Verified RealEstate™

Your trusted partner for buying, selling, and managing property, ensuring hassle-free service with 100% transparency.

3/350/2 Mettukuppam,
OMR Thoraipakkam,
Chennai, India

hello@verified.realestate
+91 9996 12 9996

Official Property Record

Digitally Verified Record - Powered by Verified RealEstate™



Gateway to Technology

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

PROPOSED CONSTRUCTION OF RESIDENTIAL BUILDING (STILT+5 UPPER FLOORS) AVANTHIKA PROJECT AT VIRUGAMBAKKAM, CHENNAI.

CLIENT NAME

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

TITLE

GEOTECHNICAL INVESTIGATION REPORT

PROJECT NO: GEC-JC-GT-5020/2023-2024

REPORTING DATE: 15/06/2023

CONTENTS

	SEC. NO.	CONTENTS	PAGE NO.
			i-ii
CHAPTER-1		**INTRODUCTION**	
	1.0	Project Information Matrix	1
	1.1	Scope of Work	1
	1.1.1	Field Work	1
	1.1.2	Laboratory Work	1
	1.2	Structure of the Report	1
CHAPTER-2		**INVESTIGATION METHODOLOGY & TEST RESULTS**	
	2.0	Preamble	2
	2.1	Methodology of Field Work	2
	2.1.1	Equipment Used and Method of Drilling	2
	2.1.2	Standard Penetration Tests	2
	2.1.3	Collection of Soil Samples	2
	2.1.4	Collection of Ground Water Samples	2-3
	2.2	Laboratory Testing	3
	2.2.1	On Coarse Grained Soil	3
	2.2.2	On Fine Grained Soil	3
	2.2.3	Chemical Analysis Tests	3
	2.3	Summary	3
FIGURES	2.0	Site Plan showing the Location of Field Investigation Points	4
	2.1 to 2.2	Soil Profile	5-8
	2.3 to 2.4	Graphical Representation of grain size distribution curve	9-10
	2.5 to 2.8	Graphical Representation of Hydrometer Analyses Curve	11-14
TABLES	2.1 to 2.2	Laboratory Test Results	15-16
	2.3	Results of Chemical analysis	17
CHAPTER-3		**GEOLOGY & SUB-SURFACE STRATIFICATION**	
	3.0	Preamble	18
	3.1	Geology of region	18
	3.2	Design sub soil profile	19-20
CHAPTER-4		**FOUNDATION SYSTEM**	
	4.0	Preamble	21
	4.1	Proposed Structures	21
	4.2	Foundation System	21

TABLE	4.1	Recommended Safe Load Carrying Capacities of Bored Cast Insitu Piles	22
CHAPTER-5		**RECOMMENDATION**	22-24
ANNEXURE		Estimation of safe load carrying capacity of vertical pile design	25
		Lateral Load Carrying Capacity of Bored Cast- Situ Piles	26
	A1	Relationship Between Angle of Internal Friction & N-Value	27
	A2	Relationship Between UCC & SPT -Value (N) of Saturated Clay	27

CHAPTER-1

INTRODUCTION

1.0 Project Information Matrix

Nature of project	: Proposed Residential Building (Stilt+5 Upper Floors)
Project Client	: **M/s Akshaya Estates Realty LLP.,**
Project Location	: Virugambakkam, Chennai.
Job Code	: JC-GT-5020

1.1 Scope Of Work

1.1.1 Field Work

- Conducting two soil investigation bore holes of 150 mm up to 30.0m depth or up to the refusal strata with SPT>100
- Conducting Standard Penetration Test (SPT) within the borehole at every 1.0m depth interval up to 5.0m and thereafter at every 1.5m depth interval up to 20.0m depth and after that at every 2.0m depth interval up to termination depth.
- Collection of soil samples and undisturbed samples from the clayey strata with SPT-value greater than 2 to less than 15 if met within the investigation depth
- Collection of water samples if groundwater table met within the investigation depth

1.1.2 Laboratory Work

- Natural Moisture Content
- Atterberg's limits
- Grain Size Analysis
- Chemical Analysis test on soil and water samples to give pH, Chlorides and Sulphates

1.2 Structure of the Report

- Contents
- Introduction
- Investigation Methodology & Test Results
- Geology &Sub-Surface Stratification
- Foundation System
- Recommendation
- Annexure

REPORT TEXT

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 2.8.

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	3
DIA OF BORE HOLE	150mm ✓		
	NX		

PROJECT NAME	PROPOSED CONSTRUCTION OF RESIDENTIAL APARTMENT AT VIRUGAMBAKKAM, CHENNAI					BORE START DATE	04/06/2023
LOCATION	Virugambakkam, Chennai	MACHINE No.	CR-01	CHAINAGE (m)	-	BORE END DATE	05/06/2023
STRUCTURE	Stilt+5 Upper Floors	DRILLING METHOD	Rotary	CO-ORDINATES	N -	TOTAL DRILL DAYS	2
JOB CODE	JC-GT-5020	FLUSHING MEDIUM	Bentonite		E -		

Depth below E.G.L. (m)	Drilling progress per metre: Date	Time: Hr.	Time: Min.	Type of Drill Bit (SC / TCB / DB)	Core Details: Total Core Recovery %	Core Details: R.Q.D %	SPT Details: Blows/cm. 0-15	SPT Details: Blows/cm. 15-30	SPT Details: Blows/cm. 30-45	SPT 'N' Value	Sample Details: Depth	Sample Details: No.	Sample Details: Type	Sample Details: RL (m)	Layer Data: Legend	Layer Data: No	Layer Data: Depth	Layer Data: Geotechnical Description
		08	05													L1	0.5	Brownish, Sand
		To		SC	-	-												
		08	06															
1							3	3	3	6	1.00	1	SS	-1.0				Brownish, Moist, Medium Stiff, **Sandy Silty CLAY (CH)** Clays of High Plasticity
		08	23								1.45							
		To		SC	-	-												
		08	25													L2	2.0	
2							1	2	2	4	2.00	2	SS	-2.0				
		08	50								2.45							Greyish Brown, Moist, Soft, **Sandy Silty CLAY (CI)** Clays of Medium Plasticity
		To		SC	-	-												
		08	51													L3	3.0	
3							5	6	8	14	3.00	3	SS	-3.0				
		11	50								3.45							
		To		SC	-	-												
		11	51															Brownish, Moist, Medium Dense , Poorly Graded, **Silty SAND (SM/SP-SM)**, Sand-Silt Mixture
4							8	8	12	20	4.00	4	SS	-4.0				
		12	11								4.45							
		To		SC	-	-												
		12	12													L4	5.0	
5	04/06/2023						2	2	2	4	5.00	5	SS	-5.0				
		12	30								5.45							
		To		SC	-	-												
		12	32															Brownish Grey, Moist, Soft, **Sandy Silty CLAY (CL)** Clays of Low Plasticity
6																		
							2	3	3	6	6.50	6	SS	-6.5		L5	6.5	
											6.95							
7		13	00															Greyish Black, Moist, Medium Stiff, **Silty CLAY (CH)** Clays of High Plasticity
		To		SC	-	-												
		13	01													L6	8.0	
8							5	5	5	10	8.00	7	SS	-8.0				
											8.45							
		14	00															Greyish Black, Moist, Loose, Poorly Graded, **Silty SAND (SM)**, Sand-Silt Mixture
		To		SC	-	-												
9		14	02													L7	9.5	
							5	7	6	13	9.50	8	SS	-9.5				
											9.95							
10																		Blackish Grey, Moist, Medium Dense, Poorly Graded, **Silty SAND (SM)**, Sand-Silt

