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PROJECT NAME

PROPOSED CONSTRUCTION OF RESIDENTIAL BUILDING (GROUND FLOOR + 4 UPPER FLOORS) AT SAI GANGA FLATS, 6TH MAIN ROAD, RAM NAGAR NORTH EXTENSION, VELACHERY, CHENNAI.

CLIENT NAME

VIKAAN SHELTERS,
CHENNAI

TITLE

GEOTECHNICAL INVESTIGATION REPORT

PROJECT NO: GEC-JC-GT-6055/2024-2025

DATE: 29/08/2024

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REPORT TEXT

CHAPTER-1

INTRODUCTION

1.0 Project Information Matrix

Nature of project	: Proposed Residential Building (G + 4 Upper Floors)
Project Client	: **M/s Vikaan Shelters**
Project Location	: Sai Ganga Flats, 6th main road, Ram Nagar North Extn., Velachery
Job Code	: GEC-JC-GT-6055

1.1 Scope Of Work

1.1.1 Field Work

- Conducting two soil investigation bore holes of 150 mm& NX diameter up to 9.0m 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 up to the termination depth
- Collection of disturbed/undisturbed soil samples
- 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

CHAPTER-2

INVESTIGATION METHODOLOGY & TEST RESULTS

2.0 Preamble:

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

2.1 Methodology of Field Work:

2.1.1 Equipment Used and Method of Drilling:

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

2.1.2 Standard Penetration Tests:

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

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

2.1.3 Collection of Soil Samples:

2.1.3.1 Disturbed Samples:

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

2.1.4 Collection of Ground Water Samples:

One representative water sample from each borehole was collected after 24 hours of completing the borehole if water table met within the investigated depth.

Note on Groundwater Table Record:

- Groundwater table observation in geotechnical report is predominantly to arrive at foundation design criteria and shall not be construed as design guidelines for the design of dewatering systems
- The groundwater level indicated in the bore logs is specific to the duration of investigation and intensity of the monsoon rains during the time of investigation.

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 2.2. The graphical representation of grain size distribution curve for the representative samples in each bore is presented in Fig. 2.3 to 2.4.

2.2.2 On Fine Grained Soil

On the SPT sample index property tests were conducted to estimate consistency. These test results are presented in Tables-2.1 to 2.2. The graphical representation of hydrometer analyses curve for the representative samples in each bore is presented in Fig.2.5 to 2.6.

2.2.3 Chemical Analysis Tests

On representative soil and water samples chemical analysis tests were conducted to estimate pH, Chloride and Sulphates and these results are presented in Table - 2.3.

2.3 Summary:

The locations of the field investigation boreholes are shown in site plan given in Fig.2.0. The average sub soil profiles encountered at each location along with their classification and engineering properties are presented in Figs.2.1 to 2.2.

SOIL PROFILE

SITE INVESTIGATION RECORD

BORE HOLE No.	BH-01						
SHEET	1	OF	1				
PROJECT NAME	PROPOSED CONSTRUCTION OF RESIDENTIAL BUILDING			DIA OF BORE HOLE	150mm ✓		
					100mm ✓		
LOCATION	Velachery, Chennai.	MACHINE No.	CR-01	CHAINAGE (m)	-	BORE START DATE	20/08/2024
STRUCTURE	G+4 Upper Floors	DRILLING METHOD	Rotary	CO-ORDINATES	N -	BORE END DATE	20/08/2024
JOB CODE	GEC-JC-GT-5055	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
1		10	50															
		To		SC	-	-												
		10	52															
2							2	2	2	4	2.00	1	SS	-2.0				
		11	09								2.45							
		To		SC	-	-												
		11	15															
3							2	1	2	3	3.00	2	SS	-3.0				
		11	32								3.45							
		To		SC	-	-												
		11	34															
4							1	1	1	2	4.00	3	SS	-4.0		L2	4.0	
		11	54								4.45							
		To		SC	-	-												
		11	56															
5	20/08/2024						1	1	1	2	5.00	4	SS	-5.0				
		12	17								5.45							
		To		SC	-	-												
		12	20															
6																		
							1	1	1	2	6.50	5	SS	-6.5				
											6.95							
7		12	35													L3	7.5	
		To		SC	-	-												
		12	40												+ + + + + +	L4	8.0	Dark Greyish,Moist, Very Dene,**Completely Weathered Rock** (Descent from Charnockite)
8							SPT Hammer Rebouded			>100	8.00	6	WS	-8.0				
		13	43												+ + + + + + + + +			
		To		DB	8	-												Greyish,**Highly Weathered Rock** (Descent from Charnockite)
		14	30															
9							-	-	-	-	9.00	CS	SS	-9.0		L5	9.0	
10																		

