GEO ENGINEERINGCONSULTANTS

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Construction of Ground + One Floor (G+1) buildings comprising twenty (20) villas, of which twelve (12) villas constitute the Promoter's share, together with one (1) Club House building (Villa Nos.16, 16A, 18, 19, 28, 29, 30, 31, 32, 33, 34, and 34A).The development is situated in the lands bearing Survey Nos. 13/9B3E, 13/9B3C, 13/9B3D, 13/9B3B, 13/9B3Q, 13/9B3R, 13/9B3S, 13/9B3T, 13/9B3U, 13/9B3V, 13/9B3W, and 13/9B3X. Further, the construction of a Ground + Two Floor (G+2) Club House building is undertaken in Survey No. 13/9B3F.
The entire development is located within Thazhambur Panchayat, Karanai Village, Vandalur Taluk, Chengalpattu District..

CLIENT NAME

FELIXA AND SKY HOMES LLP,
NO.16, BALARAMAN ROAD, ADYAR,
CHENNAI - 600 020.

TITLE

GEOTECHNICAL INVESTIGATION REPORT

PROJECT NO: GEC-JC-GT-7039/2025-2026

DATE: 09/08/2025

CONTENTS

REPORT TEXT

CHAPTER-1

INTRODUCTION

1.0 Project Information Matrix

Nature of project : Proposed Construction of Villa/Club House (G+1/2 Floors)

Project Owner : **M/s Felixa and Sky Homes LLP,**

Project Location : Karanai Village, Vandalur Taluk, Chengalpet District.

Job Code : GEC-JC-GT-7039

1.1 Scope of Work

1.1.1 Field Work

- Conducting seven 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:

Seven 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-2.1 to 2.7. The graphical representation of grain size distribution curve for the representative samples in each bore is presented in Fig. 2.8 to 2.14.

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 2.7. The graphical representation of hydrometer analyses curve for the representative samples in each bore is presented in Fig.2.15 to 2.21.

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 - 2.8.

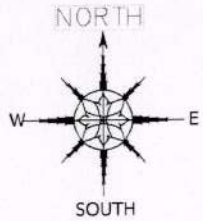
2.3 Summary:

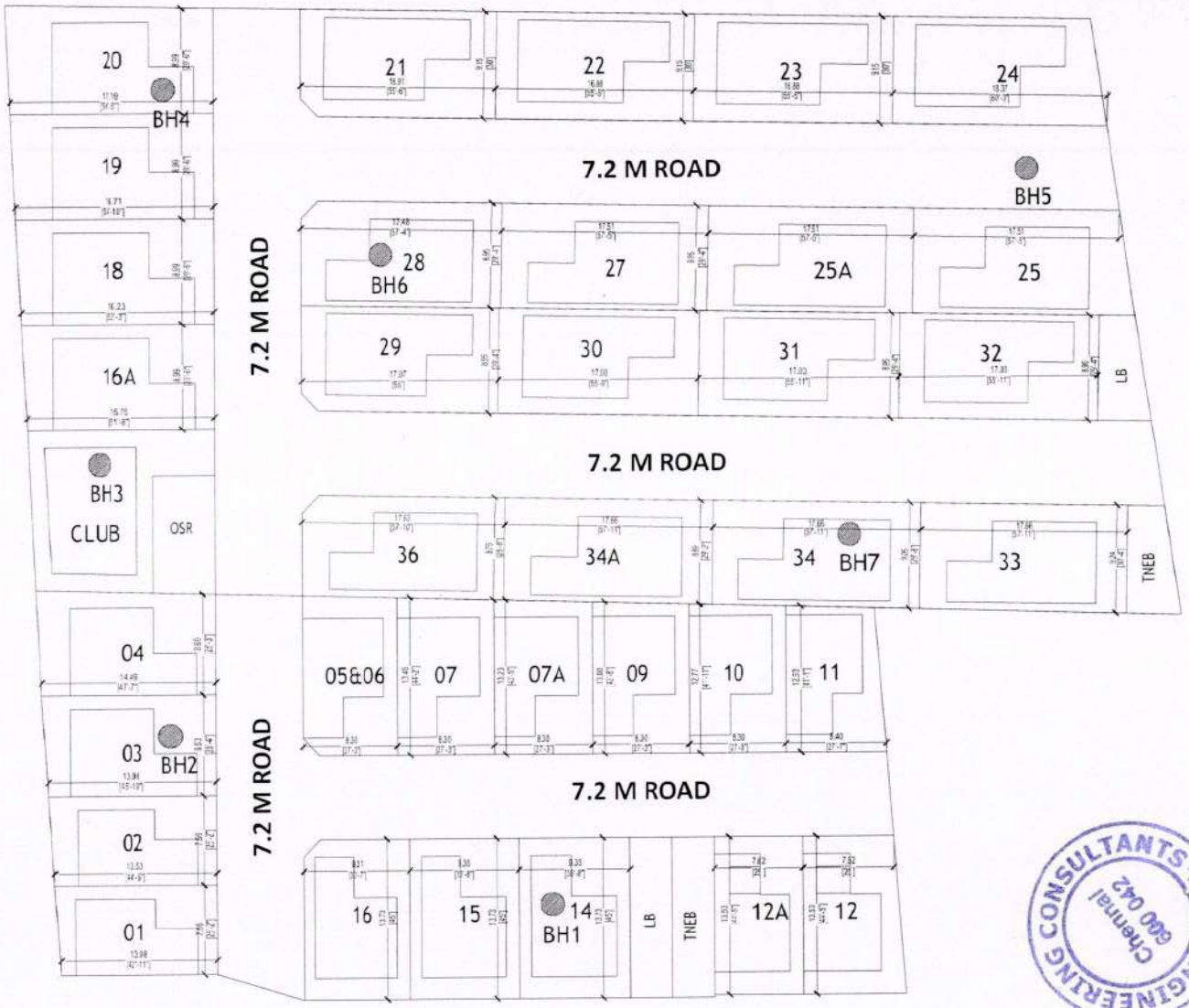
The seven locations of the field investigation boreholes are shown in site plan given in Fig.2.0. The average sub soil profiles encountered at each location along with their classification and engineering properties are presented in Figs.2.1 to 2.7.

SITE PLAN

AutoCAD SHX Text
2025-08-09 11:59:56
- NORTH

SITE PLAN





SOIL PROFILE

SITE INVESTIGATION RECORD

BORE HOLE No.	BH-01		
SHEET	1	OF	1
PROJECT NAME	PROPOSED CONSTRUCTION OF VILLA/CLUB HOUSE AT KARANAI, CHENNAI	DIA OF BORE HOLE	150mm ✓ / NX
LOCATION	Karanai, Chennai	MACHINE No.	CR-01
CHAINAGE (m)	-	BORE START DATE	01/08/2025
STRUCTURE	G+1/2 uppers	DRILLING METHOD	Rotary
CO-ORDINATES	N -	BORE END DATE	01/08/2025
JOB CODE	JC-GT-7039	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	15-30	30-45	SPT 'N' Value	Sample Details: Depth	No.	Type	RL (m)	Layer Data: Legend	No	Depth	Geotechnical Description
1	01/08/2025	16	10 To 16 11	SC	-	-	3	3	4	7	1.00	1	SS	-1.0		L1	1.0	**Filled Up Soil** Brownish Sand
		16	18 To 16 21	SC	-	-					1.45							
2							2	4	5	9	2.00	2	SS	-2.0		L2	2.0	Grey, Moist, Medium Stiff, Poorly Graded, **Sandy CLAY (Cl)** Clays of Medium Plasticity
		16	29 To 16 31	SC	-	-					2.45					L3	2.8	Grey, Moist, Loose, Poorly Graded, **Clayey SAND (SC)** Sand-Clay mixtures
3							9	9	8	17	3.00	3	SS	-3.0		L4	3.5	Grey, Moist, Medium Dense, Poorly Graded, **Clayey SAND (SC)** Sand-Clay mixtures
		16	39 To 16 42	SC	-	-					3.45							
4							26	14cm Penet.for 50 Blows		>100	4.00	4	SS	-4.0		L5	4.3	Greyish Brown, Moist, Very Dense, **Clayey SAND (SC) and Residual Soil** Descented from Charnockite
		16	55 To 17 00	SC	-	-					4.29							
5							10 cm Penet. For 50Blows			>100	5.00	5	WS	-5.0		L6	6.5	Greyish White, Moist, Very Dense, **Completetly Weathered Rock** Descented from Charnockite
		17	05 To 17 17	SC	-	-					5.10							
6							SPT Hammer Rebounded			>100	6.50	6	WS	-6.5				
7		17	28 To 18 15	DB	9	-	-	-	-	-	7.50	7	CS	-7.5		L7	7.5	Brownish Green, **Highly Weathered Rock** Descented from Charnockite
8																		
9																		
10																		

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CS - Core Sample	DS - Disturbed Sample	LOGGED	A.MD.TARIQ	PROJECT SITE DETAILS		REMARKS
SS - Split Spoon Sample	SC - Soil Cutter	DATE	01/08/2025	GROUND LEVEL (m)	0.00	
UDS- Undisturbed Sample	TCB - Tungsten Carbide Bit	CHECKED	JALEEL YASIN	WATER TABLE (m)	3.30	
WS - Wash Sample	DB - Diamond Bit	DATE	08/08/2025	CASING DEPTH (m)	0.00	

Borehole terminated at 7.5 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	1
PROJECT NAME	PROPOSED CONSTRUCTION OF VILLA/CLUB HOUSE AT KARANAI, CHENNAI	DIA OF BORE HOLE	150mm ✓ / NX
LOCATION	Karanai, Chennai	MACHINE No.	CR-01
CHAINAGE (m)	-	BORE START DATE	31/07/2025
STRUCTURE	G+1/2 uppers	DRILLING METHOD	Rotary
CO-ORDINATES	N -	BORE END DATE	31/07/2025
JOB CODE	JC-GT-7039	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	Geotechnical Description
1	31/07/2025	10	17	SC	-	-												
		To																
		10	19				3	4	5	9	1.00	1	SS	-1.0				**Filled Up Soil** Brownish Moist, Loose, **Silty SAND and Bricks**
		10	27								1.45					L1	1.5	
		To		SC	-	-												
2		10	30				4	9	12	21	2.00	2	SS	-2.0				Grey, Moist, Very Stiff, **Sandy CLAY (CH)** Clays of High Plasticity
		10	40								2.45					L2	2.5	
		To		SC	-	-												
3		10	41				12	13	13	26	3.00	3	SS	-3.0				Brown, Moist, Medium Dense, **Clayey SAND (SC)** Sand-Clay Mixtures
		10	51								3.45					L3	3.5	
		To		SC	-	-												
4		10	54				17	26	10cm Penet. For 50Blows	>100	4.00	4	SS	-4.0				Brown, Moist, Very Dense, **Residual Soil** Descented from Charnockite
		11	09								4.40					L4	4.4	
		To		SC	-	-												
5		11	20				6 cm Penet. For 50Blows			>100	5.00	5	WS	-5.0				Greyish White, Moist, Very Dense, **Completetly Weathered Rock** Descented from Charnockite
		11	33								5.06					L5	5.5	
		To		SC	-	-												
6		11	55				SPT Hammer Rebounded			>100	5.50	6	WS	-5.5				Brownish Green, **Highly Weathered Rock** Descented from Charnockite
		12	00															
		To		DB	10	-												
7		12	46				-	-	-	-	7.00	7	CS	-7.0		L6	7.0	
8																		
9																		
10																		

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CS - Core Sample	DS - Disturbed Sample	LOGGED	A.MD.TARIQ	PROJECT SITE DETAILS		REMARKS
SS - Split Spoon Sample	SC - Soil Cutter	DATE	31/07/2025	GROUND LEVEL (m)	0.00	
UDS- Undisturbed Sample	TCB - Tungsten Carbide Bit	CHECKED	JALEEL YASIN	WATER TABLE (m)	3.30	
WS - Wash Sample	DB - Diamond Bit	DATE	08/08/2025	CASING DEPTH (m)	0.00	

