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PROJECT

PROPOSED CONSTRUCTION OF RESIDENTIAL VILLAS CONSISTING OF (GROUND + 2 UPPER FLOORS) AT VILINJIYAMBAKKAM VILLAGE COMPRISED IN SURVEY NO. OLD SURVEY NO.: 35/1,2,4, 44/1 PART,2, 45/1,2PART, 47/1, WARD G, BLOCK 21, T.S.NO.: 7/14, 7/16(P), 9/1(P) OF VILINJIYAMBAKKAM VILLAGE, AVADI, CHENNAI-600054, AVADI TALUK, THIRUVALLUR DISTRICT

AS PER DOCUMENT (3.27 ACRES)

CLIENT

V.G.N HOMES PRIVATE LIMITED,
NO. 333, POONAMALLEE HIGH ROAD,
AMAINDAKARAI, CHENNAI – 600 029.

TITLE

GEOTECHNICAL INVESTIGATION REPORT

REPORT NO.: GT- 2242

DATE	REVISON	DESCRIPTION		AUTHORISED SIGNATORY
10/07/2021	FIRST SUBMISSION	SUBMISSION OF FINAL GEOTECHNICAL REPORT	SIGN	
			DATE	10/07/2021
			DESIGNATION	MANAGING DIRECTOR
			NAME	DR. C.V.PRASAD

CONTENTS

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CONTENTS

	SEC. NO.		PAGE NO.
		CONTENTS	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 Test	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 2.5	Soil Profile	5-9
	2.6	Cross section profile	10
	2.7 to 2.11	Graphical Representation of Grain Size Analyses Curve	11-15
	2.12 to 2.20	Graphical Representation of Hydrometer Analyses Curve	16-24
TABLES	2.1 to 2.5	Laboratory Test Results	25-29
	2.6	Results of Chemical analysis	30
CHAPTER-3		SUB-SURFACE STRATIFICATION	
	3.0	Preamble	31
	3.1	Climate and Rainfall	31
	3.2	Geomorphology	31
	3.3 & 3.4	Geology of the area	31-32
	3.5	Design Sub Soil Profile	32-33

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CHAPTER-4		**FOUNDATION SYSTEM**	
	4.0	Preamble	34
	4.1	Proposed Structures	34
	4.2	Sub soil characteristics	34
	4.3	Foundation System	34
FIGURE	4.1	Schematic arrangement of foundation system	35
TABLE	4.1	Recommended allowable safe bearing pressure	35
CHAPTER-5		**RECOMMENDATIONS**	36
ANNEXURE		Typical bearing capacity computations for shallow foundations	37-38
	A1	Relationship Between Angle of Internal Friction & N-Value	39
	A2	Relationship Between UCC & SPT -Value (N) of Saturated Clay	39

PLATES

SPLIT SPOON SAMPLES (SPT) PHOTOGRAPHS
FIELD INVESTIGATION PHOTOGRAPHS
MANUSCRIPT BORELOG – FIELD DATA

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REPORT TEXT

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CHAPTER-1

INTRODUCTION

1.0 Project Information Matrix

Nature of project	: **PROPOSED RESIDENTIAL VILLAS**
Structure	: **GROUND + 2 FLOOR**
Project Owner	: **M/s V.G.N HOMES PRIVATE LIMITED**
Project Location	: **VILIJIYAMBAKKAM, AVADI, CHENNAI**
Job Code	: **GT-2242**

1.1 Scope Of Work

1.1.1 Field Work

- Conducting five soil investigation bore holes of 150 mm diameter in Soil & Overburden. In case of rock formation NX Diameter with Core barrel shall be adopted to progress the drilling up the termination depth.
- Conducting Standard Penetration Test (SPT) within the borehole at:
  - Every 1.0m depth interval up to 6.0m.
  - From 6.0m to 12.0m, SPT is conducted at every 1.5m depth interval
  - From 12.0m to 20.0m SPT is conducted at every 2.0m depth interval
  - Beyond 20.0m SPT is conducted at every 2.5m depth interval till the termination depth.
- The depth of investigation varies from 7.5m to 10.5m below the existing ground level.
- Collection of disturbed soil samples at SPT location 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
- Consolidation test on undisturbed samples if applicable
- 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
- Sub-Surface Stratification
- Foundation System
- Recommendation
- Annexure

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CHAPTER-2

INVESTIGATION METHODOLOGY & TEST RESULTS

2.0 Preamble:

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

2.1 Methodology of Field Work:

2.1.1 Equipment Used and Method of Drilling:

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

2.1.2 Standard Penetration Tests:

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

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

2.1.3 Collection of Soil Samples:

2.1.3.1 Disturbed Samples:

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

2.1.3.2 Undisturbed Samples:

From the soft to stiff clay layer, representative undisturbed samples were collected. These samples were used primarily to establish the compressibility parameters to estimate the settlements of shallow foundation system wherever applicable.

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.

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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 2.5. The graphical representation of grainsize distribution curve for the representative samples in each bore is presented in Fig. 2.7 to 2.11.

2.2.2 On Fine Grained Soil

On the SPT sample index property tests were conducted to estimate consistency. These test results are presented in Tables-2.1 to 2.5. The graphical representation of hydrometer analyses curve for the representative samples in each bore is presented in Fig. 2.12 to 2.20.

2.2.3 Chemical Analysis Tests

On representative soil and water samples chemical analysis tests were conducted to estimate pH, Chloride and Sulphates and these results are presented in Table - 2.6.

2.3 Summary:

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

Further, the cross sectional variation of the sub surface profile through different bore holes in vertical and horizontal direction longitudinally or transversely are presented in Figs.2.6.

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SITE PLAN



VILINJIAMBAKKAM VILLAGE
AS PER DOCUMENT(3.27Ac)
Old Survey.No: 35/1,2,4, 44/1Part,2,45/1,2Part,47/1,
WARD - G, BLOCK 21 ,T.S.No: 7/14, 7/16(P), 9/1(P).

17.06.2021
North



Area	Ac	Sqm	Sqft
As per Document	3.270	13,233.10	1,42,441
As per Patta Line	3.315	13,416.12	1,44,410
As per Site Line	3.292	13,325.79	1,43,437
Super Impose Area	3.284	13,292.07	1,43,075

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SOIL PROFILES

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SITE INVESTIGATION RECORD

BORE HOLE No.	BH-01						
SHEET	1	OF	1				
PROJECT NAME	PROPOSED CONSTRUCTION OF A RESIDENTIAL VILLAS			DIA OF BORE HOLE	150mm	✓	
					NX		
LOCATION	Vilinjiyambakkam, Avadi	MACHINE No.	-	CHAINAGE (m)	-	BORE START DATE	03/07/2021
STRUCTURE	Ground + 2 Floor	DRILLING METHOD	Rotary	CO-ORDINATES	N -	BORE END DATE	03/07/2021
JOB CODE	GT-2242	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
1	03/07/2021	09	30 To 09 32	SC	-	-												
		09	41 To 09 44	SC	-	-	4	4	6	10	1.00 / 1.45	1	SS	-1.0				Brown, Greyish Brown, Moist, Stiff, Silty CLAY (CH) Clays of High Plasticity
2		09	51 To 09 58	SC	-	-	2	3	5	9	2.00 / 2.45	2	SS	-2.0				
3		10	12 To 10 13	SC	-	-	16	24	27	51	3.00 / 3.45	3	SS	-3.0		L1	3.0	
4		10	28 To 10 29	SC	-	-	20	41	120Cm Penet for 59 Blows	>100	4.00 / 4.42	4	SS	-4.0		L2	4.0	Greyish Brown, Moist, Poorly Graded, Predominantly Fine Grains, Very Dense, Silty Fine SAND (SM)
5		10	47 To 10 49	SC	-	-	8	36	65	101	5.00 / 5.45	5	SS	-5.0				Greyish Brown, Moist, Poorly Graded, Fine & Medium Grains Sand Fraction, Very Dense, Clayey Silty SAND (SC) & Silty SAND (SM) With Clay Binder
6		11	04 To 11 10	SC	-	-	9	16	19	35	6.00 / 6.45	6	SS	-6.0		L3	6.0	
7		11	25 To 11 28	SC	-	-	21	24	23	47	7.50 / 7.95	7	SS	-7.5				Greyish Brown, Moist, Poorly Graded, Fine & Medium Grains Sand Fraction, Dense, Clayey Silty SAND (SC)
9		11	46 To 11 48	SC	-	-	23	42	63	105	9.00 / 9.45	8	SS	-9.0		L4	9.0	
10							35	12 Cm penet for 55 Blows		>100	10.50 / 10.77	9	SS	-10.5		L5	10.8	Greyish Brown, Moist, Poorly Graded, Fine & Medium Grains Sand Fraction, Very Dense, Clayey Silty SAND (SC) & Silty SAND (SM) With Binder

CS - Core Sample	DS - Disturbed Sample	LOGGED	K.SELVAM	PROJECT SITE DETAILS	REMARKS
SS - Split Spoon Sample	SC - Soil Cutter	DATE	03/07/2021	GROUND LEVEL (m) 0.00	
UDS- Undisturbed Sample	TCB - Tungsten Carbide Bit	CHECKED	RHOZEN. D.R	WATER TABLE (m) 3.50	
WS - Wash Sample	DB - Diamond Bit	DATE	05/07/2021	CASING DEPTH (m) 0.00	

Borehole terminated at 10.5 m depth below E.G.L

FIG.2.1 Sub Soil Profile at BH-01 Location

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SITE INVESTIGATION RECORD

BORE HOLE No.	BH-02						
SHEET	1	OF	1				
PROJECT NAME	PROPOSED CONSTRUCTION OF A RESIDENTIAL VILLAS			DIA OF BORE HOLE	150mm ✓ / NX		
LOCATION	Vilinjiyambakkam, Avadi	MACHINE No.	-	CHAINAGE (m)	-	BORE START DATE	03/07/2021
STRUCTURE	Ground + 2 Floor	DRILLING METHOD	Rotary	CO-ORDINATES	N -	BORE END DATE	03/07/2021
JOB CODE	GT-2242	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	03/07/2021	14	06 To 14 07	SC	-	-	3	4	6	10	1.00 / 1.45	1	SS	-1.0				
		14	15 To 14 19	SC	-	-												
2							2	3	4	7	2.00 / 2.45	2	SS	-2.0				
		14	29 To 14 35	SC	-	-												
3							5	8	11	19	3.00 / 3.45	3	SS	-3.0		L1	3.0	Greyish Brown,Moist,Medium Stiff to Stiff,**Silty CLAY (CI & CH)** Clay of Medium & High Plasticity
		14	45 To 14 48	SC	-	-												
4							4	7	8	15	4.00 / 4.45	4	SS	-4.0				
		14	57 To 14 58	SC	-	-												
5							8	8	13	21	5.00 / 5.45	5	SS	-5.0				
		15	07 To 15 08	SC	-	-												
6							6	40	70Cm Penet for 55 Blows	>100	6.00 / 6.37	6	SS	-6.0		L2	6.0	Greyish Brown,Moist,Poorly Graded, Fine & Medium Grains Sand Fraction, Medium Dense,**Clayey Silty SAND (SC)**
		15	22 To 15 26	SC	-	-												
7							19	12 Cm penet for 50 Blows		>100	7.50 / 7.77	7	SS	-7.5				
		15	42 To 15 51	SC	-	-												
9							8 Cm Penet for 55 Blows			>100	9.00 / 9.08	8	SS	-9.0				
		16	06 To 16 10	SC	-	-												
10							7 Cm Penet for 55 Blows			>100	10.50 / 10.57	9	SS	-10.5		L4	10.6	Greyish Brown,Moist,Poorly Graded, Fine & Medium Grains Sand Fraction, Very Dense,**Clayey Silty SAND (SC) & Silty SAND (SM) With Binder**

CS - Core Sample	DS - Disturbed Sample	LOGGED	K. SELVAM	PROJECT SITE DETAILS	REMARKS
SS - Split Spoon Sample	SC - Soil Cutter	DATE	03/07/2021	GROUND LEVEL (m) 0.00	
UDS- Undisturbed Sample	TCB - Tungsten Carbide Bit	CHECKED	RHOZEN. D. R	WATER TABLE (m) 4.70	
WS - Wash Sample	DB - Diamond Bit	DATE	05/07/2021	CASING DEPTH (m) 0.00	

Borehole terminated at 10.5 m depth below E.G.L.