Layer Data

No	Depth	Geotechnical Description
L1	1.5	**Filled Up Soil** Brownish, Sand with Brick and Concrete Materials
L2	4.0	Brownish,Moist,Stiff,**Silty CLAY (Cl)** Lean Clays of Medium Plasticity.
L3	7.5	Greyish,Moist,Stiff,**Silty CLAY** / **Sandy Silty CLAY(CH/Cl)** Lean Clays of High/Medium Plasticity.
L4	8.0	Dark Greyish,Moist, Very Dene,**Completely Weathered Rock** (Descent from Charnockite)
L5	9.0	Greyish,**Highly Weathered Rock** (Descent from Charnockite)

CS - Core Sample	DS - Disturbed Sample	LOGGED	M.PANDIYARAN	PROJECT SITE DETAILS	REMARKS
SS - Split Spoon Sample	SC - Soil Cutter	DATE	20/08/2024	GROUND LEVEL (m) 0.00	
UDS- Undisturbed Sample	TCB - Tungsten Carbide Bit	CHECKED	JALEEL YASIN	WATER TABLE (m) 2.10	
WS - Wash Sample	DB - Diamond Bit	DATE	29/08/2024	CASING DEPTH (m) 0.00	

Borehole terminated at 9 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 RESIDENTIAL BUILDING			DIA OF BORE HOLE	150mm ✓		
					100mm ✓		
LOCATION	Velachery, Chennai.	MACHINE No.	CR-01	CHAINAGE (m)	-	BORE START DATE	20/08/2024
STRUCTURE	G+4 Upper Floors	DRILLING METHOD	Rotary	CO-ORDINATES	N -	BORE END DATE	20/08/2024
JOB CODE	GEC-JC-GT-5055	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
1		16	44															
		To		SC	-	-												
		16	48															
2							1	1	2	3	2.00	1	SS	-2.0				
		16	58								2.45							
		To		SC	-	-												
		17	03															
3							1	2	2	4	3.00	2	SS	-3.0				
		17	13								3.45							
		To		SC	-	-												
		17	16															
4							1	1	1	2	4.00	3	SS	-4.0		L2	4.0	
		17	26								4.45							
		To		SC	-	-												
		17	30															
5	20/08/2024						1	1	1	2	5.00	4	SS	-5.0				
		17	40								5.45							
		To		SC	-	-												
		17	42															
6																		
							1	1	1	2	6.50	5	SS	-6.5				
											6.95							
7		17	53													L3	7.5	
		To		SC	-	-												
		17	23															
8							SPT Hammer Rebounded			>100	8.00	6	WS	-8.0		L4	8.0	Dark Greyish,Moist, Very Dene,**Completely Weathered Rock** (Descent from Charnockite)
		18	07															
		To		DB	12	-												Greyish,**Moderately Weathered Rock** (Descent from Charnockite)
		18	45															
9							-	-	-	-	9.00	CS	SS	-9.0		L5	9.0	
10																		

Filled Up Soil
Brownish, Sand with Brick and Concrete Materials

Brownish,Moist,Stiff,**Sandy Silty CLAY/Silty CLAY (CI/CH)** Lean Clays of Medium/High Plasticity.

Greyish,Moist,Stiff,**Silty CLAY/Sandy Silty CLAY (CH/CI)** Lean Clays of High/Medium Plasticity.

CS - Core Sample	DS - Disturbed Sample	LOGGED	M.PANDIYARAN	PROJECT SITE DETAILS	REMARKS
SS - Split Spoon Sample	SC - Soil Cutter	DATE	20/08/2024	GROUND LEVEL (m) 0.00	
UDS- Undisturbed Sample	TCB - Tungsten Carbide Bit	CHECKED	JALEEL YASIN	WATER TABLE (m) 2.10	
WS - Wash Sample	DB - Diamond Bit	DATE	29/08/2024	CASING DEPTH (m) 0.00	

