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GEO ENGINEERING CONSULTANTS & SERVICES

(An ISO 9001:2015 Certified Company)

12B, 2nd Floor, Anbu Nagar, 3rd Street,
Alwarthirunagar, Chennai-600 087.
Ph.No. 9841226220/9444901825/9094853994.
Email: info@geoenggservices.com/geoengineeringconsultantindia@gmail.com
Web: www.geoenggservices.com

PROJECT NAME

THE PROPOSED CONSTRUCTION OF RESIDENITAL BUILDING (STILT+5 UPPER FLOORS) AT PLOT NO-237 & 238, ERODE JAGANNATHAN STREET, GOLDEN GEORGE NAGAR, COMPRISED IN SURVEY NO-420 OF MOGAPPAIR VILLAGE, CHENNAI.

CLIENT NAME

M/S.KAIZEN HOMES,
FLAT-G1, A- BLOCK, NAVARATHANA APARTMENTS,
PLOT NO-17,18,19, DHANALAKSHMI NAGAR,
MANAPAKKAM, CHENNAI-600 125.

TITLE

GEOTECHNICAL INVESTIGATION REPORT

GEO ENGINEERING CONSULTANTS & SERVICES Chennai 600 087

PROJECT NO: GECS-JC-GT-2010-2024-2025

REPORT SUBMISSION DATE:15/04/2024

CHENNAI METROPOLITAN DEVELOPMENT AUTHORITY
'ThalamuthuNatarajan Building', No.1, Gandhi Irwin Road,
Egmore, Chennai-600 008.

PROFESSIONAL REGISTRATION CERTIFICATE

This is to certify that the **Thiru M. AMMAIAPPAN** has enrolled as **Registered Geo-Technical Engineer (RGTE)** with Chennai Metropolitan Development Authority (CMDA) who has the qualification of **M.E.,(Geo Technical Engg.)** and experience in the relevant field for **07 years.**

He has been given the Registration No.**GTE/2020/08/046** on **29.08.2020.** He shall be required to comply with the duties and responsibilities prescribed by the Government of Tamil Nadu in Part-V, "Registration of Professionals", Tamil Nadu Combined Development and Building Rules, 2019 approved vide G.O.(Ms) No.18 MAWS (MA1) Dept. dated 04.02.2019.

This Registration is valid upto **28.08.2025.**



Er. M. Ammaiappan, B.E., M.E(Geo Tech), (Ph.D)
Registered Geo Technical Engineer
CMDA - Reg. No : GTE/2020/08/046
Thirumullaivoyal, Chennai - 600 062.

CHENNAI METROPOLITAN DEVELOPMENT AUTHORITY * CHENNAI-600 008 *

GEO ENGINEERING CONSULTANTS & SERVICES * Chennai 600 062

28/09/2020

(R.SHIVAKUMAR)

ASSISTANT PLANNER
METRO. PLAN DEVELOPMENT
CHENNAI - 600 008

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Chennai 600 087

CHAPTER-1

INTRODUCTION

1.0 Project Information Matrix

Nature of project	: Proposed Construction of Residential Building
Type of Structures	: Stilt+5 Upper Floors
Project Client	: **M/S.KAIZEN HOMES,**
Project location	: Plot No-237 & 238, Erode Jagannathan Street,
	: Erode Jagannathan street, Golden George Nagar, Comprised in Survey No-420 of Mogappair Village, Chennai.
Job Code	: GECS-JC-GT-2010

1.1 Scope Of Work

1.1.1 Field Work

- Conducting Two soil investigation bore holes of 150 mm& NX diameter up to 27.0m 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 4.0m and thereafter at every 1.5m up to the 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

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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.

SITE PLAN

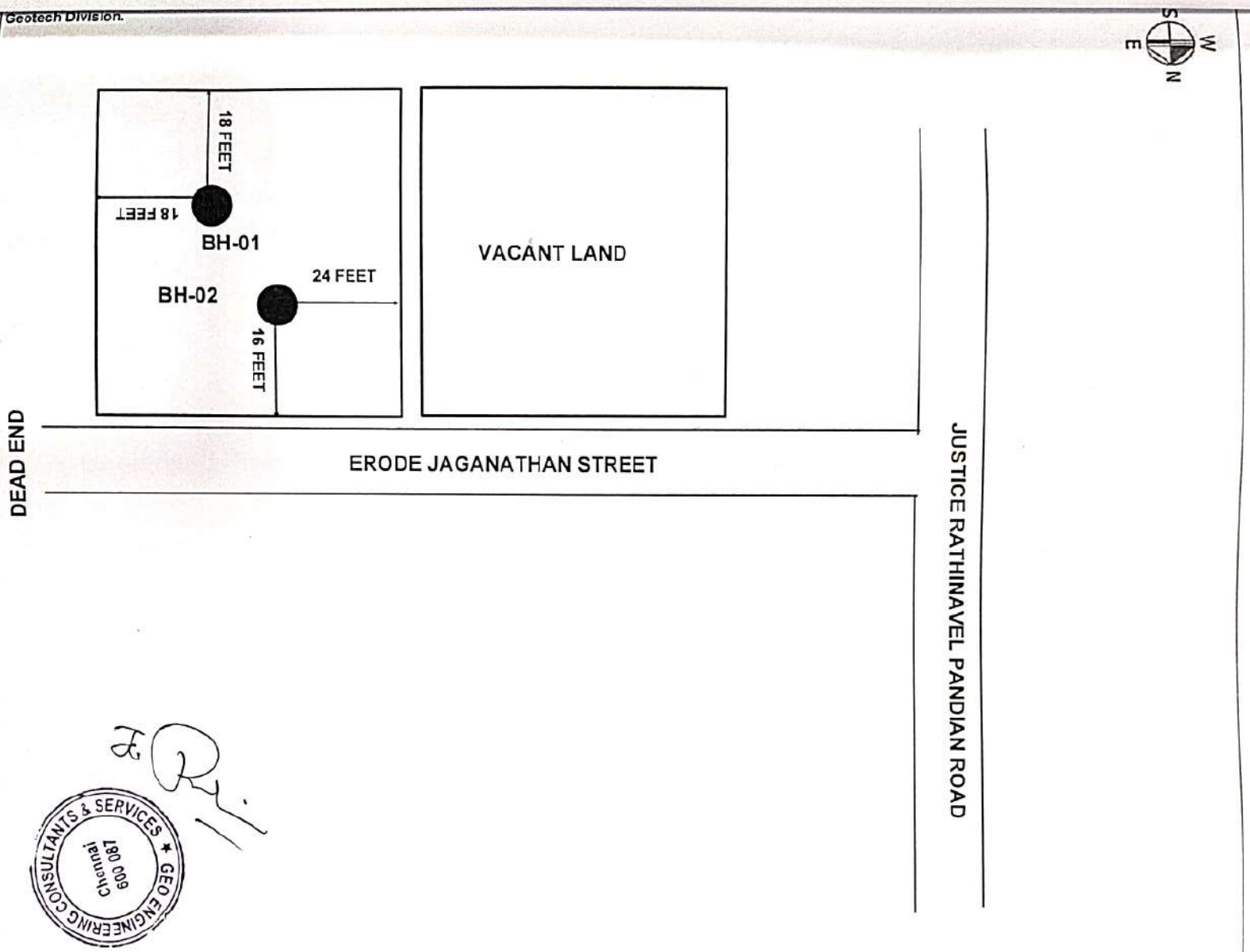


FIG-2.0 THE SITE PLAN SHOWING FIELD INVESTIGATION POINT AT PLOT NO-237 & 238, ERODE JAGANNATHAN STREET, GOLDEN GEORGE, NAGAR, MOGAPPAIR, CHENNAI.