Borehole terminated at 7 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 VILLA/CLUB HOUSE AT KARANAI, CHENNAI	DIA OF BORE HOLE	150mm ✓ / NX
LOCATION	Karanai, Chennai	MACHINE No.	CR-01
CHAINAGE (m)	-	BORE START DATE	31/07/2025
STRUCTURE	G+1/2 uppers	DRILLING METHOD	Rotary
CO-ORDINATES	N -	BORE END DATE	31/07/2025
JOB CODE	JC-GT-7039	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	15-30	30-45	SPT 'N' Value	Sample Details: Depth	No.	Type	RL (m)	Layer Data: Legend	No	Depth	Geotechnical Description
1	31/07/2025	14	03	SC	-	-												
		To																
		14	05				2	2	2	4	1.00	1	SS	-1.0				**Filled Up Soil** Brownish Moist, Very Loose, **Clayey SAND (SC)** Sand-Clay mixtures
		14	16								1.45					L1	1.5	
		To		SC	-	-												
2		14	20				3	4	5	9	2.00	2	SS	-2.0				Grey, Moist, Stiff, **Sandy CLAY (CH)** Clays of High Plasticity
		14	30								2.45					L2	2.5	
		To		SC	-	-												
3		14	33				7	8	16	24	3.00	3	SS	-3.0				Greyish Brown, Moist, Medium Dense, **Clayey SAND (SC)** Sand-Clay Mixtures
		14	40								3.45					L3	3.5	
		To		SC	-	-												
		14	44															
4		14	58				21	12cm Penet.for 50 Blows		>100	4.00	4	SS	-4.0				Brown, Moist, Very Dense, **Residual Soil** Descented from Charnockite
		To		SC	-	-					4.27					L4	4.3	
		15	15															Brownish Grey, Moist, **Completetly Weathered Rock** Descented from Charnockite
5							SPT Hammer Rebounded			>100	5.00	5	WS	-5.0		L5	5.0	
		15	21															Brownish Grey, **Highly Weathered Rock** Descented from Charnockite
		To		DB	6	-												
6		15	56				-	-	-	-	6.00	6	CS	-6.0		L6	6.0	
7																		
8																		
9																		
10																		

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CS - Core Sample	DS - Disturbed Sample	LOGGED	A.MD.TARIQ	PROJECT SITE DETAILS		REMARKS
SS - Split Spoon Sample	SC - Soil Cutter	DATE	31/07/2025	GROUND LEVEL (m)	0.00	
UDS- Undisturbed Sample	TCB - Tungsten Carbide Bit	CHECKED	JALEEL YASIN	WATER TABLE (m)	3.30	
WS - Wash Sample	DB - Diamond Bit	DATE	08/08/2025	CASING DEPTH (m)	0.00	

Borehole terminated at 6 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 VILLA/CLUB HOUSE AT KARANAI, CHENNAI			DIA OF BORE HOLE	150mm ✓ / NX		
LOCATION	Karanai, Chennai	MACHINE No.	CR-01	CHAINAGE (m)	-	BORE START DATE	31/07/2025
STRUCTURE	G+1/2 uppers	DRILLING METHOD	Rotary	CO-ORDINATES	N -	BORE END DATE	31/07/2025
JOB CODE	JC-GT-7039	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	Blows/cm. 15-30	Blows/cm. 30-45	SPT 'N' Value	Sample Details: Depth	No.	Type	RL (m)	Layer Data: Legend	No	Depth	Geotechnical Description
1	31/07/2025	16	34	SC	-	-												
		To																
		16	36				5	6	9	15	1.00	1	SS	-1.0		L1	1.0	**Filled Up Soil** Brownish Sand
		16	44								1.45							
		To		SC	-	-												
2		16	46				3	7	9	16	2.00	2	SS	-2.0				Brownish Grey, Moist, Stiff, **Sandy CLAY (CH)** Clays of High Plasticity
		16	57								2.45					L2	2.5	
		To		SC	-	-												
		17	00															
3		17	09				11	19	23	42	3.00	3	SS	-3.0				Greyish Brown, Moist, Dense, **Clayey SAND (SC) / Residual Soil** Descented from Charnockite
		To		SC	-	-					3.45					L3	3.5	
		17	10															
4		17	19				10 cm Penet. For 50Blows			>100	4.00	4	SS	-4.0				Brown, Moist, Very Dense, **Residual Soil** Descented from Charnockite
		To		SC	-	-					4.10					L4	4.2	
		17	21															
5		17	35				4 cm Penet. For 50Blows			>100	5.00	5	WS	-5.0				Brownish Grey, Moist, Very Dense, **Completetly Weathered Rock** Descented from Charnockite
		To		SC	-	-					5.04							
		18	06													L5	6.0	
6		18	15				SPT Hammer Rebounded			>100	6.00	6	WS	-6.0				Brownish Grey, **Highly Weathered Rock** Descented from Charnockite
		To		DB	9	-												
		19	00													L6	7.0	
7							-	-	-	-	7.00	7	CS	-7.0				
8																		
9																		
10																		

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CS - Core Sample	DS - Disturbed Sample	LOGGED	A.MD.TARIQ	PROJECT SITE DETAILS		REMARKS
SS - Split Spoon Sample	SC - Soil Cutter	DATE	31/07/2025	GROUND LEVEL (m)	0.00	
UDS- Undisturbed Sample	TCB - Tungsten Carbide Bit	CHECKED	JALEEL YASIN	WATER TABLE (m)	3.30	
WS - Wash Sample	DB - Diamond Bit	DATE	08/08/2025	CASING DEPTH (m)	0.00	

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

FIG.2.4 Sub Soil Profile at BH-04 Location

SITE INVESTIGATION RECORD

BORE HOLE No.	BH-05		
SHEET	1	OF	1
PROJECT NAME	PROPOSED CONSTRUCTION OF VILLA/CLUB HOUSE AT KARANAI, CHENNAI	DIA OF BORE HOLE	150mm ✓ / NX
LOCATION	Karanai, Chennai	MACHINE No.	CR-01
CHAINAGE (m)	-	BORE START DATE	01/08/2025
STRUCTURE	G+1/2 uppers	DRILLING METHOD	Rotary
CO-ORDINATES	N -	BORE END DATE	01/08/2025
JOB CODE	JC-GT-7039	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	15-30	30-45	SPT 'N' Value	Sample Details: Depth	No.	Type	RL (m)	Layer Data: Legend	No	Depth	Geotechnical Description
1	01/08/2025	10	20	SC	-	-												
		To																
		10	22				5	7	8	15	1.00	1	SS	-1.0		L1	1.0	**Filled Up Soil** Brownish Sand
		10	27								1.45							
		To		SC	-	-												
2		10	29				3	5	6	11	2.00	2	SS	-2.0				Brownish Grey, Moist, Stiff, **Sandy CLAY (CH)** Clays of High Plasticity
		10	37								2.45					L2	2.5	
		To		SC	-	-												
3		10	40				8	16	24	40	3.00	3	SS	-3.0				Greyish Brown, Moist, Dense, **Clayey SAND (SC) / Residual Soil** Descented from Charnockite
		10	54								3.45					L3	3.5	
		To		SC	-	-												
		11	00															
4		11	07				10 cm Penet. For 50Blows			>100	4.00	4	SS	-4.0				Brown, Moist, Very Dense, **Residual Soil** Descented from Charnockite
		To		SC	-	-					4.10					L4	4.1	
		11	20															Brownish Grey, Moist, **Completetly Weathered Rock** Descented from Charnockite
5		11	31				SPT Hammer Rebounded			>100	5.00	5	WS	-5.0		L5	5.0	
		To		DB	10	-												Brownish Grey, **Highly Weathered Rock** Descented from Charnockite
		12	05															
6							-	-	-	-	6.00	6	CS	-6.0		L6	6.0	
7																		
8																		
9																		
10																		

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CS - Core Sample	DS - Disturbed Sample	LOGGED	A.MD.TARIQ	PROJECT SITE DETAILS		REMARKS
SS - Split Spoon Sample	SC - Soil Cutter	DATE	01/08/2025	GROUND LEVEL (m)	0.00	
UDS- Undisturbed Sample	TCB - Tungsten Carbide Bit	CHECKED	JALEEL YASIN	WATER TABLE (m)	3.30	
WS - Wash Sample	DB - Diamond Bit	DATE	08/08/2025	CASING DEPTH (m)	0.00	

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

FIG.2.5 Sub Soil Profile at BH-05 Location

SITE INVESTIGATION RECORD

BORE HOLE No.	BH-06		
SHEET	1	OF	1
PROJECT NAME	PROPOSED CONSTRUCTION OF VILLA/CLUB HOUSE AT KARANAI, CHENNAI	DIA OF BORE HOLE	150mm ✓ / NX
LOCATION	Karanai, Chennai	MACHINE No.	CR-01
CHAINAGE (m)	-	BORE START DATE	01/08/2025
STRUCTURE	G+1/2 uppers	DRILLING METHOD	Rotary
CO-ORDINATES	N -	BORE END DATE	01/08/2025
JOB CODE	JC-GT-7039	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	Blows/cm 15-30	Blows/cm 30-45	SPT 'N' Value	Sample Details: Depth	No.	Type	RL (m)	Layer Data: Legend	No	Depth	Geotechnical Description
0	01/08/2025	08	00	SC	-	-										L1	0.8	**Filled Up Soil** Brownish Sand
		To																
		08	03															
1		08	03				5	6	6	**12**	1.00	1	SS	-1.0				
		08	11								1.45					L2	1.5	Grey, Moist, Stiff, **Sandy CLAY (CH)** Clays of High Plasticity
		To		SC	-	-												
2		08	14				9	14	17	**31**	2.00	2	SS	-2.0				
		08	26								2.45					L3	2.5	Grey, Moist, Hard, Poorly Graded, **Sandy CLAY (CH)** Clays of High Plasticity
		To		SC	-	-												
3		08	27				11	16	20	**36**	3.00	3	SS	-3.0				
		08	38								3.45					L4	3.5	Greyish Brown, Moist, Dense, **Clayey SAND (SC) / Residual Soil** Descented from Charnockite
		To		SC	-	-												
4		08	41				17	12cm Penet.for 50 Blows		**>100**	4.00	4	SS	-4.0				
		08	50								4.27					L5	4.3	Greyish Brown, Moist, Very Dense, **Residual Soil** Descented from Charnockite
		To		SC	-	-												
5		09	05				SPT Hammer Rebounded			**>100**	5.00	5	WS	-5.0		L6	5.0	Brownish Grey, Moist, Very Dense, **Completetly Weathered Rock** Descented from Charnockite
		09	12															
		To		DB	8	-										L7	6.0	Brownish Grey, **Highly Weathered Rock** Descented from Charnockite
6		09	51				-	-	-	-	6.00	6	CS	-6.0				
7																		
8																		
9																		
10																		

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CS - Core Sample	DS - Disturbed Sample	LOGGED	A.MD.TARIQ	PROJECT SITE DETAILS	REMARKS
SS - Split Spoon Sample	SC - Soil Cutter	DATE	01/08/2025	GROUND LEVEL (m) 0.00	
UDS- Undisturbed Sample	TCB - Tungsten Carbide Bit	CHECKED	JALEEL YASIN	WATER TABLE (m) 3.30	
WS - Wash Sample	DB - Diamond Bit	DATE	08/08/2025	CASING DEPTH (m) 0.00	

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

FIG.2.6 Sub Soil Profile at BH-06 Location

SITE INVESTIGATION RECORD

BORE HOLE No.	BH-07						
SHEET	1	OF	1				
PROJECT NAME	PROPOSED CONSTRUCTION OF VILLA/CLUB HOUSE AT KARANAI, CHENNAI			DIA OF BORE HOLE	150mm ✓ / NX		
LOCATION	Karanai, Chennai	MACHINE No.	CR-01	CHAINAGE (m)	-	BORE START DATE	01/08/2025
STRUCTURE	G+1/2 uppers	DRILLING METHOD	Rotary	CO-ORDINATES	N -	BORE END DATE	01/08/2025
JOB CODE	JC-GT-7039	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	01/08/2025	13	30	SC	-	-										L1	0.8	**Filled Up Soil** Brownish Sand
		To 13	33															
1		13	45				2	3	4	**7**	1.00 / 1.45	1	SS	-1.0		L2	1.5	Grey, Moist, Medium Stiff, Poorly Graded, **Sandy CLAY (CI)** Clays of Medium Plasticity
		To 13	46	SC	-	-												
2		14	00				2	4	4	**8**	2.00 / 2.45	2	SS	-2.0		L3	2.5	Grey, Moist, Loose, Poorly Graded, **Clayey SAND (SC)** Sand-Clay mixtures
		To 14	05	SC	-	-												
3		14	19				6	9	13	**22**	3.00 / 3.45	3	SS	-3.0		L4	3.5	Grey, Moist, Medium Dense, Poorly Graded, **Clayey SAND (SC)** Sand-Clay mixtures
		To 14	21	SC	-	-												
4		14	31				27	10cm Penet.for 50 Blows		**>100**	4.00 / 4.25	4	SS	-4.0		L5	4.3	Brown, Moist, Very Dense, **Residual Soil** Descented from Charnockite
		To 14	38	SC	-	-												
5		14	48				5 cm Penet. For 50Blows			**>100**	5.00 / 5.05	5	WS	-5.0		L6	5.5	Brownish Grey, Moist, **Completetly Weathered Rock** Descented from Charnockite
		To 15	00	SC	-	-												
6		15	06				SPT Hammer Rebounded			**>100**	5.50	6	WS	-5.5		L7	6.5	Brownish Green, **Highly Weathered Rock** Descented from Charnockite
		To 15	50	DB	11	-	-	-	-	-	6.50	7	CS	-6.5				
7																		
8																		
9																		
10																		

CS - Core Sample	DS - Disturbed Sample	LOGGED	A.MD.TARIQ	PROJECT SITE DETAILS		REMARKS
SS - Split Spoon Sample	SC - Soil Cutter	DATE	01/08/2025	GROUND LEVEL (m)	0.00	
UDS- Undisturbed Sample	TCB - Tungsten Carbide Bit	CHECKED	JALEEL YASIN	WATER TABLE (m)	3.30	
WS - Wash Sample	DB - Diamond Bit	DATE	08/08/2025	CASING DEPTH (m)	0.00	