Borehole terminated at 9 m depth below E.G.L

FIG.2.2 Sub Soil Profile at BH-02 Location

Grain Size Distribution Curves

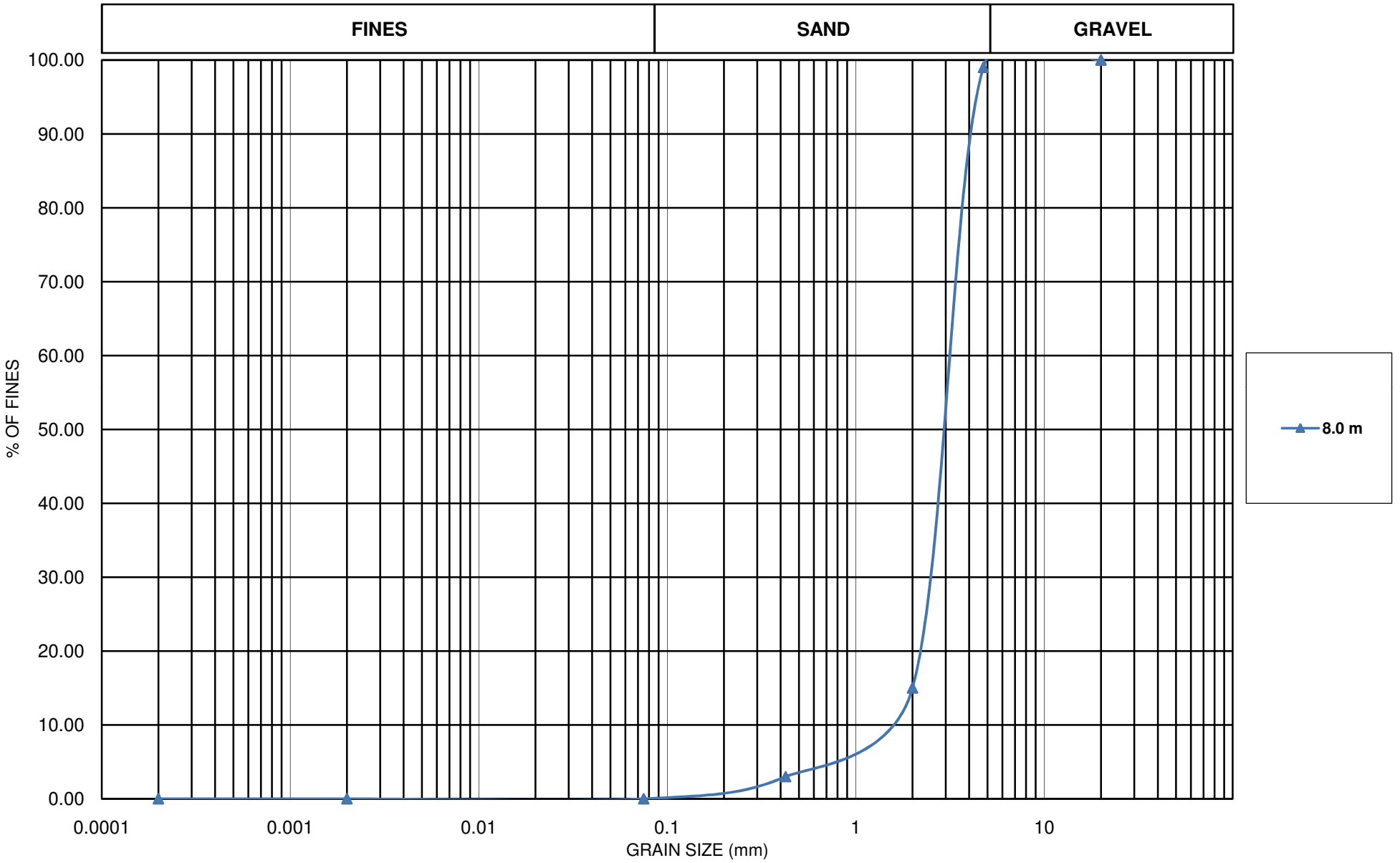


Fig. 2.3 GRAIN SIZE DISTRIBUTION CURVE - BH-01

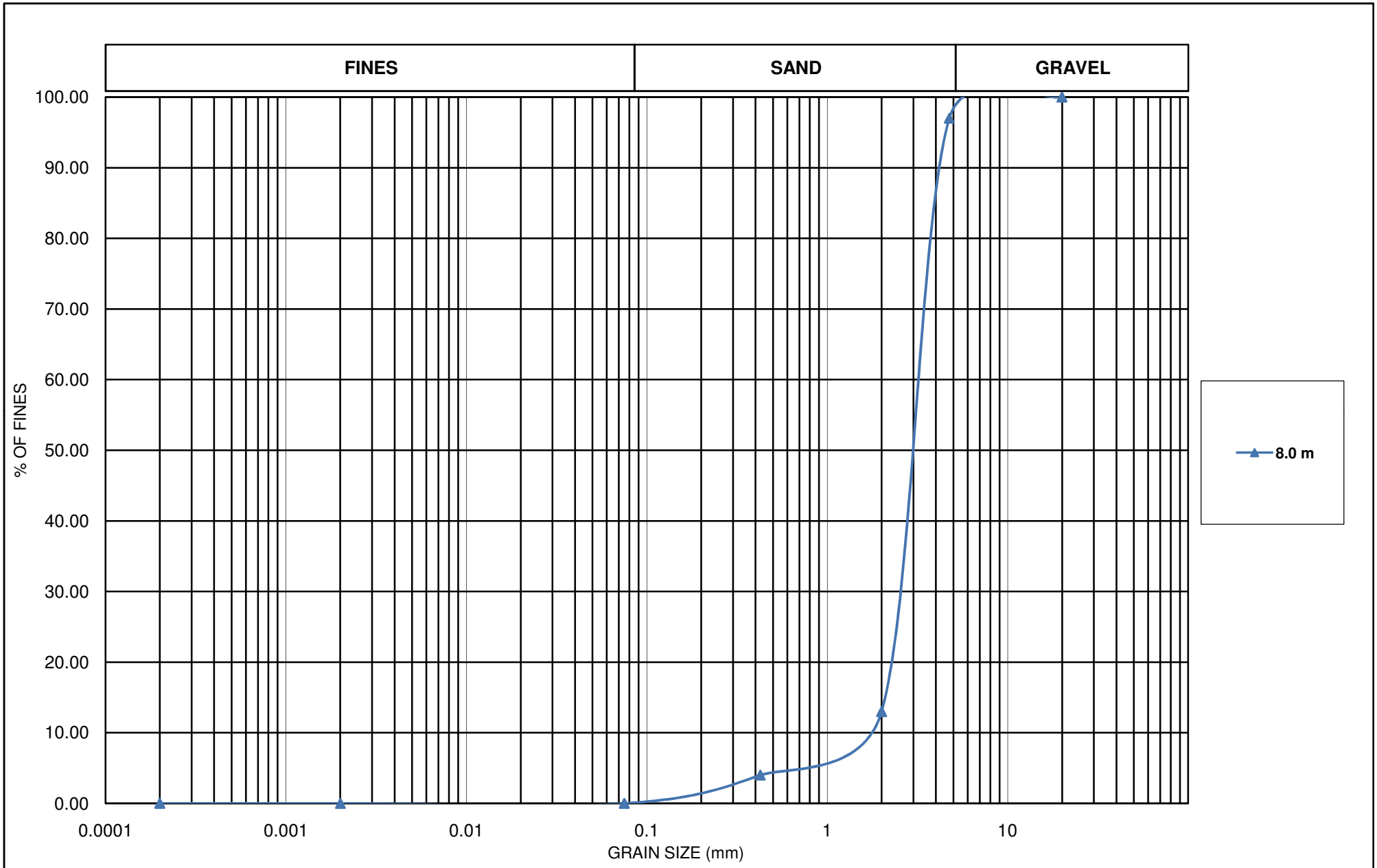


Fig. 2.4 GRAIN SIZE DISTRIBUTION CURVE - BH-02

HYDROMETER ANALYSIS CURVE

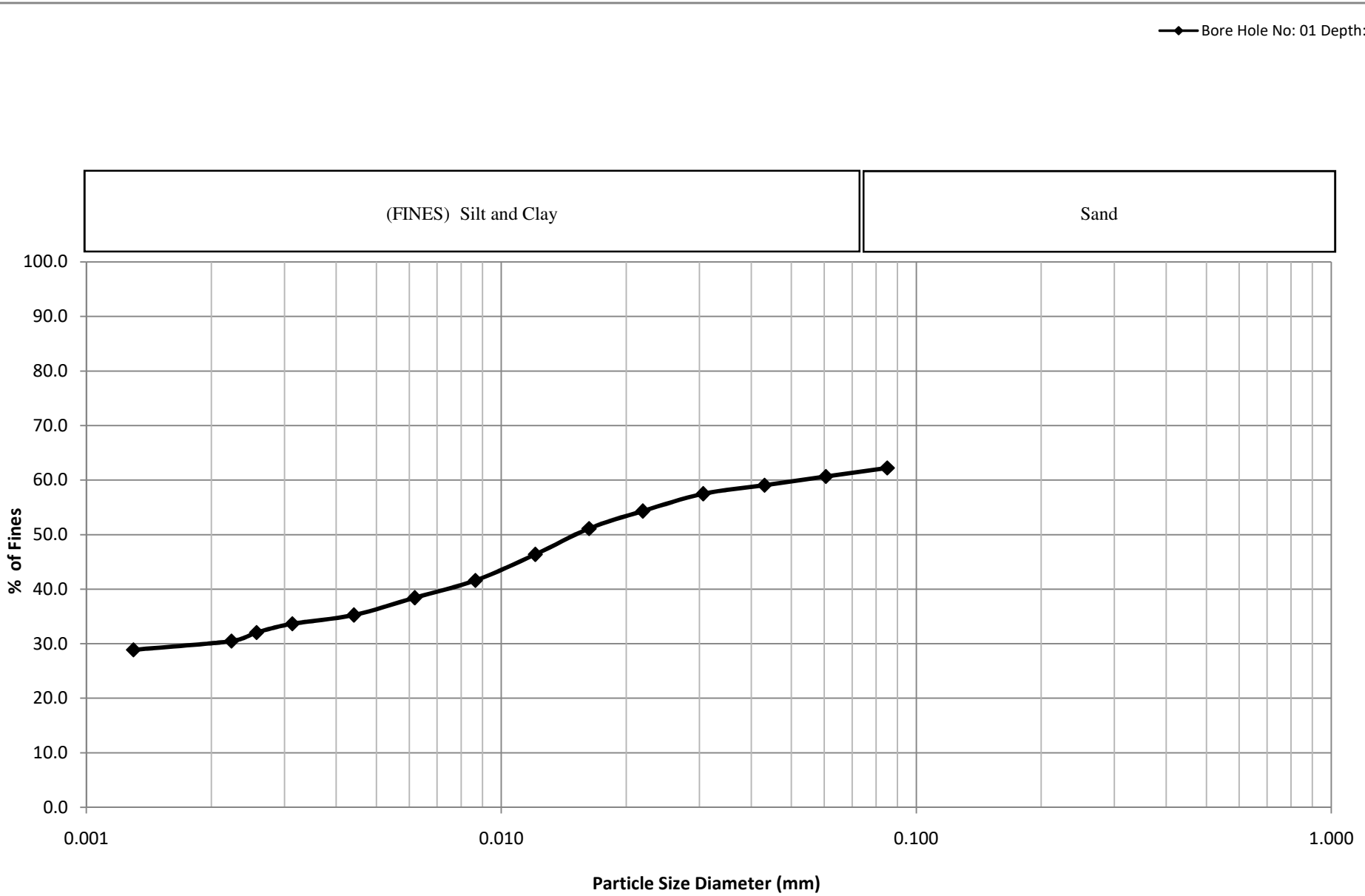


Fig 2.5 Hydrometer Analysis Master Curve

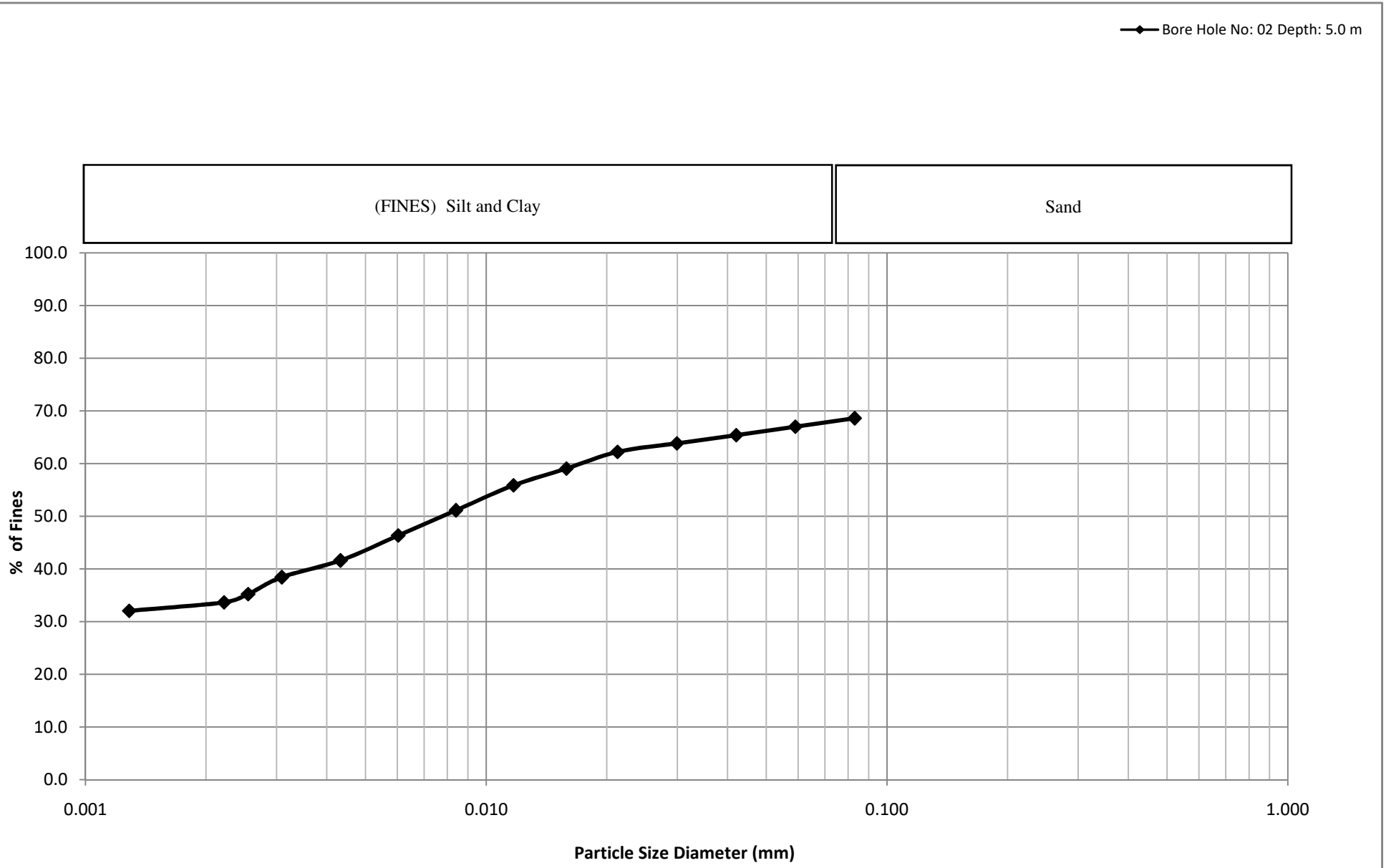


Fig 2.6 Hydrometer Analysis Master Curve

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)													
			N.M.C(%)	L.L (%)	P.L (%)	I_P	Ic	Shrinkage (cm^3)	D.F.S (%)	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	IS-Notation	
																									Gravel	Sand
2.0	4	SS	42	58	25	33	0.48	11	89	Soft	Above	CH	-	-	-	-	72	28	-	-	-	-	-	FG>50%	FG>50%	FG>50%
3.0	3	SS	60	75	27	48	0.31	12	58	Soft	Above	CH	-	-	-	-	68	32	-	-	-	-	-	FG>50%	FG>50%	FG>50%
4.0	2	SS	50	53	21	32	0.09	12	78	Very Soft	Above	CH	-	-	-	-	73	27	-	-	-	-	-	FG>50%	FG>50%	FG>50%
5.0	2	SS	38	43	18	25	0.20	15	27	Very Soft	Above	CI	0	5	18	20	37	20	-	-	-	-	-	FG>50%	FG>50%	FG>50%