CS - Core Sample	DS - Disturbed Sample	LOGGED	K.J.VINODPRADAP	PROJECT SITE DETAILS	REMARKS
SS - Split Spoon Sample	SC - Soil Cutter	DATE	04/06/2023	GROUND LEVEL (m) 0.00	
UDS- Undisturbed Sample	TCB - Tungsten Carbide Bit	CHECKED	Jaleel Yasin	WATER TABLE (m) 2.50	
WS - Wash Sample	DB - Diamond Bit	DATE	15/06/2023	CASING DEPTH (m) 0.00	

SITE INVESTIGATION RECORD

BORE HOLE No.	BH-01				
SHEET	2	OF	3		
PROJECT NAME	PROPOSED CONSTRUCTION OF RESIDENTIAL APARTMENT AT VIRUGAMBAKKAM, CHENNAI	DIA OF BORE HOLE	150mm ✓	NX	
LOCATION	Virugambakkam, Chennai	MACHINE No.	CR-02	CHAINAGE (m)	-
STRUCTURE	Stilt+3 Upper Floors	DRILLING METHOD	Rotary	CO-ORDINATES N	-
JOB CODE	JC-GT-5020	FLUSHING MEDIUM	Bentonite	CO-ORDINATES E	-
BORE START DATE	04/06/2023				
BORE END DATE	05/06/2023				
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	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
11	04/06/2023	14	22 To 14 23	SC	-	-	1	1	1	2	11.00 | 11.45	9	SS	-11.0		L8	11.0	Blackish Grey, Moist, Medium Dense, Poorly Graded, **Silty SAND (SM)**, Sand-Silt Mixture
12		14	50 To 14 56	SC	-	-	1	1	1	2	12.50 | 12.95	10	SS	-12.5				Greyish Black, Moist, Soft, **Silty CLAY (CI/CH)** Clays of Low/High Plasticity
13		15	30 To 15 32															
14				SC	-	-	8	5	3	8	14.00 | 14.45	11	SS	-14.0		L9	14.0	
15		16	03 To 16 08															Greyish, Moist, Loose, Poorly Graded, **Silty SAND (SP-SM)**, Sand-Silt Mixture
16				SC	-	-	1	1	1	2	15.50 | 15.95	12	SS	-15.5		L10	15.5	
17		16	40 To 16 45				1	1	1	2	17.00 | 17.45	13	SS	-17.0				
18		17	10 To 17 16	SC	-	-												Blackish Grey, Moist, Very Soft to Soft, **Silty CLAY (CH)** Clays of High Plasticity
19		17	50 To 17 56	SC	-	-	1	1	1	2	18.50 | 18.95	14	SS	-18.5				
20							1	1	2	3	20.00 | 20.45	15	SS	-20.0				

CS - Core Sample	DS - Disturbed Sample	LOGGED	K.J.VINODPRADAP	PROJECT SITE DETAILS	REMARKS
SS - Split Spoon Sample	SC - Soil Cutter	DATE	04/06/2023	GROUND LEVEL (m) 0.00	
UDS- Undisturbed Sample	TCB - Tungsten Carbide Bit	CHECKED	Jaleel Yasin	WATER TABLE (m) 2.50	
WS - Wash Sample	DB - Diamond Bit	DATE	15/06/2023	CASING DEPTH (m) 0.00	

SITE INVESTIGATION RECORD

BORE HOLE No.	BH-01						
SHEET	3	OF	3				
PROJECT NAME	PROPOSED CONSTRUCTION OF RESIDENTIAL APARTMENT AT VIRUGAMBAKKAM, CHENNAI			DIA OF BORE HOLE	150mm ✓ / NX		
LOCATION	Virugambakkam, Chennai	MACHINE No.	CR-02	CHAINAGE (m)	-	BORE START DATE	04/06/2023
STRUCTURE	Stilt+3 Upper Floors	DRILLING METHOD	Rotary	CO-ORDINATES	N -	BORE END DATE	05/06/2023
JOB CODE	JC-GT-5020	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	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
21	05/06/2023	08	10	SC	-	-												
		To																
		08	17															
22							1	1	1	2	22.00 / 22.45	16	SS	-22.0				
23		09	40	SC	-	-												Greyish Black/Blackish, Moist, Very Soft, **Silty CLAY (CH)** Clays of High Plasticity
		To																
		09	48															
24							1	1	1	2	24.00 / 24.45	17	SS	-24.0				
25		10	50	SC	-	-												
		To																
		10	57															
26							12	15	15	30	26.00 / 26.45	18	SS	-26.0		L11	26.0	
27		12	20	SC	-	-												Greyish, Moist, Medium Dense, Poorly Graded, Fine to Medium Grained, **SAND (SP)**
		To																
		12	23															
28							13	20	23	43	28.00 / 28.45	19	SS	-28.0		L12	28.0	
																L13	28.5	Greyish, Moist, Dense, Poorly Graded, **Silty SAND (SM),**
29		14	29	SC	-	-												Greyish, Moist, Very Hard, **Compacted CLAY (SHALE)**
		To																
		14	45															
30							14cm Penet. For 50Blows			>100	30.00 / 30.14	20	SS	-30.0		L14	30.5	

CS - Core Sample	DS - Disturbed Sample	LOGGED	K.J.VINODPRADAP	PROJECT SITE DETAILS		REMARKS	
SS - Split Spoon Sample	SC - Soil Cutter	DATE	05/06/2023	GROUND LEVEL (m)	0.00		
UDS- Undisturbed Sample	TCB - Tungsten Carbide Bit	CHECKED	Jaleel Yasin	WATER TABLE (m)	2.50		
WS - Wash Sample	DB - Diamond Bit	DATE	15/06/2023	CASING DEPTH (m)	0.00		

Borehole terminated at 30 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 APARTMENT AT VIRUGAMBAKKAM, CHENNAI			DIA OF BORE HOLE	150mm ✓ / NX		
LOCATION	Virugambakkam, Chennai	MACHINE No.	CR-01	CHAINAGE (m)	-	BORE START DATE	06/06/2023
STRUCTURE	Stilt+5 Upper Floors	DRILLING METHOD	Rotary	CO-ORDINATES	N -	BORE END DATE	06/06/2023
JOB CODE	JC-GT-5020	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
		08	20															
		To		SC	-	-										L1	0.5	Brownish SAND
		08	23															
1							4	4	4	8	1.00	1	SS	-1.0				
		08	35								1.45							Brownish, Moist, Stiff, **Sandy Silty CLAY (CH)** Clays of High Plasticity
		To		SC	-	-												
		08	39															
2							3	3	3	6	2.00	2	SS	-2.0		L2	2.0	
		09	40								2.45							
		To		SC	-	-												
		09	43															
3							3	3	4	7	3.00	3	SS	-3.0				Brownish, Moist, Medium Stiff, **Sandy Silty CLAY (CI)** Clays of Medium Plasticity
		09	55								3.45							
		To		SC	-	-												
		09	56															
4							3	1	1	2	4.00	4	SS	-4.0		L3	4.0	
		10	15								4.45							
		To		SC	-	-												Brownish, Moist, Very Loose , Poorly Graded, **Silty SAND (SP-SM)**, Sand-Silt Mixture
		10	18															
5	06/06/2023						3	2	1	3	5.00	5	SS	-5.0		L4	5.0	
		10	35								5.45							
		To		SC	-	-												
		10	38															Brownish, Moist, Soft, **Sandy Silty CLAY (CI)** Clays of Medium Plasticity
6																		
							1	5	5	10	6.50	6	SS	-6.5		L5	6.5	
											6.95							
7		11	30															
		To		SC	-	-												Blackish, Moist, Stiff, **Silty CLAY (CH)** Clays of High Plasticity
		11	36															
8							2	5	5	10	8.00	7	SS	-8.0		L6	8.0	
											8.45							
		12	00															
		To		SC	-	-												Greyish Black, Moist, Loose, Poorly Graded, **Silty SAND (SM)**, Sand-Silt Mixture
		12	03															
9																L7	9.5	
							4	1	1	2	9.50	8	SS	-9.5				
											9.95							
10																		Greyish, Moist, Very Loose, Poorly Graded, **Clayey SAND (SC)**, Sand-Clay Mixture
																L8	10.0	