FIG.2.2 Sub Soil Profile at BH-02 Location

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SITE INVESTIGATION RECORD

BORE HOLE No.	BH-03
SHEET	1 OF 1

PROJECT NAME	PROPOSED CONSTRUCTION OF A RESIDENTIAL VILLAS					DIA OF BORE HOLE	150mm ✓ / NX
LOCATION	Vilinjiyambakkam, Avadi	MACHINE No.	-	CHAINAGE (m)	-	BORE START DATE	05/07/2021
STRUCTURE	Ground + 2 Floor	DRILLING METHOD	Rotary	CO-ORDINATES	N -	BORE END DATE	05/07/2021
JOB CODE	GT-2242	FLUSHING MEDIUM	Bentonite		E -	TOTAL DRILL DAYS	1

Depth below E.G.L (m)	Drilling progress per metre: Date	Time: Hr.	Time: Min.	Type of Drill Bit (SC / TCB / DB)	Core Details: Total Core Recovery %	Core Details: R.Q.D %	SPT Details: Blows/cm. 0-15	SPT Details: Blows/cm. 15-30	SPT Details: Blows/cm. 30-45	SPT 'N' Value	Sample Details: Depth	Sample Details: No	Sample Details: Type	Sample Details: RL (m)	Layer Data: Legend	Layer Data: No	Layer Data: Depth	Geotechnical Description
0	05/07/2021	10	25	SC	-	-												
		To																
		10	27															
1		10	35				4	5	7	12	1.00	1	SS	-1.0				Brown,Moist,Stiff,**Silty CLAY (CI)** Lean Clay of Medium Plasticity
		To		SC	-	-					1.45							
		10	38															
2		10	48				5	12	12	24	2.00	2	SS	-2.0		L1	2.0	
		To		SC	-	-					2.45							
		10	53															
3		11	02				-	-	-	-	3.00	3	UDS	-3.0				Greyish Brown,Moist,Poorly Graded, Fine & Medium Grains Sand Fraction, Medium Dense,**Clayey Silty SAND (SC)**
		To		SC	-	-												
		11	05															
4		11	15				7	15	20	35	4.00	4	SS	-4.0		L2	4.0	
		To		SC	-	-					4.45							
		11	18															
5		11	26				30	32	27	59	5.00	5	SS	-5.0				Greyish Brown,Moist,Poorly Graded, Fine & Medium Grains Sand Fraction, Dense to Very Dense,**Clayey Silty SAND (SC) & Silty SAND (SM) With Binder**
		To		SC	-	-					5.45							
		11	30															
6		11	52				16	12 Cm penet for 90 Blows		>100	6.00	6	SS	-6.0		L3	6.0	
		To		SC	-	-					6.27							
		11	56															
7																		Greyish Brown,Moist,Poorly Graded, Fine & Medium Grains Sand Fraction, Very Dense,**Silty SAND (SM) With Binder**
							22	15 Cm penet for 62 Blows		>100	7.50	7	SS	-7.5				
											7.80					L4	7.8	
8																		
9																		
10																		

CS - Core Sample	DS - Disturbed Sample	LOGGED	K. SELVAM	PROJECT SITE DETAILS		REMARKS
SS - Split Spoon Sample	SC - Soil Cutter	DATE	05/07/2021	GROUND LEVEL (m)	0.00	
UDS- Undisturbed Sample	TCB - Tungsten Carbide Bit	CHECKED	RHOZEN. D.R	WATER TABLE (m)	2.50	
WS - Wash Sample	DB - Diamond Bit	DATE	05/07/2021	CASING DEPTH (m)	0.00	

Borehole terminated at 7.5 m depth below E.G.L

FIG.2.3 Sub Soil Profile at BH-03 Location

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SITE INVESTIGATION RECORD

BORE HOLE No.	BH-04
SHEET	1 OF 1
DIA OF BORE HOLE	150mm ✓ / NX
BORE START DATE	06/07/2021
BORE END DATE	06/07/2021
TOTAL DRILL DAYS	1

PROJECT NAME	PROPOSED CONSTRUCTION OF A RESIDENTIAL VILLAS						
LOCATION	Vilinjiyambakkam, Avadi	MACHINE No.	-	CHAINAGE (m)	-		
STRUCTURE	Ground + 2 Floor	DRILLING METHOD	Rotary	CO-ORDINATES	N	-	
JOB CODE	GT-2242	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	Geotechnical Description
1	06/07/2021	10	10	SC	-	-												
		To																
		10	12				6	7	8	15	1.00	1	SS	-1.0				Brown,Moist,Stiff,**Silty CLAY (CI)** Lean Clay of Medium Plasticity
		10	20	SC	-	-					1.45							
		To																
2		10	23				12	12	14	26	2.00	2	SS	-2.0		L1	2.0	
		10	29								2.45							Grey,Moist,Very Stiff,**Silty CLAY With GRAVELS (CI)** Lean Clay of Medium Plasticity
		To		SC	-	-												
		10	32													L2	3.0	
3		10	42				8	16	16	32	3.00	3	SS	-3.0				
		To		SC	-	-					3.45							
		10	43															
4		10	54				9	25	26	51	4.00	4	SS	-4.0				Greyish Brown,Moist,Poorly Graded, Fine & Medium Grains Sand Fraction, Dense to Very Dense,**Clayey Silty SAND (SC)**
		To		SC	-	-					4.45							
		10	58													L3	5.0	
5		11	08				26	8cm Penet for 50Blows		>100	5.00	5	SS	-5.0				
		To		SC	-	-					5.23							
		11	12															
6		11	25				37	8cm Penet for 50Blows		>100	6.00	6	SS	-6.0				Greyish Brown,Moist,Poorly Graded, Fine & Medium Grains Sand Fraction, Very Dense,**Silty SAND (SM) With Binder**
		To		SC	-	-					6.23							
7		11	30				35	7cm Penet for 50Blows		>100	7.50	7	SS	-7.5		L4	7.8	
											7.72							
8																		
9																		
10																		

CS - Core Sample	DS - Disturbed Sample	LOGGED	K.Selvam	PROJECT SITE DETAILS		REMARKS
SS - Split Spoon Sample	SC - Soil Cutter	DATE	06/07/2021	GROUND LEVEL (m)	0.00	
UDS- Undisturbed Sample	TCB - Tungsten Carbide Bit	CHECKED	A.Vinoth	WATER TABLE (m)	2.70	
WS - Wash Sample	DB - Diamond Bit	DATE	06/07/2021	CASING DEPTH (m)	0.00	

Borehole terminated at 7.5 m depth below E.G.L

FIG.2.4 Sub Soil Profile at BH-04 Location

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SITE INVESTIGATION RECORD

BORE HOLE No.	BH-05		
SHEET	1	OF	1
DIA OF BORE HOLE	150mm	✓	
	NX		
BORE START DATE	05/07/2021		
BORE END DATE	05/07/2021		
TOTAL DRILL DAYS	1		

PROJECT NAME	PROPOSED CONSTRUCTION OF A RESIDENTIAL VILLAS						
LOCATION	Vilinjiyambakkam, Avadi	MACHINE No.	-	CHAINAGE (m)	-		
STRUCTURE	Ground + 2 Floor	DRILLING METHOD	Rotary	CO-ORDINATES	N	-	
JOB CODE	GT-2242	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	Geotechnical Description
1	05/07/2021	14	45 To 14 51	SC	-	-	12	28	8cm Penet for 60Blows	>100	1.00 / 1.38	1	SS	-1.0				Brownish Red,Moist,Poorly Graded, Fine & Medium Sand With Gravels, Very Dense,**Clayey Silty SAND (SC)**
2		14	56 To 15 01	SC	-	-	7	10	15	25	2.00 / 2.45	2	SS	-2.0		L1	2.0	
3		15	05 To 15 11	SC	-	-	8	14	17	31	3.00 / 3.45	3	SS	-3.0				Greyish Brown,Moist,Poorly Graded, Fine & Medium Grains Sand Fraction, Medium Dense to Dense,**Clayey Silty SAND (SC)**
4		15	20 To 15 22	SC	-	-	16	27	32	59	4.00 / 4.45	4	SS	-4.0		L2	4.0	
5		15	32 To 15 34	SC	-	-	10	20	28	48	5.00 / 5.45	5	SS	-5.0				Greyish Brown,Moist,Poorly Graded, Fine & Medium Grains Sand Fraction, Dense to Very Dense,**Clayey Silty SAND (SC)**
6		15	45 To 15 47	SC	-	-	27	35	35	70	6.00 / 6.45	6	SS	-6.0		L3	6.0	
7		15	58 To 16 00	SC	-	-	32	12cm Penet for 55Blows		>100	7.50 / 7.77	7	SS	-7.5				Greyish Brown,Moist,Poorly Graded, Fine & Medium Grains Sand Fraction, Very Dense,**Silty SAND (SM) With Binder**
8																L4	7.8	
9																		
10																		

CS - Core Sample	DS - Disturbed Sample	LOGGED	K.Selvam	PROJECT SITE DETAILS	REMARKS
SS - Split Spoon Sample	SC - Soil Cutter	DATE	06/07/2021	GROUND LEVEL (m) 0.00	
UDS- Undisturbed Sample	TCB - Tungsten Carbide Bit	CHECKED	A.Vinoth	WATER TABLE (m) 2.50	
WS - Wash Sample	DB - Diamond Bit	DATE	06/07/2021	CASING DEPTH (m) 0.00	

Borehole terminated at 7.5 m depth below E.G.L

FIG.2.5 Sub Soil Profile at BH-05 Location

GEO MARINE CONSULTANTS PVT. LTD. Chennai

CROSS SECTION PROFILE

GEO MARINE CONSULTANTS PVT. LTD.

GRAIN SIZE DISTRIBUTION CURVE

GEO MARINE CONSULTANTS PVT. LTD.

