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GEO ENGINEERINGCONSULTANTS

(An ISO 9001:2015 Certified Company)

15, 2nd Floor, Murphy Das Street,
Dr. Seethapathy Nagar, Velachery,
Chennai – 600 042.
Ph.No. 9841036964 / 9940176229.
Email: info@gecindia.net/geoengineeringconsultant@gmail.com.

PROJECT NAME

THE PROPOSED CONSTRUCTION OF RESIDENTIAL HIGH RISE AND NON HIGH RISE GROUP DEVELOPMENT CONSISTS OF 5 BLOCKS, BLOCK 1 TO 4: GROUND + FIRST + SECOND FLOOR (PART) (36 D/U), BLOCK 5: BASEMENT + GROUND FLOOR (PART) CLUB HOUSE (PART) + 12 UPPER FLOORS (137 D/U) TOTALLY 173 D/U WITH SWIMMING POOL ON THE GROUND LEVEL COMPRISED IN S.NOS: 560/1, 561/1B1B2, RAKKIAPALAYAM VILLAGE, AVINASHI TALUK, TIRUPPUR DISRICT.

CLIENT NAME

CASA GRANDE COIMBATORE LLP,

COIMBATORE.

PROJECT ADDRESS

CASAGRAND TIRUPPUR,

S.NOS: 560/1, 561/1B1B2, RAKKIAPALAYAM VILLAGE,

AVINASHI TALUK, TIRUPPUR.

TITLE

GEOTECHNICAL INVESTIGATION REPORT

PROJECT NO: GEC-JC-GT-4121/2022-2023

DATE: 22/01/2023

GEO ENGINEERING CONSULTANTS
G. MANOJ KUMAR
DDTC - No: GTE/TVLR/01/2019
CMDA No: GTE:19/03/012
IInd Floor, No.15, Murphy Das Stree
Dr. Seethapathy Nagar, Velachery
Chennai - 600 042

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CMDA No: GTE/19/03/012
IInd Floor, No.15, Murphy Das Street
Dr. Seethapathy Nagar, Velachery
Chennai - 600 042

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Dr. Seethapathy Nagar, Velachery
Chennai - 600 042

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IInd Floor, No.15, Murphy Das Street
Dr. Seethapathy Nagar, Velachery
Chennai - 600 042

REPORT TEXT

GEO ENGINEERING CONSULTANTS
G. MANOJ KUMAR
DDTC - No: GTE/TVLR/01/2019
CMDA No: GTE/19/03/012
IInd Floor, No.15, Murphy Das Street
Dr. Seethapathy Nagar, Velachery
Chennai - 600 042

CHAPTER-1

INTRODUCTION

1.0 Project Information Matrix

Nature of project : Proposed Construction of Villas (G+2Upper Floors) & Apartment Building (1B+Ground+12 Upper Floors)

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

Project Location : Casagrand Tiruppur, SF.No.560/1, 561/1B1B2, Rakiapalayam, Village, Tiruppur, Tamil Nadu.

Job Code : GEC-JC-GT-4121

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

1.1.2 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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Dr. Seethapathy Nagar, Velachery
Chennai - 600 042

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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Dr. Seethapathy Nagar, Velachery
Chennai - 600 042

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.

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 four locations of the field investigation boreholes are shown in site plan given in Fig.2.0. The average sub soil profiles encountered at each location along with their classification and engineering properties are presented in Figs.2.1 to 2.5.

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Dr. Seethapathy Nagar, Velachery
Chennai - 600 042

SITE PLAN

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Dr. Seethapathy Nagar, Velachery
Chennai - 600 042

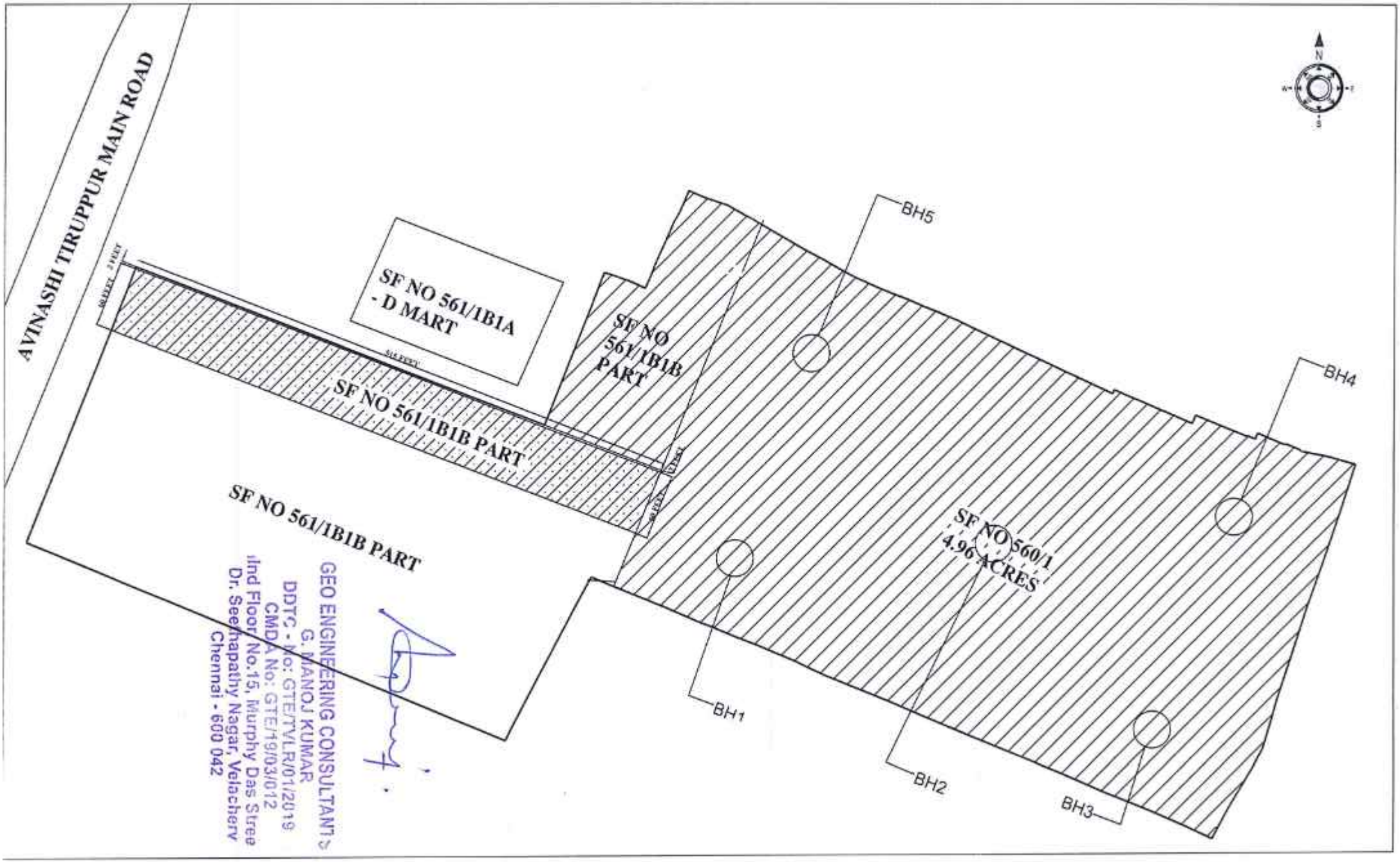


FIG:2.0. SITE PLAN SHOWING THE BOREHOLE LOCATIONS

SOIL PROFILE

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Dr. Seethapathy Nagar, Velachery
Chennai - 600 042