SOIL PROFILES

SITE INVESTIGATION RECORD

BORE HOLE No.	BH-01						
SHEET	1	OF	3				
PROJECT NAME	THE PROPOSED CONSTRUCTION OF RESIDENTIAL BUILDING			DIA OF BORE HOLE	150mm	✓	
					NX		
LOCATION	Plot No-237 & 238, Erode Jagannathan Street, Golden George Nagar, Mogappair.	MACHINE No.	CR-02	CHAINAGE (m)	-	BORE START DATE	04/04/2024
STRUCTURE	Stilt+5 Upper Floors	DRILLING METHOD	Rotary	CO-ORDINATES N	-	BORE END DATE	04/04/2024
JOB CODE	GECS-JC-GT-2010	FLUSHING MEDIUM	Bentonite	CO-ORDINATES E	-	TOTAL DRILL DAYS	1

Depth below E.G.L. (m)	Drilling progress per metre: Date	Drilling progress per metre: Time Hr.	Drilling progress per metre: 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	04/04/2024	09	36															
		To																
		09	38	SC	-	-	3	3	4	7	1.00	1	SS	-1.0				Brown,Moist,Medium Stiff,**Sandy Silty CLAY (CI)** Lean Clay of Medium plasticity
											1.45							
		09	41															
		To																
2		09	43	SC	-	-	8	7	6	13	2.00	2	SS	-2.0		L1	2.0	
											2.45							Brown, Moist,Medium Dense,Poorly Graded,**Silty Sand(SM)** Sand-Silt mixtures
		09	49															
		To																
3		09	51	SC	-	-	3	4	5	9	3.00	3	SS	-3.0		L2	3.0	
		09	57								3.45							
		To																
4		09	59	SC	-	-	5	5	9	14	4.00	4	SS	-4.0				
		10	20								4.45							
		To																
5		10	23															Greyish Brown,Moist,Stiff,**Silty Clay (CH)** Silty Clays of High plasticity
				SC	-	-	3	5	5	10	5.50	5	SS	-5.5				
											5.95							
6		10	38															
		To																
		10	42															
7				SC	-	-	6	7	20	27	7.00	6	SS	-7.0		L3	7.0	
		10	52								7.45							
		To																
8		10	55															Grey, Moist,Medium Dense,Poorly Graded,Fine to Medium Grains,**Silty Sand(SM)** Sand-Silt mixtures
				SC	-	-	1	2	4	6	8.50	7	SS	-8.5		L4	8.5	
											8.95							
9		11	13															
		To																
		11	15															Greyish Black,Moist,Medium Stiff,**Silty Clay (CH)** Silty Clays of High plasticity
10				SC	-	-	2	3	3	6	10.00	8	SS	-10.0				
											10.45							

CS - Core Sample	DS - Disturbed Sample	LOGGED	Subash	PROJECT SITE DETAILS	REMARKS
SS - Split Spoon Sample	SC - Soil Cutter	DATE	04/04/2024	GROUND LEVEL (m) 0.00	
UDS- Undisturbed Sample	TCB - Tungsten Carbide Bit	CHECKED	Bhuvana	WATER TABLE (m) 2.40	
WS - Wash Sample	DB - Diamond Bit	DATE	09/04/2024	CASING DEPTH (m) 0.00	

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SITE INVESTIGATION RECORD

BORE HOLE No.	BH-01						
SHEET	2	OF	3				
PROJECT NAME	THE PROPOSED CONSTRUCTION OF RESIDENTIAL BUILDING			DIA OF BORE HOLE	150mm ✓	NX	
LOCATION	Plot No-237 & 238, Erode Jagannathan Street, Golden George Nagar, Mogappair.	MACHINE No.	CR-02	CHAINAGE (m)	-	BORE START DATE	04/04/2024
STRUCTURE	Stilt+5 Upper Floors	DRILLING METHOD	Rotary	CO-ORDINATES	N -	BORE END DATE	04/04/2024
JOB CODE	GECS-JC-GT-2010	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	15-30	30-45	SPT 'N' Value	Sample Details: Depth	No.	Type	RL (m)	Layer Data: Legend	No	Depth	Geotechnical Description
11	04/04/2024	12	07 To 12 10	SC	-	-	3	3	4	7	11.50 | 11.95	10	SS	-11.5				
12		12	29 To 12 32															Greyish Black,Moist,Medium Stiff,Silty Clay (CH) Silty Clays of High plasticity
13				SC	-	-	2	2	3	5	13.00 | 13.45	11	SS	-13.0				
14		12	43 To 12 45													L5	14.5	
15				SC	-	-	1	1	2	3	14.50 | 14.95	12	SS	-14.5				
16		13	17 To 13 20	SC	-	-	1	1	1	2	16.00 | 16.45	13	SS	-16.0				Greyish Black,Moist,Soft,Silty Clay (CH) Silty Clays of High plasticity
17		14	21 To 14 25													L6	17.5	
18				SC	-	-	6	7	11	18	17.50 | 17.95	14	SS	-17.5				
19		15	02 To 15 05	SC	-	-	10	12	25	37	19.00 | 19.45	15	SS	-19.0				Greyish Brown, Green,Moist,Very Stiff to Hard Compacted Clay (CH) Silty Clays of High plasticity
20		15	20 To 15 24														20.5	

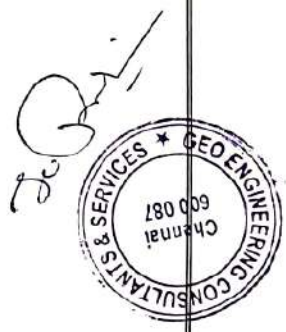
CS - Core Sample	DS - Disturbed Sample	LOGGED	Subash	PROJECT SITE DETAILS		REMARKS	
SS - Split Spoon Sample	SC - Soil Cutter	DATE	04/04/2024	GROUND LEVEL (m)	0.00		
UDS- Undisturbed Sample	TCB - Tungsten Carbide Bit	CHECKED	Bhuvana	WATER TABLE (m)	2.40		
WS - Wash Sample	DB - Diamond Bit	DATE	09/04//2024	CASING DEPTH (m)	0.00		

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SITE INVESTIGATION RECORD

BORE HOLE No.	BH-01						
SHEET	3	OF	3				
PROJECT NAME	THE PROPOSED CONSTRUCTION OF RESIDENTIAL BUILDING					DIA OF BORE HOLE	150mm ✓ / NX
LOCATION	Plot No-237 & 238, Erode Jagannathan Street, Golden George Nagar, Mogappair.	MACHINE No.	CR-02	CHAINAGE (m)	-	BORE START DATE	04/04/2024
STRUCTURE	Stilt+5 Upper Floors	DRILLING METHOD	Rotary	CO-ORDINATES	N -	BORE END DATE	04/04/2024
JOB CODE	GECS-JC-GT-2010	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
21	04/04/2024	16	04	SC	-	-	18	22	34	56	21.00	16	SS	-21.0				
		To									21.45							Greyish Brown,Moist,Very Dense,Poorly Graded,Fine to Medium Grains,**Silty Sand(SM)with Clay Binder**, Sand-Silt mixtures
22		16	10															
23				SC	-	-	21	27	38	65	23.00	17	SS	-23.0		L6	23.0	
											23.45					L7	23.5	Brownish Greyish Yellow,Moist,Very Hard **Compacted Clay (CH)(Shale)** Silty Clays of High plasticity
24																		
25																		
26																		
27																		
28																		
29																		
30																		



CS - Core Sample	DS - Disturbed Sample	LOGGED	Subash	PROJECT SITE DETAILS	REMARKS
SS - Split Spoon Sample	SC - Soil Cutter	DATE	04/04/2024	GROUND LEVEL (m) 0.00	
UDS- Undisturbed Sample	TCB - Tungsten Carbide Bit	CHECKED	Bhuvana	WATER TABLE (m) 2.40	
WS - Wash Sample	DB - Diamond Bit	DATE	09/04//2024	CASING DEPTH (m) 0.00	

Borehole terminated at 23 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	3				
DIA OF BORE HOLE	150mm ✓	NX					
PROJECT NAME	THE PROPOSED CONSTRUCTION OF RESIDENTIAL BUILDING						
LOCATION	Plot No-237 & 238, Erode Jagannathan Street, Golden George Nagar, Mogappair.	MACHINE No.	CR-02	CHAINAGE (m)	-	BORE START DATE	07/04/2024
STRUCTURE	Stilt+5 Upper Floors	DRILLING METHOD	Rotary	CO-ORDINATES	N -	BORE END DATE	08/04/2024
JOB CODE	GECS-JC-GT-2010	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
1	07/04/2024	11	04	SC	-	-	8	8	9	17	1.00	1	SS	-1.0				
		To									1.45							
		11	07															
		11	17															
2		To		SC	-	-	4	4	7	11	2.00	2	SS	-2.0				Brown,Moist,Very Stiff to Stiff,Sandy Silty CLAY (Cl) Lean Clay of Medium plasticity
		11	19								2.45							
		11	29															
3		To		SC	-	-	5	5	6	11	3.00	3	SS	-3.0		L1	3.0	
		11	31								3.45							
		11	38															
4		To		SC	-	-	6	8	12	20	4.00	4	SS	-4.0				Greyish Brown,Moist,Soft,Silty Clay (CH) Silty Clays of High plasticity
		11	41								4.45							
		11	53															
5		To																
		11	57	SC	-	-	7	10	11	21	5.50	5	SS	-5.5		L2	5.5	
											5.95							
6		12	10															Grey, Moist,Medium Dense,Poorly Graded,Fine to Medium Grains,Silty Sand(SM) Sand-Silt mixtures
		To																
		12	13															
7				SC	-	-	2	2	3	5	7.00	6	SS	-7.0		L3	7.0	
											7.45							
		12	31															
8		To																
		12	34															
				SC	-	-	4	4	5	9	8.50	7	SS	-8.5				Grey,Moist,Medium Stiff to Stiff,Silty Clay (CH) Silty Clays of High plasticity
9											8.95							
		12	53															
		To																
		12	58															
10				SC	-	-	6	7	9	16	10.00	8	SS	-10.0		L4	10.0	
											10.45							
																	10.5	Grey,Moist,Medium Dense,Poorly Graded,Fine to Medium Grains,Silty Sand(SM) Sand-Silt mixtures