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

FIG.2.7 Sub Soil Profile at BH-07 Location

Grain Size Distribution Curves

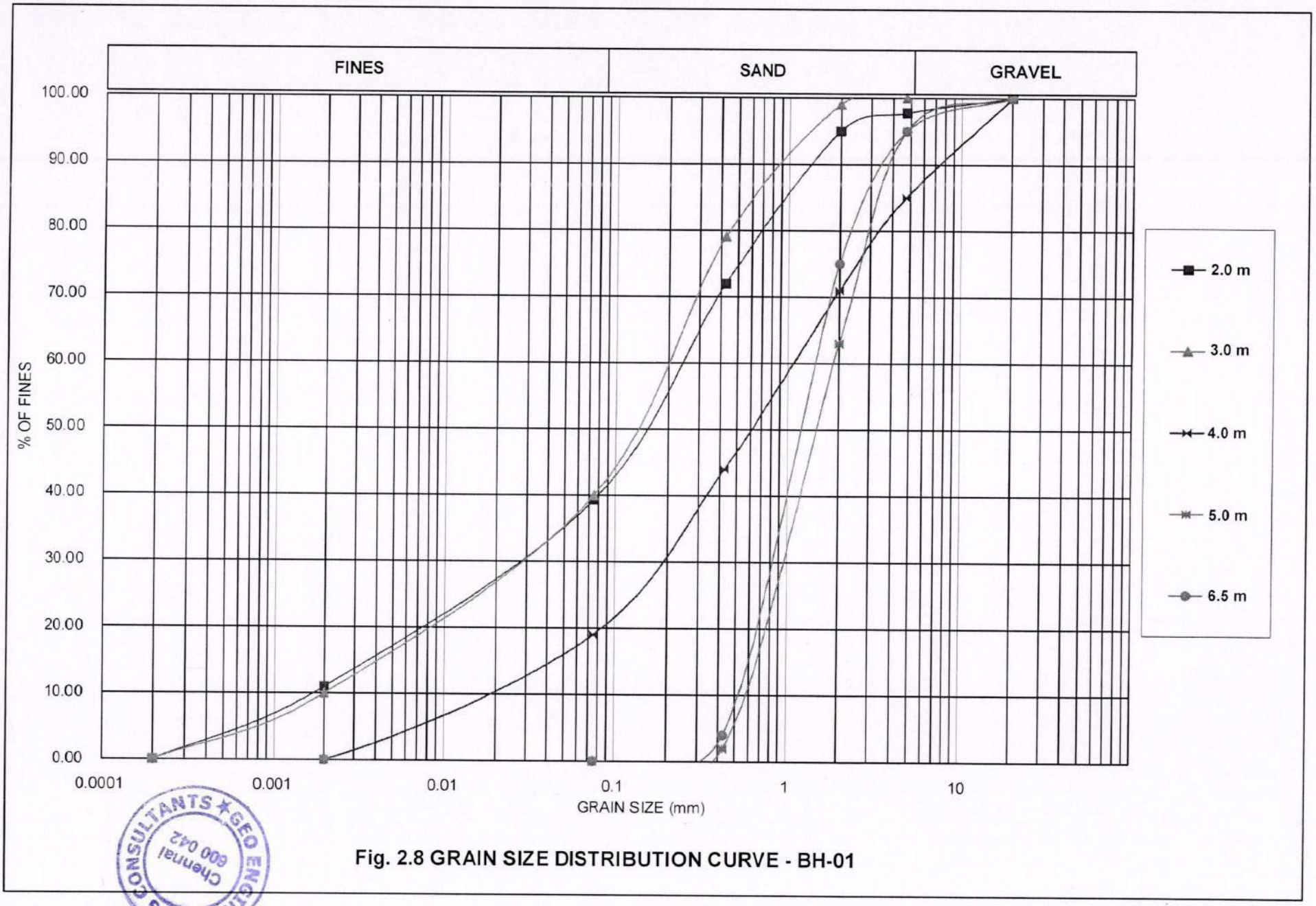

Fig. 2.8 GRAIN SIZE DISTRIBUTION CURVE - BH-01

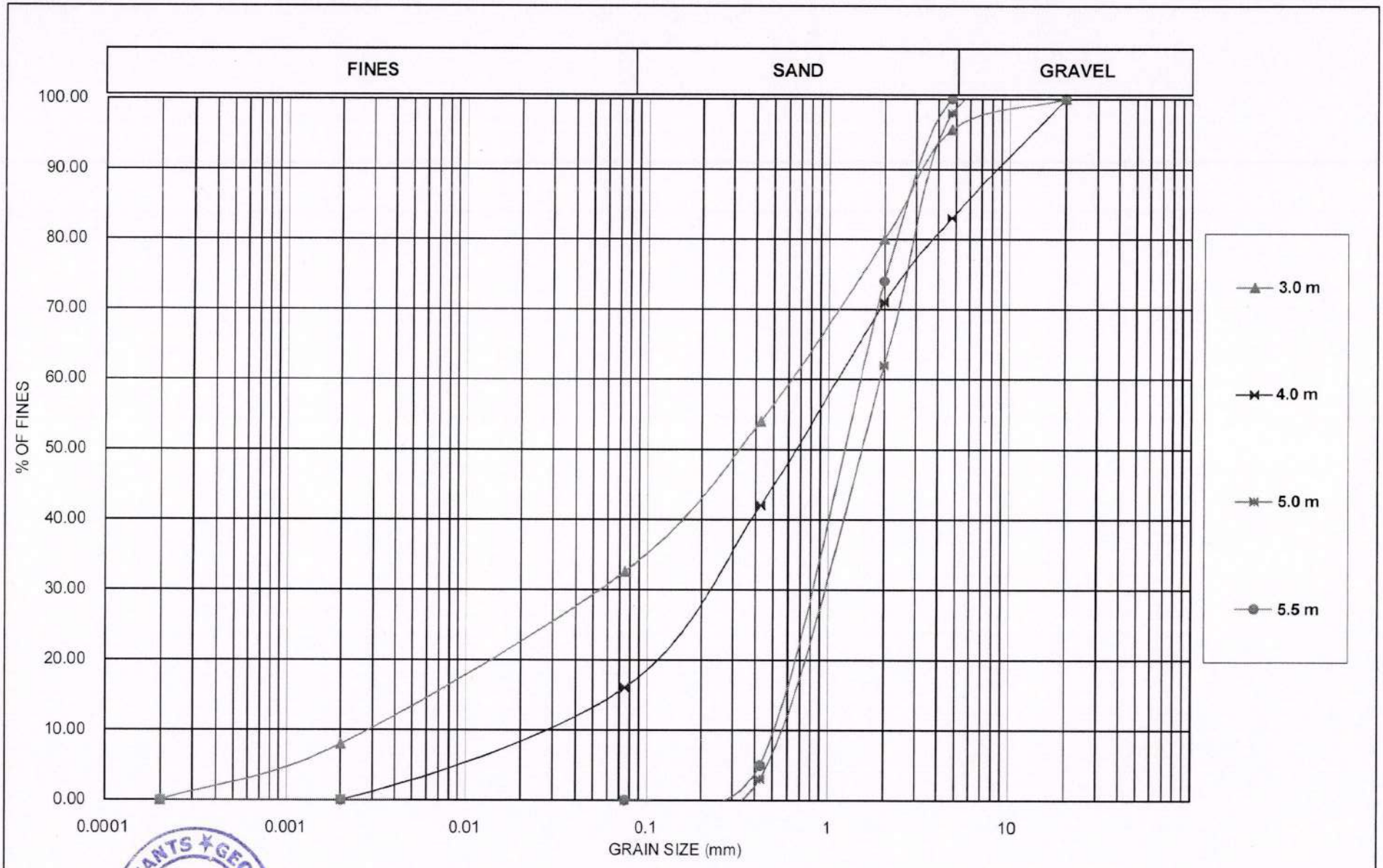

Fig. 2.9 GRAIN SIZE DISTRIBUTION CURVE - BH-02

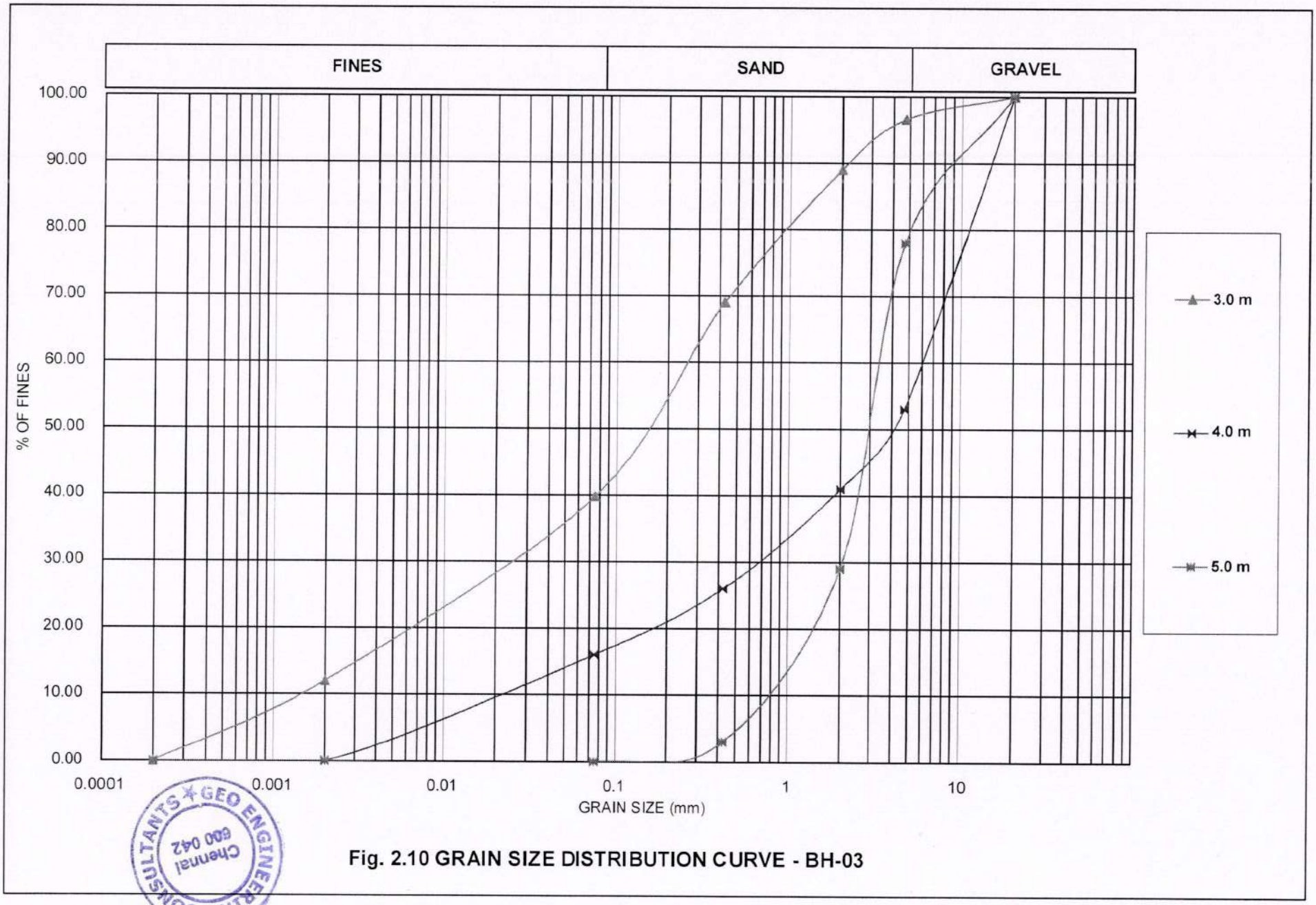

Fig. 2.10 GRAIN SIZE DISTRIBUTION CURVE - BH-03

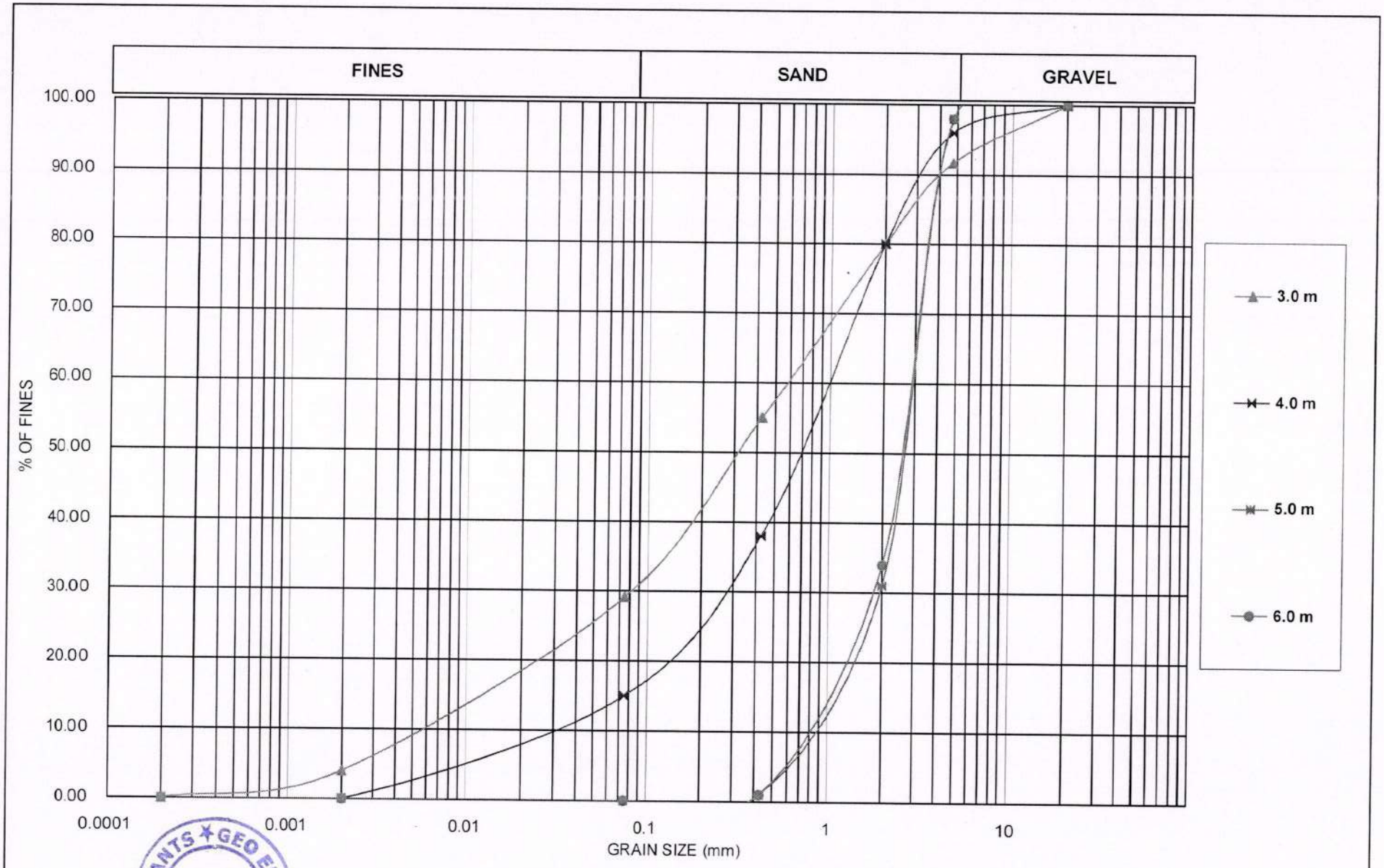

Fig. 2.11 GRAIN SIZE DISTRIBUTION CURVE - BH-04

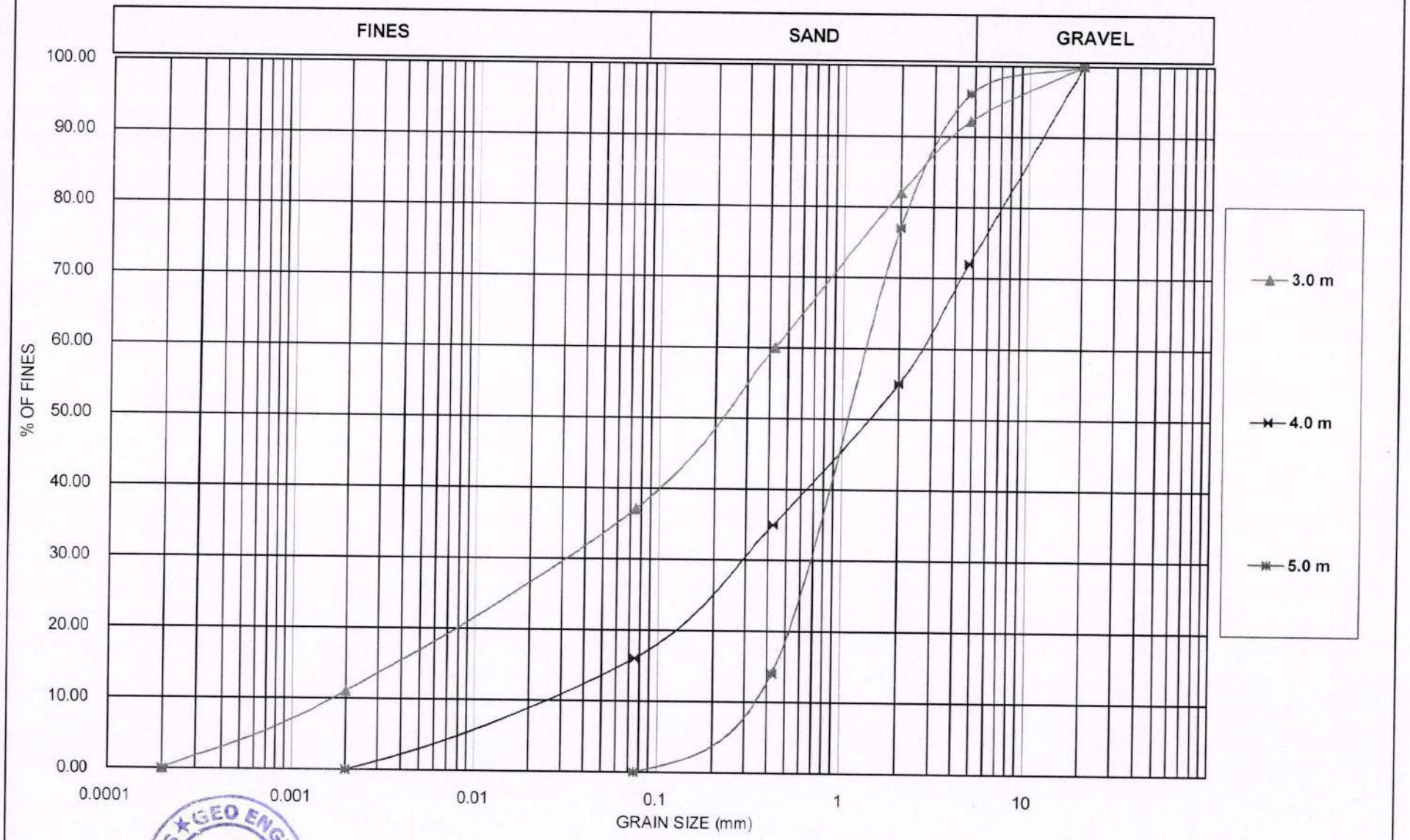

Fig. 2.12 GRAIN SIZE DISTRIBUTION CURVE - BH-05

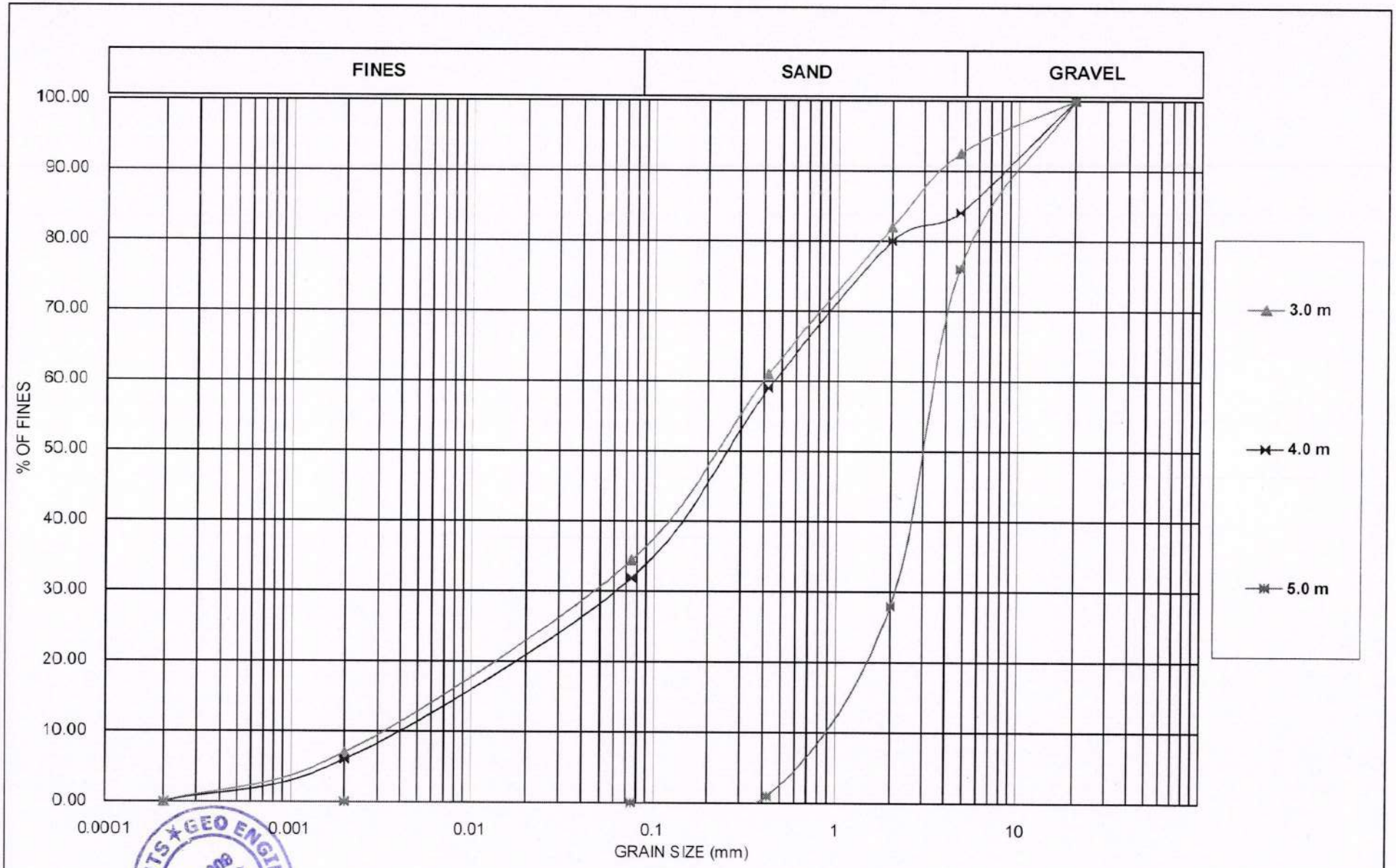

Fig. 2.13 GRAIN SIZE DISTRIBUTION CURVE - BH-06

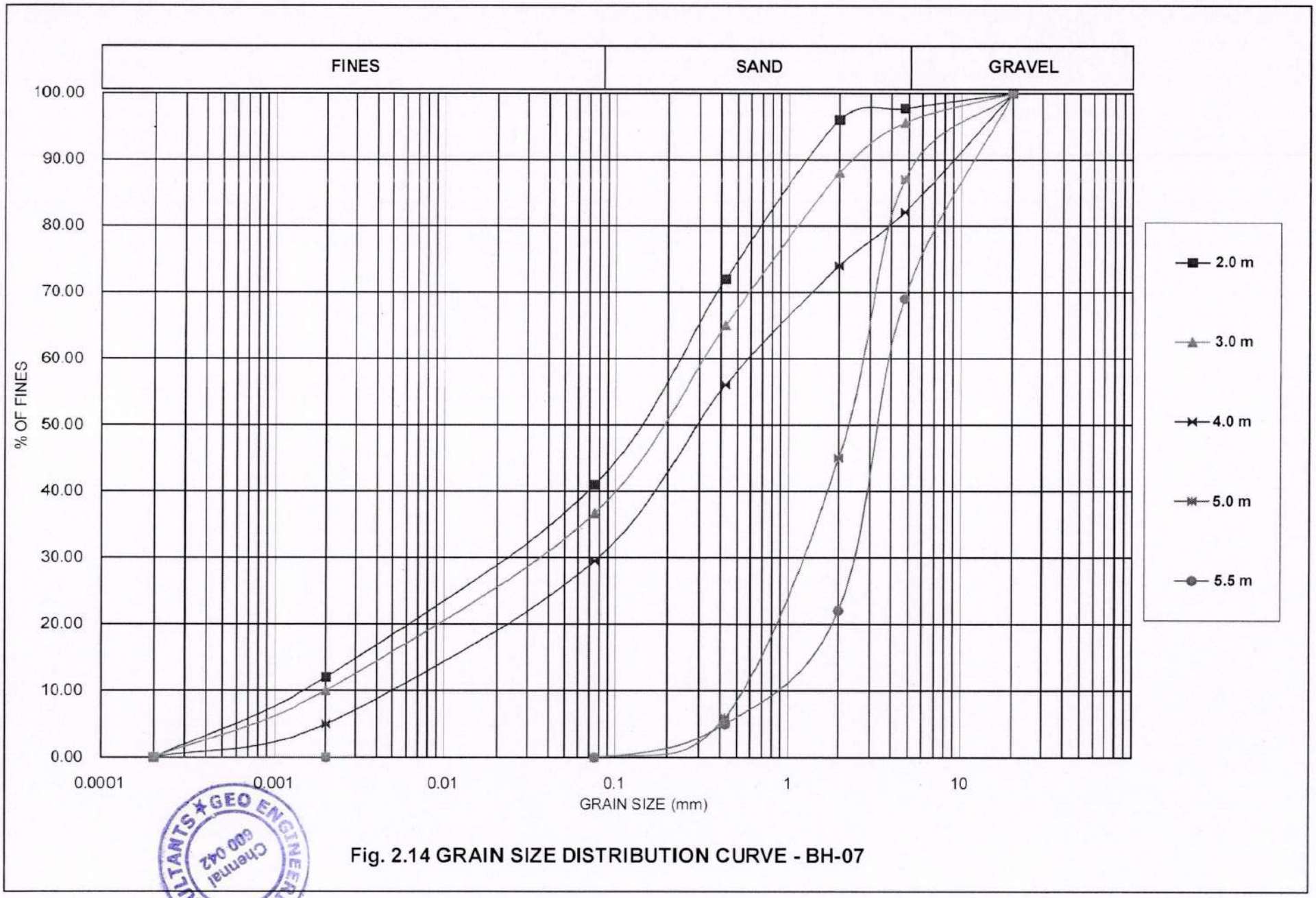

Fig. 2.14 GRAIN SIZE DISTRIBUTION CURVE - BH-07

HYDROMETER ANALYSIS CURVE

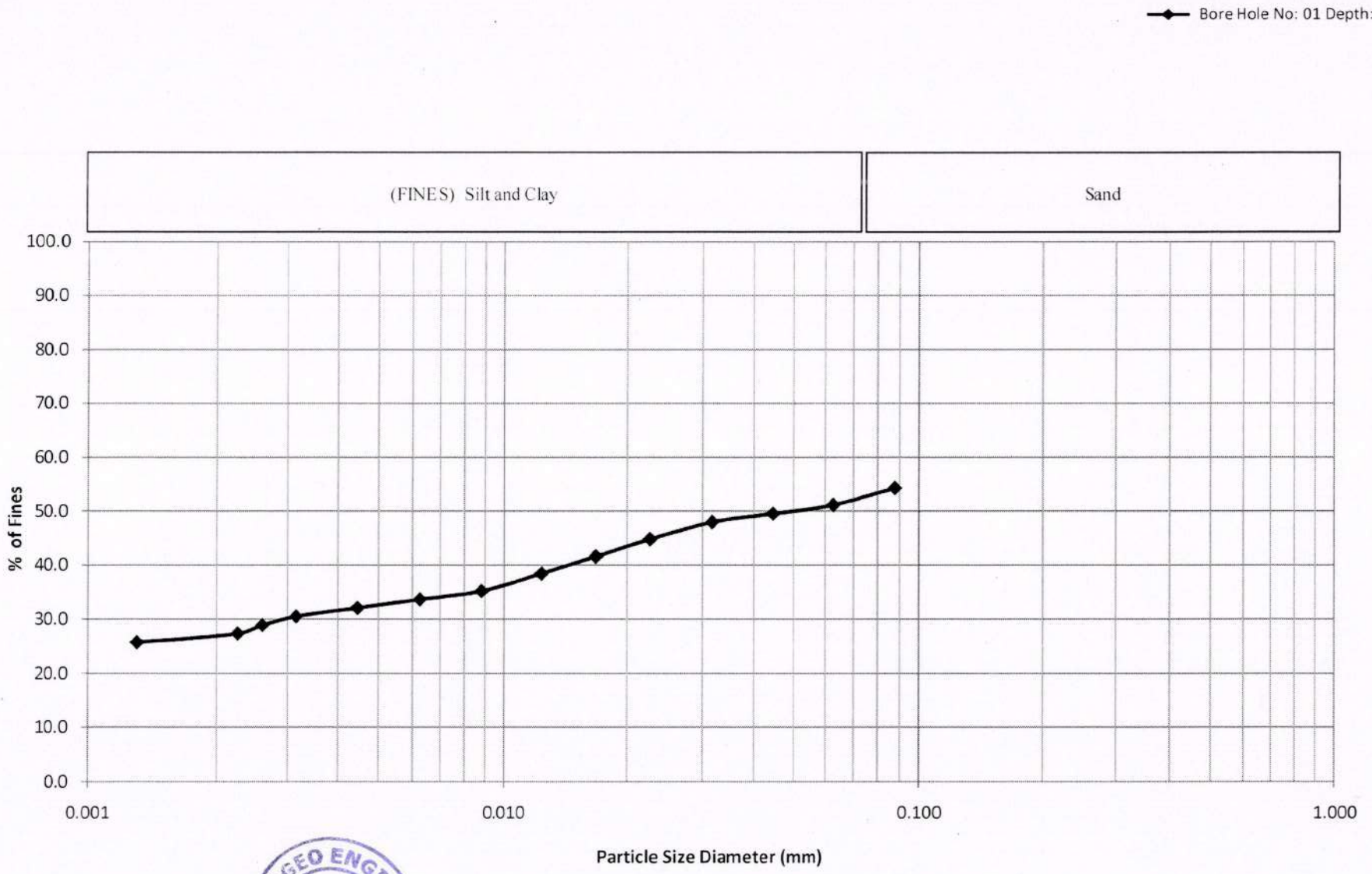

Fig 2.17 Hydrometer Analysis Master Curve

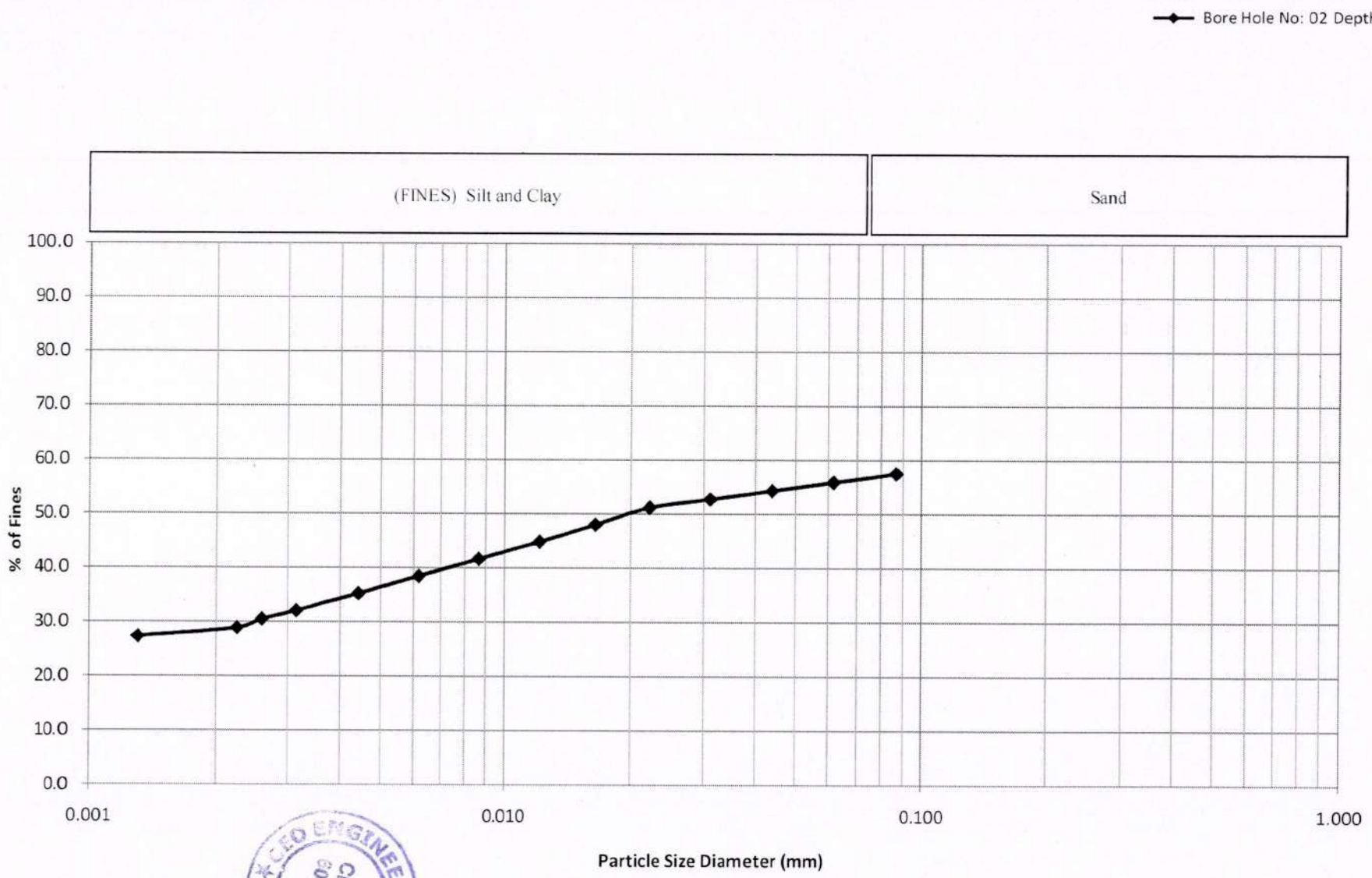

Fig 2.18 Hydrometer Analysis Master Curve

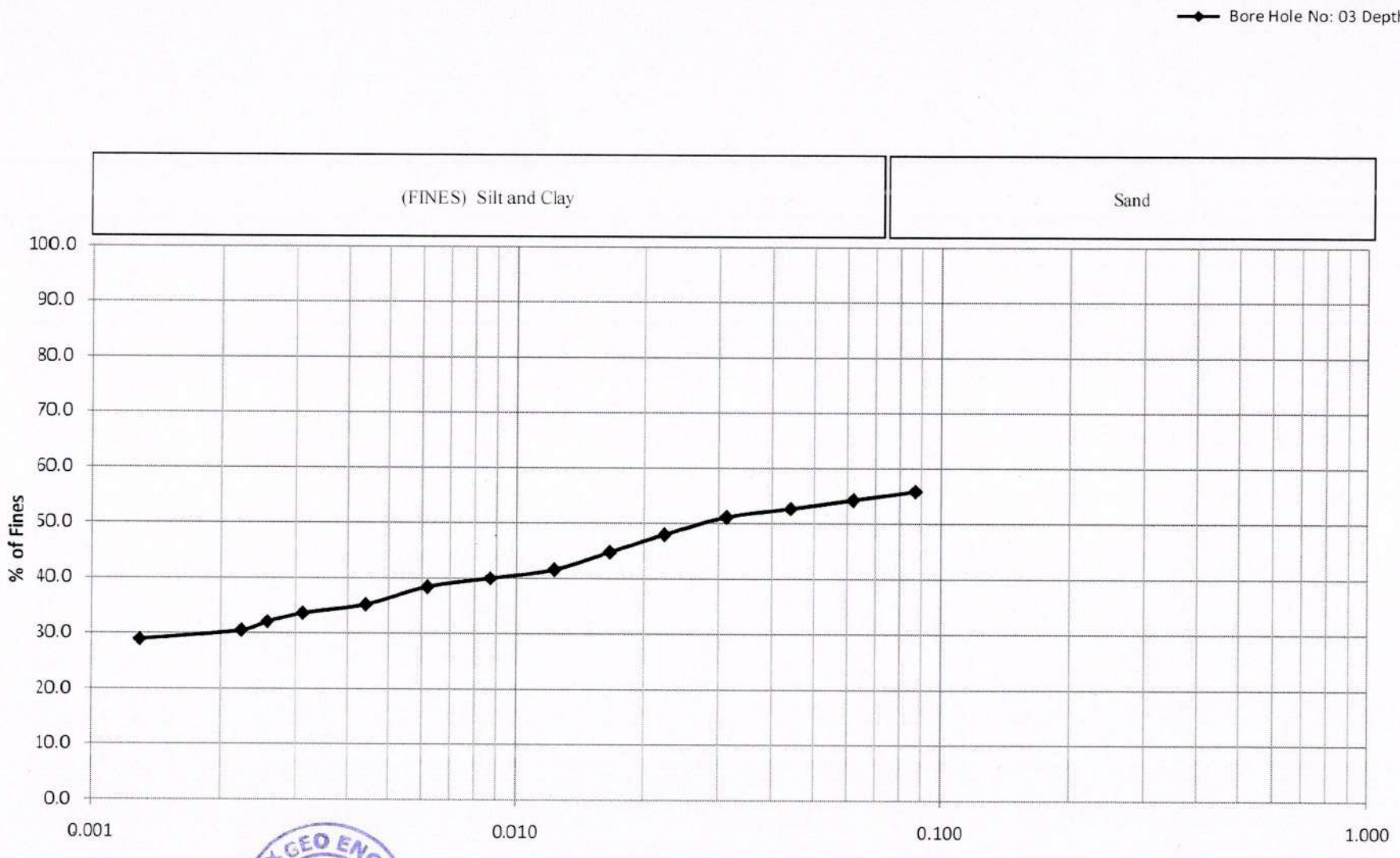

Fig 2.19 Hydrometer Analysis Master Curve

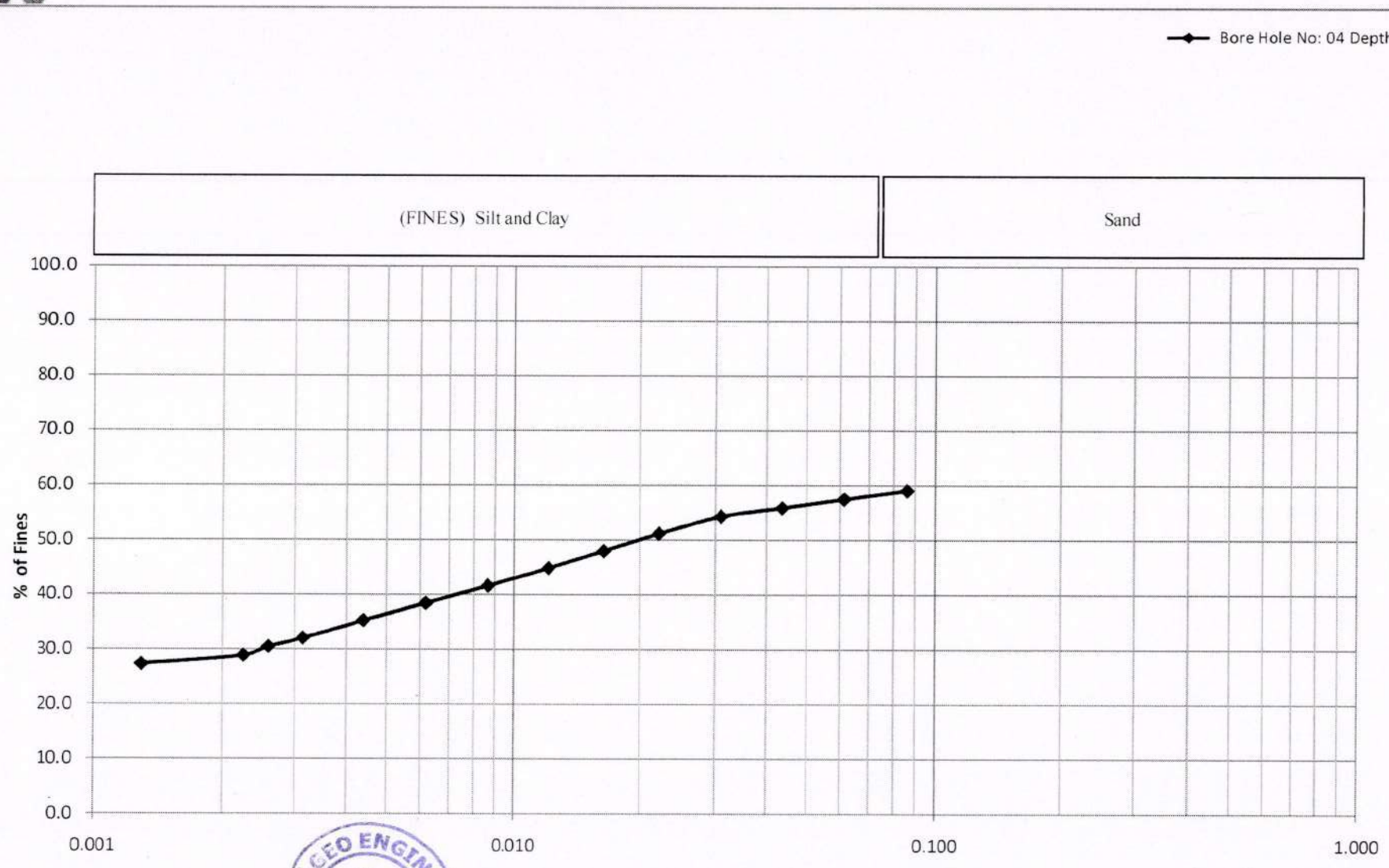

Fig 2.20 Hydrometer Analysis Master Curve

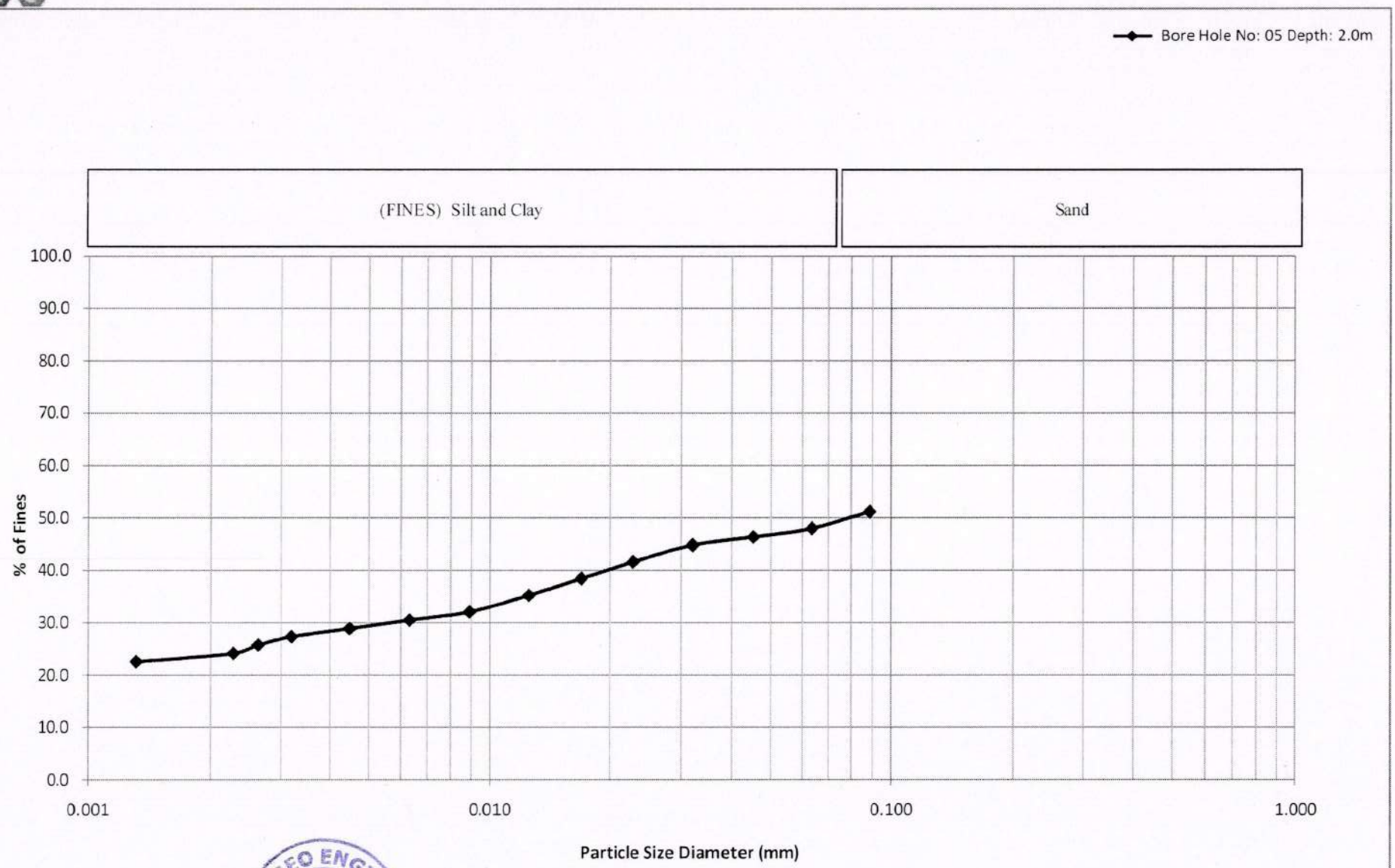

Fig 2.21 Hydrometer Analysis Master Curve

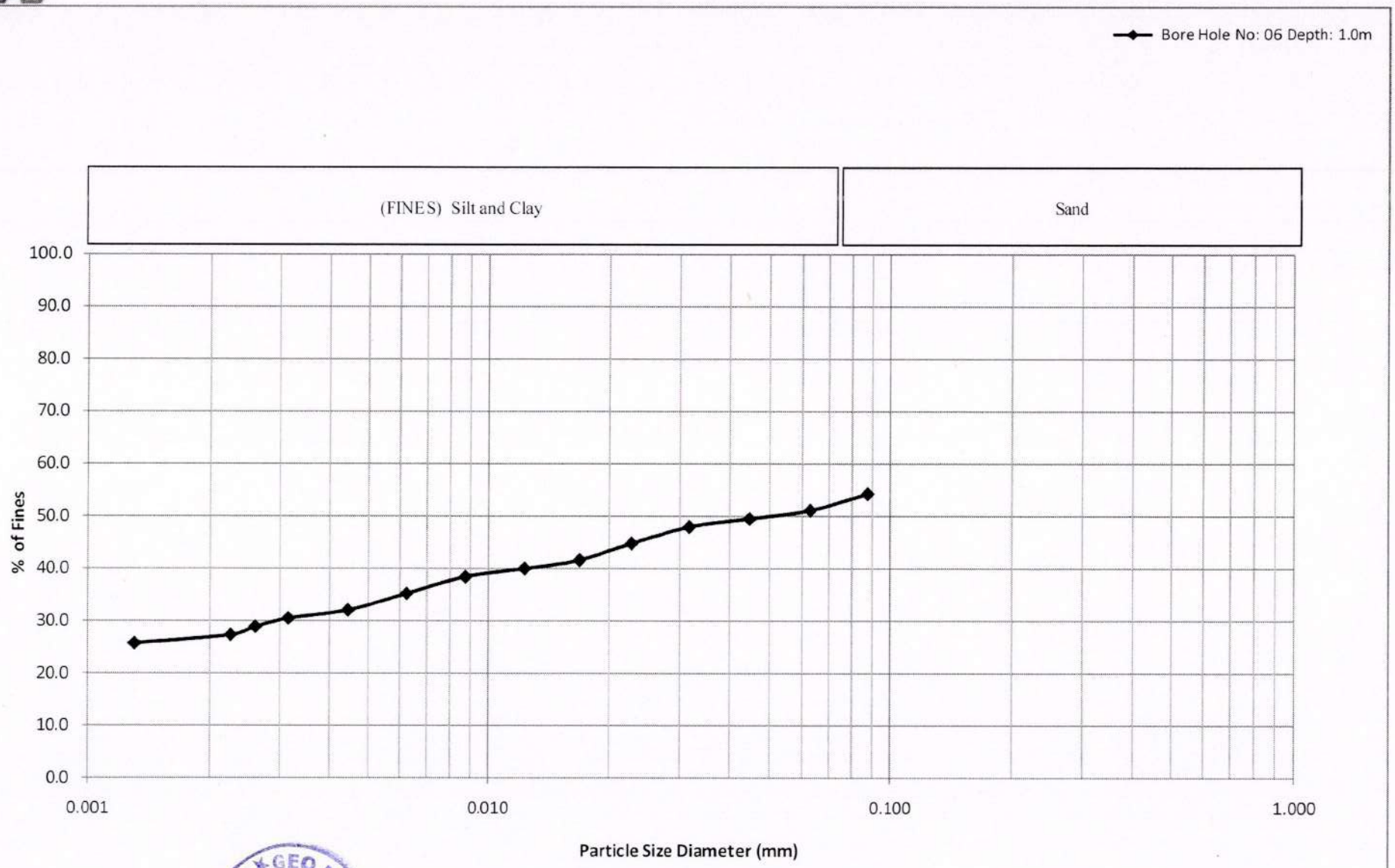

Fig 2.22 Hydrometer Analysis Master Curve

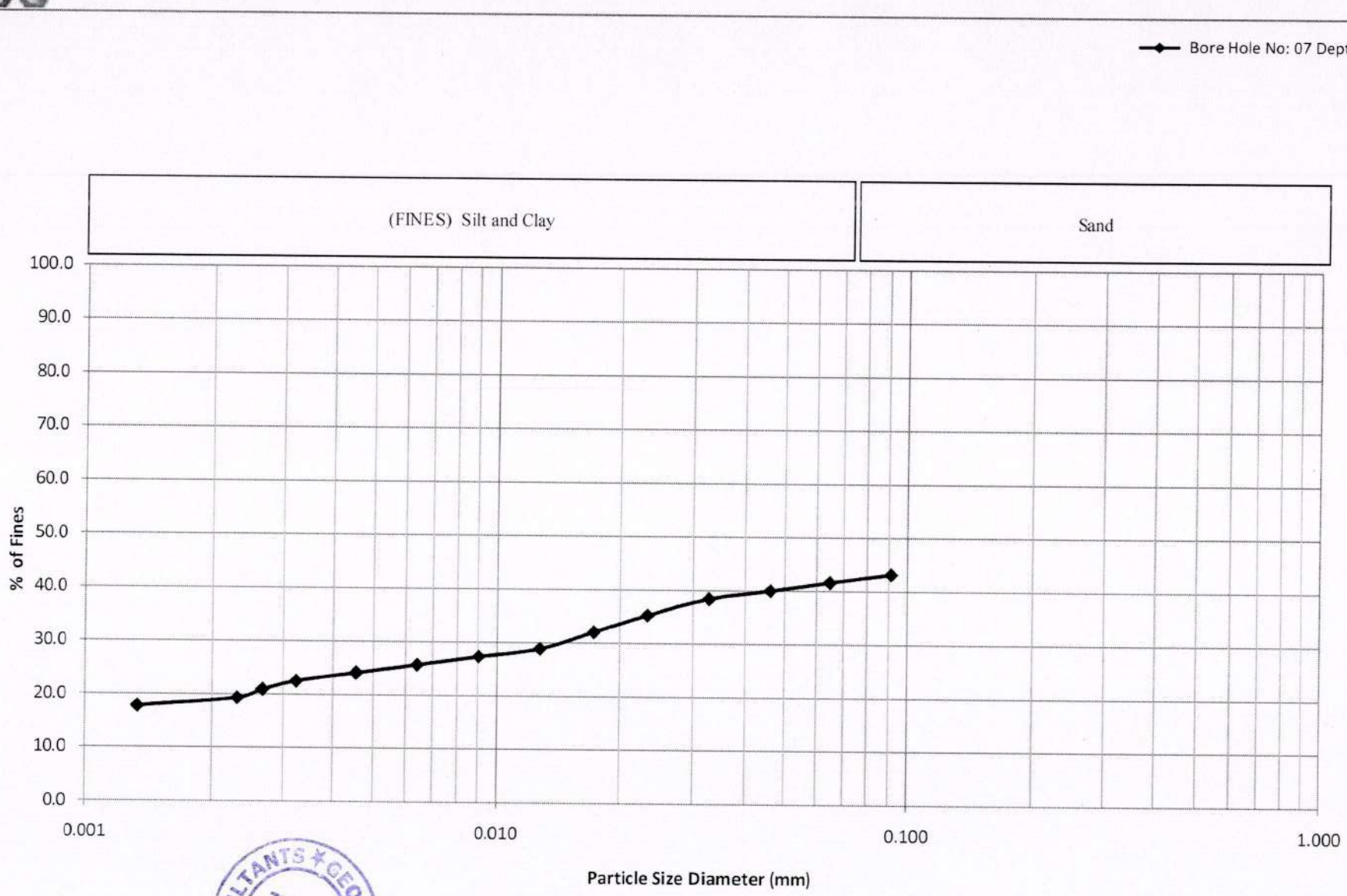

Fig 2.23 Hydrometer Analysis Master Curve

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	7	SS	29	48	20	28	0.68	11	30	M.Stiff	Above	CI	2	3	13	16	40	26	-	-	-	-	-	FG>50%	FG>50%	FG>50%
2.0	9	SS	23	42	18	24	0.79	14	56	CG>50%	Above	-	2	3	23	26	35	11	-	-	-	-	-	Loose	<50%	SC
3.0	17	SS	16	40	17	23	1.04	13	47	CG>50%	Above	-	0	1	20	33	36	10	-	-	-	-	-	M.Dense	<50%	SC