SITE INVESTIGATION RECORD

BORE HOLE No.	BH-01						
SHEET	1	OF	1				
PROJECT NAME	PROPOSED CONSTRUCTION OF VILLAS (G+2 UPPER FLOORS) & APARTMENT BUILDING			DIA OF BORE HOLE	150mm ✓	100mm	
LOCATION	Tiruppur, Tamil Nadu	MACHINE No.	CR-01	CHAINAGE (m)	-	BORE START DATE	09/01/2023
STRUCTURE	1B+G+12 Upper Floors	DRILLING METHOD	Rotary	CO-ORDINATES	N	BORE END DATE	09/01/2023
JOB CODE	GEC-JC-GT-4121	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: 15-30	SPT Details: 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
		11	50													L1	0.5	Brown, Moist, **Silty Sand**
		To		SC	-	-												
		11	59															Brown Moist, Very Dense, **Completely Weathered Rock** (Desent from Granite Rock)
1							SPT Hammer Rebounded			>100	1.00	1	WS	-1.0		L2	1.0	
2		12	15															Brown, **Highly Weathered Rock** (Desent from Granite Rock)
		To		DB	11	-												
		13	11				-	-	-	-	2.50	2	CS	-2.5		L3	2.5	
3	09/01/2023	13	28															
		To		DB	15	-												
		14	29				-	-	-	-	4.00	3	CS	-4.0				
4																		
5		15	00															Grey, **Moderately Weathered Rock** (Desent from Granite Rock)
		To		DB	19	-												
		17	13				-	-	-	-	5.50	4	CS	-5.5				
6																		
		17	22															
		To		DB	26	-												
		18	39															
7							-	-	-	-	7.00	5	CS	-7.0		L4	7.0	
8																		
9																		
10																		

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G. MANOJ KUMAR
DDTC - No: GTE/TVLR/01/2019
CMDA No: GTE/19/03/012
IInd Floor, No.15, Murphy Das Street
Dr. Seethapathy Nagar, Velachery
Chennai - 600 042

CS - Core Sample	DS - Disturbed Sample	LOGGED	Vinod Pradap	PROJECT SITE DETAILS		REMARKS	
SS - Split Spoon Sample	SC - Soil Cutter	DATE	09/01/2023	GROUND LEVEL (m)	0.00		
UDS- Undisturbed Sample	TCB - Tungsten Carbide Bit	CHECKED	Jaleel Yasin	WATER TABLE (m)	5.50		
WS - Wash Sample	DB - Diamond Bit	DATE	22/01/2023	CASING DEPTH (m)	0.00		

Borehole terminated at 7 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 VILLAS (G+2 UPPER FLOORS) & APARTMENT BUILDING			DIA OF BORE HOLE	150mm ✓		
					100mm		
LOCATION	Tiruppur, Tamil Nadu	MACHINE No.	CR-01	CHAINAGE (m)	-	BORE START DATE	08/01/2023
STRUCTURE	1B+G+12 Upper Floors	DRILLING METHOD	Rotary	CO-ORDINATES	N	BORE END DATE	08/01/2023
JOB CODE	GEC-JC-GT-4121	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																L1	0.5	Brown, Moist, **Silty Sand**
		13	01															
		To		SC	-	-												
		13	03															
1		13	15				10cm Penet. For 50 Blows			>100	1.00	1	SS	-1.0				Brown Moist, Very Dense, **Completely Weathered Rock** (Desent from Granite Rock)
		To		SC	-	-					1.10							
		13	22				SPT Hammer Rebounded			>100	1.60	2	WS	-1.6		L2	1.6	
2																		Brown, **Highly Weathered Rock** (Desent from Granite Rock)
		13	40															
		To		DB	9	-												
3	08/01/2023	14	15				-	-	-	-	3.00	3	CS	-3.0		L3	3.0	
		14	30															
4		To		DB	13	-												
		15	13				-	-	-	-	4.50	4	CS	-4.5				Grey, **Moderately Weathered Rock** (Desent from Granite Rock)
5		15	30															
		To		DB	19	-												
		16	09				-	-	-	-	5.50	5	CS	-5.5				
6		16	20															
		To		DB	26	-												
		17	01				-	-	-	-	6.50	6	CS	-6.5		L4	6.5	
7																		
8																		
9																		
10																		

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G. MANOJ KUMAR
DDTC - No: GTE/TVLR/01/2019
CMDA No: GTE/19/03/012
IInd Floor, No.15, Murphy Das Stree
Dr. Seethapathy Nagar, Velachery
Chennai - 600 042

CS - Core Sample	DS - Disturbed Sample	LOGGED	Vinod Pradap	PROJECT SITE DETAILS		REMARKS	
SS - Split Spoon Sample	SC - Soil Cutter	DATE	08/01/2023	GROUND LEVEL (m)	0.00		
UDS- Undisturbed Sample	TCB - Tungsten Carbide Bit	CHECKED	Jaleel Yasin	WATER TABLE (m)	4.00		
WS - Wash Sample	DB - Diamond Bit	DATE	22/01/2023	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

SITE INVESTIGATION RECORD

BORE HOLE No.	BH-03						
SHEET	1	OF	1				
PROJECT NAME	PROPOSED CONSTRUCTION OF VILLAS (G+2 UPPER FLOORS) & APARTMENT BUILDING			DIA OF BORE HOLE	150mm	✓	
					NX		
LOCATION	Tiruppur, Tamil Nadu	MACHINE No.	CR-01	CHAINAGE (m)	-	BORE START DATE	07/01/2023
STRUCTURE	1B+G+12 Upper Floors	DRILLING METHOD	Rotary	CO-ORDINATES	N -	BORE END DATE	07/01/2023
JOB CODE	GEC-JC-GT-4121	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
		12	00													L1	0.5	Brown, Moist, **Silty Sand**
		To		SC	-	-												
		12	02															
1							42	10cm Penet. For 50Blows		>100	1.00	1	SS	-1.0				Brown Moist, Very Dense, **Completely Weathered Rock** (Desent from Granite Rock)
		12	20								1.25							
		To		SC	-	-												
		12	27															
2							SPT Hammer Rebounded			>100	2.00	2	WS	-2.0		L2	2.0	
		12	36															
		To		DB	11	-												Brown, **Highly Weathered Rock** (Desent from Granite Rock)
		12	10															
3	07/01/2023						-	-	-	-	3.00	3	CS	-3.0		L3	3.0	
		13	20															
		To		DB	14	-												
		14	09															
4							-	-	-	-	4.00	4	CS	-4.0				
		14	21															White/Grey, **Moderately Weathered Rock** (Desent from Granite Rock)
		To		DB	15	-												
		15	20															
5							-	-	-	-	5.00	5	CS	-5.0				
		15	32															
		To		DB	22	-												
		16	31															
6							-	-	-	-	6.00	6	CS	-6.0		L4	6.0	
7																		
8																		
9																		
10																		

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G. MANOJ KUMAR
DDTC - No: GTE/TVLR/01/2019
CMDA No: GTE/19/03/012
IInd Floor, No.15, Murphy Das Street
Dr. Seethapathy Nagar, Velachery
Chennai - 600 042