6.5	2	SS	37	39	17	22	0.09	14	30	Very Soft	Above	CI	0	2	18	27	35	18	-	-	-	-	-	FG>50%	FG>50%	FG>50%
8.0	>100	WS	-	-	-	-	-	-	-	CG>50%	-	-	1	84	12	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 Free Swell Index
C_U = Uniformity Coefficient
C_C = Coefficient of Curvature
IP=LL-PL

LAB IN-CHARGE	M.PRAVEEN
REVIEWED BY	JALEEL YASIN

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)													
			N.M.C(%)	L.L (%)	P.L (%)	I_P	Ic	Shrinkage (cm^3)	D.F.S (%)	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	IS-Notation	
																									Gravel	Sand
2.0	3	SS	35	45	20	25	0.40	13	40	Soft	Above	CI	3	9	14	12	44	18	-	-	-	-	-	FG>50%	FG>50%	FG>50%
3.0	4	SS	45	58	27	31	0.42	12	70	Soft	Above	CH	-	-	-	-	72	28	-	-	-	-	-	FG>50%	FG>50%	FG>50%
4.0	2	SS	65	73	26	47	0.17	12	58	Very Soft	Above	CH	-	-	-	-	70	30	-	-	-	-	-	FG>50%	FG>50%	FG>50%
5.0	2	SS	72	85	29	56	0.23	10	73	Very Soft	Above	CH	-	-	-	-	68	32	-	-	-	-	-	FG>50%	FG>50%	FG>50%
6.5	2	SS	48	48	21	27	0.00	14	49	Very Soft	Above	CI	6	9	10	11	44	20	-	-	-	-	-	FG>50%	FG>50%	FG>50%
8.0	>100	WS	-	-	-	-	-	-	-	CG>50%	-	-	3	84	9	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 Free Swell Index