CS - Core Sample	DS - Disturbed Sample	LOGGED	Subash	PROJECT SITE DETAILS		REMARKS
SS - Split Spoon Sample	SC - Soil Cutter	DATE	07/04/2024	GROUND LEVEL (m)	0.00	
UDS- Undisturbed Sample	TCB - Tungsten Carbide Bit	CHECKED	Bhuvana	WATER TABLE (m)	2.40	
WS - Wash Sample	DB - Diamond Bit	DATE	11/04//2024	CASING DEPTH (m)	0.00	

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SITE INVESTIGATION RECORD

BORE HOLE No.	BH-02						
SHEET	2	OF	3				
PROJECT NAME	THE PROPOSED CONSTRUCTION OF RESIDENTIAL BUILDING					DIA OF BORE HOLE	150mm ✓ / NX
LOCATION	Plot No-237 & 238, Erode Jagannathan Street, Golden George Nagar, Nogappair.	MACHINE No.	CR-02	CHAINAGE (m)	-	BORE START DATE	07/04/2024
STRUCTURE	Stilt+5 Upper Floors	DRILLING METHOD	Rotary	CO-ORDINATES	N -	BORE END DATE	08/04/2024
JOB CODE	GECS-JC-GT-2010	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	15-30	30-45	SPT 'N' Value	Sample Details: Depth	No.	Type	RL (m)	Layer Data: Legend	No	Depth	Geotechnical Description
11	07/04/2024	14	50 To 14 55	SC	-	-	3	5	8	13	11.50 / 11.95	10	SS	-11.5		L5	11.5	Grey,Moist,Medium Dense,Poorly Graded,Fine to Medium Grains,Silty Sand(SM) Sand-Silt mixtures
12		15	14 To 15 17															
13		15	42 To 15 46	SC	-	-	2	2	4	6	13.00 / 13.45	11	SS	-13.0				
14				SC	-	-	2	4	7	11	14.50 / 14.95	12	SS	-14.5				Greyish Black,Moist,Medium Stiff to Stiff,Silty Clay (CH) Silty Clays of High plasticity
15		16	33 To 16 38															
16		07	30 To 07 34	SC	-	-	2	3	7	10	16.00 / 16.45	13	SS	-16.0				
17				SC	-	-	6	7	8	15	17.50 / 17.95	14	SS	-17.5		L6	17.5	
18	08/04/2024	08	12 To 08 15															
19		09	05 To 09 10	SC	-	-	6	7	9	16	19.00 / 19.45	15	SS	-19.0				Greyish Brown, Green,,Moist,Stiff,Compacted Clay(CH) Silty Clays of High plasticity
20																L7	20.5	

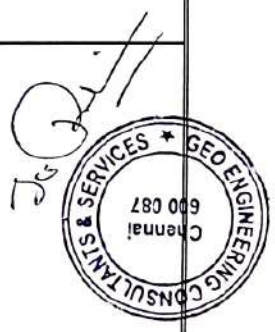
CS - Core Sample	DS - Disturbed Sample	LOGGED	Subash	PROJECT SITE DETAILS		REMARKS
SS - Split Spoon Sample	SC - Soil Cutter	DATE	07/04/2024	GROUND LEVEL (m)	0.00	
UDS- Undisturbed Sample	TCB - Tungsten Carbide Bit	CHECKED	Bhuvana	WATER TABLE (m)	2.40	
WS - Wash Sample	DB - Diamond Bit	DATE	11/04/2024	CASING DEPTH (m)	0.00	

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SITE INVESTIGATION RECORD

PROJECT NAME	THE PROPOSED CONSTRUCTION OF RESIDENTIAL BUILDING					BORE HOLE No	BH-02
						SHEET	3 OF 3
						DIA OF BORE HOLE	150mm ✓ / NX
LOCATION	Plot No-237 & 238, Erode Jagannathan Street, Golden George Nagar, Mogappair.	MACHINE No.	CR-02	CHAINAGE (m)	-	BORE START DATE	07/04/2024
STRUCTURE	Stilt+5 Upper Floors	DRILLING METHOD	Rotary	CO-ORDINATES	N -	BORE END DATE	08/04/2024
JOB CODE	GECS-JC-GT-2010	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	15-30	30-45	SPT 'N' Value	Sample Details: Depth	No.	Type	RL (m)	Layer Data: Legend	No	Depth	Geotechnical Description
21				SC	-	-	21	25	38	63	21.00	16	SS	-21.0				Greyish Brown,Moist,Very Dense,Poorly Graded,Fine to Medium Coarse, Grains,Silty Sand(SM) with Gravel mixture, Sand-Silt mixtures
											21.45							
22		09	48															
		To																
		09	52															
23				SC	-	-	15	21	34	55	23.00	17	SS	-23.0		L8	23.0	
											23.45							Brownish Greyish Yellow,Moist,Very Hard,Compacted Clay(Shale) Silty Clays of High plasticity
24	08/04/2024	10	30						11CM Penet. For 50 Blows									
		To																
		10	35															
25				SC	-	-	24	45		>100	25.00	18	SS	-25.0		L9	25.0	
											25.41							
26		11	00															Greenish Grey,Moist,Very Hard,Fine Grains,Feebly,Fissile Structures,SHALE (Sedimenatry Orgin)
		To																
		11	15															
27				SC	-	-	9CM Penet. For 50 Blows			>100	27.00	19	SS	-27.0		L10	27.5	
											27.09							
28																		
29																		
30																		



CS - Core Sample	DS - Disturbed Sample	LOGGED	Subash	PROJECT SITE DETAILS		REMARKS
SS - Split Spoon Sample	SC - Soil Cutter	DATE	07/04/2024	GROUND LEVEL (m)	0.00	
UDS- Undisturbed Sample	TCB - Tungsten Carbide Bit	CHECKED	Bhuvana	WATER TABLE (m)	2.40	
WS - Wash Sample	DB - Diamond Bit	DATE	11/04/2024	CASING DEPTH (m)	0.00	