CS - Core Sample	DS - Disturbed Sample	LOGGED	Vinod Pradap	PROJECT SITE DETAILS		REMARKS	
SS - Split Spoon Sample	SC - Soil Cutter	DATE	07/01/2023	GROUND LEVEL (m)	0.00		
UDS- Undisturbed Sample	TCB - Tungsten Carbide Bit	CHECKED	Jaleel Yasin	WATER TABLE (m)	5.00		
WS - Wash Sample	DB - Diamond Bit	DATE	20/07/2022	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 VILLAS (G+2 UPPER FLOORS) & APARTMENT BUILDING			DIA OF BORE HOLE	150mm ✓ / 100mm		
LOCATION	Tiruppur, Tamil Nadu	MACHINE No.	CR-01	CHAINAGE (m)	-	BORE START DATE	08/01/2023
STRUCTURE	1B+G+12 Upper Floors	DRILLING METHOD	Rotary	CO-ORDINATES	N	BORE END DATE	08/01/2023
JOB CODE	GEC-JC-GT-4121	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		06	30															
		To		SC	-	-												
		06	32															
1							3	3	5	8	1.00	1	SS	-1.0				Brown, Moist, Loose, Poorly Graded, **Silty SAND (SM),** Sand-Silt Mixture
		06	48								1.45					L1	1.5	
		To		SC	-	-												
		06	56															
2		07	10				13cm Penet. For 50 Blows			>100	2.00	2	SS	-2.0				Brown Moist, Very Dense, **Completely Weathered Rock** (Desent from Granite Rock)
		To		SC	-	-					2.13							
		07	20				SPT Hammer Rebounded			>100	2.50	3	WS	-2.5		L2	2.5	
3	08/01/2023																	Brown, **Highly Weathered Rock** (Desent from Granite Rock)
		07	08															
		To		DB	10	-												
		08	31													L3	3.0	
4							-	-	-	-	4.00	4	CS	-4.0				
		08	45															
5		To		DB	16	-												
		09	47				-	-	-	-	5.50	5	CS	-5.5				Grey, **Moderately Weathered Rock** (Desent from Granite Rock)
6																		
		10	01															
		To		DB	23	-												
		11	37													L4	6.0	
7							-	-	-	-	7.00	6	CS	-7.0				
8																		
9																		
10																		

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G. MANOJ KUMAR
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IInd Floor, No.15, Murphy Das Stree
Dr. Seethapathy Nagar, Velachery
Chennai - 600 042

CS - Core Sample	DS - Disturbed Sample	LOGGED	Vinod Pradap	PROJECT SITE DETAILS		REMARKS	
SS - Split Spoon Sample	SC - Soil Cutter	DATE	08/01/2023	GROUND LEVEL (m)	0.00		
UDS- Undisturbed Sample	TCB - Tungsten Carbide Bit	CHECKED	Jaleel Yasin	WATER TABLE (m)	3.00		
WS - Wash Sample	DB - Diamond Bit	DATE	22/01/2023	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 VILLAS (G+2 UPPER FLOORS) & APARTMENT BUILDING			DIA OF BORE HOLE	150mm ✓ / NX		
LOCATION	Tiruppur, Tamil Nadu	MACHINE No.	CR-01	CHAINAGE (m)	-	BORE START DATE	08/01/2023
STRUCTURE	1B+G+12 Upper Floors	DRILLING METHOD	Rotary	CO-ORDINATES	N -	BORE END DATE	09/01/2023
JOB CODE	GEC-JC-GT-4121	FLUSHING MEDIUM	Bentonite		E -	TOTAL DRILL DAYS	2

Depth below E.G.L (m)	Drilling progress per metre: Date	Time: Hr.	Time: Min.	Type of Drill Bit (SC / TCB / DB)	Core Details: Total Core Recovery %	Core Details: R.Q.D %	SPT Details: Blows/cm. 0-15	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		18	02													L1	0.5	Brown, Moist, **Silty Sand**
		To		SC	-	-												
		18	03															
1	08/01/2023	18	10				6cm Penet. For 50Blows			>100	1.00	1	SS	-1.0				Greyish Black, Moist, Very Dense, **Completely Weathered Rock** (Desent from Granite Rock)
		To		SC	-	-					1.06							
		18	12				SPT Hammer Rebounded			>100	1.20	2	WS	-1.2		L2	1.2	
2		18	20															Brown, **Highly Weathered Rock** (Desent from Granite Rock)
		To		DB	10	-												
		18	52															
3							-	-	-	-	3.00	3	CS	-3.0		L3	3.0	
4		06	20															Grey, **Moderately Weathered Rock** (Desent from Granite Rock)
		To		DB	14	-												
	09/01/2023	07	01				-	-	-	-	4.50	4	CS	-4.5				
5		07	16															
		To		DB	20	-												
		08	03															
6							-	-	-	-	6.00	5	CS	-6.0				
		08	15															
		To		DB	26	-												
		09	21															
7							-	-	-	-	7.00	6	CS	-7.0		L4	7.0	
8																		
9																		
10																		

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G. MANOJ KUMAR
DDTC - No: GTE/TVLR/01/2010
CMDA No: GTE/19/03/012
IInd Floor, No.15, Murphy Das Stree
Dr. Seethapathy Nagar, Velachery
Chennai - 600 042

CS - Core Sample	DS - Disturbed Sample	LOGGED	Vinod Pradap	PROJECT SITE DETAILS		REMARKS	
SS - Split Spoon Sample	SC - Soil Cutter	DATE	09/01/2023	GROUND LEVEL (m)	0.00		
UDS- Undisturbed Sample	TCB - Tungsten Carbide Bit	CHECKED	Jaleel Yasin	WATER TABLE (m)	4.00		
WS - Wash Sample	DB - Diamond Bit	DATE	20/07/2022	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

Grain Size Distribution Curves

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IInd Floor, No.15, Murphy Das Street
Dr. Seethapathy Nagar, Velachery
Chennai - 600 042

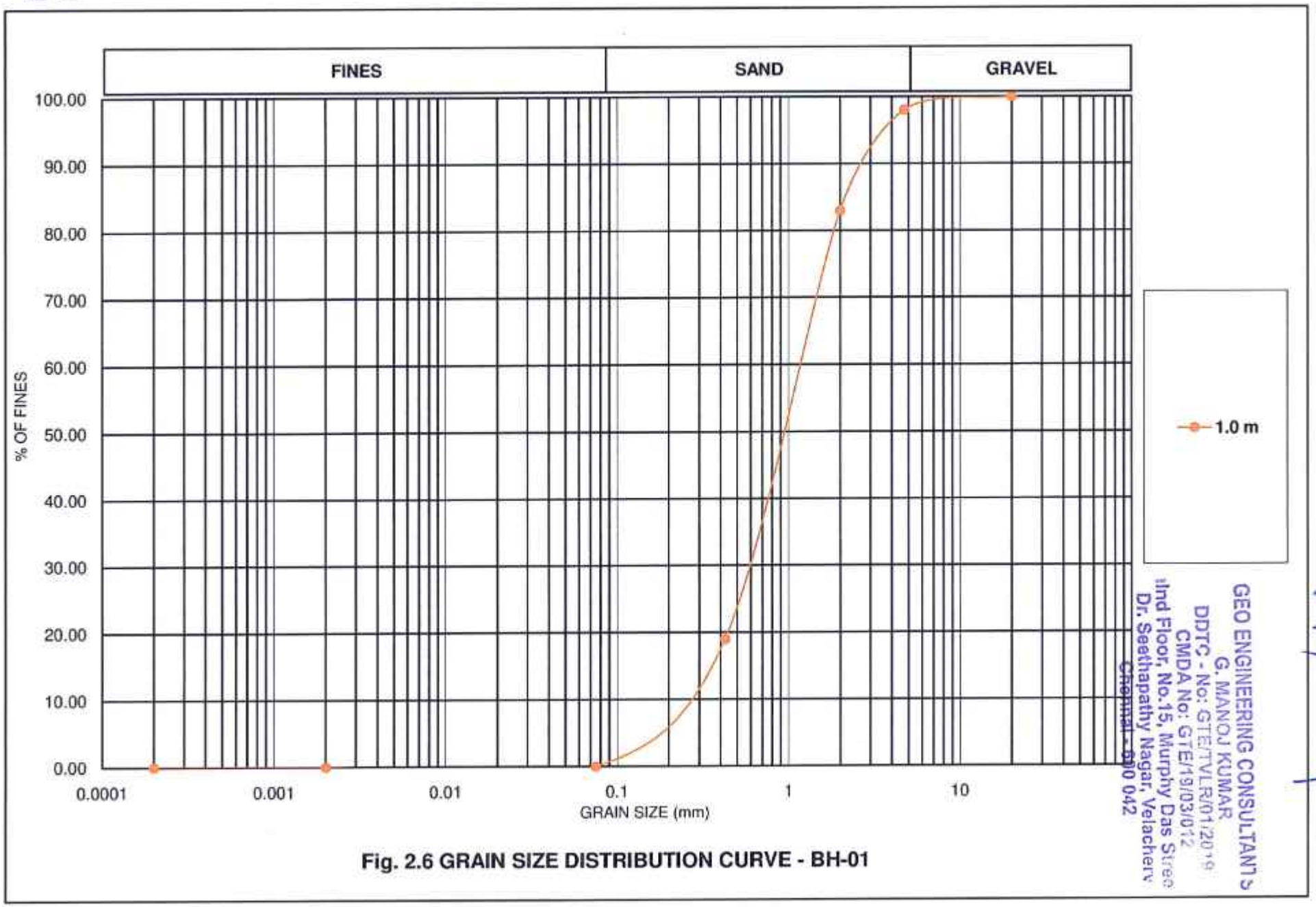


Fig. 2.6 GRAIN SIZE DISTRIBUTION CURVE - BH-01

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Dr. Seethapathy Nagar, Velachery
Chennai - 600 042