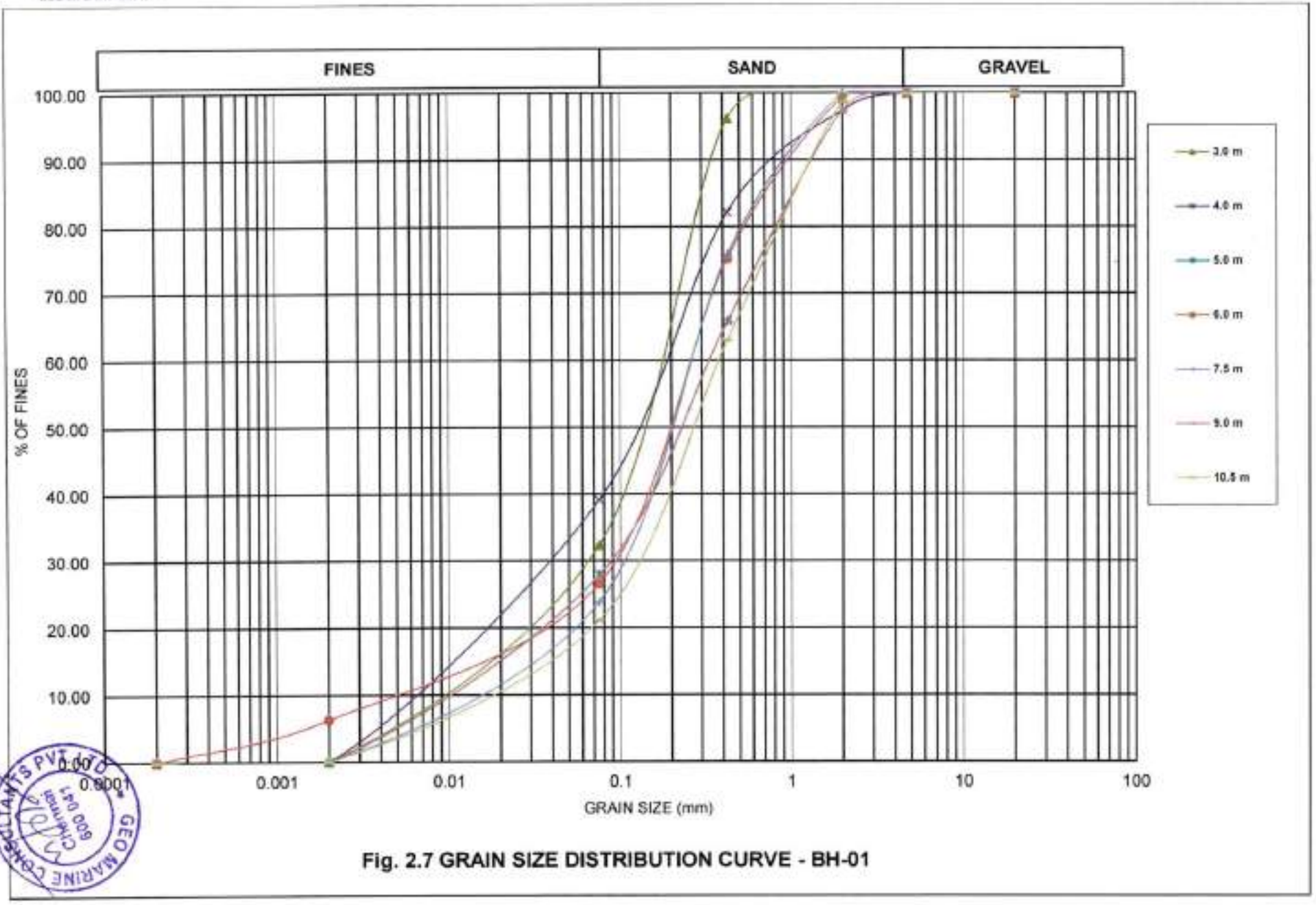


Fig. 2.7 GRAIN SIZE DISTRIBUTION CURVE - BH-01

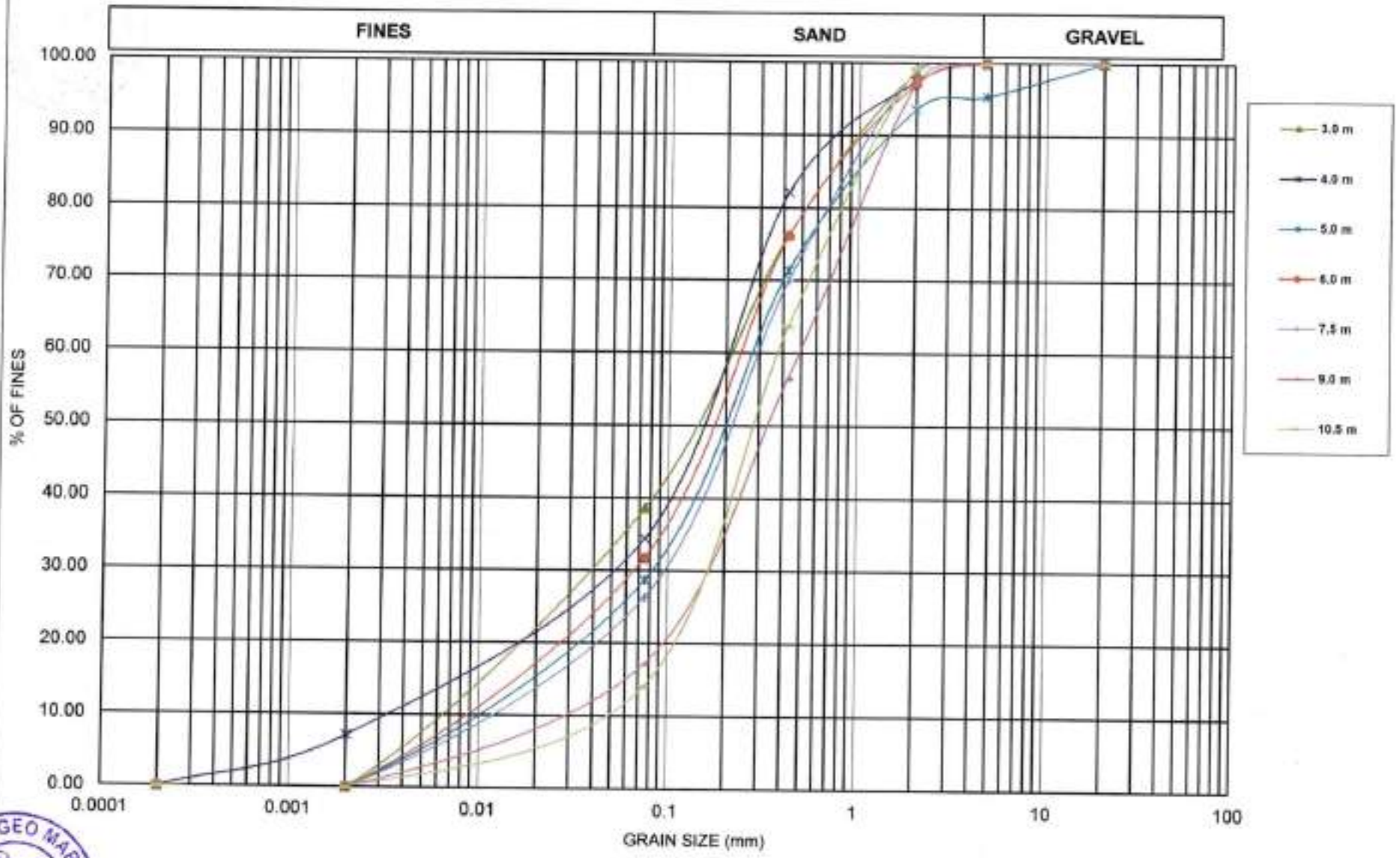


Fig. 2.8 GRAIN SIZE DISTRIBUTION CURVE - BH-02

GEO MARINE CONSULTANTS PVT. LTD. Chennai 600 041

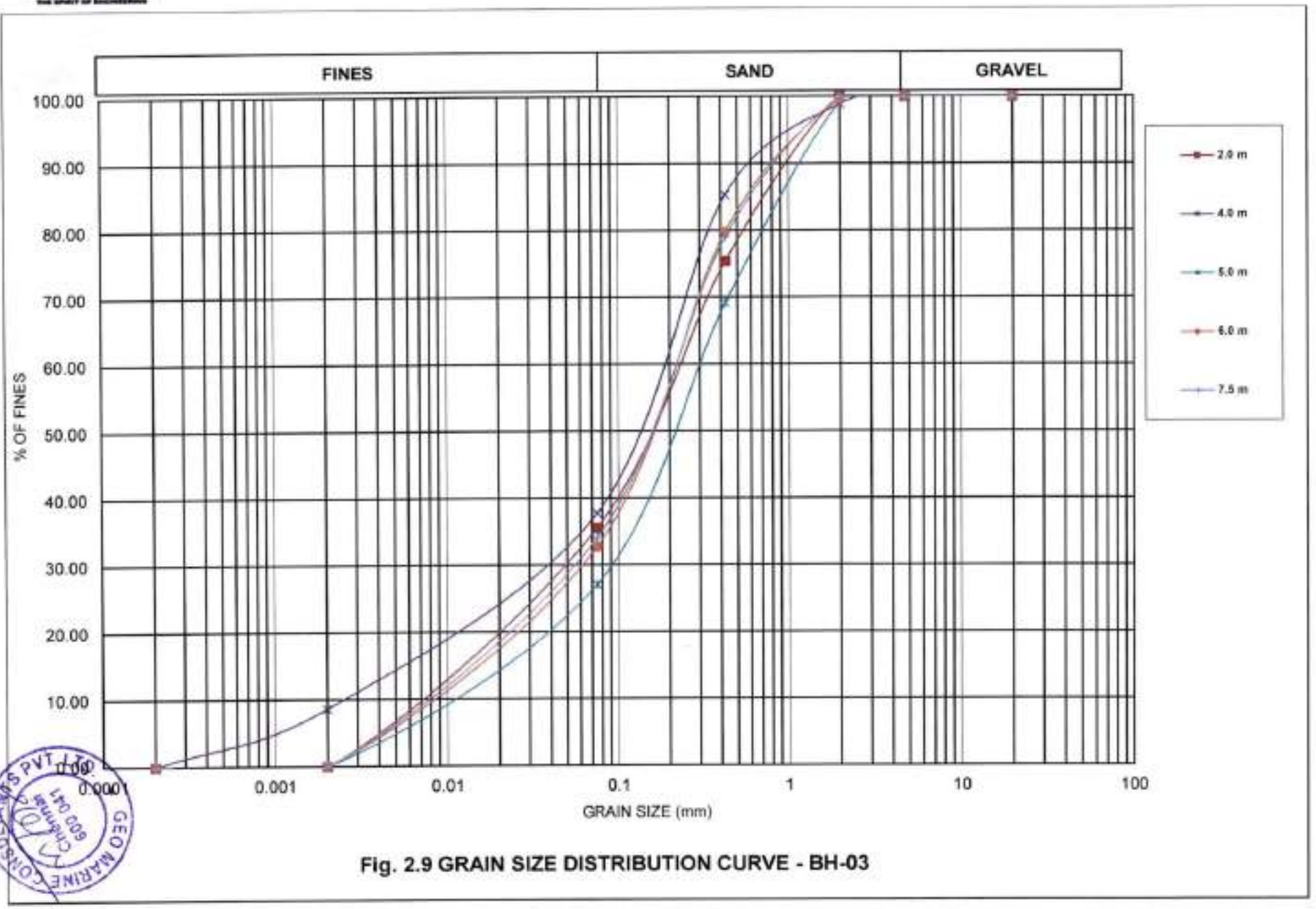


Fig. 2.9 GRAIN SIZE DISTRIBUTION CURVE - BH-03

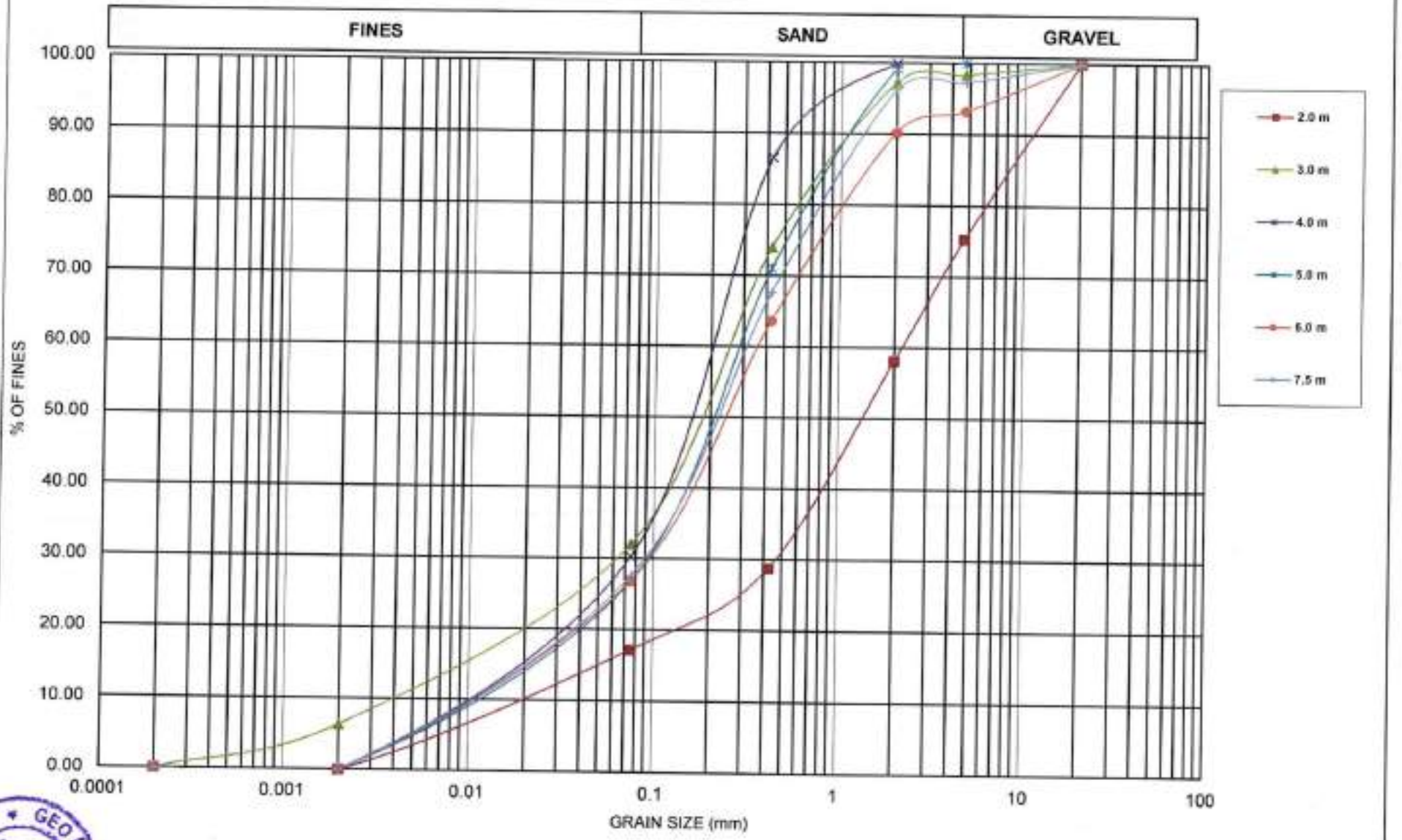


Fig. 2.10 GRAIN SIZE DISTRIBUTION CURVE - BH-04