CS - Core Sample	DS - Disturbed Sample	LOGGED	K.J.VINODPRADAP	PROJECT SITE DETAILS	REMARKS
SS - Split Spoon Sample	SC - Soil Cutter	DATE	27/05/2023	GROUND LEVEL (m) 0.00	
UDS- Undisturbed Sample	TCB - Tungsten Carbide Bit	CHECKED	Jaleel Yasin	WATER TABLE (m) 2.50	
WS - Wash Sample	DB - Diamond Bit	DATE	15/06/2023	CASING DEPTH (m) 0.00	

Borehole terminated at 10 m depth below E.G.L

FIG.2.2 Sub Soil Profile at BH-02 Location

Grain Size Distribution Curves

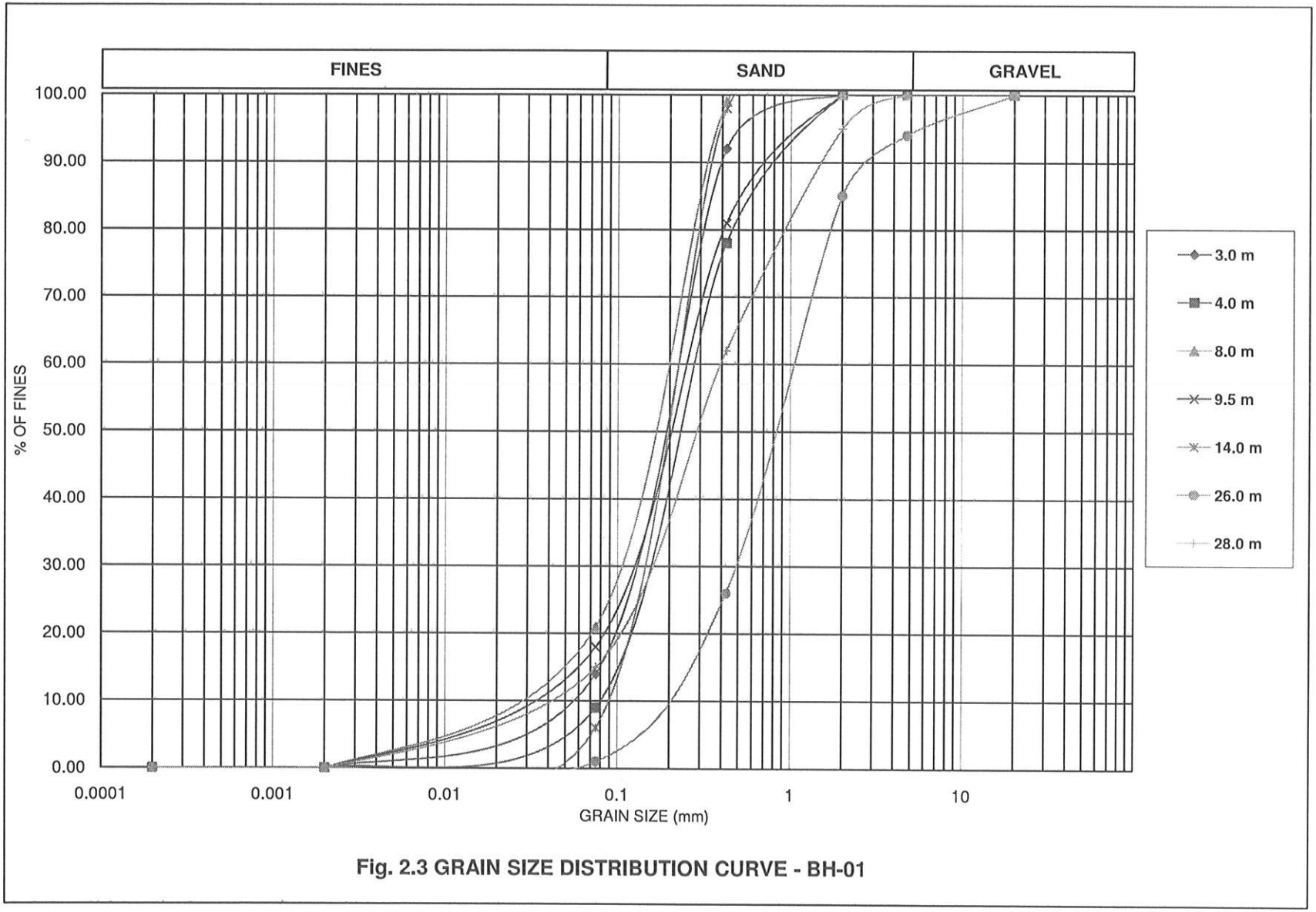


Fig. 2.3 GRAIN SIZE DISTRIBUTION CURVE - BH-01

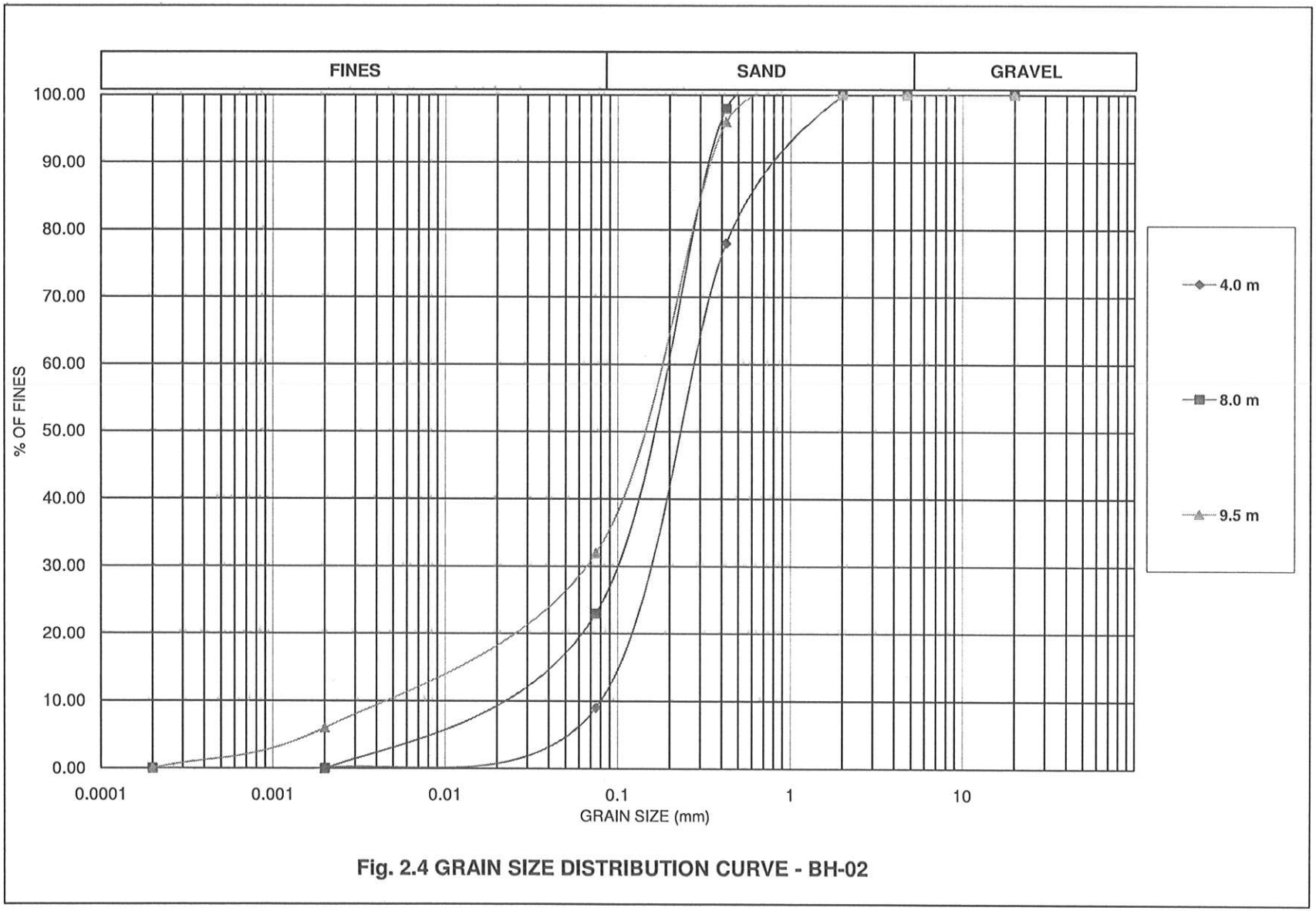


Fig. 2.4 GRAIN SIZE DISTRIBUTION CURVE - BH-02

HYDROMETER ANALYSIS CURVE

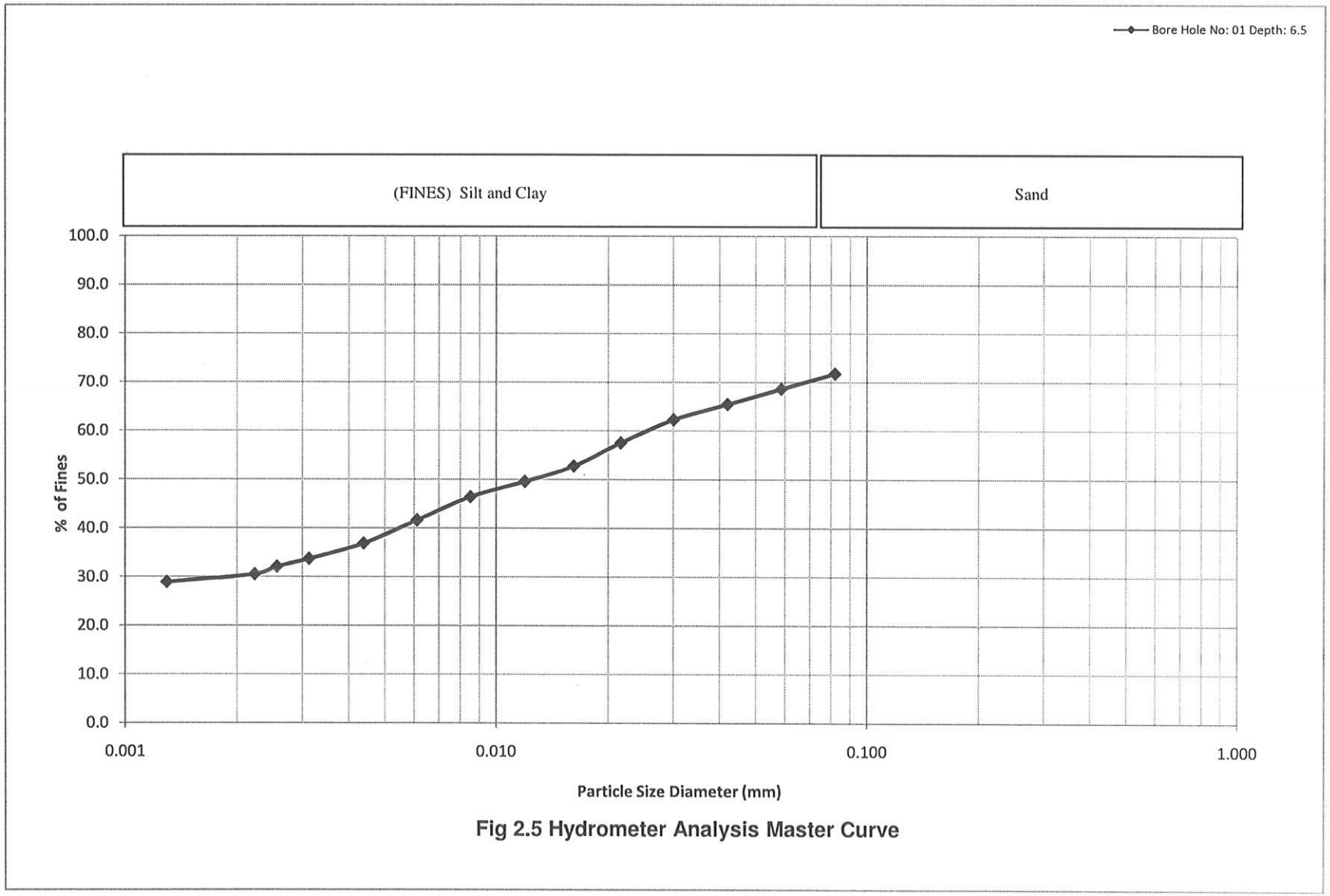


Fig 2.5 Hydrometer Analysis Master Curve

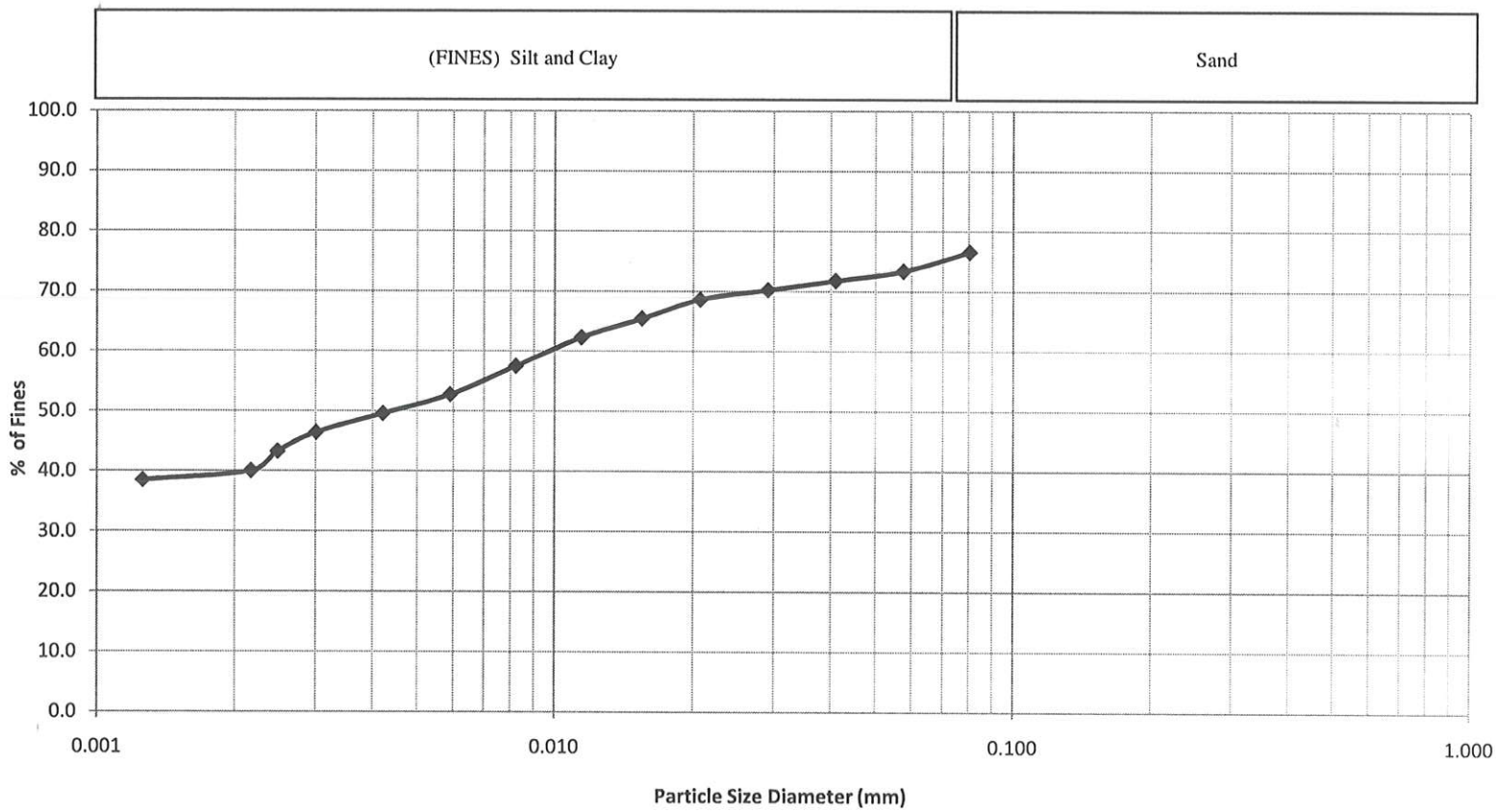


Fig 2.6 Hydrometer Analysis Master Curve

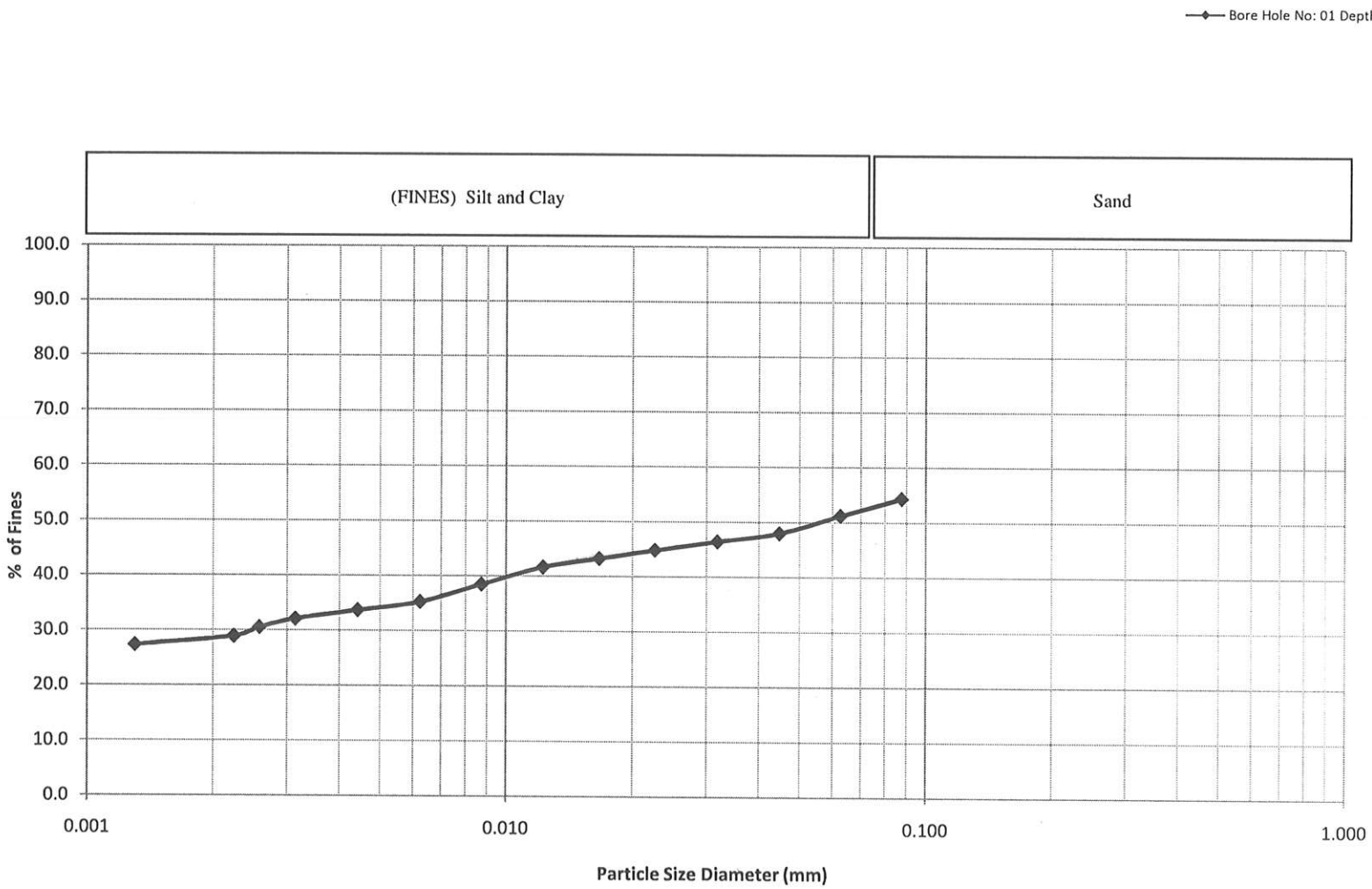


Fig 2.7 Hydrometer Analysis Master Curve