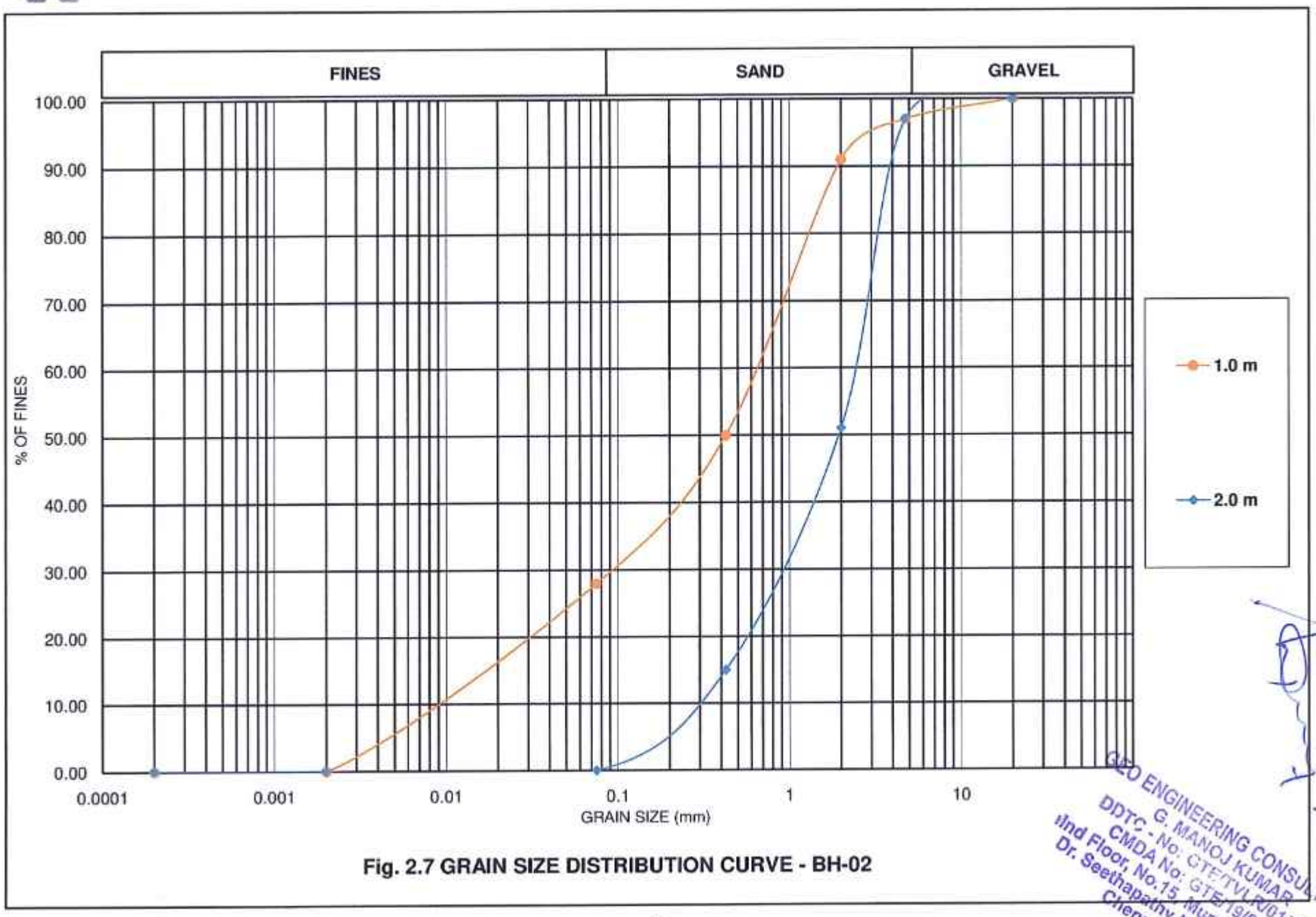


Fig. 2.7 GRAIN SIZE DISTRIBUTION CURVE - BH-02

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Dr. Seethapathy Nagar, Vela
Chennai - 600 04