4.0	>100	SS	-	-	-	-	-	-	-	CG>50%	-	-	15	14	27	25	19	0	-	-	-	-	-	V.Dense	<50%	SM
5.0	>100	WS	-	-	-	-	-	-	-	CG>50%	-	-	5	32	61	2	0	0	-	-	-	-	-	V.Dense	<50%	SP
6.5	>100	WS	-	-	-	-	-	-	-	CG>50%	-	-	5	20	71	4	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	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
2.0	21	SS	26	60	27	33	1.03	12	55	V.Stiff	Above	CH	3	2	6	9	53	27	-	-	-	-	-	FG>50%	FG>50%	FG>50%
3.0	26	SS	15	38	16	22	1.05	14	20	CG>50%	Above	-	4	16	26	16	30	8	-	-	-	-	-	M.Dense	<50%	SC
4.0	>100	SS	-	-	-	-	-	-	-	CG>50%	-	-	17	12	29	26	16	0	-	-	-	-	-	V.Dense	<50%	SM
5.0	>100	WS	-	-	-	-	-	-	-	CG>50%	-	-	2	36	59	3	0	0	-	-	-	-	-	V.Dense	<50%	SP
5.5	>100	WS	-	-	-	-	-	-	-	CG>50%	-	-	0	26	69	5	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	PRAVEEN
REVIEWED BY	JALEEL YASIN

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
2.0	9	SS	29	76	26	50	0.94	13	70	Stiff	Above	CH	2	1	6	8	55	28	-	-	-	-	-	FG>50%	FG>50%	FG>50%
3.0	24	SS	18	44	19	25	1.04	14	40	CG>50%	Above	-	3	8	20	22	35	12	-	-	-	-	-	M.Dense	<50%	SC
4.0	>100	SS	-	-	-	-	-	-	-	CG>50%	-	-	47	12	15	10	16	0	-	-	-	-	-	V.Dense	GM	<50%
5.0	>100	WS	-	-	-	-	-	-	-	CG>50%	-	-	22	49	26	3	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	PRAVEEN
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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	30	60	26	34	0.88	11	80	Stiff	Above	CH	4	5	8	9	49	25	-	-	-	-	-	FG>50%	FG>50%	FG>50%
2.0	16	SS	24	69	25	44	1.02	12	52	V.Stiff	Above	CH	3	3	6	9	52	27	-	-	-	-	-	FG>50%	FG>50%	FG>50%
3.0	42	SS	15	33	16	17	1.06	17	22	CG>50%	Above	-	8	12	25	23	28	4	-	-	-	-	-	Dense	<50%	SC
4.0	>100	SS	-	-	-	-	-	-	-	CG>50%	-	-	4	16	42	23	15	0	-	-	-	-	-	V.Dense	<50%	SM