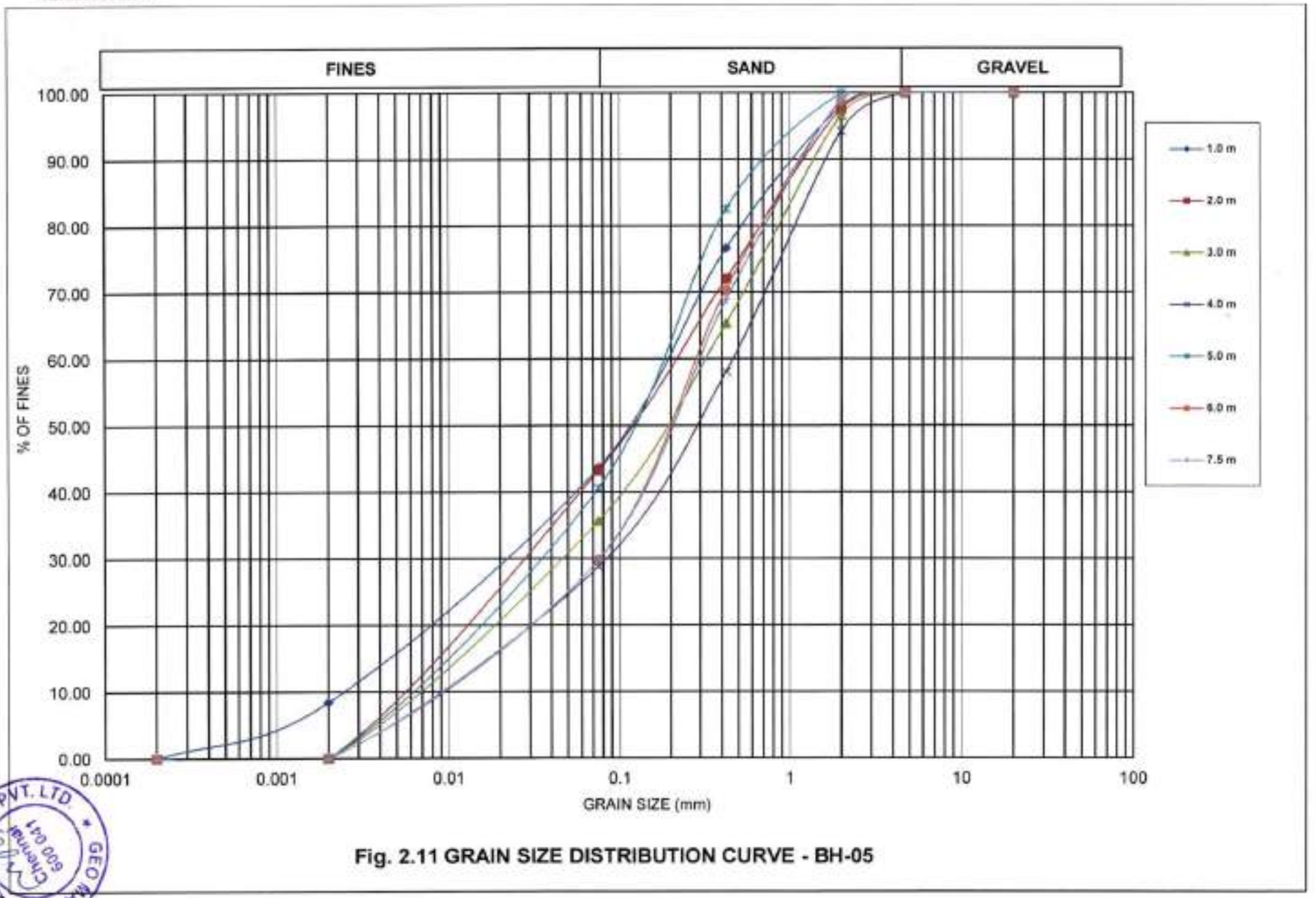


Fig. 2.11 GRAIN SIZE DISTRIBUTION CURVE - BH-05

GEO MARINE CONSULTANTS PVT. LTD. Chennai 600 041

HYDROMETER ANALYSIS CURVE



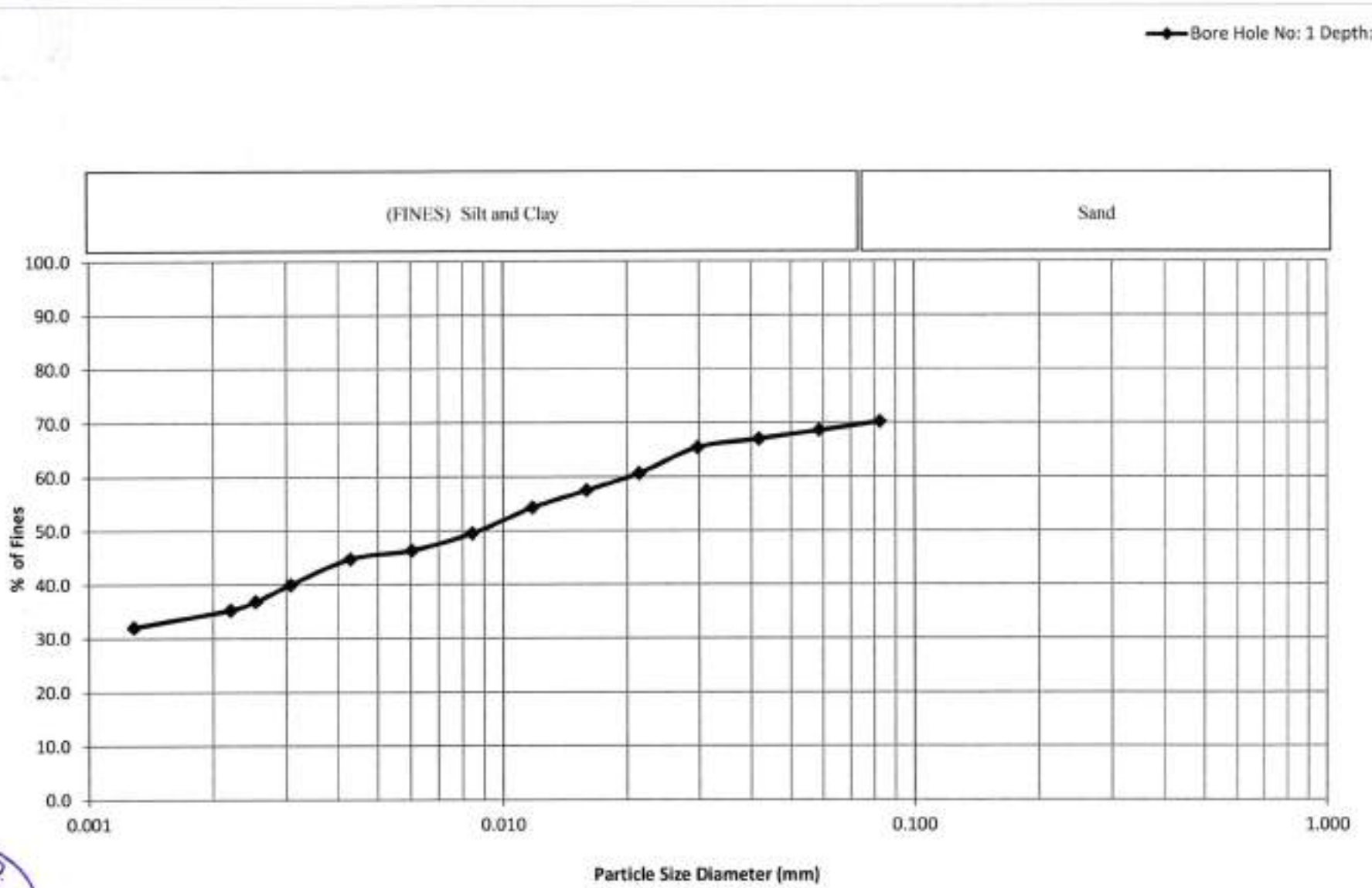


Fig 2.12 Hydrometer Analysis Master Curve

GEO MARINE CONSULTANTS PVT. LTD.

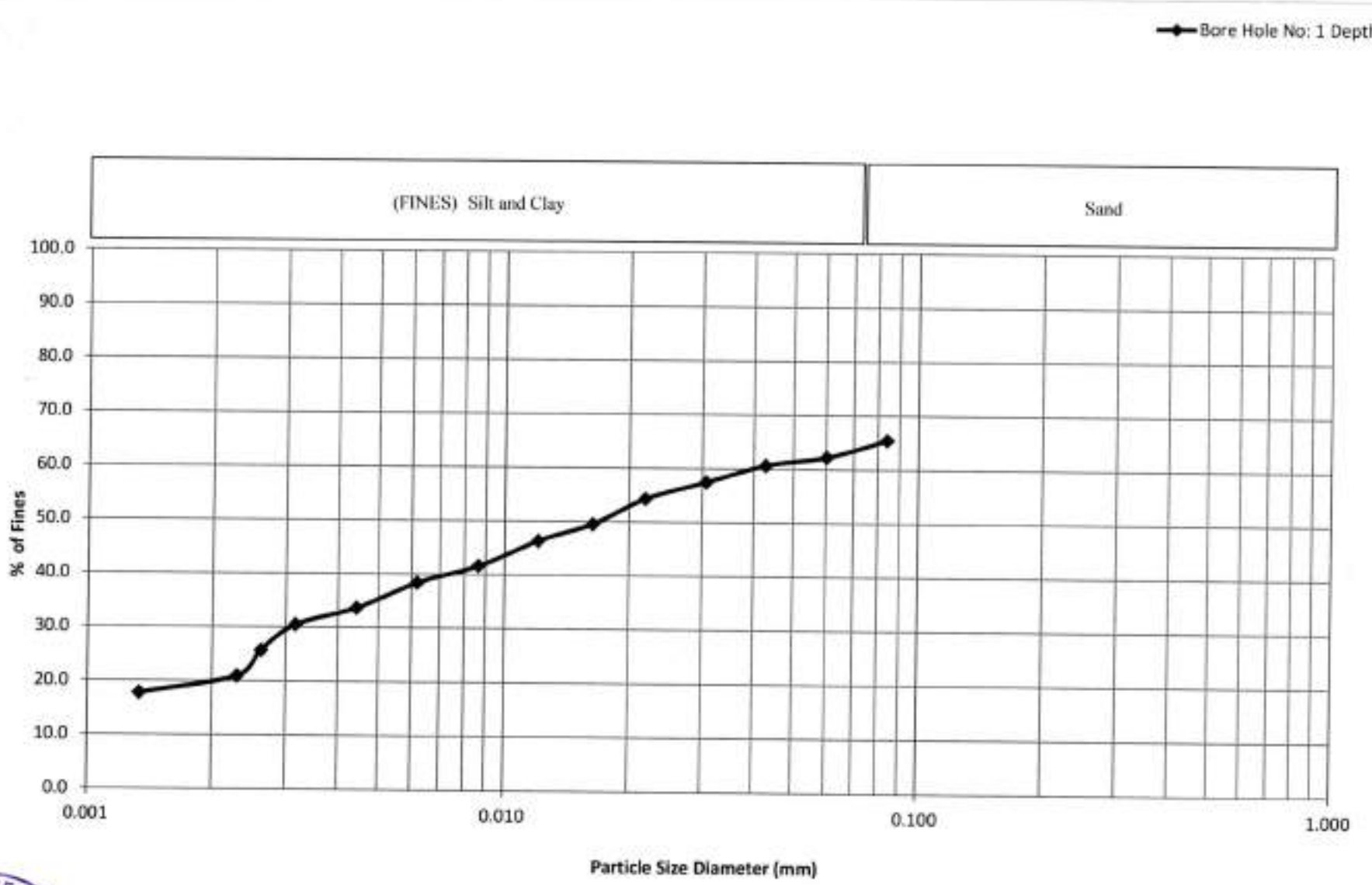


Fig 2.13 Hydrometer Analysis Master Curve

GEO MARINE CONSULTANTS PVT. LTD.