C_U = Uniformity Coefficient
C_C = Coefficient of Curvature
IP=LL-PL

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REVIEWED BY	JALEEL YASIN

Table-2.3 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-01	2.1	7.34	385	289	2.0	7.33	345	239
2	BH-02	2.1	7.34	375	269	3.0	7.33	355	232

CHAPTER-3

GEOLOGY & SUB-SURFACE STRATIFICATION

3.0 Preamble:

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

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

Formation Characteristics:

The present location falls under Chennai, geologically it is classified as recent alluvium deposits consisting of Silty Clay/Sandy Silty Clay, which is underlain with basement rock.

Recent Clays/Sand (Alluvium Deposits)

---------- Eparchean Unconformity ----------

Archaean Basement Rock (Charnockite Rock / Hypersthene Granite)

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

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

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

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

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	1.50	1.50	Filled Up Soil	-	-	-	-	-	-	-
2	1.50	4.00	2.50	Silty Clay	Brownish	4	-	Soft	14.5	27	-
3	4.00	7.50	3.50	Silty Clay	Greyish	2	-	Very Soft	14	13	-
4	7.50	8.00	0.50	Completely Weathered Rock	Dark Greyish	>100	Very Dense	-	21	-	42.5
5	8.00	9.00	1.00	Highly Weathered Rock	Greyish	CRR-8%, 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	1.50	1.50	Filled Up Soil	-	-	-	-	-	-	-
2	1.50	4.00	2.50	Silty Clay	Brownish	4	-	Soft	14.5	27	-
3	4.00	7.50	3.50	Silty Clay	Greyish	2	-	Very Soft	14	13	-
4	7.50	8.00	0.50	Completely Weathered Rock	Dark Greyish	>100	Very Dense	-	21	-	42.5
5	8.00	9.00	1.00	Moderately Weathered Rock	Greyish	CRR-12%, RQD-0%					

- Note: -Bulk density, & "C", "ϕ" values are given in SPT correlation

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 and four upper floors, and is meant for residential use. For this kind of structure, the column loads could vary between 1,200kN to 2,500kN. The above-mentioned loads have no bearing on the design of either sub or super structures and are mentioned just to provide an insight to choose an appropriate foundation system with respect to subsoil conditions.