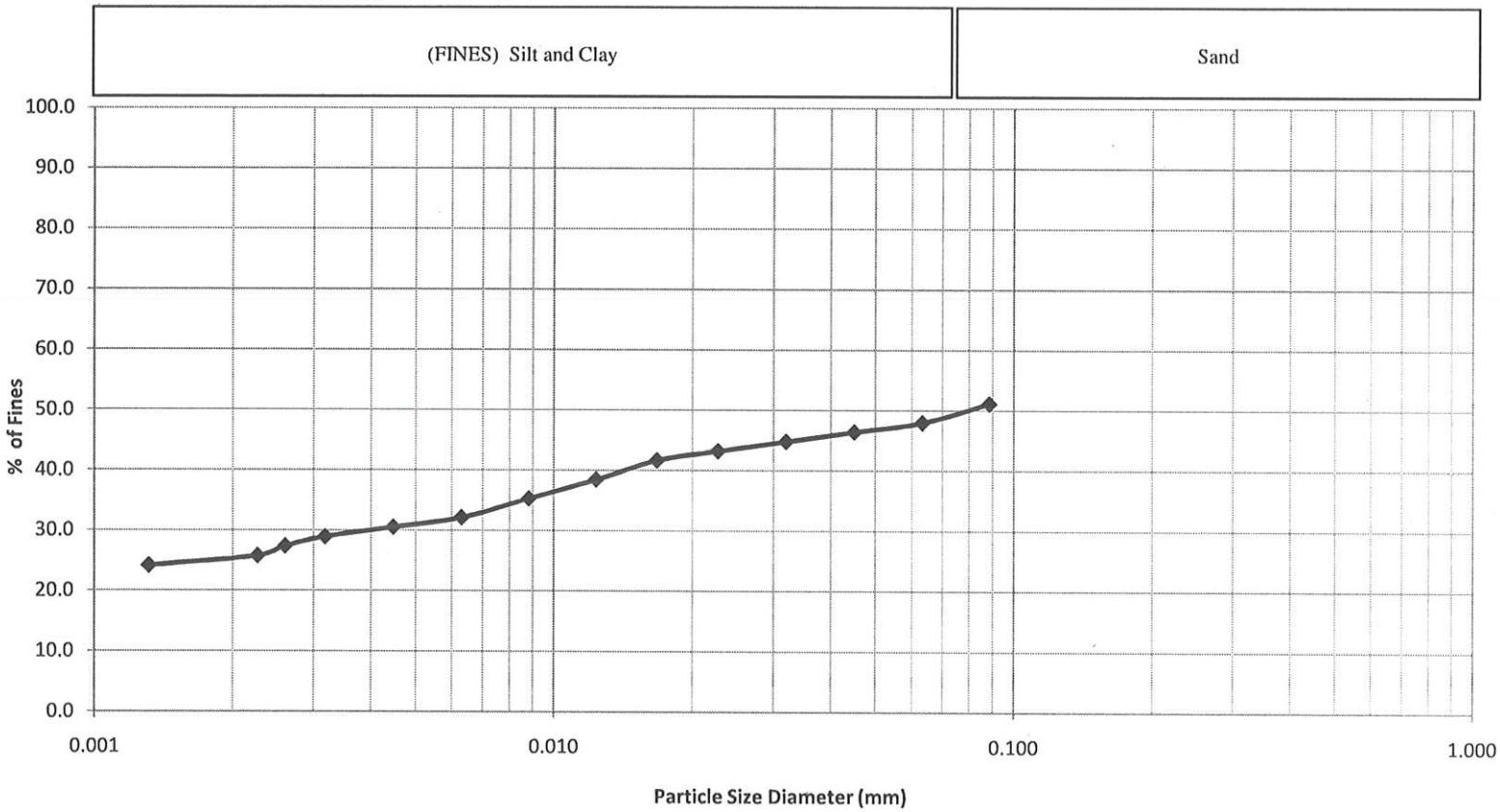


Fig 2.8 Hydrometer Analysis Master Curve

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	6	SS	38	52	27	25	0.56	13	60	M.Stiff	Above	CH	0	1	3	15	55	26	-	-	-	-	-	FG>50%	FG>50%	FG>50%
2.0	4	SS	30	38	20	18	0.44	14	12	Soft	Above	CI	0	0	14	23	46	17	-	-	-	-	-	FG>50%	FG>50%	FG>50%
3.0	14	SS	-	-	-	-	-	-	-	CG>50%	-	-	0	0	8	78	14	0	-	-	-	-	-	M.Dense	<50%	SM
4.0	20	SS	-	-	-	-	-	-	-	CG>50%	-	-	0	0	22	69	9	0	-	-	-	-	-	M.Dense	<50%	SP-SM
5.0	4	SS	25	28	18	10	0.30	18	20	Soft	Above	CL	0	0	0	27	58	15	-	-	-	-	-	FG>50%	FG>50%	FG>50%
6.5	6	SS	39	60	30	30	0.70	11	42	M.Stiff	Above	CH	-	-	-	-	72	28	-	-	-	-	-	FG>50%	FG>50%	FG>50%
8.0	10	SS	-	-	-	-	-	-	-	CG>50%	-	-	0	0	1	78	21	0	-	-	-	-	-	Loose	<50%	SM
9.5	13	SS	-	-	-	-	-	-	-	CG>50%	-	-	0	0	19	63	18	0	-	-	-	-	-	M.Dense	<50%	SM
11.0	2	SS	42	39	22	17	-0.18	14	45	Very Soft	Above	CI	-	-	-	-	75	25	-	-	-	-	-	FG>50%	FG>50%	FG>50%