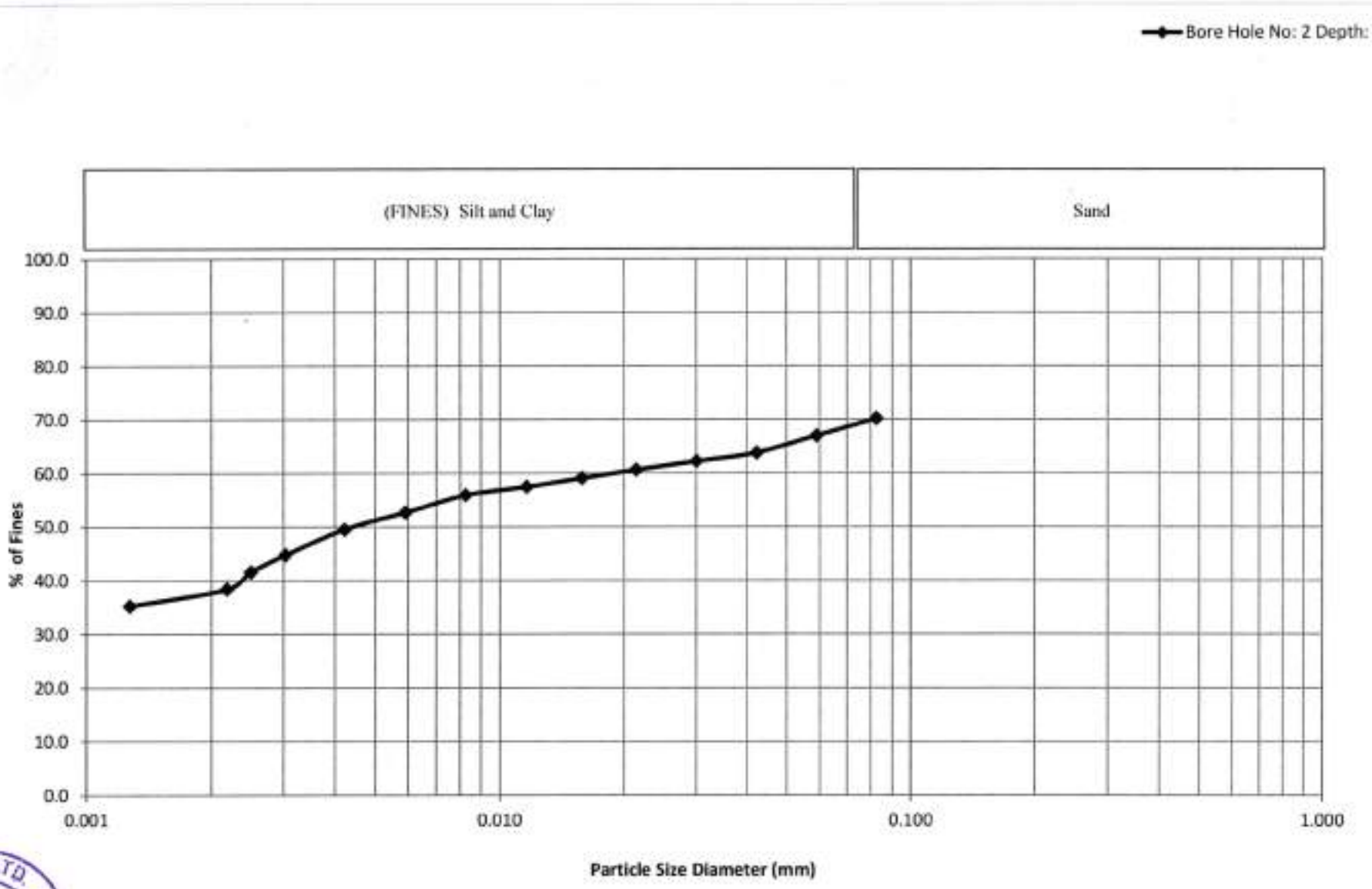


Fig 2.14 Hydrometer Analysis Master Curve

GEO MARINE CONSULTANTS PVT. LTD.

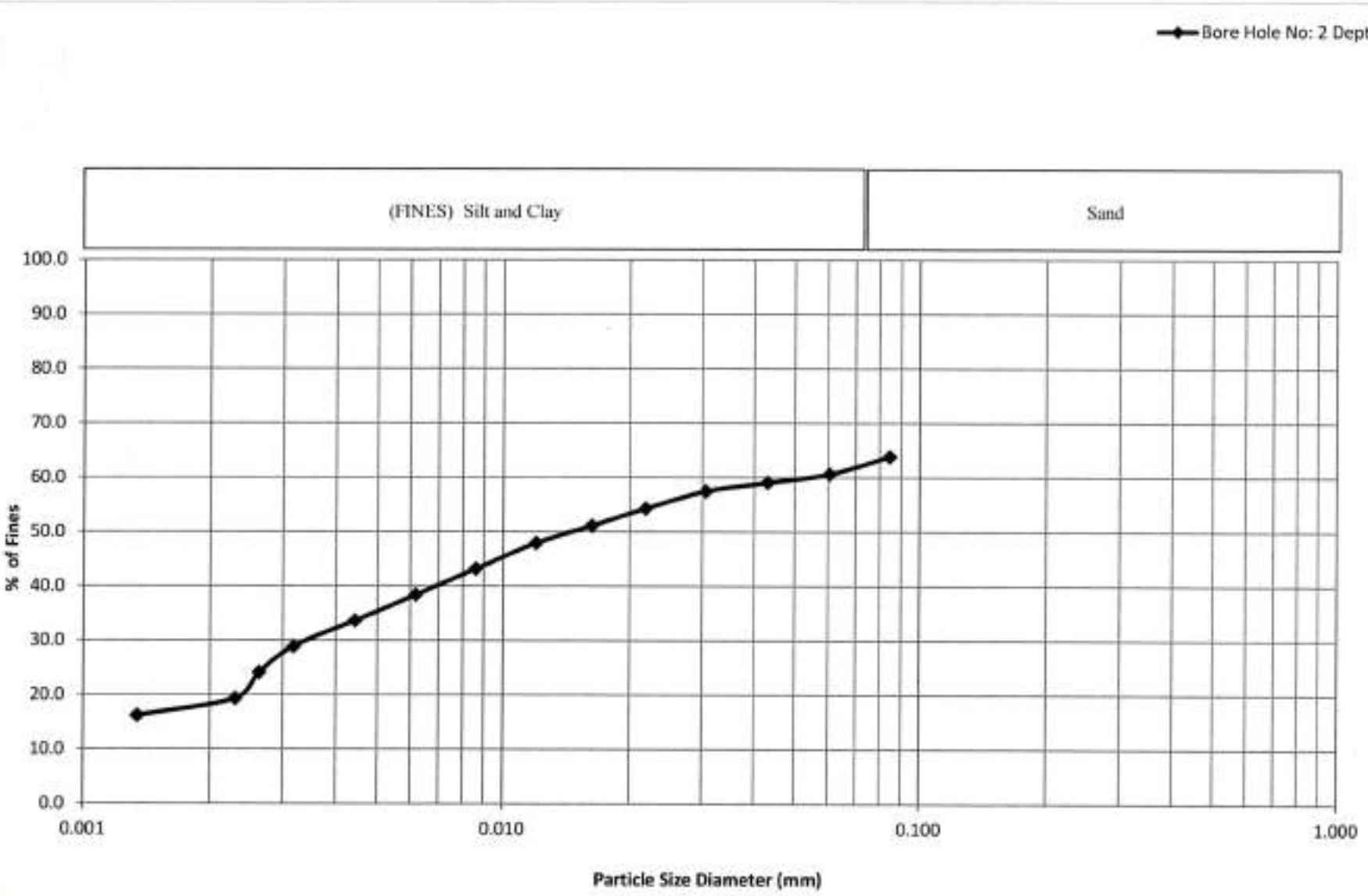


Fig 2.15 Hydrometer Analysis Master Curve

GEO MARINE CONSULTANTS PVT. LTD. Chennai

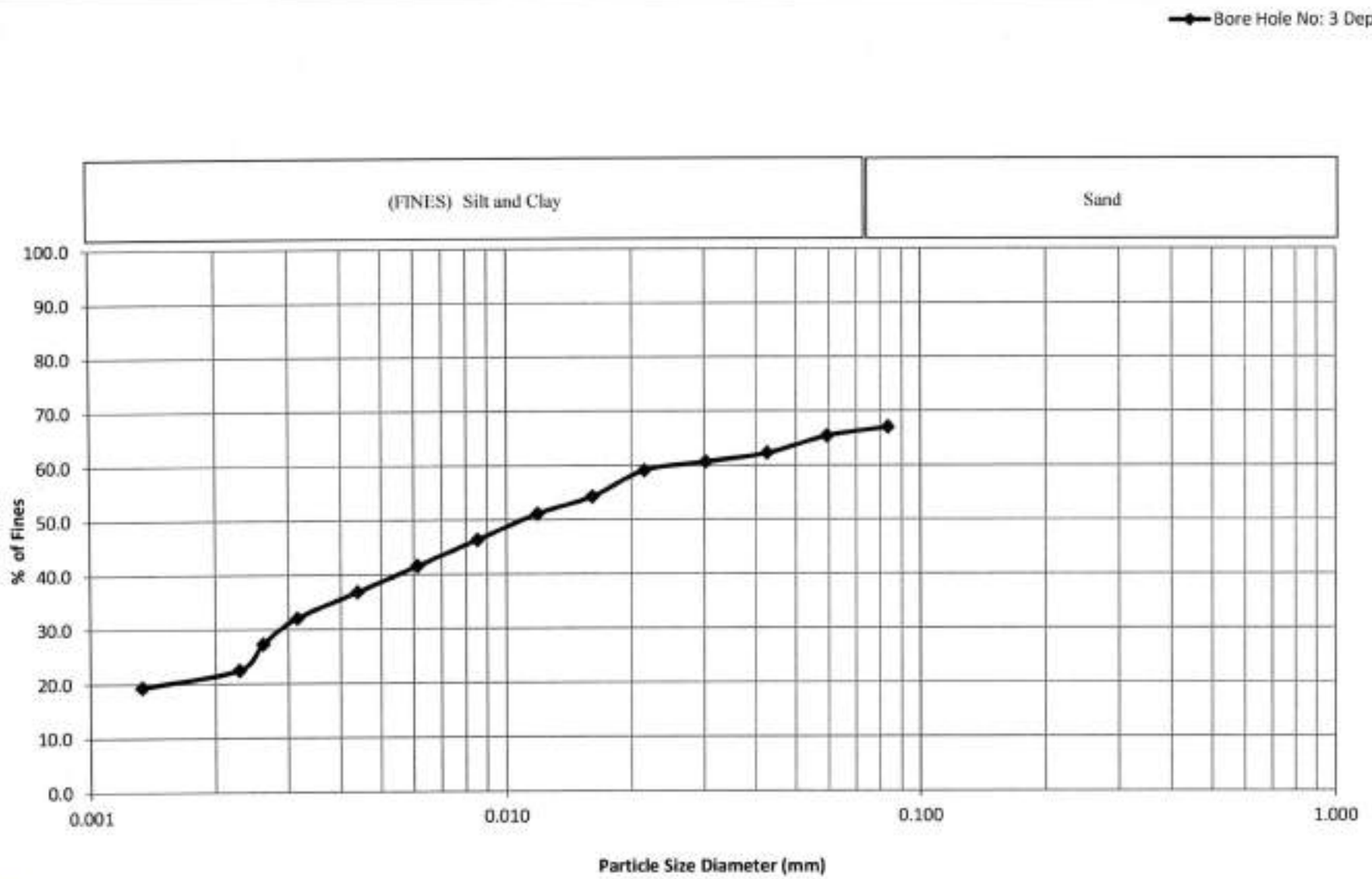


Fig 2.16 Hydrometer Analysis Master Curve

GEO MARINE CONSULTANTS PVT. LTD.