5.0	>100	WS	-	-	-	-	-	-	-	CG>50%	-	-	2	67	30	1	0	0	-	-	-	-	-	V.Dense	<50%	SP
6.0	>100	WS	-	-	-	-	-	-	-	CG>50%	-	-	2	64	33	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

LAB IN-CHARGE	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	15	SS	26	58	23	35	0.91	11	118	Stiff	Above	CH	2	4	10	13	47	24	-	-	-	-	-	FG>50%	FG>50%	FG>50%
2.0	11	SS	23	53	20	33	0.91	12	67	Stiff	Above	CH	0	4	11	14	49	22	-	-	-	-	-	FG>50%	FG>50%	FG>50%
3.0	40	SS	16	39	17	22	1.05	15	75	CG>50%	Above	-	7	11	22	16	33	11	-	-	-	-	-	Dense	<50%	SC
4.0	>100	SS	-	-	-	-	-	-	-	CG>50%	-	-	28	17	20	19	16	0	-	-	-	-	-	V.Dense	<50%	SM
5.0	>100	WS	-	-	-	-	-	-	-	CG>50%	-	-	4	19	63	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	PRAVEEN
REVIEWED BY	JALEEL YASIN

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Table-2.6 Laboratory Classification of Soil Samples from BH-06

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	12	SS	24	52	21	31	0.90	12	88	Stiff	Above	CH	0	5	13	12	45	25	-	-	-	-	-	FG>50%	FG>50%	FG>50%
2.0	31	SS	18	53	20	33	1.06	14	29	Hard	Above	CH	22	3	6	8	39	22	-	-	-	-	-	FG>50%	FG>50%	FG>50%
3.0	36	SS	17	39	19	20	1.10	16	8	CG>50%	Above	-	7	11	21	22	32	7	-	-	-	-	-	Dense	<50%	SC
4.0	>100	SS	16	34	18	16	1.13	20	25	CG>50%	Above	-	15	5	21	23	30	6	-	-	-	-	-	V.Dense	<50%	SC
5.0	>100	WS	-	-	-	-	-	-	-	CG>50%	-	-	24	48	27	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

LAB IN-CHARGE	PRAVEEN
REVIEWED BY	JALEEL YASIN

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Table-2.7 Laboratory Classification of Soil Samples from BH-07

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	22	37	16	21	0.71	14	44	M.Stiff	Above	Cl	2	3	12	19	47	17	-	-	-	-	-	FG>50%	FG>50%	FG>50%