12.5	2	SS	65	72	33	39	0.18	12	34	Very Soft	Above	CH	-	-	-	-	72	28	-	-	-	-	-	FG>50%	FG>50%	FG>50%
14.0	12	SS	-	-	-	-	-	-	-	CG>50%	-	-	0	0	2	92	6	0	-	-	-	-	-	M.Dense	<50%	SP-SM
15.5	2	SS	85	94	34	60	0.15	10	127	Very Soft	Above	CH	-	-	-	-	68	32	-	-	-	-	-	FG>50%	FG>50%	FG>50%
17.0	2	SS	86	98	38	60	0.20	9	136	Very Soft	Above	CH	-	-	-	-	64	36	-	-	-	-	-	FG>50%	FG>50%	FG>50%
18.5	2	SS	95	101	35	66	0.09	9	108	Very Soft	Above	CH	-	-	-	-	62	38	-	-	-	-	-	FG>50%	FG>50%	FG>50%
20.0	2	SS	93	105	35	70	0.17	9	245	Very Soft	Above	CH	-	-	-	-	62	38	-	-	-	-	-	FG>50%	FG>50%	FG>50%
22.0	2	SS	90	103	36	67	0.19	11	162	Very Soft	Above	CH	-	-	-	-	63	37	-	-	-	-	-	FG>50%	FG>50%	FG>50%
24.0	2	SS	52	57	25	32	0.16	12	91	Very Soft	Above	CH	-	-	-	-	75	25	-	-	-	-	-	FG>50%	FG>50%	FG>50%
26.0	30	SS	-	-	-	-	-	-	-	CG>50%	-	-	6	9	59	25	1	0	-	-	-	-	-	M.Dense	<50%	SP
28.0	43	SS	-	-	-	-	-	-	-	CG>50%	-	-	0	5	33	47	15	0	-	-	-	-	-	Dense	<50%	SM