Borehole terminated at 27 m depth below E.G.L

FIG.2.2 Sub Soil Profile at BH-02 Location

GRAIN SIZE DISTRIBUTION CURVE

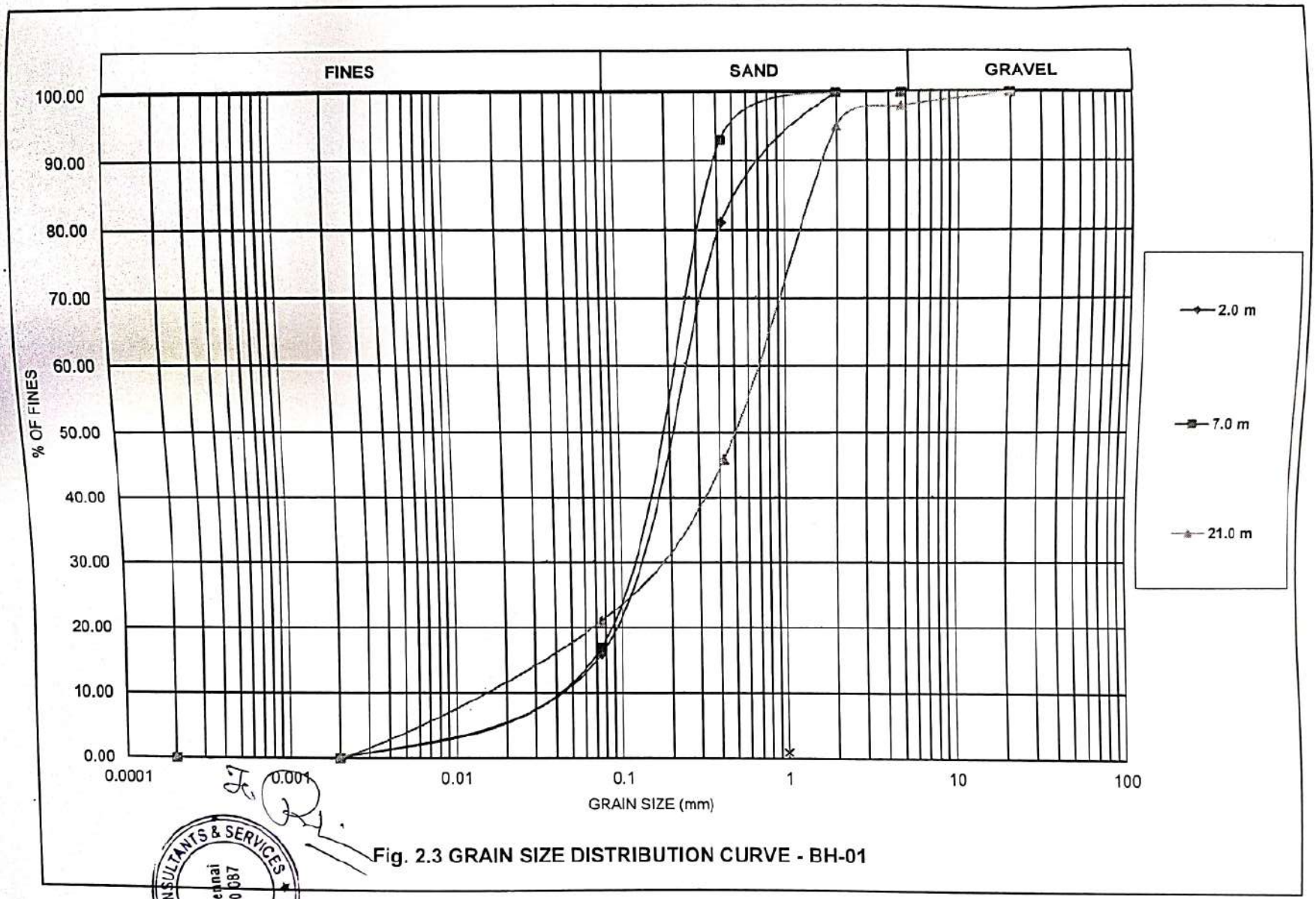


Fig. 2.3 GRAIN SIZE DISTRIBUTION CURVE - BH-01

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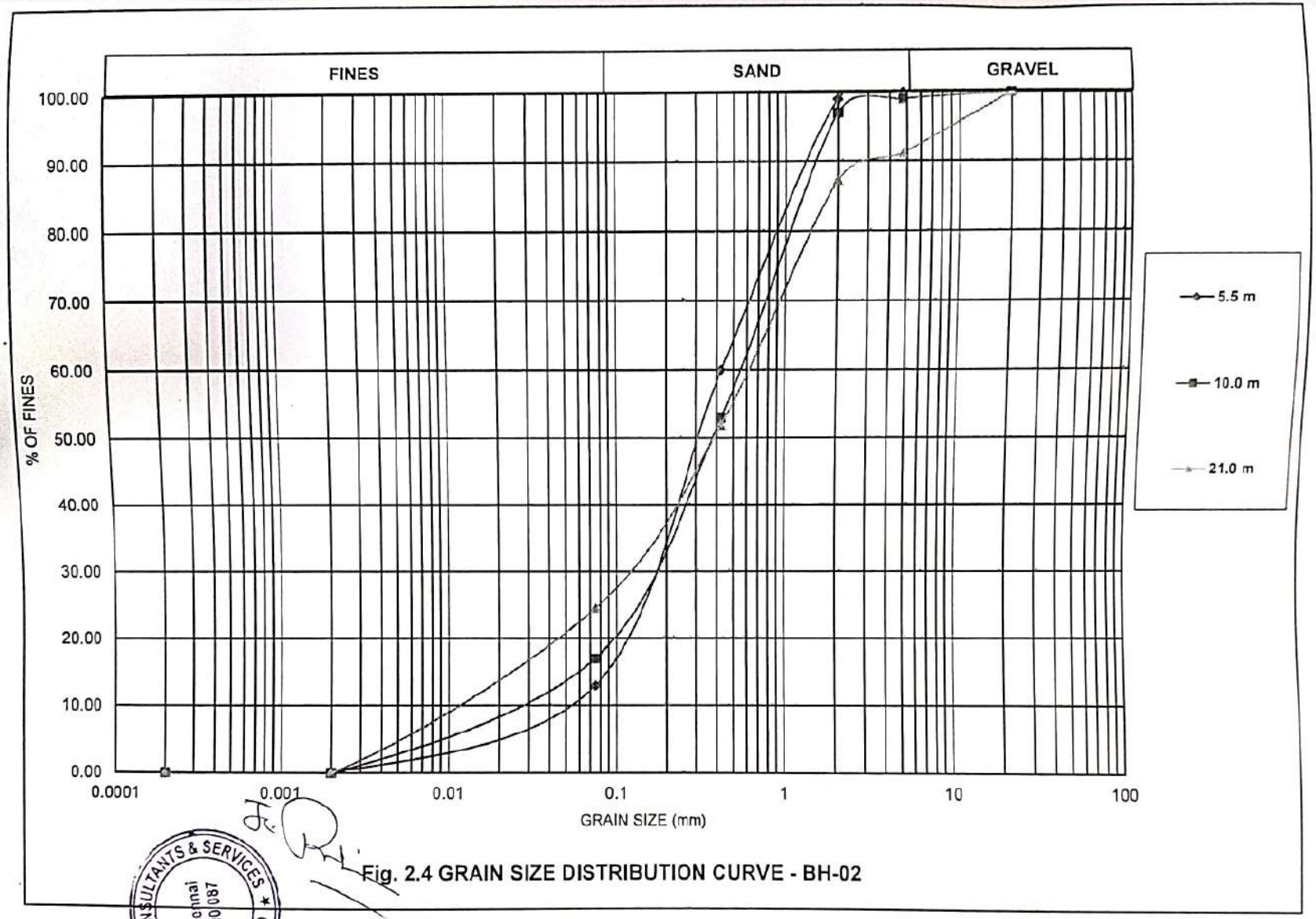