4.2 Foundation System

For the kind of proposed structure and 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 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

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	8.5	0.6	7.90	450	500	50	18
2					500	650	55	20
3					550	800	65	22
4					600	950	70	25
5					650	1100	75	27

RECOMMENDATIONS

CHAPTER-5

RECOMMENDATIONS

5.0 Recommendation for Bored Cast In-situ Pile Foundation:

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

5.1 Construction method statement of pile foundation:

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

5.2 General Recommendation:

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

5.3 Special Recommendations

- Since, the sub soil stratum is soft to very soft clay layer top 7.5m depth below ground level. The soft layer will affect when the pile boring of sub soil is necking and bulging factor upon the installation of pile, due to Lateral soil expansion. Hence, in order to assure quality of the pile, it is ideal to carryout pile integrity test on all piles.

FOR GEO ENGINEERING CONSULTANTS, CHENNAI

AUTHORIZED SIGNATURE

ANNEXURE

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)	8.5	As Per IS:2911-(P-I,S-2)-2010	
Reference Bore Hole	BH-01		500	mm	Surcharge Pressure	0	kPa	

Layer No.	Layer Thk. (m) Top. R.L.	Bot. R.L.	Thickness	Type of Strata	Ave. SPT	(γ) kN/m³ of Layer	Ave. upto Layer	Shear Parameters (C_u) kPa	(ϕ) Deg.	Effective Overburden Pressure (kPa) At top of Layer	At Bot. of Layer	At Mid. of Layer	Adhesion Factor (α)	Earth Pressure Coefficient (k)	Skin Friction (Q_f) kN		
1	0	0.6	0.6	Cut-Off Level													
2	0.6	1.5	0.9	Sand	3	13.0	13.0	-	20.1	0.0	2.7	1.4	-	1.0	qf	2	0.7
3	1.5	4	2.5	Clay	4	14.5	13.8	27	-	2.7	14.0	8.3	1.0	-	qf	3	106.0
4	4	7.5	3.5	Clay	2	14.0	14.3	13	-	14.0	28.0	21.0	1.0	-	qf	4	-71.5
5	7.5	8.5	1.0	Weathered Rock	60	20.5	17.3	-	42.5	28.0	38.5	33.2	-	1.5	qf	5	71.8

Summation of Positive Skin Resitance (kN) Q_f= 178.48

Summation of Negative Skin Resistance (kN) -Qf= -71.47

Computation of End Bearing Resistance

		SPT	ϕ	C_u	N_q	N_c			
Bearing Stratum	Weathered Rock	60	38.75	-	240.00	-	Eff.Ht.of Overburden	8	m
							Effective Overburden Pressure	34.22	kN/m^2

End Bearing Resistance (kN) Q_p= 1612.52

Ultimate Load Carrying Capacity (Q_{ult})	**$Q_u=Q_f-Q_f+Q_p$ (kN)**	1719.53
Safe Load Carrying Capacity (Q_{safe})	**$Q_u/2.5$ (kN)**	687.81
Allowable Safe Load Carrying Capacity	**$Q_{A\text{-}safe}$ (kN)**	650.00
Allowable Safe Pull out Capacity	**$Q_{A\text{-}pull}$: Qf/3 (kN)**	59.49

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

Skin Resistance in Sand Layer is $\pi*d*T_l*q_l*K*Tan(\phi)$

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

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

Note: The End being is Highly Weathered Rock modeld as Very Dense Sand with restricted to SPT-value of 60 corresponding phi angle 38.75

Where

Cu=Undrained Shear Strength of Clay — **K=Coef. Earth Pressure at Rest** — **d=Dia. Of Pile**

ϕ=Angle of Shearing Resistance — **q_l=Effecitve Overburden Pressure at middle of Layer** — **α=Adhession Factor**

N_c=Bearing Capacity Factor = 9 — **N_q=Bearing Capacity Factor, Ref. Fig.1 of IS: Code Refered above** — **T_l=Thickness of Layer**

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

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)	:	0.50	m
Free standing Length of Pile (e)	:	0	m
Length of Pile below E.G.L (Le)	:	8.5	m
Cut-Off Level From E.G.L	:	0.6	
Length of Pile below Cut-Off Level (Le)	:	7.9	m
Grade of Concrete (M)	:	25	MN/m^2
Young's Modulus of Concrete (E)	:	25000000	kN/m^2
Momemnt of Inertia (I)	:	0.003068	m^4