30.0	>100	SS	20	53	26	27	1.22	14	64	Hard	Above	CH	-	-	-	-	73	27	-	-	-	-	-	FG>50%	FG>50%	FG>50%

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

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)												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	28	51	25	26	0.88	12	56	Stiff	Above	CH	0	1	5	19	51	24	-	-	-	-	-	FG>50%	FG>50%	FG>50%
2.0	6	SS	27	39	21	18	0.67	14	22	M.Stiff	Above	CI	0	1	11	25	45	18	-	-	-	-	-	FG>50%	FG>50%	FG>50%
3.0	7	SS	26	36	19	17	0.59	16	10	M.Stiff	Above	CI	0	2	15	24	44	15	-	-	-	-	-	FG>50%	FG>50%	FG>50%
4.0	2	SS	-	-	-	-	-	-	-	CG>50%	-	-	0	0	22	69	9	0	-	-	-	-	-	V.Loose	<50%	SP-SM
5.0	3	SS	30	36	22	14	0.43	14	33	Soft	Above	CI	0	0	1	25	56	18	-	-	-	-	-	FG>50%	FG>50%	FG>50%
6.5	10	SS	29	55	28	27	0.96	12	40	Stiff	Above	CH	-	-	-	-	73	27	-	-	-	-	-	FG>50%	FG>50%	FG>50%
8.0	10	SS	-	-	-	-	-	-	-	CG>50%	-	-	0	0	2	75	23	0	-	-	-	-	-	Loose	<50%	SM
9.5	2	SS	33	35	20	15	0.13	16	21	CG>50%	Above	-	0	0	4	60	30	6	-	-	-	-	-	V.Loose	<50%	SC