Fig. 2.4 GRAIN SIZE DISTRIBUTION CURVE - BH-02

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HYDROMETER ANALYSIS CURVE

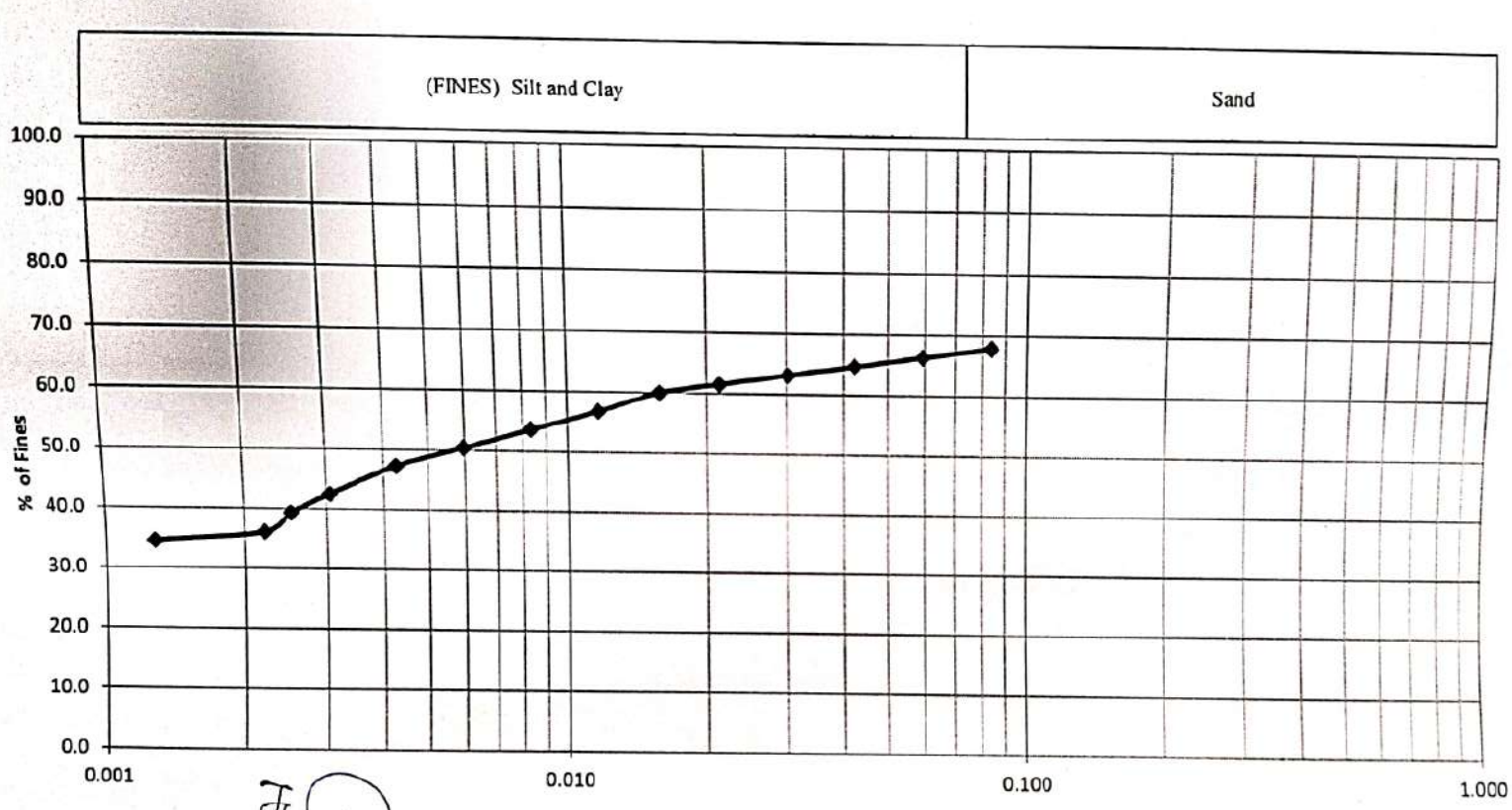


Fig 2.5 Hydrometer Analysis Master Curve

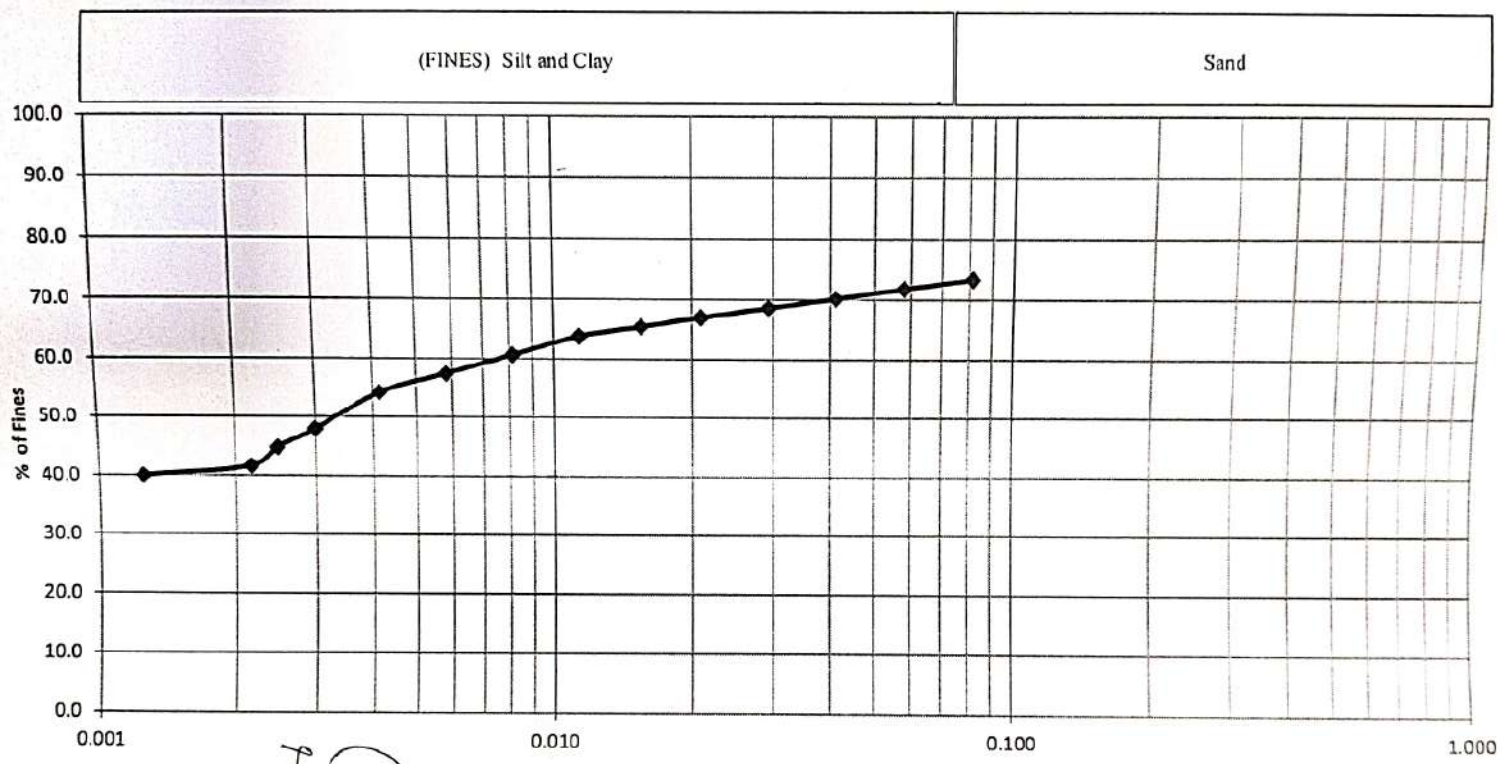


Fig 2.6 Hydrometer Analysis Master Curve

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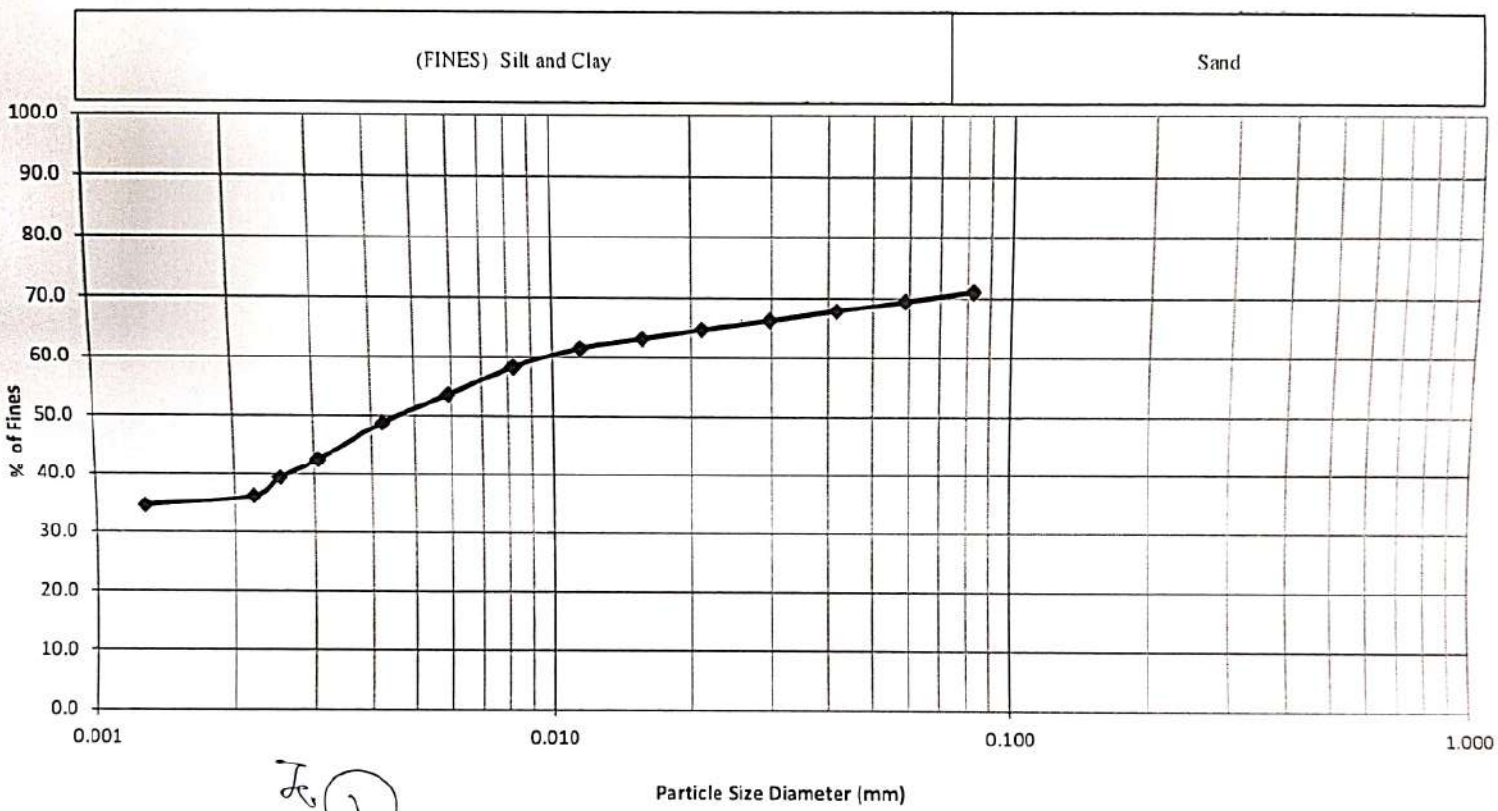