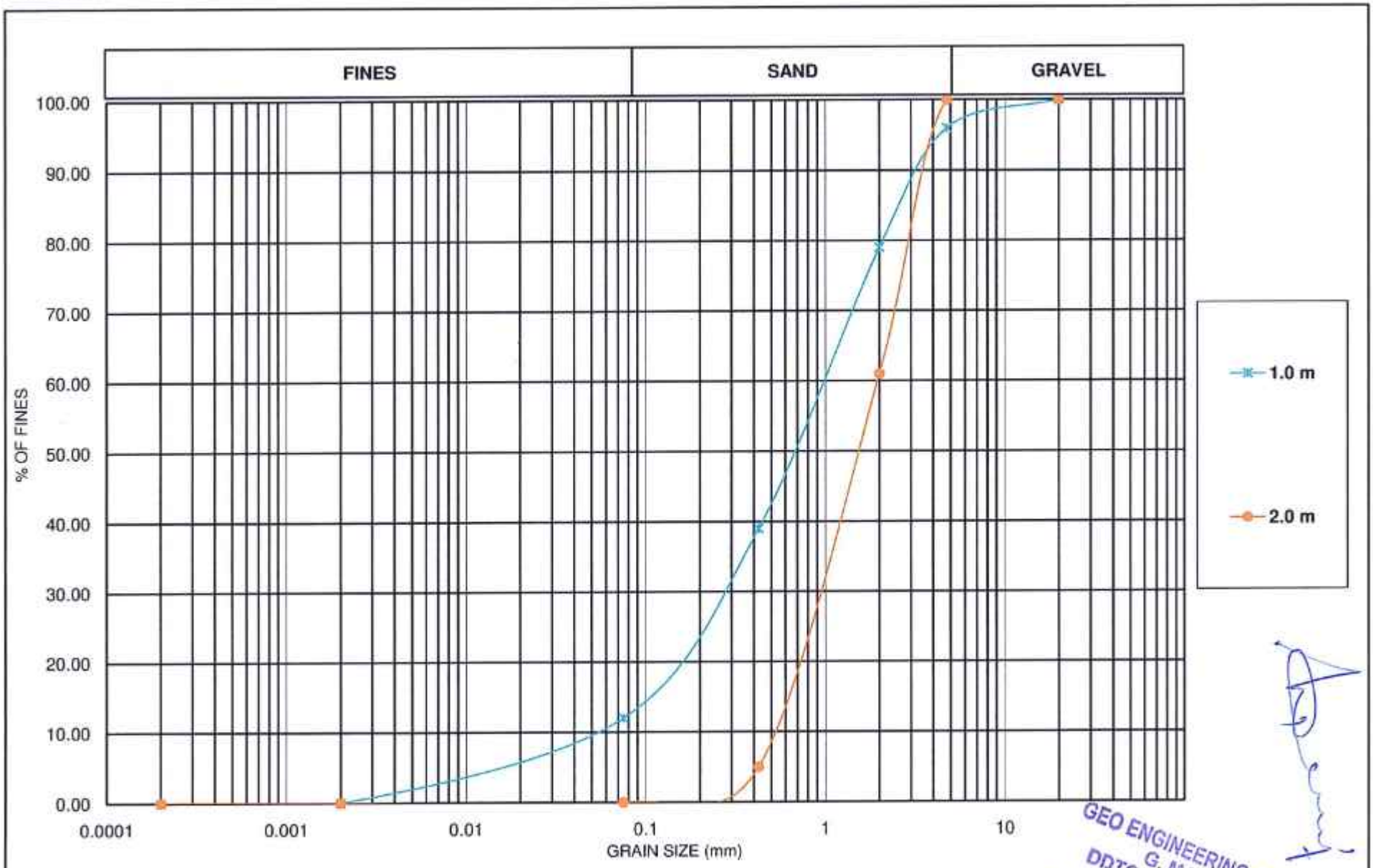


Fig. 2.8 GRAIN SIZE DISTRIBUTION CURVE - BH-03

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IInd Floor, No.15, Murphy Das Stree
Dr. Seethapathy Nagar, Velache
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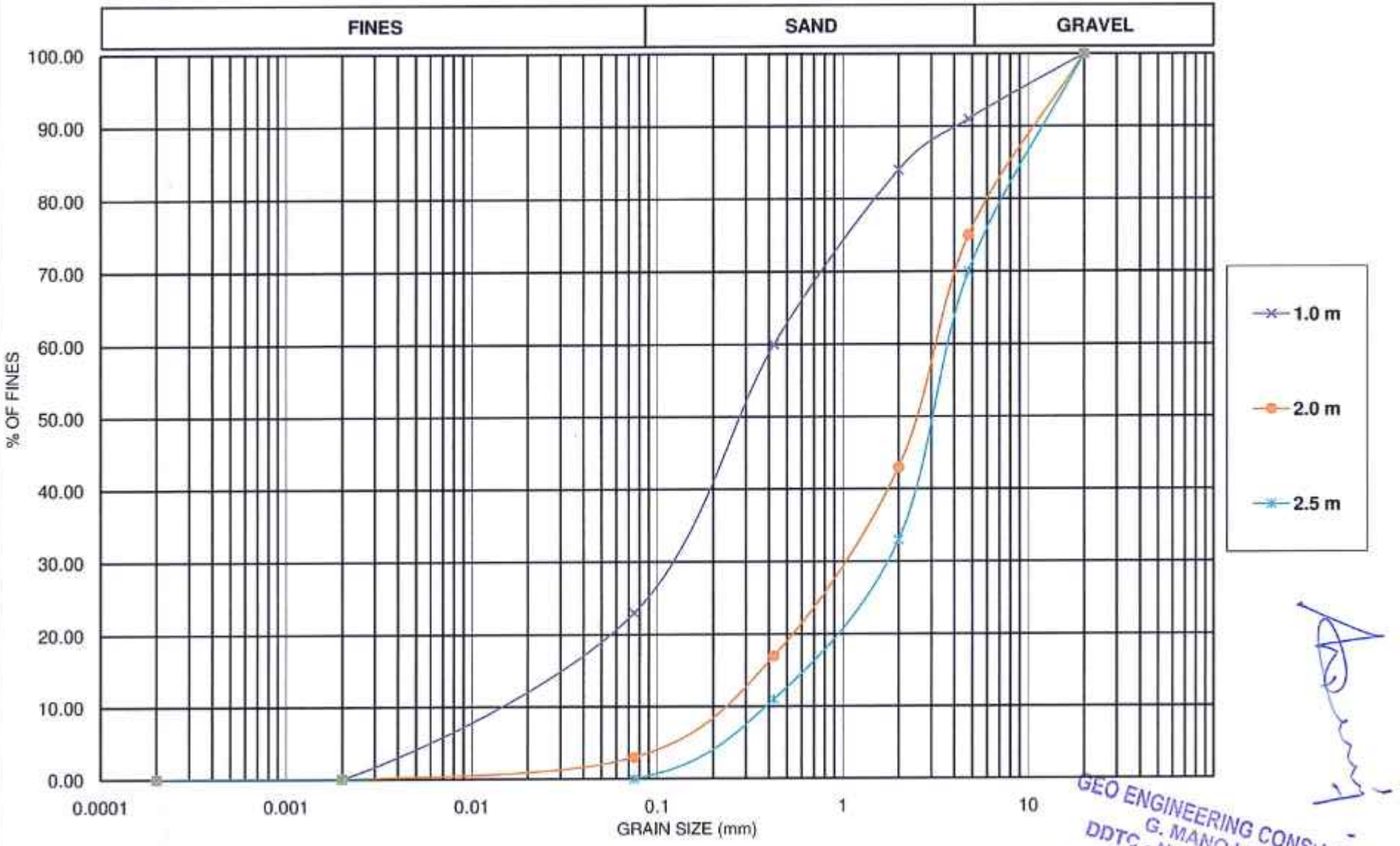


Fig. 2.9 GRAIN SIZE DISTRIBUTION CURVE - BH-04

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CMDA No: GTE/19/03/012
IInd Floor, No.15, Murphy Das Stree
Dr. Seethapathy Nagar, Velachery
Chennai - 600 042