2.0 Determination of Depth of Fixity

Type of Soil Strata	:	Clay	
Ground Water Condition	:	Submerged	
Average Design SPT "N" Value	:	3	
K=((k1/1.5)*(0.3/B))			
(n can be read as η in the above and below equation in case of Sand)			
K1=	:	6750	kN/m^3
K=	:	2700	kN/m^2
R=	:	2.75	
L1/R	:	0.00	
Lf/R	:	2.20	
Depth of Fixity below Cut off (z_f)	:	6.04	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	:	20.88	kN
Recommended Design Lateral Load carrying Capacity	:	**20**	**kN**
Fixed End Moment,M_F=H(e+z_f)/2		63	
Reduction Factor (L_1/T)	:	0.67	m
Actual Moment (Fixed End Moment/Reduction Factor),M_F		**42**	kN-m

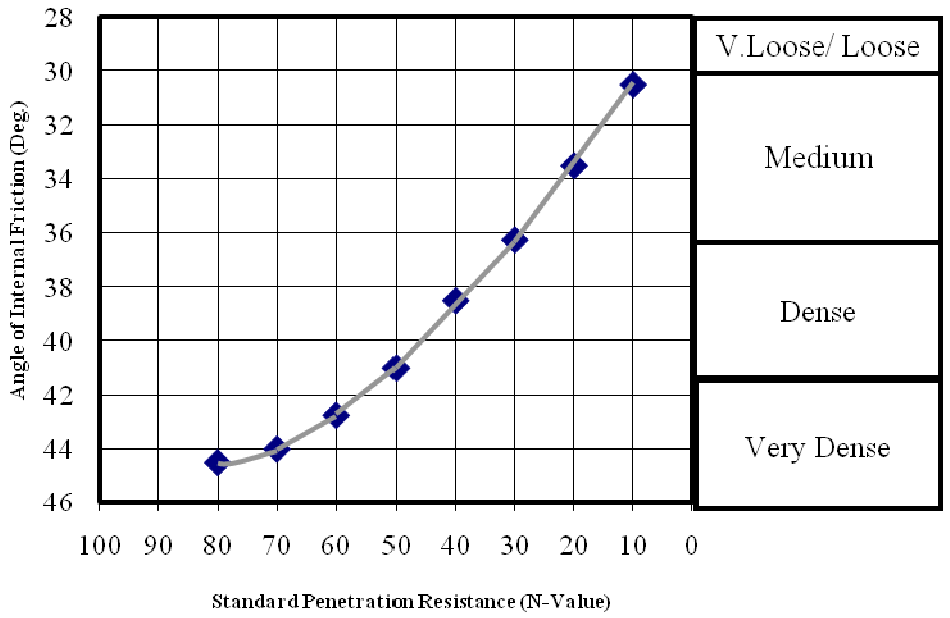


FIG. A1 Relation Ship between Angle of Internal Friction & N-value (Reproduced from IS:6403-1981)

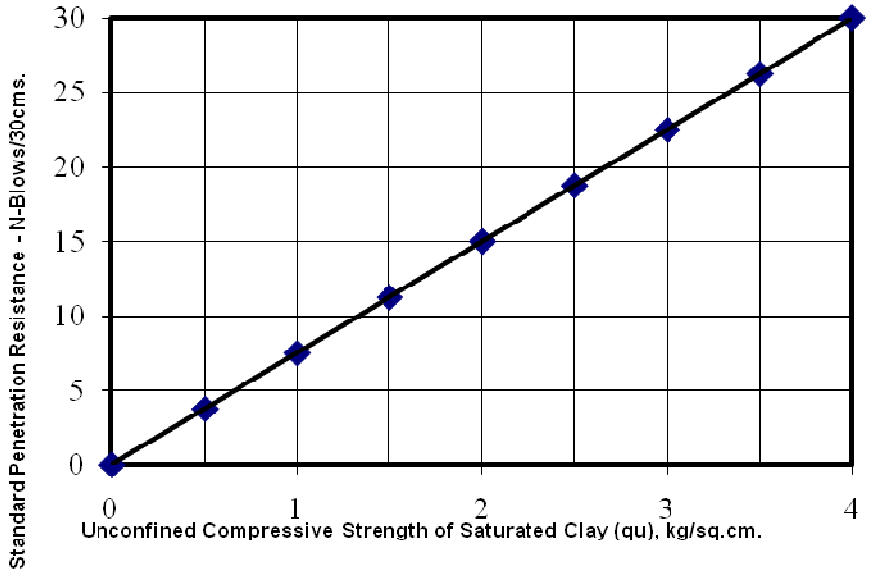


FIG. A2 : Relationship between UCC & SPT-Value (N) of Saturated Clay (AfterTerzhagi & Peck, 1948)



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