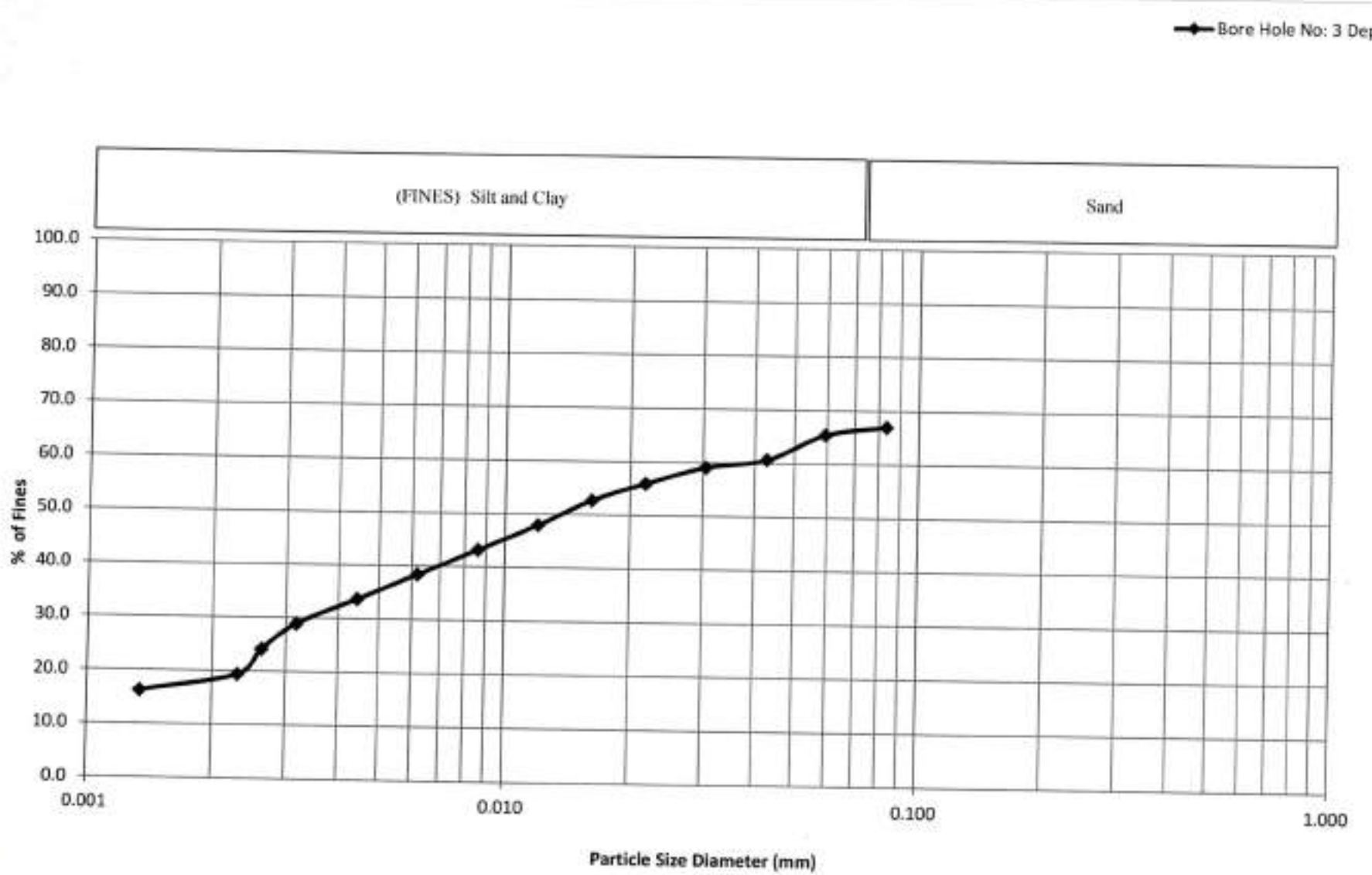


Fig 2.17 Hydrometer Analysis Master Curve

GEOMARINE CONSULTANTS PVT. LTD.

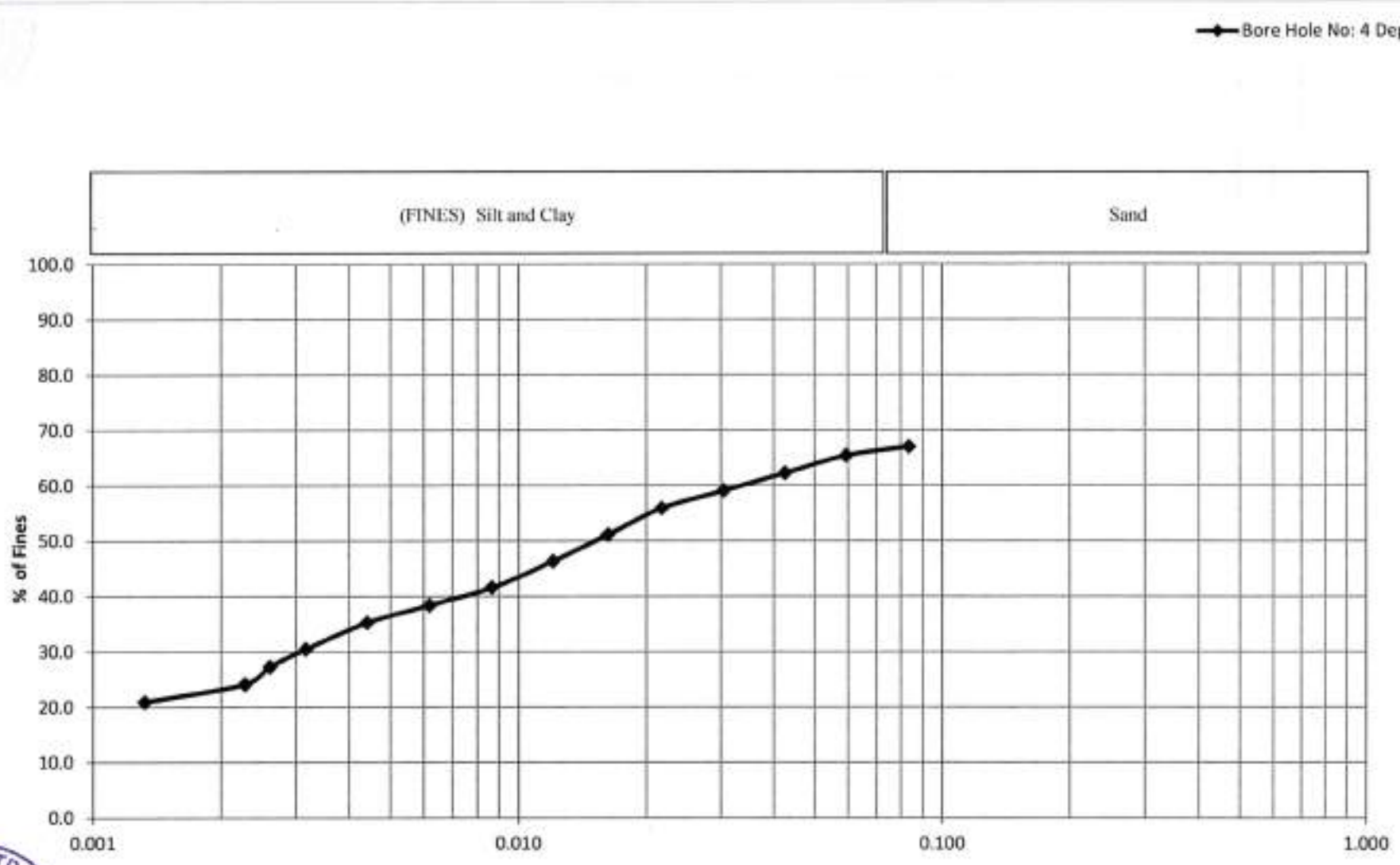


Fig 2.18 Hydrometer Analysis Master Curve

GEO MARINE CONSULTANTS PVT. LTD.