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

LAB IN-CHARGE	M.PRAVEEN
REVIEWED BY	JALEEL YASIN

Table-2.3 Results of Chemical Analysis									
SL No.	Bore HoleNo.	Water				Soil (2:1)			
		Depth of Sample (m)	pH	Chlorides (mg/l)	Sulphates (mg/l)	Depth of Sample (m)	pH	Chlorides (mg/l)	Sulphates (mg/l)
1	BH-01	2.50	7.58	735	545	2.0	7.51	581	504
2	BH-02	2.50	7.58	732	539	2.0	7.51	598	510

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)

Geologically, the present site is located in a coastal region with sub surface consisting of sedimentary deposits. The top sedimentary deposit is under laid by upper Gondwana system, particularly lower stage of Sriperumpudur (Shale Formation).The formation mechanism of the sediments is chiefly due to transportation of surface water and marine deposition.

The above geological characteristics are also observed in the direct bore hole investigation, which confirms that the present site does not depict any surprising geological features that are different from that of the region.

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	0.50	0.50	Filled Up Soil	-	-	-	-	-	-	-
2	0.50	2.00	1.50	Sandy Silty Clay	Brownish	6	-	Medium Stiff	15.5	40	-
3	2.00	3.00	1.00	Sandy Silty Clay	Greyish Brown	4	-	Soft	14.5	27	-
4	3.00	5.00	2.00	Silty Sand	Brownish	17	Medium Dense	-	18	-	32.1
5	5.00	6.50	1.50	Sandy Silty Clay	Brownish Grey	4	-	Soft	14.5	27	-
6	6.50	8.00	1.50	Silty Clay	Greyish Black	6	-	Medium Stiff	15.5	40	-
7	8.00	9.50	1.50	Silty Sand	Greyish Black	10	Loose	-	15	-	30
8	9.50	11.00	1.50	Silty Sand	Blackish Grey	13	Medium Dense	-	21	-	30.9
9	11.00	14.00	3.00	Silty Clay	Greyish Black	2	-	Very Soft	21	13	-
10	14.00	15.50	1.50	Silty Sand	Greyish	8	Loose	-	14.5	-	29.6
11	15.50	26.00	10.50	Silty Clay	Blackish Grey	2	-	Very Soft	14	13	-
12	26.00	28.00	2.00	Sand	Greyish	30	Medium Dense	-	21	-	36
13	28.00	28.50	0.50	Silty Sand	Greyish	43	Dense	-	20	-	39.43
14	28.50	30.00	1.50	Compacted Clay (Shale)	Greyish	>100	-	Hard	21	400	-

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	Filled Up Soil	-	-	-	-	-	-	-
2	0.50	2.00	1.50	Sandy Silty Clay	Brownish	8	-	Medium Stiff	16.5	53	-
3	2.00	4.00	2.00	Sandy Silty Clay	Brownish	7	-	Medium Stiff	16	47	-
4	4.00	5.00	1.00	Silty Sand	Brownish	2	Very Loose	-	13	-	19.91
5	5.00	6.50	1.50	Sandy Silty Clay	Brownish	3	-	Soft	14	20	-
6	6.50	8.00	1.50	Silty Clay	Blackish Grey	10	-	Stiff	17.5	67	-
7	8.00	9.50	1.50	Silty Sand	Greyish Black	10	Loose	-	15	-	30
8	9.50	10.00	0.50	Clayey Silty Sand	Greyish	2	Very Loose	-	13	-	19.91

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 stilt plus five upper floors, and is meant for residential use. For this kind of structure, the column loads could vary between 1500kN to 2500kN. 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 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

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	30.0	1.0	29.00	500	900	500	38
2					550	1000	550	41
3					600	1200	650	45
4					650	1300	700	48
5					750	1600	800	56
6					800	1750	850	60
7					900	2100	950	68

RECOMMENDATIONS

CHAPTER-5

RECOMMENDATIONS

5.1 Recommendation for Deep pile foundation system:

- If deep pile foundation system adopt, 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 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.
- 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.

5.2 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.

5.3 General Recommendation:

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

GEOTECHNICAL ENGINEERING CONSULTANTS Chennai 042

5.4 Special Recommendations

- Since, the sub soil strata are soft and very soft silty clay layer between 5.0 to 8.0m and 11.0m to 26.0m depth below ground level. The loose 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

GEO ENGINEERING CONSULTANTS Chennai 600 042

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)	30	As Per IS:2911-(P-I,S-2)-2010
Reference Bore Hole	BH-01		600	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	1	1	Cut-Off Level													
2	1	2	1.0	Clay	6	15.5	15.5	40	-	0.0	5.5	2.8	1.0	-	qf	2	75.4
3	2	3	1.0	Clay	4	14.5	15.0	27	-	5.5	10.0	7.8	1.0	-	qf	3	50.9
4	3	5	2.0	Sand	17	18.0	16.3	-	32.1	10.0	26.0	18.0	-	1.1	qf	4	47.1
6	5	8	3.0	Clay	5	15.0	16.5	33	-	26.0	41.0	33.5	1.0	-	qf	6	186.6
7	8	9.5	1.5	Sand	10	15.0	15.0	-	30.0	41.0	48.5	44.8	-	1.0	qf	7	73.1
8	9.5	11	1.5	Sand	13	16.5	15.8	-	30.9	48.5	58.3	53.4	-	1.0	qf	8	94.4
9	11	14	3.0	Clay	2	14.0	15.3	13	-	58.3	70.3	64.3	1.0	-	qf	9	73.5
10	14	15.5	1.5	Sand	8	14.5	14.3	-	29.6	70.3	77.0	73.6	-	1.0	qf	10	118.3
11	15.5	26	10.5	Clay	2	14.0	14.3	13	-	77.0	119.0	98.0	1.0	-	qf	11	257.3
12	26	28.5	2.5	Sand	40	20.0	17.0	-	38.8	119.0	144.0	131.5	-	1.4	qf	12	717.7
13	28.5	30	1.5	Clay	60	22.0	21.0	400	-	144.0	162.0	153.0	0.3	-	qf	13	294.1

Summation of Positive Skin Resitance (kN) Q_f= 1988.31

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

Computation of End Bearing Resistance

		SPT	φ	C_u	N_q	N_c			
Bearing Stratum	Clay	60	-	400	-	9	Eff.Ht.of Overburden	9	m
							Effective Overburden Pressure	53.80	kN/m²

End Bearing Resistance (kN) Q_p= 1017.88

Ultimate Load Carrying Capacity (Q_{ult})	$Q_u=Q_f-Q_f+Q_p$ (kN)	3006.18
Safe Load Carrying Capacity (Q_{safe})	$Q_u/2.5$ (kN)	1202.47
Allowable Safe Load Carrying Capacity	$Q_{A\text{-}safe}$ (kN)	1202.47
Allowable Safe Pull out Capacity	$Q_{A\text{-}pull}$: Qf/3 (kN)	662.77

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 $\pi*d^2/4*Q*N_q$

Where

Cu=Undrained Shear Strength of Clay

ϕ=Angle of Shearing Resistance

N_c=Bearing Capacity Factor = 9

K=Coef. Earth Pressure at Rest

q_l=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_l=Thickness of Layer

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

Note: The End bearing is compacted clay shale modeld as Clay with restricted to SPT-value of 60 corresponding Cu Value Taken as 400 kPa.