Fig 2.7 Hydrometer Analysis Master Curve

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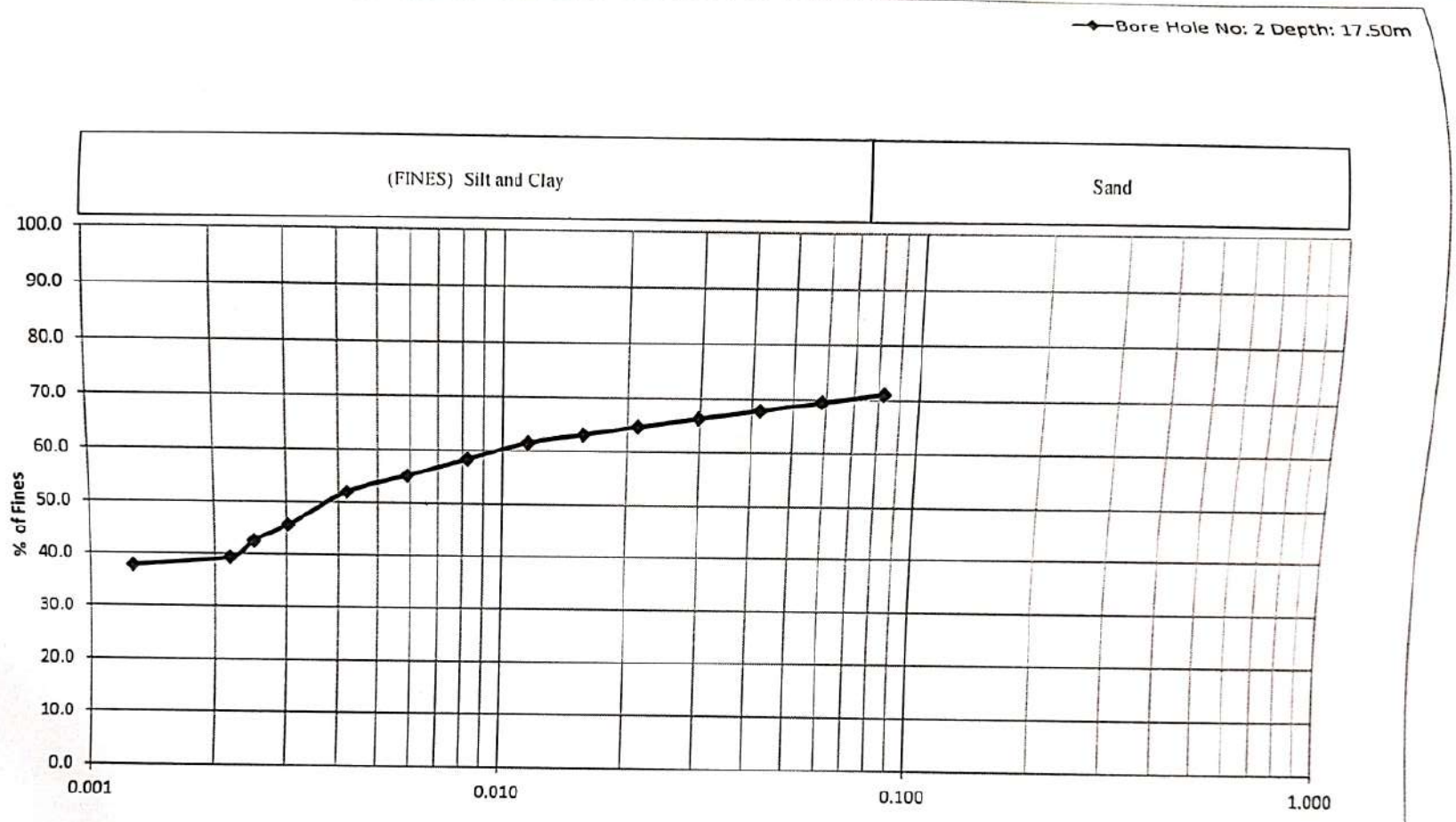


Fig 2.8 Hydrometer Analysis Master Curve

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LABORATORY TEST RESULTS

Table-2.1 Laboratory Classification of Soil Samples from BH-01

Depth of Sample below E.G.L. (m)	SPT-Value	Type of Sample	Sub Soil Classification																									
			Fine Grained (FG)										Coarse Grained (CG)												IS-Notation		
			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)	$C_U=D_{60}/D_{10}$	$C_c=D_{30}^2/(D_{10}\times D_{60})$	Relative Density	Gravel	Sand
1.0	7	SS	32	48	25	23	0.70	13	55	M.Stiff	Above	CI	-	-	-	-	70	30	-	-	-	-	-	FG>50%	FG>50%	FG>50%
2.0	13	SS	-	-	-	-	-	-	-	-	-	-	0	0	19	65	16	0	-	-	-	-	-	M.Dense	<50%	SM
3.0	9	SS	30	52	24	28	0.79	11	45	Stiff	Above	CH	-	-	-	-	66	34	-	-	-	-	-	FG>50%	FG>50%	FG>50%
4.0	14	SS	28	57	23	34	0.85	12	58	Stiff	Above	CH	-	-	-	-	64	36	-	-	-	-	-	FG>50%	FG>50%	FG>50%
5.5	10	SS	32	59	25	34	0.79	13	42	Stiff	Above	CH	-	-	-	-	62	38	-	-	-	-	-	FG>50%	FG>50%	FG>50%
7.0	27	SS	-	-	-	-	-	-	-	CG>50%	-	-	0	0	7	76	17	0	-	-	-	-	-	M.Dense	<50%	SM
8.5	6	SS	35	55	25	30	0.67	12	60	M.Stiff	Above	CH	-	-	-	-	64	36	-	-	-	-	-	FG>50%	FG>50%	FG>50%
10.0	6	SS	44	66	27	39	0.56	10	71	M.Stiff	Above	CH	-	-	-	-	62	38	-	-	-	-	-	FG>50%	FG>50%	FG>50%
11.5	7	SS	55	67	28	39	0.31	11	42	False	Above	CH	-	-	-	-	64	36	-	-	-	-	-	FG>50%	FG>50%	FG>50%
13.0	5	SS	45	72	27	45	0.60	12	60	M.Stiff	Above	CH	-	-	-	-	65	35	-	-	-	-	-	FG>50%	FG>50%	FG>50%
14.5	3	SS	52	65	26	39	0.33	11	67	Soft	Above	CH	-	-	-	-	63	37	-	-	-	-	-	FG>50%	FG>50%	FG>50%
16.0	2	SS	60	64	28	36	0.11	11	58	Very Soft	Above	CH	-	-	-	-	58	42	-	-	-	-	-	FG>50%	FG>50%	FG>50%
17.5	18	SS	24	59	27	32	1.09	12	60	V.Stiff	Above	CH	-	-	-	-	61	39	-	-	-	-	-	FG>50%	FG>50%	FG>50%
19.0	37	SS	21	61	26	35	1.14	12	75	Hard	Above	CH	-	-	-	-	60	40	-	-	-	-	-	FG>50%	FG>50%	FG>50%
21.0	56	SS	Clay Binder							CG>50%	Above	-	2	3	49	25	21	0	-	-	-	-	-	V.Dense	<50%	SM
23.0	65	SS	21	58	26	32	1.16	14	48	Hard	Above	CH	-	-	-	-	64	36	-	-	-	-	-	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 Free Swell Index
C_U = Uniformity Coefficient
C_C = Coefficient of Curvature
IP=LL-PL

