATIONS

6.1 Recommendation for Villas (Ground+2 Upper Floors)

- 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 300kPa.
- 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.

6.2 Recommendation for Residential / Commercial Building – 1B+Ground+5 Upper Floors / 1B+Ground+4 Upper Floors

- For the kind of sub soil conditions, the foundation system as described in Chapter-4, Section 4.2.2 can be adopted
- In the present case, the depth of excavation including the foundation embedment is about 4.0m below the existing ground level.
- For the kind of proposed structure and the sub soil stratification isolated footing can be adopted.
- In case the foundation area is more than 50% of the plan area it is ideal to adopt raft with shear block.
- The raft or isolated footing can be designed for an allowable safe bearing pressure of 850kPa.
- In the present case, the basement floor slab shall be designed for the uplift pressure corresponding to ground water level at the existing ground level.

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- The strata beyond the founding depth is rock formation the settlement will be of immediate elastic in nature.

6.3 Recommendations for Excavation

- As discussed in chapter-5, Section 5.4 it is recommended to adopt open excavation with a slope of 2 Vertical : 1 Horizontal
- Considering the possible monsoon rains during construction, it is recommended to cover the surface of the slope with 1mm thick HDPE sheet suitably anchored at top and toe with either sand bags or 100mm thick P.C.C. of M10 grade with minimum 1.0m width

6.4 General Recommendation:

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

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ANNEXURE

TYPICAL BEARING CAPACITY COMPUTATIONS FOR SHALLOW FOUNDATIONS

1.0 COMPUTATION OF BEARING CAPACITY AS PER IS:6403

Ref.BH-01

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)	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	30.00	
Type of Shear Failure:	General	
Angle of Shearing Resistance	36.00	phi

1.3 Design Parameters:

Bulk Density of Soil above the foundation depth (γ_{bulk})	18.50	kN/m^3
Water Table Correction Factor (w')	0.50	
Effective Overburden pressure at foundation level (q)	12.75	kPa

Bearing Capacity Factors:

N_c = N/A

N_q = 39.48

N_g = 60.31

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' (g should be read as gama)	831.16	kPa

1.5 Safe Bearing Capacity (Qsafe) :

Factor of Safety (F.S.) :	2.50	
Qsafe :	332.47	kPa
Say Q_{safe}	**300**	**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	300.00	kPa
Poission's Ratio (μ)	0.30	

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

Modulus of Elasticity (E_s)	78000.00	kPa
Size of footing considered for maximum settlement(m)	1.00	
Influence factor	1.00	
Rigidity Factor	1.00	
Elastic Settlement (DH_i)	3.50	mm
	<50	mm

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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-1
1.1 Geometrical Data		
	Shape of the Foundation	Sqaure
	Depth of Basement floor Height Below R.L (m)	3.00
	Assumed Thickness of Foundation or Depth of Embedment (m)	1.00
	Though the over all foundation excavation	4.00
	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 :	Moderately Weathered Rock
	Design SPT-value of the Bearing Strata :	60.00
	Type of Shear Failure:	General
	Angle of Shearing Resistance	42.50
1.3 Design Parameters		
	Bulk Density of Soil above the foundation depth (γ_{bulk})	20.00
	Effective Overburden pressure at foundation level (q)	10.00
	Water Table Correction Factor (w')	0.50
	Bearing Capacity Factors:	
	N_c =	N/A
	N_q =	99.54
	N_g =	190.59
	Shape Factors:	
	S_c =	-
	S_q =	1.20
	S_g =	0.60
	Depth Factors :	
	D_c =	-
	D_q =	1.01
	D_g =	1.01
	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' (g should be read as gama)	**2341.22 kPa**
1.5 Safe Bearing Capacity (Qsafe) :		
	Factor of Safety (FOS) :	2.50
	Qsafe :	936.49 kPa
	However limit Q_{safe}	**850 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	Moderately Weathered Rock
Immediate Settlement (S_i)=	$qB(1-m^2)*I/E_s$
Bearing Capacity (q)	850.00
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)	156000
Size of footing/Raft considered for maximum settlement(m)	2.00
Influence factor	1.00
Rigidity Factor	1.00
Elastic Settlement (DH_i)	10.46 mm
	<50 mm

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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-1
1.1 Geometrical Data		
	Shape of the Foundation	Raft
	Depth of Basement floor Height Below R.L (m)	3.00
	Assumed Thickness of Foundation or Depth of Embedment (m)	1.00
	Though the over all foundation excavation	4.00
	Breadth of Footing "B" (m)	10.00
	Length of Footing "L" (m)	10.00
	B/L	1.00
	Inclination of Vertical Load with the Vertical (a)	0.00
1.2 Soil Data		
	Type of Effective Bearing Strata :	Moderately Weathered Rock
	Design SPT-value of the Bearing Strata :	60.00
	Type of Shear Failure:	General
	Angle of Shearing Resistance	42.50
1.3 Design Parameters		
	Bulk Density of Soil above the foundation depth (γ_{bulk})	20.00
	Effective Overburden pressure at foundation level (q)	10.00
	Water Table Correction Factor (w')	0.50
	Bearing Capacity Factors:	
	N_c =	N/A
	N_q =	99.54
	N_g =	190.59
	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' (g should be read as gama)	**6909.07 kPa**
1.5 Safe Bearing Capacity (Qsafe) :		
	Factor of Safety (FOS) :	2.50
	Qsafe :	2763.63 kPa
	However limit Q_{safe}	**850 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	Moderately Weathered Rock
Immediate Settlement (S_i)=	$qB(1-m^2)*I/E_s$
Bearing Capacity (q)	850.00
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)	156000
Size of footing/Raft considered for maximum settlement(m)	10.00
Influence factor	1.00
Rigidity Factor	0.80
Elastic Settlement (DH_i)	41.85 mm
	<50 mm