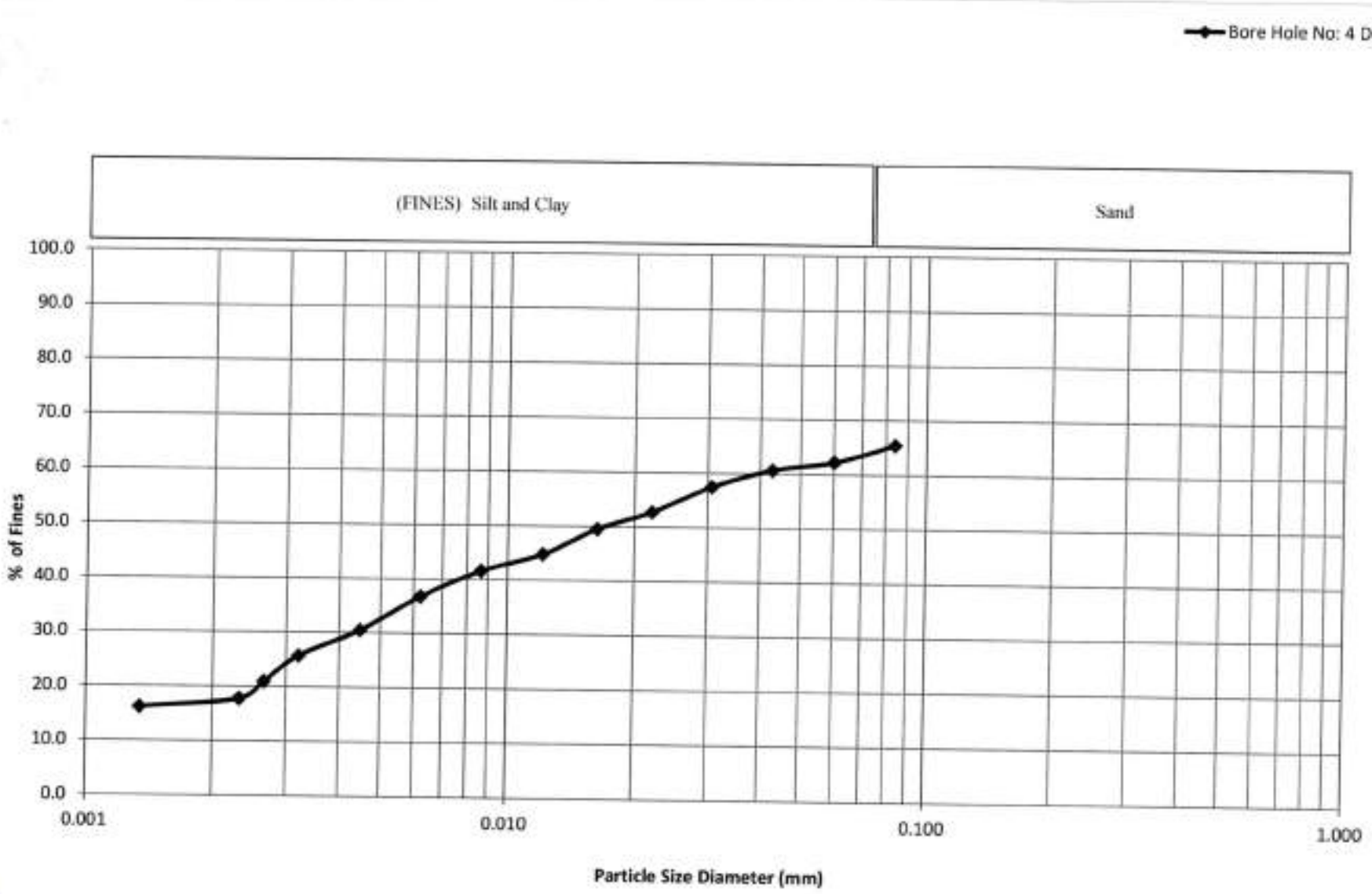


Fig 2.19 Hydrometer Analysis Master Curve

GEO MARINE CONSULTANTS PVT LTD Chennai

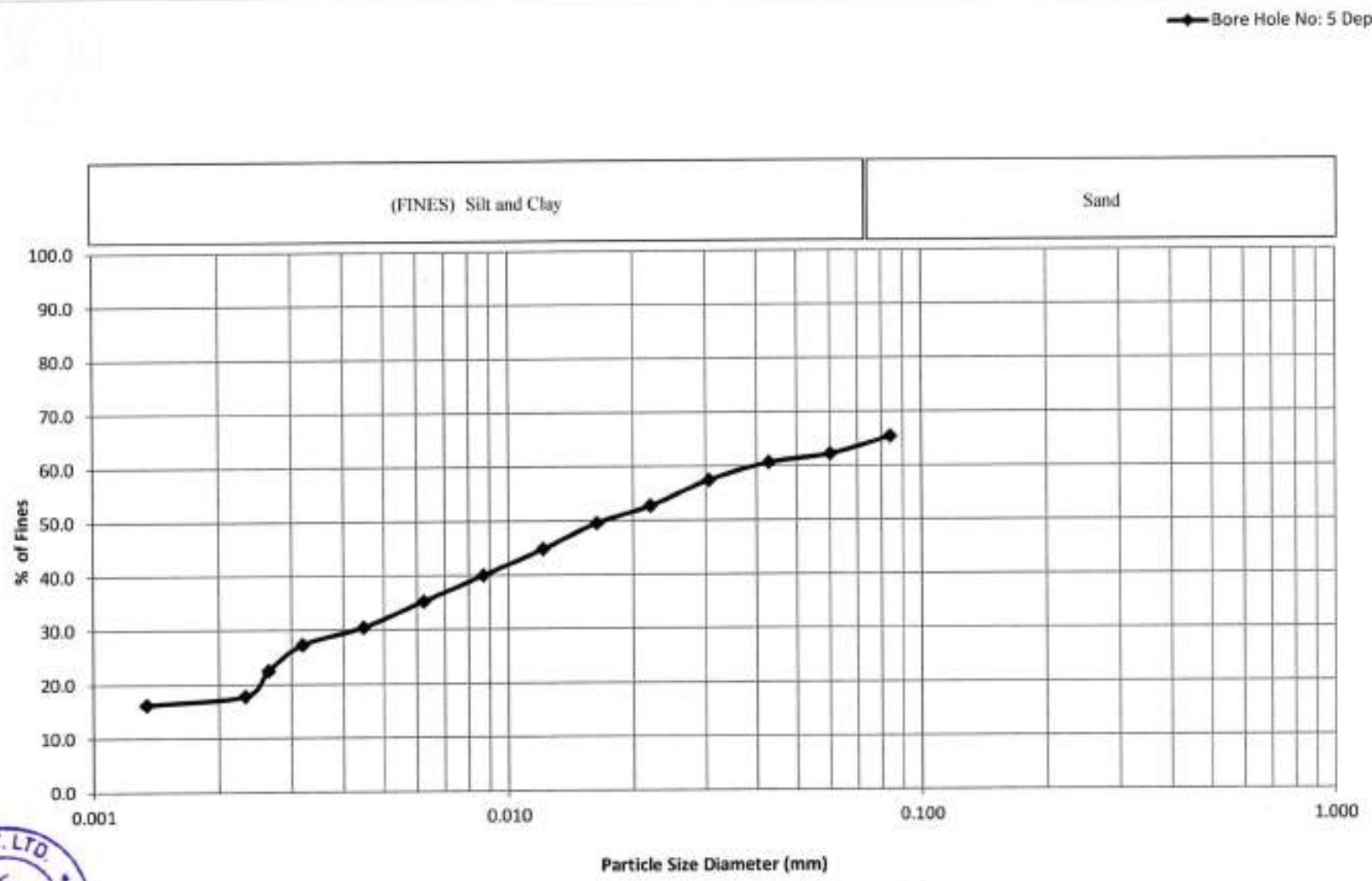


Fig 2.20 Hydrometer Analysis Master Curve

GEO MARINE CONSULTANTS PVT. LTD. LTO 009

LABORATORY TEST RESULTS



GEOMARINE
Phone No.: 044-24481485, 044-24480305
ULR: TC855921000000000133P

LABORATORY TEST REPORT

GEOMARINE CONSULTANTS PVT LTD- GEOTECHNICAL LABORATORY
NO.11 2nd MAIN ROAD, KANNAPA NAGAR EXTN,
KOTTIVAKKAM, CHENNAI

Name & Address of the Customer	:	**M/s VGN Homes Private Limited, Amaindakarai, Ch-29**	**Customer Reference**	:	Email Confirmation
Sample Description	:	Soil Sample	**Period of Testing**	:	08/07/2021 to 10/07/2021
Source of Sample	:	Customer Supplied- Borehole No. BH-01	**Sample Identification Number**	:	SS/GMC/062021/350/BH01
Sample Condition	:	Satisfactory	**Test Report No.**	:	GT-2242/BH-01
Test Method	:	As per Bureau of Indian Standards	**Report Date**	:	10/07/2021
Sample Receipt Date	:	07/07/2021	**Test Report Pages**	:	One Page

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

Sample Depth (m)	SPT- "N" Value	Type of Sample	Fine Grained (FG)										Specific Gravity AS PER IS 2720 (P-III, SEC-1) - 1980, RA-2010	Coarse Grained (CG)													
			Moisture Content (%) AS PER IS 2720 (P-II) - 1973, RA-2015	LIQUID LIMIT (%) AS PER IS 2720 (P-V) - 1985, RA-2015	PLASTIC LIMIT (%) AS PER IS 2720 (P-V) - 1985, RA-2015	Plasticity Index (I_p= LL-PL)	Consistency Index (I_c=LL-NMC/I_p)	SHRINKAGE LIMIT (%) AS PER IS 2720 (P-VI) - 1972, RA-2011	FREE SWELL INDEX (%) AS PER IS 2720 (P-XL) - 1977, RA-2011	Consistency	Position With Respect to A-Line	IS:Notation		GRAIN SIZE ANALYSIS AS PER IS 2720 (P-IV) - 1985, RA-2015						D_{10} (mm)	D_{30}(mm)	D_{60} (mm)	Uniformity Co-Efficient $C_u=D_{60}/D_{10}$	Co-Efficient of Curvature $C_c=D_{30}^2/(D_{10}xD_{60})$	Relative Density	IS-Notation	
														Gravel (%)	Coarse (%)	Medium (%)	Fine (%)	Silt (%)	Clay (%)							Gravel	Sand
1.0	10	SS	27.0	55.6	25.4	30.2	0.9	13.5	50.0	Stiff	Above	CH	-	-	-	-	-	65.0	35.0	-	-	-	-	-	FG>50%	FG>50%	FG>50%
2.0	9	SS	33.9	68.1	28.8	39.3	0.9	13.0	50.0	Stiff	Above	CH	-	0.0	0.0	0.4	1.7	97.9		-	-	-	-	-	FG>50%	FG>50%	FG>50%
3.0	51	SS	-	-	-	-	-	-	-	CG>50%	-	-	-	0.0	0.0	3.8	63.8	32.4		-	-	-	-	-	V.Dense	<50%	SM
4.0	>100	SS	-	-	-	-	-	-	-	CG>50%	-	-	-	0.0	2.5	15.3	43.0	39.2		-	-	-	-	-	V.Dense	<50%	SM
5.0	101	SS	13.8	33.2	15.8	17.4	1.1	19.0	9.5	CG>50%	Above	-	-	0.0	2.5	31.6	37.9	28.0		-	-	-	-	-	V.Dense	<50%	SC
6.0	35	SS	18.2	39.1	20.1	19.0	1.1	17.8	22.2	CG>50%	Above	-	-	0.0	0.6	24.1	43.9	25.0	6.4	-	-	-	-	-	Dense	<50%	SC
7.5	47	SS	15.2	31.7	17.8	13.9	1.2	19.0	17.5	CG>50%	Above	-	-	0.0	0.0	24.1	52.0	23.9		-	-	-	-	-	Dense	<50%	SC
9.0	105	SS	17.1	34.2	19.5	14.7	1.2	18.2	50.0	CG>50%	Above	-	-	0.0	2.5	31.7	37.9	27.9		-	-	-	-	-	V.Dense	<50%	SC
10.5	>100	SS	-	-	-	-	-	-	-	CG>50%	-	-	-	0.0	1.4	35.6	41.9	21.1		-	-	-	-	-	V.Dense	<50%	SM

** END OF REPORT**

Terms and Conditions

(1) The test results furnished corresponds to the sample received
(2) The tested sample will not be retained for more than 45 days from the date of issue of test report except in the case as required by the applicable regulations.
(3) Any correction in this reports invalidates the reports

Authorised Signatory

A. VINOTH
(Technical Manager)

GEO MARINE CONSULTANTS PVT. LTD. CHENNAI 600 041

GEO MARINE
Phone No.: 044-24481485, 044-24480305
ULR: TC855921000000003 3P

LABORATORY TEST REPORT

GEOMARINE CONSULTANTS PVT LTD- GEOTECHNICAL LABORATORY
NO.11 2nd MAIN ROAD, KANNAPA NAGAR EXTN,
KOTTIVAKKAM, CHENNAI

Name & Address of the Customer	:	**M/s VGN Homes Private Limited, Amaindakarai, Ch-29**	**Customer Reference**	:	Email Confirmation
Sample Description	:	Soil Sample	**Period of Testing**	:	08/07/2021 to 10/07/2021
Source of Sample	:	Customer Supplied- Borehole No. BH-02	**Sample Identification Number**	:	SS/GMC/062021/350/BH02
Sample Condition	:	Satisfactory	**Test Report No.**	:	GT-2242/BH-02
Test Method	:	As per Bureau of Indian Standards	**Report Date**	:	10/07/2021
Sample Receipt Date	:	07/07/2021	**Test Report Pages**	:	One Page