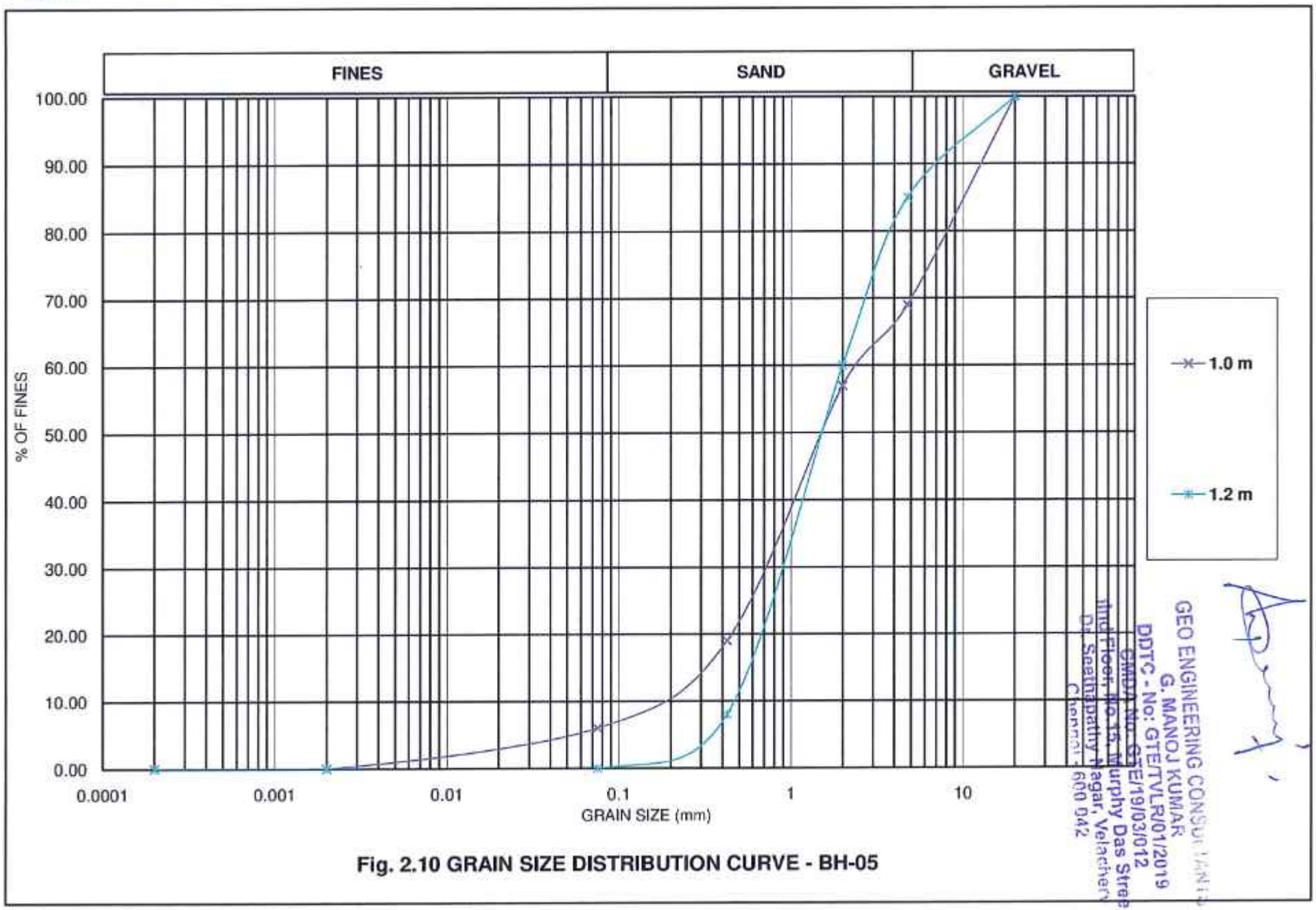


Fig. 2.10 GRAIN SIZE DISTRIBUTION CURVE - BH-05

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G. MANOJ KUMAR
DDTC - No: GTE/TVLR/01/2019
GMDT No: GTE/19/03/012
IInd Floor, No.15, Murphy Das Street
Dr. Seethapathy Nagar, Velachery
Chennai - 600 042

LABORATORY TEST RESULTS

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G. MANOJ KUMAR
DDTC - No: GTE/TVLR/01/2019
CMDA No: GTE/19/03/012
IInd Floor, No.15, Murphy Das Stree
Dr. Seethapathy Nagar, Velachery,
Chennai - 600 042

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	>100	WS	-	-	-	-	-	-	-	CG>50%	-	-	2	15	64	19	0	0	-	-	-	-	-	V.Dense	<50%	SP

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

LAB IN-CHARGE	M.PRAVEEN
REVIEWED BY	JALEEL YASIN

GEO ENGINEERING CONSULTANTS
G. MANOJ KUMAR
DDTC - No: GTE/TVLR/01/2019
CMDA No: GTE/19/03/012
IInd Floor, No.15, Murphy Das Stree
Dr. Seethapathy Nagar, Velachery
Chennai - 600 042

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	>100	SS	-	-	-	-	-	-	-	CG>50%	-	-	3	6	41	22	28	0	-	-	-	-	-	V.Dense	<50%	SM			
2.0	>100	WS	-	-	-	-	-	-	-	CG>50%	-	-	3	46	36	15	0	0	-	-	-	-	-	V.Dense	<50%	SP			

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

LAB IN-CHARGE	M.PRAVEEN
REVIEWED BY	JALEEL YASIN

GEO ENGINEERING CONSULTANTS
G. MANOJ KUMAR
DDTC - No: GTE/TVLR/01/2019
CMDA No: GTE/19/03/012
IInd Floor, No.15, Murphy Das Stree
Dr. Seethapathy Nagar, Velachery
Chennai - 600 042

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	>100	SS	-	-	-	-	-	-	-	CG>50%	-	-	4	17	40	27	12	0	-	-	-	-	-	V.Dense	<50%	SP-SM		
2.0	>100	WS	-	-	-	-	-	-	-	CG>50%	-	-	0	39	56	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	M.PRAVEEN
REVIEWED BY	JALEEL YASIN

GEO ENGINEERING CONSULTANTS
G. MANOJ KUMAR
DDTC - No: GTE/TVLR/01/2019
CMDA No: GTE/19/03/012
IInd Floor, No.15, Murphy Das Stree
Dr. Seethapathy Nagar, Velachery
Chennai - 600 042

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	8	SS	-	-	-	-	-	-	-	CG>50%	-	-	9	7	24	37	23	0	-	-	-	-	-	Loose	<50%	SM
2.0	>100	SS	-	-	-	-	-	-	-	CG>50%	-	-	25	32	26	14	3	0	-	-	-	-	-	V.Dense	<50%	SP
2.5	>100	WS	-	-	-	-	-	-	-	CG>50%	-	-	30	37	22	11	0	0	-	-	-	-	-	V.Dense	<50%	SP

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

LAB IN-CHARGE	M.PRAVEEN
REVIEWED BY	JALEEL YASIN

GEO ENGINEERING CONSULTANTS
G. MANOJ KUMAR
DDTC - No: GTE/TVLR/01/2019
CMDA No: GTE/19/03/012
IInd Floor, No.15, Murphy Das Stree
Dr. Seethapathy Nagar, Velachery
Chennai - 600 042

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	>100	SS	-	-	-	-	-	-	-	CG>50%	-	-	31	12	38	13	6	0	-	-	-	-	-	V.Dense	<50%	SP-SM		
1.2	>100	WS	-	-	-	-	-	-	-	CG>50%	-	-	15	25	52	8	0	0	-	-	-	-	-	V.Dense	<50%	SP		

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

LAB IN-CHARGE	M.PRAVEEN
REVIEWED BY	JALEEL YASIN

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G. MANOJ KUMAR
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Dr. Seethapathy Nagar, Velachery
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Table-2.6 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	4.00	7.35	268	365	1.0	7.33	298	345
2	BH-03	5.00	7.35	271	359	1.0	7.33	302	338
3	BH-04	3.00	7.35	272	367	2.0	7.33	295	342

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G. MANOJ KUMAR
DDTC - No: GTE/TVLR/01/2019
CMDA No: GTE/19/03/012
IInd Floor, No.15, Murphy Das Stree
Dr. Seethapathy Nagar, Velachery
Chennai - 600 042

CHAPTER-3

GEOLOGY & SUB-SURFACE STRATIFICATION

3.0 Preamble:

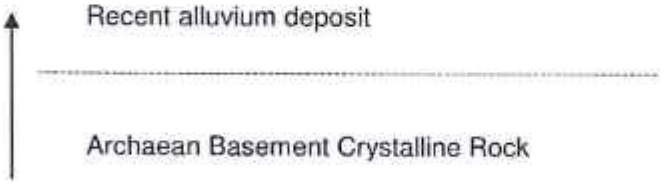
Geotechnical investigation carried out at a specific site provides location specific sub surface characteristics based on which the design of sub structures/foundations is generally carried out. However, the macro-level understanding of the sub surface is also needed for a comprehensive understanding 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 Tiruppur district, which can be geologically classified as hard rock formation (Granite /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 Archaean age undergone weathering to variable extent. The thickness of alluvium deposit is around 1 to 2 meter underlain by varying degree of weathering.