LAB IN-CHARGE	R.BHUVANA
REVIEWED BY	GEOTECH TEAM

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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	
			N.M.C(%)	L.L (%)	P.L (%)	I_p	I_c	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	Gravel	Sand
1.0	17	SS	21	50	26	24	1.21	13	45	V.Stiff	Above	CI	-	-	-	-	69	31	-	-	-	-	-	FG>50%	FG>50%	FG>50%
2.0	11	SS	28	48	25	23	0.87	14	42	Stiff	Above	CI	-	-	-	-	68	32	-	-	-	-	-	FG>50%	FG>50%	SM
3.0	11	SS	32	52	27	25	0.80	11	55	Stiff	Above	CH	-	-	-	-	64	36	-	-	-	-	-	FG>50%	FG>50%	FG>50%
4.0	20	SS	21	56	26	30	1.17	12	61	V.Stiff	Above	CH	-	-	-	-	66	34	-	-	-	-	-	FG>50%	FG>50%	FG>50%
5.5	21	SS	-	-	-	-	-	-	-	CG>50%	-	-	0	1	39	47	13	0	-	-	-	-	-	M.Dense	<50%	SM
7.0	5	SS	36	61	26	35	0.71	11	72	M.Stiff	Above	CH	-	-	-	-	64	36	-	-	-	-	-	FG>50%	FG>50%	FG>50%
8.5	9	SS	29	55	25	30	0.87	12	60	Stiff	Above	CH	-	-	-	-	62	38	-	-	-	-	-	FG>50%	FG>50%	FG>50%
10.0	16	SS	-	-	-	-	-	-	-	CG>50%	-	-	1	2	44	36	17	0	-	-	-	-	-	M.Dense	<50%	SM
11.5	13	SS	30	64	26	38	0.89	10	82	Stiff	Above	CH	-	-	-	-	64	36	-	-	-	-	-	FG>50%	FG>50%	FG>50%
13.0	6	SS	39	61	28	33	0.67	11	41	M.Stiff	Above	CH	-	-	-	-	60	40	-	-	-	-	-	FG>50%	FG>50%	FG>50%
14.5	11	SS	28	66	27	39	0.97	10	82	Stiff	Above	CH	-	-	-	-	63	37	-	-	-	-	-	FG>50%	FG>50%	FG>50%
16.0	10	SS	34	57	28	29	0.79	11	41	Stiff	Above	CH	-	-	-	-	58	42	-	-	-	-	-	FG>50%	FG>50%	FG>50%
17.5	15	SS	32	59	27	32	0.84	12	60	Stiff	Above	CH	-	-	-	-	61	39	-	-	-	-	-	FG>50%	FG>50%	FG>50%
19.0	16	SS	24	55	26	29	1.07	13	53	V.Stiff	Above	CH	-	-	-	-	60	40	-	-	-	-	-	FG>50%	FG>50%	FG>50%
21.0	63	SS	Clay Binder							CG>50%	Above	-	9	4	36	28	25	0	-	-	-	-	-	V.Dense	<50%	SM
23.0	55	SS	24	52	26	26	1.08	13	53	Hard	Above	CH	-	-	-	-	65	35	-	-	-	-	-	FG>50%	FG>50%	FG>50%
25.0	>100	SS	20	46	24	22	1.18	13	38	Hard	Above	CI	-	-	-	-	68	32	-	-	-	-	-	FG>50%	FG>50%	FG>50%
27.0	>100	SS	19	44	23	21	1.19	14	41	Hard	Above	CI	-	-	-	-	69	31	-	-	-	-	-	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
I_c = (LL-NMC)/Ip
I_s = Shrinkage Limit
FS = Differential Free Swell Index
C_U = Uniformity Coefficient
C_C = Coefficient of Curvature
IP=LL-PL

LAB IN-CHARGE	R.BHUVANA
REVIEWED BY	GEOTECH TEAM

GEO ENGINEERING CONSULTANTS & SERVICES Chennai 600 086

Table-2.3 Results of Chemical Analysis									
		Water				Soil(2:1)			
SL No.	Bore HoleNo.	Depth of Sample (m)	pH	Chlorides (ppm)	Sulphates (ppm)	Depth of Sample (m)	pH	Chlorides (ppm)	Sulphates (ppm)
1	BH-01	2.4	7.21	262	343	3.0	7.16	224	316



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:

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REFERENCE BORE HOLE-BH:					1.0	Ref R.L. of G.L. (m):			0.00		
Layer No.	Layer Thk. (m)			Type of Strata	Colour	Ave. Design SPT	Relative Density	Consistency	* (γ) kN/m³	Shear Parameters	
	Top. R.L.	Bot. R.L.	Thickness							* (C_u) kPa	* (ϕ) Deg.
1	0.00	2.00	2.00	Sandy Silty Clay	Brown	7	-	Medium Stiff	16	47	-
2	2.00	3.00	1.00	Silty Sand	Brown	13	Medium Dense	-	16.5	-	30.9
3	3.00	7.00	4.00	Silty Clay	Greyish Brown	11	-	Stiff	18	73	-
4	7.00	8.50	1.50	Silty Sand	Grey	27	Medium Dense	-	19	-	35.1
5	8.50	14.50	6.00	Silty Clay	Greyish Black	6	-	Medium Stiff	15.5	40	-
6	14.50	17.50	3.00	Silty Clay	Greyish Black	3	-	Soft	14	20	-
7	17.50	20.50	3.00	Silty Clay	Greyish Brown, Green	28	-	Very Stiff	20.5	187	-
8	20.50	23.00	2.50	Silty Sand with Clay Binder	Greyish Brown	56	Very Dense	-	20.5	-	41.9
	23.00	23.50	0.50	Compacted Clay	Brownish Grey, Yellow	65	-	Hard	21	400	-

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

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REFERENCE BORE HOLE-BH:					2.0	Ref R.L. of G.L. (m):			0.00		
Layer No.	Layer Thk. (m)			Type of Strata	Colour	Ave. Design SPT	Relative Density	Consistency	* (γ) kN/m³	Shear Parameters	
	Top. R.L.	Bot. R.L.	Thickness							* (C_u) kPa	* (ϕ) Deg.
1	0.00	3.00	3.00	Sandy Silty Clay	Brown	14	-	Stiff	19.5	93	-
2	3.00	5.50	2.50	Silty Clay	Greyish Brown	16	-	Very Stiff	20	107	-
3	5.50	7.00	1.50	Silty Sand	Grey	21	Medium Dense	-	18.5	-	33.3
4	7.00	10.00	3.00	Silty Clay	Grey	7	-	Medium Stiff	16	47	-
5	10.00	11.50	1.50	Silty Sand	Grey	16	Medium Dense	-	18	-	31.8
6	11.50	17.50	6.00	Silty Clay	Greyish Black	10	-	Stiff	17.5	67	-
7	17.50	20.50	3.00	Compacted Clay	Greyish Brown	16	-	Very Stiff	18	107	-
8	20.50	23.00	2.50	Silty Sand with Gravel Mixture	Greyish Brown	63	Very Dense	-	21	-	42.5
9	23.00	25.00	2.00	Compacted Clay	Brownish Grey, Yellow	55	-	Hard	20.5	367	-
10	25.00	27.00	2.00	Shale	Greenish Grey	>100	-	Hard	22	400	-

❖ 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 stilt+5 upper floors, and is meant for residential building occupancy. For this kind of structure, the column loads could vary between 2000kN to 3000 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 Sub Soil Stratification:

In the present location the sub soil strata consist of the following:

0.0m to 2.0m	: Stiff Sandy Silty Clay
2.0m to 3.0m	:Medium Dense Silty Sand/Stiff silty Clay
3.0mto 5.50m	:Stiff silty Clay
5.50m to 8.50m	:Medium Dense silty Sand
8.50m to 10.0m	:Stiff silty Clay
10.0m to 11.50m	:Medium Silty Sand
11.50m to 17.50m	Soft to Medium Stiff Silty Clay
17.50m to 20.50m	:Stiff silty Clay
20.50m to 23.0m	:Very Dense Silty Sand with Clay Binder with gravel mixture
23.0m to 25.0m	:Very Hard Compacted Clay(Shale)
25.0m to 27.00m	:Very Hard Shale

During the time of investigation (1st Week of April-2024) the ground water table observed at 2.4m below existing ground level.