2.0	8	SS	20	47	18	29	0.93	14	50	CG>50%	Above	-	2	2	24	24	36	12	-	-	-	-	-	Loose	<50%	SC
3.0	22	SS	16	46	17	29	1.03	15	20	CG>50%	Above	-	4	8	23	22	33	10	-	-	-	-	-	M.Dense	<50%	SC
4.0	>100	SS	14	30	15	15	1.07	17	15	CG>50%	Above	-	17	9	18	23	28	5	-	-	-	-	-	V.Dense	<50%	SC
5.0	>100	WS	-	-	-	-	-	-	-	CG>50%	-	-	13	42	39	6	0	0	-	-	-	-	-	V.Dense	<50%	SP
5.5	>100	WS	-	-	-	-	-	-	-	CG>50%	-	-	31	47	17	5	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	PRAVEEN
REVIEWED BY	JALEEL YASIN

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Table-2.8 Results of Chemical Analysis									
SL No.	Bore HoleNo.	Water				Soil (2:1)			
		Depth of Sample (m)	pH	Chlorides (ppm)	Sulphates (ppm)	Depth of Sample (m)	pH	Chlorides (ppm)	Sulphates (ppm)
1	BH-02	3.30	7.38	485	395	2.0	7.49	445	352
2	BH-04	3.30	7.35	452	386	3.0	7.53	438	374
3	BH-06	3.30	7.39	465	388	2.0	7.49	429	365

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 4.0 to 4.5 meter underlain by varying degree of weathering.

The present site is Karanai village, Vandalur Taluk, geologically it is classified as recent alluvium deposits consisting of Sandy Clay/Clayey 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):			0.00		
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	1.00	1.00	Filled Up Soil	Brownish	-	-	-	-	-	-
2	1.00	2.00	1.00	Sandy Clay	Grey	7	-	Medium Stiff	16	47	-
3	2.00	2.80	0.80	Clayey Sand	Grey	9	Loose	-	14.5	-	29.8
4	2.80	3.50	0.70	Clayey Sand	Grey	17	Medium Dense	-	18	-	32.1
5	3.50	4.30	0.80	Residual Soil	Greyish Brown	>100	Very Dense	-	21	-	42.5
6	4.30	6.30	2.00	Completely Weathered Rock	Greyish White	>100	Very Dense	-	21	-	42.5