The present location falls under Tiruppur District, geologically it is classified as recent alluvium deposits consisting of Clayey Silty Sand/Silty Sand, which is underlying by basement 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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Dr. Seethapathy Nagar, Velachery
Chennai - 600 042

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	Silty Sand	-	-	-	-	-	-	-
2	0.50	1.00	0.50	Completely Weathered Rock	Brown	>100	Very Dense	-	21	-	42.5
3	1.00	2.50	1.50	Highly Weathered Rock	Brown	CRR-11 %, RQD-0%					
4	2.50	7.00	4.50	Moderately Weathered Rock	Grey	CRR-15%, 19% & 26%, RQD-0%					

REFERENCE BORE HOLE-BH:					02	Ref R.L. of G.L. (m):			0.00		
Layer No.	Layer Thk. (m)			Type of Strata	Colour	Ave. Design SPT	Relative Density	Consistency	(γ) kN/m^3	Shear Parameters	
	Top. R.L.	Bot. R.L.	Thickness							(C_u) kPa	(ϕ) Deg.
1	0.00	0.50	0.50	Silty Sand	-	-	-	-	-	-	-
2	0.50	1.60	1.10	Completely Weathered Rock	Brown	>100	Very Dense	-	21	-	42.5
3	1.60	3.00	1.40	Highly Weathered Rock	Brown	CRR-9 %, RQD-0%					
4	3.00	6.50	3.50	Moderately Weathered Rock	Grey	CRR-13%, 19% & 26%, RQD-0%					

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G. MANOJ KUMAR
DDTC - No: GTE/TVLR/01/2019
CMDA No: GTE/19/03/012
IInd Floor, No.15, Murphy Das Stree
Dr. Seethapathy Nagar, Velachery
Chennai - 600 042

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							(Cu) kPa	(ϕ) Deg.
1	0.00	0.50	0.50	Silty Sand	-	-	-	-	-	-	-
2	0.50	2.00	1.50	Completely Weathered Rock	Brown	>100	Very Dense	-	21	-	42.5
3	2.00	3.00	1.00	Highly Weathered Rock	Brown	CRR-11 %, RQD-0%					
4	3.00	6.00	3.00	Moderately Weathered Rock	Grey	CRR-14%, 15% & 22%, RQD-0%					

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/m³	Shear Parameters	
	Top. R.L.	Bot. R.L.	Thickness							(Cu) kPa	(ϕ) Deg.
1	0.00	1.50	1.50	Silty Sand	Brown	8	Loose	-	14.5	-	29.6
2	1.50	2.50	1.00	Completely Weathered Rock	Brown	>100	Very Dense	-	21	-	42.5
3	2.50	4.00	1.50	Highly Weathered Rock	Grey	CRR-10.0 % , RQD-0%					
4	4.00	6.00	2.00	Moderately Weathered Rock	Grey	CRR-16% & 23%, RQD-0%					

GEO ENGINEERING CONSULTANTS
G. MANOJ KUMAR
DDTC - No: GTE/TVLR/01/2019
CMDA No: GTE/19/03/012
IInd Floor, No.15, Murphy Das Stree
Dr. Seethapathy Nagar, Velachery
Chennai - 600 042

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	Silty Sand	-	-	-	-	-	-	-
2	0.50	1.20	0.70	Completely Weathered Rock	Greyish Black	>100	Very Dense	-	21	-	42.5
3	1.20	3.00	1.80	Highly Weathered Rock	Brown	CRR-10 %, RQD-0%					
4	3.00	7.00	4.00	Moderately Weathered Rock	Grey	CRR-14%, \20% & 26%, RQD-0%					

GEO ENGINEERING CONSULTANTS
G. MANOJ KUMAR
DDTC - No: GTE/TVLR/01/2019
CMDA No: GTE/19/03/012
IInd Floor, No.15, Murphy Das Street,
Dr. Seethapathy Nagar, Velachery
Chennai - 600 042

FOUNDATION SYSTEM

GEO ENGINEERING CONSULTANTS
G. MANOJ KUMAR
DDTC - No: GTE/TVLR/01/2019
CMDA No: GTE/19/03/012
IInd Floor, No.15, Murphy Das Street
Dr. Seethapathy Nagar, Velachery
Chennai - 600 042

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 (Villas – ground floor plus two upper floors) & (Apartment Building-one basement + ground + twelve upper floors, and is meant for residential occupancy. For this kind of structure, the column loads could vary between (Villa-900 kN to 1,000 kN) & (Apartment Building-(3500 kN to 4500 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 Villas-(G+2 Upper Floors)

For the kind of proposed structure and sub soil conditions, shallow foundation system can be adopted. The Isolated Column Footings can be located at a depth of 1.50m below the existing ground level. The footings shall be designed for a recommended allowable safe bearing pressure is 200kPa. All footings shall rest on 100mm thick M10 Grade levelling coarse bed. Typical computations are presented in the annexure.

4.2.2 Apartment Building-(1B+G+12 Upper Floors)

In order to construct a basement floors an excavation of about 3.00m excluding the foundation depth is needed (as informed by the client in charge 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.

The foundation system shall be Isolated Footing or Raft and it can be located at a depth of 1.0m (assumed thickness of raft or embedment thickness) below the top of lower basement floor, hence the overall depth of foundation excavation shall be 4.0m below the existing ground level.

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IInd Floor, No.15, Murphy Das Stree
Dr. Seethapathy Nagar, Velachery
Chennai - 600

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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G. MANOJ KUMAR
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IInd Floor, No.15, Murphy Das Street
Dr. Seethapathy Nagar, Velachery
Chennai - 600 042

DEEP EXCAVATION DESIGN

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G. MANOJ KUMAR
DDTC - No: GTE/TVLR/01/2019
CMDA No: GTE/19/03/012
IInd Floor, No.15, Murphy Das Street
Dr. Seethapathy Nagar, Velachery
Chennai - 600 042

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:

Though the sub-surface stratigraphy is in line the regional geological characteristics, the site specific sub surface characteristicsof the site is:

0.0 m to 1.5m	:	Silty Sand/Completely Weathered Rock
1.5 m to 3.0m	:	Completely/Highly Weathered Rock
3.0 m to 7.0m	:	Moderately Weathered Rock

During the time of investigation (2nd week of January 2023) the ground water table is observed in different borehole in varying depth from 3.0m to 5.50m below the existing ground level.

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G. MANOJ KUMAR
DDTC - No: GTE/TVLR/01/2019
CMDA No: GTE/19/03/012
IInd Floor, No.15, Murphy Das Stree
Dr. Seethapathy Nagar, Velachery
Chennai - 600 042

5.3 Dewatering Technique:

Since the excavation extending into the weathered rock formation (Moderately Weathered Rock) that is 4.0m 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 15.0m 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 2.0m depth:

The excavation in the top 2.0m depth shall be carried out by using mechanical excavator.

From 2.0m to 4.0m depth:

The formation between 2.0m and 4.0m depth being highly to Moderately weathered rock formation (Grade IV to III), mechanical excavator fitted with hydraulic breaks/ hammers can be adopted.

The sub soil strata in the excavation zone being silty sand formation of consistency loose and 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 7.0m from the existing ground level.

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G. MANOJ KUMAR
DDTC - No: GTE/TVLR/01/2019
CMDA No: GTE/19/03/012
IInd Floor, No.15, Murphy Das Stree
Dr. Seethapathy Nagar, Velachery
Chennai - 600 042

RECOMMENDATIONS

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G. MANOJ KUMAR
DDTC - No: GTE/TVLR/01/2019
CMDA No: GTE/19/03/012
IInd Floor, No.15, Murphy Das Stree
Dr. Seethapathy Nagar, Velachery
Chennai - 600 042

CHAPTER-6

RECOMMENDATIONS

6.0 Recommendation for Villas:

- For the kind of proposed structure and the sub soil conditions, open foundation system shall be adopted.
- The footing shall be located at a depth of 1.5m below existing ground level.
- The footings shall be designed for a recommended allowable safe bearing pressure is 200kPa.
- All footings shall rest on 100mm thick M10 Grade levelling coarse bed.
- All columns shall be connected with grade beams in both the directions irrespective of wall layout

6.1 Recommendation for Apartment Building:

- For the kind of sub soil conditions, the foundation system as described in Chapter-4, Section 4.2 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.
- The strata beyond the founding depth is rock formation the settlement will be of immediate elastic in nature.

6.2 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

6.3 General Recommendation

- Since, chlorides and sulphates are well within the permissible limits, no special steel or cement is required for the construction.
- The basement floor slab shall be designed for the uplift pressure corresponding to the ground water table assumed at the existing ground level.
- The foundation excavated earth shall be used for backfilling purpose.