4.3 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	27.0	1.0	26.00	500	1000	700	40
2					550	1100	750	45
3					600	1200	800	50
4					650	1400	850	55
5					750	1600	900	60
6					800	1800	1000	65
7					900	2000	1100	75



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 suitable 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 should be prepared using sodium bentonite with a density of range 1.03 g/cc to 1.10 g/cc. However, while flushing before concreting the density should not be more than 1.12 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 foundation.

5.3 Special Recommendation

- During drilling operations, water loss was experienced at 21.0m to 23.0m and this aspect shall be considered by the piling execution agency and necessary precautionary measures shall be planned for the successful installation of piles.

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FOR GEO ENGINEERING CONSULTANTS & SERVICES., CHENNAI.

K. RAMALINGAM *(M.Sc., M. Phil (Geologist) BE (CIVIL)*

Geotechnical Engineers

K. RAMALINGAM
M.Sc., M.Phil.(Geologist), BE (Civil),
Sr. Geotechnical Engineer
Geo Engineering Consultants & Services
No.12B, Anbu Nagar, 3rd Street, Aiwarthiru Nagar, Chennai-600087.
Ph: 9841226220 / 9444901825.
info@geoengsservices.com

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)	27	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	Corrected Ave. SPT	(γ) kN/m³ of Layer	(γ) kN/m³ Ave. upto Layer	Shear Parameters (C_u) kPa	Shear Parameters (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	7	16.0	16.0	47	-	0.0	6.0	3.0	0.9	-	qf	2	79.7
3	2	3	1.0	Sand	10	15.0	15.5	-	30.0	6.0	11.0	8.5	-	1.0	qf	3	9.3
4	3	7	4.0	Clay	10	17.5	16.3	67	-	11.0	41.0	26.0	0.7	-	qf	4	368.8
5	7	8.5	1.5	Sand	20	18.0	17.8	-	33.0	41.0	53.0	47.0	-	1.2	qf	5	99.4
6	8.5	14.5	6.0	Clay	6	15.5	16.8	40	-	53.0	86.0	69.5	1.0	-	qf	6	452.4
7	14.5	17.5	3.0	Clay	2	14.0	14.8	13	-	86.0	98.0	92.0	1.0	-	qf	7	73.5
8	17.5	20.5	3.0	Clay	25	20.5	17.3	167	-	98.0	129.5	113.8	0.3	-	qf	8	283.3
9	20.5	23	2.5	Sand	50	20.5	20.5	-	41.0	129.5	155.8	142.6	-	1.5	qf	9	876.4
10	23	27	4.0	Clay	50	21.0	20.8	333	-	155.8	199.8	177.8	0.3	-	qf	10	652.8

Summation of Positive Skin Resitance (kN) Q_f= 2895.58

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

Computation of End Bearing Resistance

		SPT	ϕ	C_u	N_q	N_c			
Bearing Stratum	Clay	50	-	300	-	9	Eff.Ht.of Overburden	9	m
							Effective Overburden Pressure	61.59	kN/m²

End Bearing Resistance (kN) Q_p= 763.41

Ultimate Load Carrying Capacity (Q_{ult})	$Q_u=Q_f+Q_p$ (kN)	3658.99
Safe Load Carrying Capacity (Q_{safe})	$Q_u/2.5$ (kN)	1463.60
Allowable Safe Load Carrying Capacity	$Q_{A\text{-}safe}$ (kN)	1463.60
Allowable Safe Pull out Capacity	$Q_{A\text{-}pull}$: Qf/3 (kN)	965.19

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

Skin Resistance in Sand Layer is $\pi*d*T_i*q_i*K*\tan(\phi)$

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

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

Where

Cu=Undrained Shear Strength of Clay

ϕ=Angle of Shearing Resistance

N_c=Bearing Capacity Factor, Ref. Fig.1 of IS: Code Referred above

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

K=Coef. Earth Pressure at Rest

q_i=Effecitve Overburden Pressure at middle of Layer

N_q=Bearing Capacity Factor, Ref. Fig.1 of IS: Code Referred above

d=Dia. Of Pile

α=Adhesion Factor

T_i=Thickness of Layer

Note: The End being is Very Hard Compacted Clay Shale modeld as Clay with restricted to SPT-value of 50 corresponding Cu=400

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LATERAL LOAD CARRYING CAPACITY OF BORED CAST- SITU PILES

Reference Bore Hole : BH-01

1 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)	:	27.0	m
Cut-Off Level From E.G.L	:	1.0	
Length of Pile below Cut-Off Level (Le)	:	26.0	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 Determination of Depth of Fixity

Type of Soil Strata	:	Clay	
Ground Water Condition	:	Submerged	
Average Design Corrected SPT "N" Value	:	7	
K=((k1/1.5)*(0.3/B))			
(n can be read as η in the above and below equation in case of Sand)			
K1=	:	18000	kN/m^3
K=	:	6000	kN/m^2
R=	:	2.58	
L1/R	:	0.00	
Lf/R	:	2.20	
Depth of Fixity below Cut off (z_f)	:	5.67	m

3 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	:	52.30	kN
Recommended Design Lateral Load carrying Capacity	:	**52**	**kN**
Fixed End Moment,M_F=H(e+z_f)/2		148	
Reduction Factor (L_1/T)	:	0.67	m
Actual Moment (Fixed End Moment/Reduction Factor),M_F		**99**	kN-m

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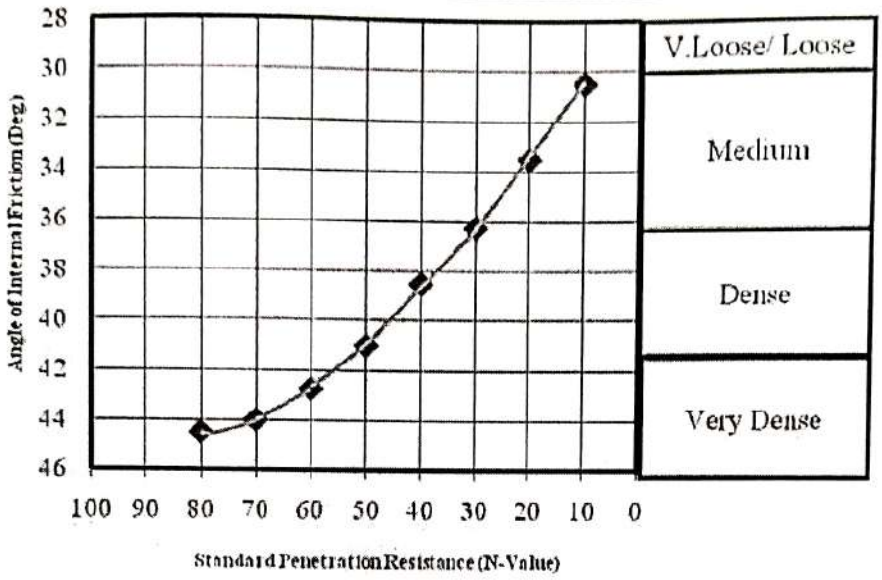


FIG. A1 Relation Ship between Angle of Internal Friction & N-value (Reproduced from IS:6403-1981)

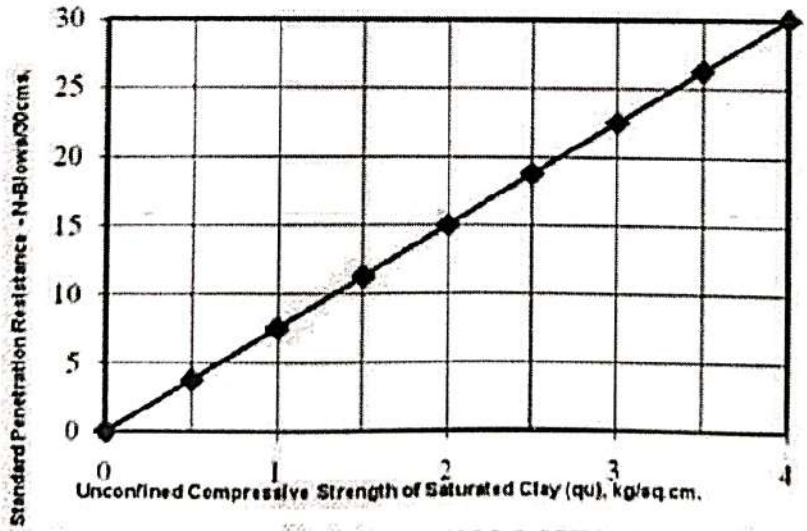


FIG. A2 : Relationship between UCC & SPT-Value (N) of Saturated Clay (After Terzhagi & Peck, 1948)

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3/350/2 Mettukuppam,
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Chennai, India

hello@verified.realestate
+91 9996 12 9996
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