7	6.30	7.30	1.00	Highly Weathered Rock	Brownish Green	CRR-9%, RQD-0%					

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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	1.50	1.50	Filled Up Soil	Brownish	9	Loose	-	14.5	-	29.8
2	1.50	2.50	1.00	Sandy Clay	Grey	21	-	Very Stiff	20.5	140	-
3	2.50	3.50	1.00	Clayey Sand	Brown	26	Medium Dense	-	19	-	34.8
4	3.50	4.40	0.90	Residual Soil	Brown	>100	Very Dense	-	21	-	42.5
5	4.40	5.50	1.10	Completely Weathered Rock	Greyish White	>100	Very Dense	-	21	-	42.5
6	5.50	7.00	1.50	Highly Weathered Rock	Brownish Green	CRR-10%, RQD-0%					

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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/m³	Shear Parameters	
	Top. R.L.	Bot. R.L.	Thickness							(C_u) kPa	(ϕ) Deg.
1	0.00	1.50	1.50	Filled Up Soil	Brownish	4	Very Loose	-	13.5	-	20.22
2	1.50	2.50	1.00	Sandy Clay	Grey	9	-	Stiff	17	60	-
3	2.50	3.50	1.00	Clayey Sand	Greyish Brown	24	Medium Dense	-	18.5	-	34.2
4	3.50	4.30	0.80	Residual Soil	Brown	>100	Very Dense	-	21	-	42.5
5	4.30	5.00	0.70	Completely Weathered Rock	Brownish Grey	>100	Very Dense	-	21	-	42.5
6	5.00	6.00	1.00	Highly Weathered Rock	Brownish Grey	CRR-6%, RQD-0%					

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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	1.00	1.00	Filled Up Soil	Brownish	-	-	-	-	-	-
2	1.00	2.50	1.50	Sandy Clay	Brownish Grey	16	-	Very Stiff	20	107	-
3	2.50	3.50	1.00	Clayey Sand	Greyish Brown	42	Dense	-	20	-	39.2
4	3.50	4.20	0.70	Residual Soil	Brown	>100	Very Dense	-	21	-	42.5
5	4.20	6.00	1.80	Completely Weathered Rock	Brownish Grey	>100	Very Dense	-	21	-	42.5
6	6.00	7.00	1.00	Highly Weathered Rock	Brownish Grey	CRR-9, RQD-0%					