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G. MANOJ KUMAR
DDTC - No: GTE/TVLR/01/2019
CMDA No: GTE/19/03/012
IInd Floor, No.15, Murphy Das Stree
Dr. Seethapathy Nagar, Velachery
Chennai - 600 042

6.4 Special Recommendations

- Before construction activities are initiated, a scientific due-diligence of the condition of the neighbouring structures shall be carried out and authenticated. This is required to ensure that no undue claims or interpretations are made by the neighbourhood that the construction activities cause damages to their structures

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GEO ENGINEERING CONSULTANTS
G. MANOJ KUMAR
DDTC - No: GTE/TVLR/01/2019
CMDA No: GTE/19/03/012
IInd Floor, No.15, Murphy Das Stree
Dr. Seethapathy Nagar, Velachery
Chennai - 600 042

ANNEXURE

GEO ENGINEERING CONSULTANTS
G. MANOJ KUMAR
DDTC - No: GTE/TVLR/01/2019
CMDA No: GTE/19/93/012
IInd Floor, No.15, Murphy Das Stree
Dr. Seethapathy Nagar, Velachery
Chennai - 600 042

TYPICAL BEARING CAPACITY COMPUTATIONS FOR SHALLOW FOUNDATIONS

1.0 COMPUTATION OF BEARING CAPACITY AS PER IS:6403

1.1 Geometrical Data :

	Villas-Ref.BH-04
Shape of the Foundation	Square
Depth of Foundation Below E.G.L"Df" (m)	1.50
Soil Replacement Thickness of CNS Layer (m)	0.00
Total Depth of Foundation (m)	1.50
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	
Design SPT-value of the Bearing Strata	25.00	
Type of Shear Failure:	General	
Angle of Shearing Resistance	34.50	kPa

1.3 Design Parameters:

Bulk Density of Soil above the foundation depth (γ_{bulk})	18.00	kN/m^3
Water Table Correction Factor (w')	0.50	
Effective Overburden pressure at foundation level (q)	12.00	kPa

Bearing Capacity Factors:

N_c = N/A

N_q = 31.81

N_g = 45.47

Shape Factors:

S_c = -

S_q = 1.20

S_g = 0.80

Depth Factors :

D_c = -

D_q = 1.03

D_g = 1.03

Inclination Factor:

I_c = 1.00

I_q = 1.00

I_g = 1.00

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G. MANOJ KUMAR
DDTC - No. GTE/TVLR/01/2019
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IInd Floor, No.15, Murphy Das Street
Dr. Seethapathy Nagar, Velachery
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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)	624.23	kPa

1.5 Safe Bearing Capacity (Qsafe) :

Factor of Safety (F.S.) :	2.50	
Qsafe :	249.69	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)	65000.00	kPa
Size of footing considered for maximum settlement(m)	1.00	
Influence factor	1.00	
Rigidity Factor	1.00	
Elastic Settlement (DH_i)	2.31	mm
	<50	mm

TYPICAL BEARING CAPACITY COMPUTATIONS FOR SHALLOW FOUNDATIONS

1.0 COMPUTATION OF BEARING CAPACITY AS PER IS:6403

Reference Borehole No.	**BH-04**

1.1 Geometrical Data

Shape of the Foundation	Sqaure
Depth of two 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

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G. MANOJ KUMAR
DDTC - No: GTE/TVLR/01/2019
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IInd Floor, No.15, Murphy Das Stree
Dr. Seethapathy Nagar, Velachery
Chennai - 600 042

1.4 Ultimate Bearing Capacity (Qu)

$Qu=q*(Nq-1)*Sq*Dq*Iq + 0.5*B*g*Ng*Sg*Dg*Ig*w'$ **2341.22 kPa**

(g should be read as gama)

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

TYPICAL BEARING CAPACITY COMPUTATIONS FOR SHALLOW FOUNDATIONS

1.0 COMPUTATION OF BEARING CAPACITY AS PER IS:6403

	Reference Borehole No.	BH-04

1.1 Geometrical Data

Shape of the Foundation	Raft
Depth of two 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

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G. MANOJ KUMAR
DDTC - No: GTE/TVLR/01/2019
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IInd Floor, No.15, Murphy Das Stree
Dr. Seethapathy Nagar, Velachery
Chennai - 600 042

1.4 Ultimate Bearing Capacity (Qu)

Qu=q*(Nq-1)*Sq*Dq*Iq + 0.5*B*g*Ng*Sg*Dg*Ig*w' **6909.07 kPa**

(g should be read as gama)

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
	<75 mm

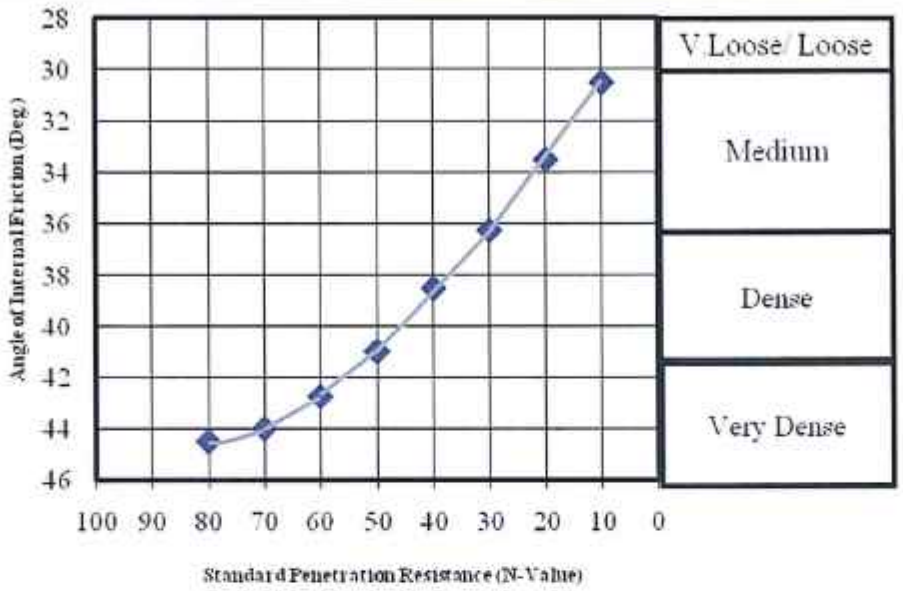


FIG. A1 Relation Ship between Angle of Internal Friction & N-value (Reproduced from IS:6403-1981)

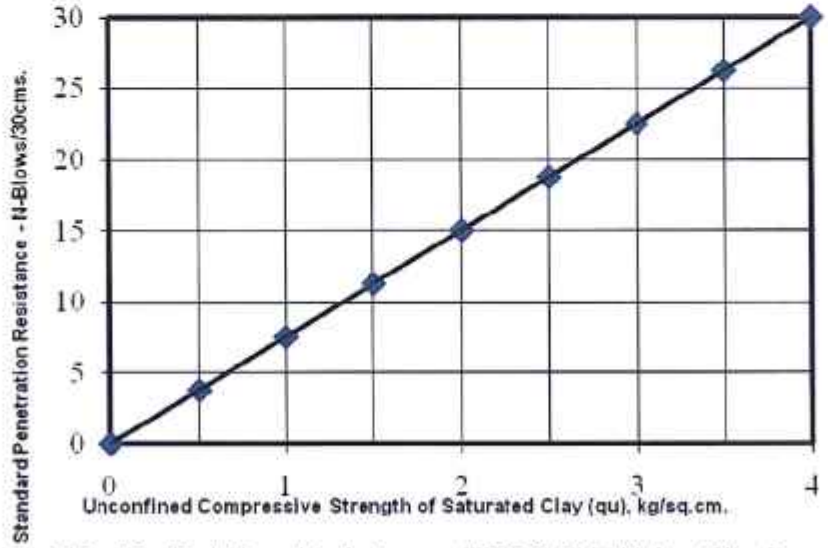


FIG. A2 : Relationship between UCC & SPT-Value (N) of Saturated Clay (AfterTerzhagi & Peck, 1948)

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G. MANOJ KUMAR
DDTC - No: GTE/TVLR/01/2019
CMDA No. GTE/19/03/012
IInd Floor, No.15, Murphy Das Street
Dr. Seethapathy Nagar, Velachery
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