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)	:	0.60	m
Free standing Length of Pile (e)	:	0	m
Length of Pile below E.G.L (Le)	:	30.0	m
Cut-Off Level From E.G.L	:	1.0	
Length of Pile below Cut-Off Level (Le)	:	29.0	m
Grade of Concrete (M)	:	25	MN/m^2
Young's Modulus of Concrete (E)	:	25000000	kN/m^2
Momemnt of Inertia (I)	:	0.006362	m^4

2.0 Determination of Depth of Fixity

Type of Soil Strata	:	clay	
Ground Water Condition	:	Submerged	
Average Design SPT "N" Value	:	6	
K=((k1/1.5)*(0.3/B))			
(n can be read as η in the above and below equation in case of Sand)			
K1=	:	15000	kN/m^3
K=	:	5000	kN/m^2
R=	:	2.70	
L1/R	:	0.00	
Lf/R	:	2.20	
Depth of Fixity below Cut off (z_f)	:	5.94	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	:	45.61	kN
Recommended Design Lateral Load carrying Capacity	:	**45**	**kN**
Fixed End Moment,M_F=H(e+z_f)/2		135	
Reduction Factor (L_1/T)	:	0.67	m
Actual Moment (Fixed End Moment/Reduction Factor),M_F		**91**	kN-m

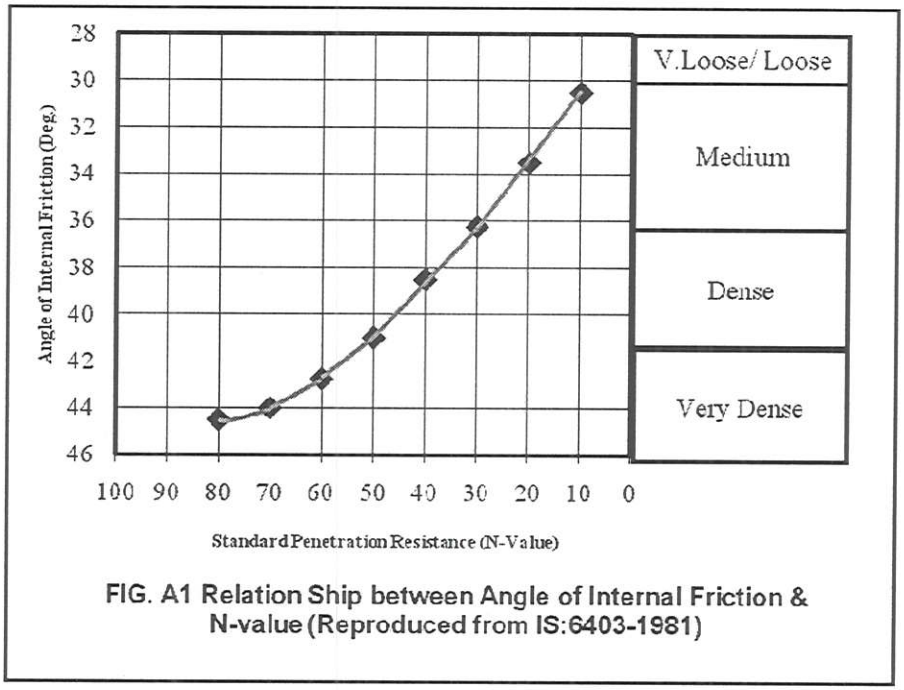


FIG. A1 Relation Ship between Angle of Internal Friction & N-value (Reproduced from IS:6403-1981)

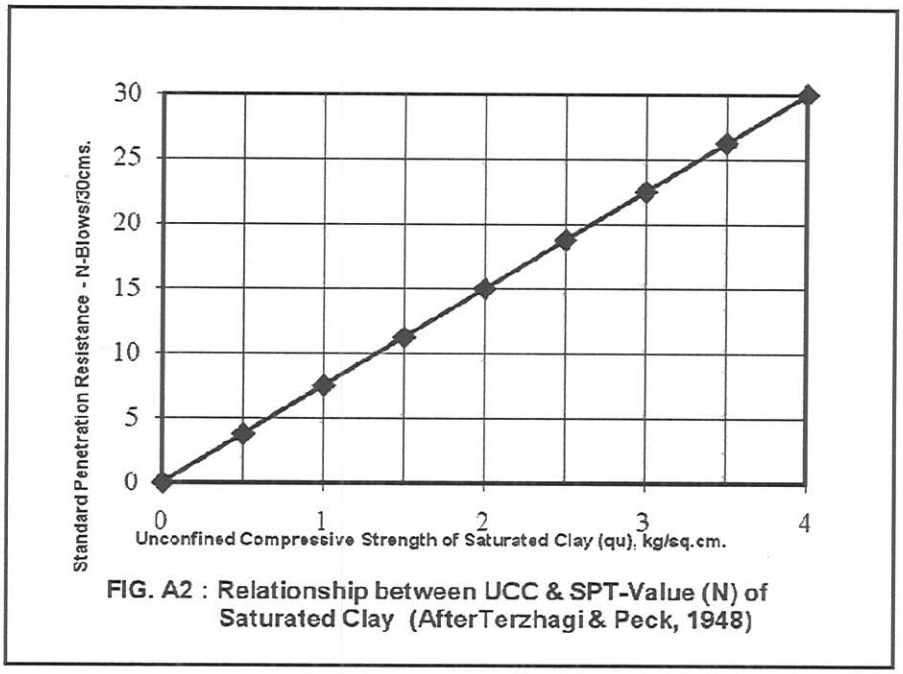


FIG. A2 : Relationship between UCC & SPT-Value (N) of Saturated Clay (AfterTerzhagi & Peck, 1948)



our services doesn't just end there

Buying & Selling Services

Property Buying Assistance, Property Selling Support, Market Price Analysis, Owner Outreach and Negotiation.

Legal & Documentation Services

Certified EC, Patta, legal opinions, property verification, due diligence, litigation solutions, and legal heir certificates.

Property Development & Approvals

Building plan approvals, construction, layout and sub-division approvals, zone conversion, and occupancy certification.

NRI & Investment Services

Escrow Services, Rentals, Litigation Solutions, Property Valuation and Property Management

Compliance & Special Services

Demolition, Vaasthu checks, regularization of unauthorized buildings, and office space solutions.



empowering your real estate decisions with smart tools

Property Valuation & Cost Estimation

Guideline Value, Apartment Composite Value, Stamp Duty & Registration Fees Calculator, Building Value Calculator, Capital Gains Calculator, Area Unit Converter, Length Unit Converter

Ownership, Compliance & Legal Verification

Encumbrance Certificate (EC) Search, Find Your SRO, Temple Property Check, WAQF Property Check, View Patta/Chitta, View FMB, Patta Analyzer, EC Analyzer

Zoning & Land Use Analysis

Land Use Zone Finder, CRZ Zone Check, Aquifer Zone Check, CBA Check, EWS Check, Road Width Check, Proposed Road Widening Check, FSI Calculator

Property Documentation & Workflow Tools

Forms & Templates, Document Generator, Document Translation, Dictionary

Vastu & Property Management Tools

Home Vastu Shastra, Plot Vastu Shastra, Property Management

Verified RealEstate™

We're honored to be part of your real estate journey

3/350/2 Mettukuppam,
OMR Thoraipakkam,
Chennai, India

hello@verified.realestate
+91 9996 12 9996
www.verified.realestate