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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/m³	Shear Parameters	
	Top. R.L.	Bot. R.L.	Thickness							(C_u) kPa	(ϕ) Deg.
1	0.00	1.00	1.00	Filled Up Soil	Brownish	-	-	-	-	-	-
2	1.00	2.50	1.50	Sandy Clay	Brownish Grey	13	-	Stiff	19	87	-
3	2.50	3.50	1.00	Clayey Sand	Greyish Brown	40	Dense	-	20	-	38.75
4	3.50	4.10	0.60	Residual Soil	Brown	>100	Very Dense	-	21	-	42.5
5	4.10	5.00	0.90	Completely Weathered Rock	Brownish Grey	>100	Very Dense	-	21	-	42.5
6	5.00	6.00	1.00	Highly Weathered Rock	Brownish Grey	CRR-10, RQD-0%					

REFERENCE BORE HOLE-BH:					06	Ref R.L. of G.L. (m):			0.00		
Layer No.	Layer Thk. (m)			Type of Strata	Colour	Ave. Design SPT	Relative Density	Consistency	(γ) kN/m³	Shear Parameters	
	Top. R.L.	Bot. R.L.	Thickness							(C_u) kPa	(ϕ) Deg.
1	0.00	0.80	0.80	Filled Up Soil	Brownish	-	-	-	-	-	-
2	0.80	1.50	0.70	Sandy Clay	Grey	12	-	Stiff	18.5	80	-
3	1.50	2.50	1.00	Sandy Clay	Grey	31	-	Hard	21	207	-
4	2.50	3.50	1.00	Clayey Sand	Brown	36	Dense	-	19.5	-	37.65
5	3.50	4.30	0.80	Residual Soil	Brownish Grey	>100	Very Dense	-	21	-	42.5
6	4.30	5.00	0.70	Completely Weathered Rock	Brownish Grey	>100	Very Dense	-	21	-	42.5
7	5.00	6.00	1.00	Highly Weathered Rock	Brownish Grey	CRR-8, RQD-0%					

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REFERENCE BORE HOLE-BH:					07	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	0.80	0.80	Filled Up Soil	Brownish	-	-	-	-	-	-
2	0.80	1.50	0.70	Sandy Clay	Grey	7	-	Medium Stiff	16	47	-
3	1.50	2.50	1.00	Clayey Sand	Grey	8	Loose	-	14.5	-	29.6
4	2.50	3.50	1.00	Clayey Sand	Brown	22	Medium Dense	-	18.5	-	33.6
5	3.50	4.30	0.80	Residual Soil	Brownish Grey	>100	Very Dense	-	21	-	42.5
6	4.30	5.50	1.20	Completely Weathered Rock	Brownish Grey	>100	Very Dense	-	21	-	42.5
7	5.50	6.50	1.00	Highly Weathered Rock	Brownish Grey	CRR-11, 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 plus one floor, and is meant for residential building occupancy. For this kind of structure, the column loads could vary between 600 kN to 900 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

4.2.1 Villa

For the kind of proposed structure and the sub soil conditions, it is not possible to adopt any kind of open foundation system from both shear and settlement considerations. Hence, it is advisable to adopt deep pile foundation system.

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 depth and diameters is worked out as per IS 2911-Part-I-Section-2 and are presented in Table 4.1.

Typical computations are presented in Annexure

4.2.2 Club House Area

For the kind of proposed structure and the sub soil conditions, open foundation system shall be adopted. The R.C.C Raft shall be located at a depth of 4.50m below the existing ground level. The raft can be designed for an allowable safe bearing pressure of 200kPa.

Typical computation is presented in the Annexure-I

For the design of raft, the recommended modulus of sub grade reaction of the bearing strata (ks) is 27000 kN/m3

Table:- 4.1 Recommended Safe Load Carrying Capacities of Bored Cast-in Situ Piles								
Sl.No	Reference Bore hole No.	Length of Pile below E.G.L	Assumed Length of Cut-Off Below E.G.L	Length of Pile below Cut-off	Dia.of Pile in (mm)	SAFE LOAD CARRYING CAPACITY (kN)		
						Vertical Load Carrying Capacity	Pull Out Capacity	Lateral Load Carrying Capacity
1	BH-01	5.5	1.0	4.50	400	300	40	25
2					450	350	45	30
3					500	450	50	35
4					550	550	55	42

RECOMMENDATIONS

CHAPTER-5

RECOMMENDATIONS

5.0 RecommendationforDeeppilefoundationsystem:

- For the kind of sub soil conditions Bored Cast in situ piles are recommended as the suitable foundation system.
- The allowable safe load carrying capacities as per IS 2911-Part-I-Section-2 (2010) for different diameters of piles with two different approaches are 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.
- Thetheoreticalloadcarryingestimatesofpilesshallbeconfirmedbyconductingpileloads tests as per the guide lines laid down in IS: 2911-Part-IV.
- The boring shall be carried out using direct mud circulation prepared out of sodium bentonite.
- After reaching the borehole termination depth, the borehole shall be cleaned using mud circulation for a minimum period of 30min or till the return mud is relatively clear of soil particles.
- Afterensuring the borehole is clean, thetremie pipeshall belowered and concretecan be done.

5.1 Constructionmethodstatementofpilefoundation:

- Fortheboredcastinsitupiles,aguidecasingof2.0mlengthcanbeadopted
- 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%.
- Themudwaspreparedusingsodiumbentonitewithadensityof1.10to1.15g/cc.

5.2 GeneralRecommendation:

- 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

1.1 Geometrical Data : **Ref.BH-01**

Shape of the Foundation	Raft
Depth of Foundation Below E.G.L"Df" (m)	4.50
Soil Replacement Thickness of CNS Layer (m)	0.00
Total Depth of Foundation (m)	4.50
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 :	Sand	
Average Design SPT-value of the Bearing Strata	40.00	
Type of Shear Failure:	General	
Angle of Shearing Resistance	38.75	Phi

1.3 Design Parameters:

Bulk Density of Soil above the foundation depth (γ_{bulk})	16.50	kN/m^3
Water Table Correction Factor (w')	0.50	
Effective Overburden pressure at foundation level (q)	6.50	kPa

Bearing Capacity Factors:

N_c = N/A

N_q = 56.48

N_g = 94.07

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' 2774.42 kPa

(g should be read as gama)

1.5 Safe Bearing Capacity (Qsafe) :

Factor of Safety (F.S.) :	2.50	
Qsafe :	1109.77	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	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_s)	104000.00	kPa
Size of footing considered for maximum settlement(m)	10.00	
Influence factor	1.00	
Rigidity Factor	1.00	
Elastic Settlement (DH_i)	14.42	mm
	<50	mm

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)	5.5	As Per IS:2911-(P-I,S-2)-2010
Reference Bore Hole	BH-01		400	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 (Cu) 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	1.5	0.5	Clay	9	17.0	17.0	60	-	0.0	3.5	1.8	0.7	-	qf	2	27.5
3	1.5	2.8	1.3	Sand	9	14.5	15.8	-	29.8	3.5	9.4	6.4	-	1.0	qf	3	6.0
4	2.8	3.5	0.7	Sand	17	18.0	16.3	-	32.1	9.4	15.0	12.2	-	1.1	qf	4	7.4
5	3.5	4.3	0.8	Sand	50	20.5	19.3	-	41.0	15.0	23.4	19.2	-	1.5	qf	5	25.1
6	4.3	5.5	1.2	Weathered Rock	60	20.5	20.5	-	42.5	23.4	36.0	29.7	-	1.5	qf	6	61.5

Summation of Positive Skin Resitance (kN) Q_f= 127.58

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

Computation of End Bearing Resistance

		SPT	ϕ	C_u	N_q	N_c		
Bearing Stratum	Weathered Rock	60	40.55	-	142.77	-	Eff.Ht.of Overburden	5 m
							Effective Overburden Pressure	34.88 kN/m²

End Bearing Resistance (kN) Q_p= 625.69

Ultimate Load Carrying Capacity (Q_{ult})	**$Q_u=Q_f-Q_r+Q_p$ (kN)**	753.27
Safe Load Carrying Capacity (Q_{safe})	**$Q_u/2.5$ (kN)**	301.31
Allowable Safe Load Carrying Capacity	**$Q_{A\text{-}safe}$ (kN)**	301.31
Allowable Safe Pull out Capacity	**$Q_{A\text{-}pull}$: Qf/3 (kN)**	42.53

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

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

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

Note: The End being is completely weathreed rock modeld as Very Dense Sand with restricted to SPT-value of 60 corresponding phi angle 40.55

LATERAL LOAD CARRYING CAPACITY OF BORED CAST- SITU PILES

Reference Bore Hole : BH-01

1.0 Geometrical Data

Type of Pile Head Considered		Fixed	
Diameter of Pile (d)	:	0.45	m
Free standing Length of Pile (e)	:	0	m
Length of Pile below E.G.L (Le)	:	5.5	m
Cut-Off Level From E.G.L	:	1.0	
Length of Pile below Cut-Off Level (Le)	:	4.5	m
Grade of Concrete (M)	:	25	MN/m^2
Young's Modulus of Concrete (E)	:	25000000	kN/m^2
Momemnt of Inertia (I)	:	0.002013	m^4

2.0 Determination of Depth of Fixity

Type of Soil Strata	:	Sand	
Ground Water Condition	:	Submerged	
Average Design SPT "N" Value	:	9	
T=(EI/nh)1/5			
(n can be read as η in the above and below equation in case of Sand)			
nh=	:	1200	kN/m^3
In Case of Sand	:	-	kN/m^2
T=	:	2.11	
L1/T	:	0.00	
Lf/T	:	2.20	
Depth of Fixity below Cut off (z_f)	:	4.64	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	:	30.14	kN
Recommended Design Lateral Load carrying Capacity	:	**30**	**kN**
Fixed End Moment, M_F=H(e+z_f)/2		70	
Reduction Factor (L_1/T)	:	0.83	m
Actual Moment (Fixed End Moment/Reduction Factor), M_F		**58**	kN-m

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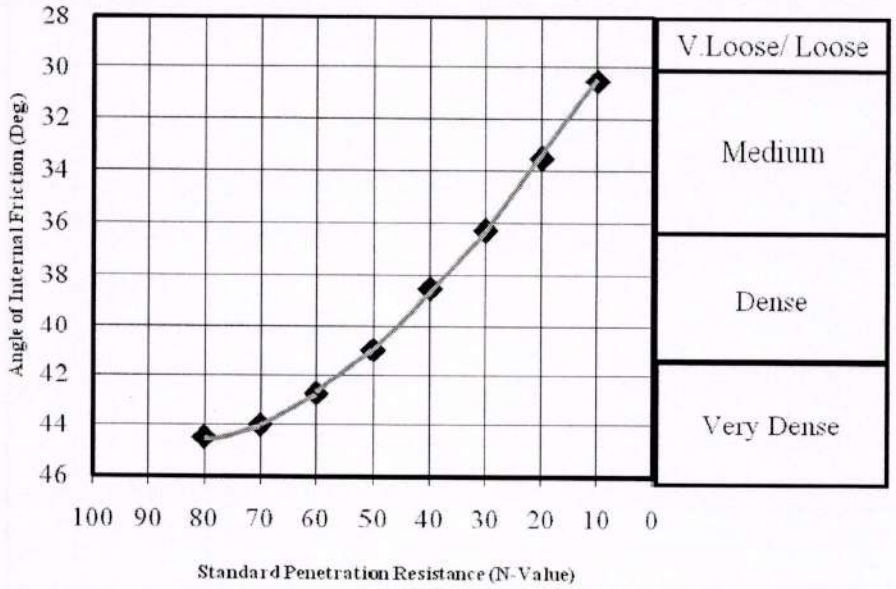

FIG. A1 Relation Ship between Angle of Internal Friction & N-value (Reproduced from IS:6403-1981)

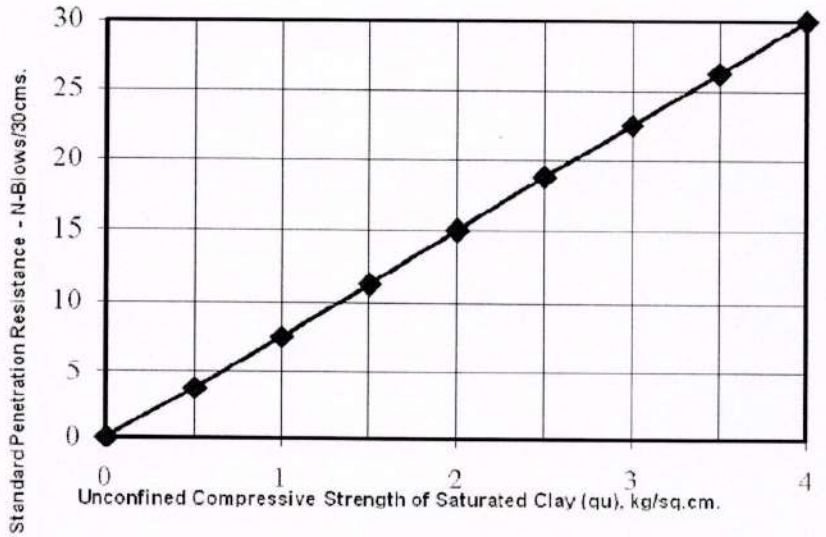

FIG. A2 : Relationship between UCC & SPT-Value (N) of Saturated Clay (AfterTerzhagi & Peck, 1948)