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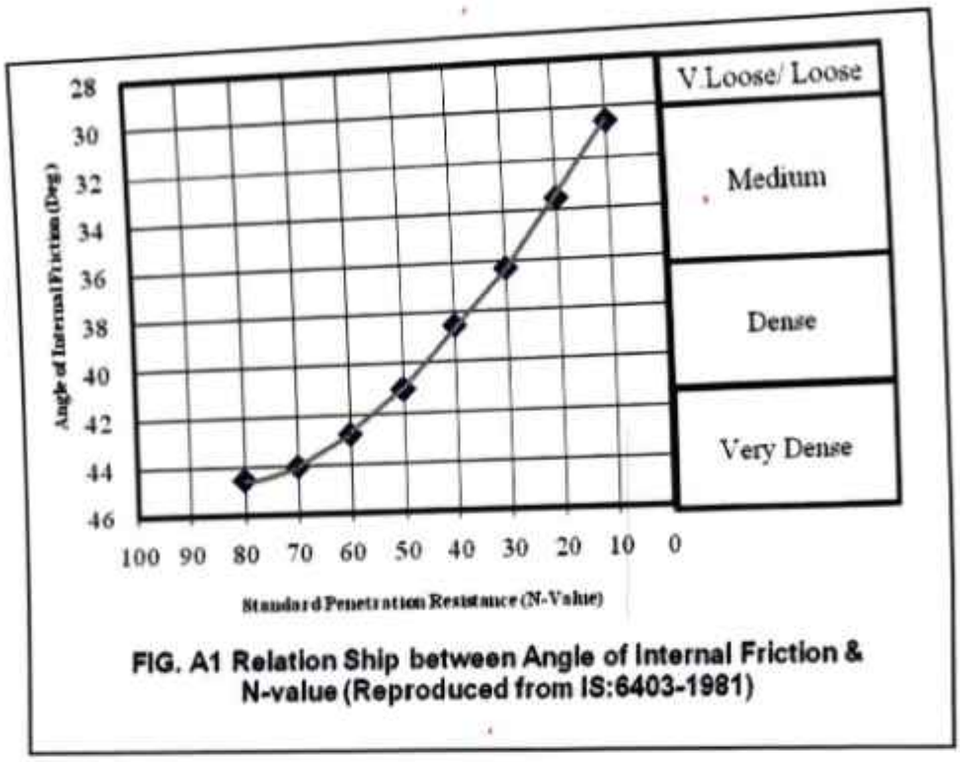


FIG. A1 Relation Ship between Angle of Internal Friction & N-value (Reproduced from IS:6403-1981)

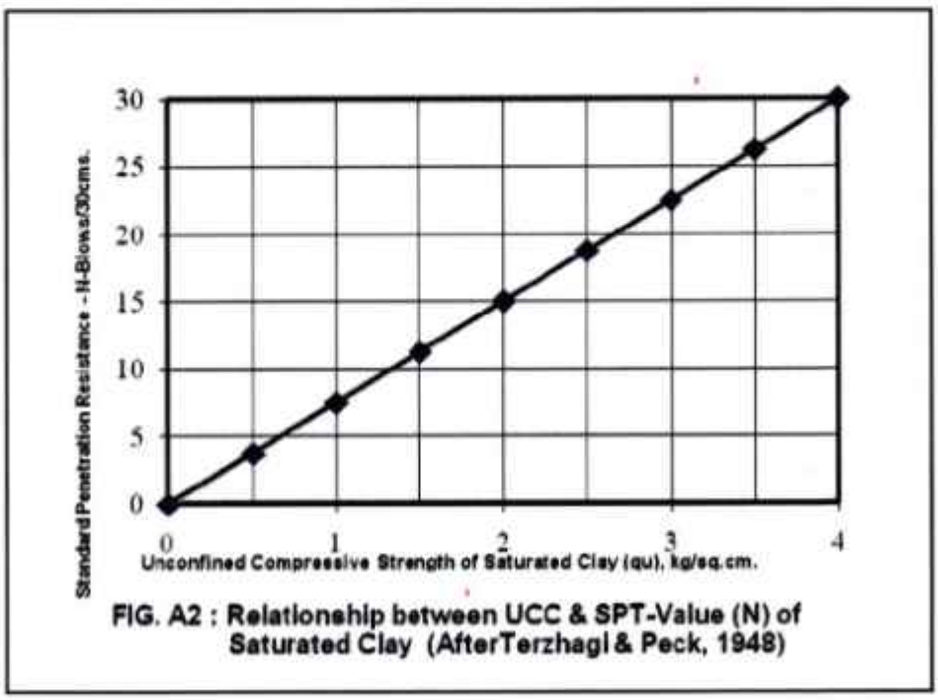


FIG. A2 : Relationship between UCC & SPT-Value (N) of Saturated Clay (AfterTerzhagi & Peck, 1948)

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