Table-2.2 Laboratory Classification of Soil Samples from BH-02

Sample Depth (m)	SPT- "N" Value	Type of Sample	Fine Grained (FG)										Specific Gravity AS PER IS 2720 (P-III, SEC-1) - 1980, RA-2010	Coarse Grained (CG)												IS-Notation	
			Moisture Content (%) AS PER IS 2720 (P-II) - 1973, RA-2015	LIQUID LIMIT (%) AS PER IS 2720 (P-V) - 1985, RA-2015	PLASTIC LIMIT (%) AS PER IS 2720 (P-V) - 1985, RA-2015	Plasticity Index (I_p= LL-PL)	Consistency Index (Ic=LL-WMC/I_p)	SHRINKAGE LIMIT (%) AS PER IS 2720 (P-VI) - 1972, RA-2011	FREE SWELL INDEX (%) AS PER IS 2720 (P-XL) - 1977, RA-2011	Consistency	Position With Respect to A-Line	IS Notation		GRAIN SIZE ANALYSIS AS PER IS 2720 (P-IV) - 1985, RA-2015						D_{10} (mm)	D_{30}(mm)	D_{60} (mm)	Uniformity Co-Efficient C_u=D_{60}/D_{10}	Co-Efficient of Curvature C_c=$D_{30}^2/(D_{10}$x$D_{60})$	Relative Density		
														Gravel (%)	Coarse (%)	Medium (%)	Fine (%)	Silt (%)	Clay (%)							Gravel	Sand
1.0	10	SS	22.5	35.0	18.9	16.1	0.8	15.5	22.2	Stiff	Above	CI	-	0.0	0.0	4.1	16.2	79.7		-	-	-	-	-	FG>50%	FG>50%	FG>50%
2.0	7	SS	44.8	67.9	29.7	38.2	0.6	11.5	66.7	M.Stiff	Above	CH	-	-	-	-	-	62.0	38.0	-	-	-	-	-	FG>50%	FG>50%	FG>50%
3.0	19	SS	15.6	38.9	17.0	22.0	1.1	16.8	63.2	CG>50%	Above	-	-	0.0	1.3	22.4	37.7	38.7		-	-	-	-	-	M.Dense	<50%	SC
4.0	15	SS	18.5	37.3	21.7	15.5	1.2	16.5	33.3	CG>50%	Above	-	-	0.0	2.5	15.3	43.0	32.0	7.2	-	-	-	-	-	M.Dense	<50%	SC
5.0	21	SS	14.5	34.5	16.5	18.0	1.1	19.0	17.5	CG>50%	Above	-	-	4.6	1.8	22.2	42.7	28.7		-	-	-	-	-	M.Dense	<50%	SC
6.0	>100	SS	12.8	33.8	16.8	17.0	1.2	-	23.9	CG>50%	Above	-	-	0.0	2.8	21.0	44.4	31.8		-	-	-	-	-	V.Dense	<50%	SC
7.5	>100	SS	-	-	-	-	-	-	-	CG>50%	-	-	-	0.0	0.9	29.0	43.7	26.4		-	-	-	-	-	V.Dense	<50%	SM
9.0	>100	SS	-	-	-	-	-	-	-	CG>50%	-	-	-	0.0	2.8	40.7	39.3	17.2		-	-	-	-	-	V.Dense	<50%	SM
10.5	>100	SS	-	-	-	-	-	-	-	CG>50%	-	-	-	0.0	0.7	35.7	49.6	14.0		-	-	-	-	-	V.Dense	<50%	SM

** END OF REPORT**

Terms and Conditions
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(3) Any correction in this reports invalidates the reports

Authorised Signatory
A. VINOTH
(Technical Manager)

GEO MARINE CONSULTANTS PVT LTD Chennai 600 044

GEOMARINE
Phone No.: 044-24481485, 044-24480305
ULR: TC855921000000000133P

LABORATORY TEST REPORT

GEOMARINE CONSULTANTS PVT LTD- GEOTECHNICAL LABORATORY
NO.11 2nd MAIN ROAD, KANNAPA NAGAR EXTN,
KOTTIVAKKAM, CHENNAI

Name & Address of the Customer	:	**M/s VGN Homes Private Limited, Amaindakaral, Ch-29**	**Customer Reference**	:	Email Confirmation
Sample Description	:	Soil Sample	**Period of Testing**	:	08/07/2021 to 10/07/2021
Source of Sample	:	Customer Supplied- Borehole No. BH-03	**Sample Identification Number**	:	SS/GMC/062021/350/BH03
Sample Condition	:	Satisfactory	**Test Report No.**	:	GT-2242/BH-03
Test Method	:	As per Bureau of Indian Standards	**Report Date**	:	10/07/2021
Sample Receipt Date	:	07/07/2021	**Test Report Pages**	:	One Page

Table-2.3 Laboratory Classification of Soil Samples from BH-03

Sample Depth (m)	SPT- "N" Value	Type of Sample	Fine Grained (FG)										Coarse Grained (CG)														
			Moisture Content (%) AS PER IS 2720 (P-II) - 1973, RA-2015	LIQUID LIMIT (%) AS PER IS 2720 (P-V) - 1985, RA-2015	PLASTIC LIMIT (%) AS PER IS 2720 (P-V) - 1985, RA-2015	Plasticity Index (I_p= LL-PL)	Consistency Index (I_c=LL-NMC/I_p)	SHRINKAGE LIMIT (%) AS PER IS 2720 (P-VI) - 1972, RA-2011	FREE SWELL INDEX (%) AS PER IS 2720 (P-XL) - 1977, RA-2011	Consistancy	Position With Respect to A-Aline	IS:Notation	SPECIFIC GRAVITY AS PER IS 2720 (P-III, SEC-1) - 1980, RA-2010	GRAIN SIZE ANALYSIS AS PER IS 2720 (P-IV) - 1985, RA-2015						D_{10} (mm)	D_{30}(mm)	D_{60} (mm)	Uniformity Co-Efficient C_u=D_{60}/D_{10}	Co-Efficient of Curvature C_c=D_{30}^2/D_{10}xD_{60}	Relative Density	IS-Notation	
													Gravel (%)	Coarse (%)	Medium (%)	Fine (%)	Silt (%)	Clay (%)							Gravel	Sand
1.0	12	SS	16.4	37.5	15.8	21.7	1.0	14.8	66.7	Stiff	Above	CI	-	-	-	-	-	78.0	22.0	-	-	-	-	-	FG>50%	FG>50%	FG>50%
2.0	24	SS	11.8	27.2	14.6	12.7	1.2	19.0	10.5	CG>50%	Above	-	-	0.0	0.0	24.6	39.8	35.6		-	-	-	-	-	M.Dense	<50%	SC
4.0	35	SS	17.1	41.2	20.2	21.0	1.1	17.0	50.0	CG>50%	Above	-	-	0.0	1.1	13.5	42.2	34.5	8.6	-	-	-	-	-	Dense	<50%	SC
5.0	59	SS	-	-	-	-	-	-	-	-	-	-	-	0.0	1.0	29.8	42.1	27.1		-	-	-	-	-	V.Dense	<50%	SM
6.0	>100	SS	-	-	-	-	-	-	-	CG>50%	-	-	-	0.0	0.4	19.7	47.1	32.8		-	-	-	-	-	V.Dense	<50%	SM
7.5	>100	SS	-	-	-	-	-	-	-	CG>50%	-	-	-	0.0	0.0	21.0	44.9	34.1		-	-	-	-	-	V.Dense	<50%	SM

** END OF REPORT**

Terms and Conditions
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Authorised Signatory
A. VINOTH
(Technical Manager)

GEO MARINE CONSULTANTS PVT. LTD. CHENNAI 600 041

GEOMARINE
Phone No.. 044-24481485, 044-24480305
ULR: TC855921000000000133P

LABORATORY TEST REPORT

GEOMARINE CONSULTANTS PVT LTD- GEOTECHNICAL LABORATORY
NO.11 2ND MAIN ROAD, KANNAPA NAGAR EXTN,
KOTTIVAKKAM, CHENNAI

Name & Address of the Customer	:	**M/s VGN Homes Private Limited, Amaindakarai, Ch-29**	**Customer Reference**	:	Email Confirmation
Sample Description	:	Soil Sample	**Period of Testing**	:	08/07/2021 to 10/07/2021
Source of Sample	:	Customer Supplied- Borehole No. BH-04	**Sample Identification Number**	:	SS/GMC/062021/350/BH04
Sample Condition	:	Satisfactory	**Test Report No.**	:	GT-2242/BH-04
Test Method	:	As per Bureau of Indian Standards	**Report Date**	:	10/07/2021
Sample Receipt Date	:	07/07/2021	**Test Report Pages**	:	One Page

Table-2.4 Laboratory Classification of Soil Samples from BH-04

Sample Depth (m)	SPT- "N" Value	Type of Sample	Fine Grained (FG)										Coarse Grained (CG)													
			Moisture Content (%) AS PER IS 2720 (P-II) - 1973, RA-2015	LIQUID LIMIT (%) AS PER IS 2720 (P-V) - 1985, RA-2015	PLASTIC LIMIT (%) AS PER IS 2720 (P-V) - 1985, RA-2015	Plasticity Index (I_p= LL-PL)	Consistency Index (I_c=LL-NMC/I_p)	SHRINKAGE LIMIT (%) AS PER IS 2720 (P-VI) - 1972, RA-2011	FREE SWELL INDEX (%) AS PER IS 2720 (P-XL) - 1977, RA-2011	Consistency	Position With Respect to A-Aline	IS-Notation	SPECIFIC GRAVITY AS PER IS 2720 (P-III, SEC-1) - 1980, RA-2016	GRAIN SIZE ANALYSIS AS PER IS 2720 (P-IV) - 1985, RA-2015						D_{10} (mm)	D_{30}(mm)	D_{60} (mm)	Uniformity Co-Efficient C_u=D_{60}/D_{10}	Co-Efficient of Curvature C_c=$D_{30}^2/(D_{10}xD_{60})$	Relative Density	IS-Notation	
													Gravel (%)	Coarse (%)	Medium (%)	Fine (%)	Silt (%)	Clay (%)							Gravel	Sand
1.0	15	SS	17.5	38.5	16.6	21.9	1.0	15.0	26.1	Stiff	Above	CI	-	-	-	-	-	76.0	24.0	-	-	-	-	-	FG>50%	FG>50%	FG>50%
2.0	26	SS	-	-	-	-	-	-	-	CG>50%	-	-	-	24.7	17.1	29.3	11.6	17.2		-	-	-	-	-	M.Dense	<50%	SM
3.0	32	SS	16.2	35.5	18.7	16.8	1.2	17.0	40.0	CG>50%	Above	-	-	1.5	1.2	23.3	37.7	30.0	6.3	-	-	-	-	-	Dense	<50%	SC
4.0	51	SS	15.5	34.7	17.6	17.1	1.1	18.0	44.4	CG>50%	Above	-	-	0.0	0.0	13.4	56.3	30.3		-	-	-	-	-	V.Dense	<50%	SC
5.0	>100	SS	-	-	-	-	-	-	-	CG>50%	-	-	-	0.0	0.7	28.2	44.3	26.8		-	-	-	-	-	V.Dense	<50%	SM
6.0	>100	SS	-	-	-	-	-	-	-	CG>50%	-	-	-	6.7	3.0	26.6	35.8	26.9		-	-	-	-	-	V.Dense	<50%	SM
7.5	>100	SS	-	-	-	-	-	-	-	CG>50%	-	-	-	2.6	1.1	26.6	40.1	27.6		-	-	-	-	-	V.Dense	<50%	SM

** END OF REPORT**

Terms and Conditions
(1) The test results furnished corresponds to the sample received
(2) The tested sample will not be retained for more than 45 days from the date of issue of test report except in the case as required by the applicable regulations.
(3) Any correction in this reports invalidates the reports

Authorised Signatory
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(Technical Manager)

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GEOMARINE
Phone No.: 044-24481485, 044-24480305
ULR: TC8559210000000133P

LABORATORY TEST REPORT

GEOMARINE CONSULTANTS PVT LTD- GEOTECHNICAL LABORATORY
NO.11 2nd MAIN ROAD, KANNAPA NAGAR EXTN,
KOTTIVAKKAM, CHENNAI

Name & Address of the Customer	: M/s VGN Homes Private Limited, Amaindakarai, Ch-29	**Customer Reference**	: Email Confirmation
Sample Description	: Soil Sample	**Period of Testing**	: 08/07/2021 to 10/07/2021
Source of Sample	: Customer Supplied- Borehole No. BH-05	**Sample Identification Number**	: SS/GMC/062021/350/BH05
Sample Condition	: Satisfactory	**Test Report No.**	: GT-2242/BH-05
Test Method	: As per Bureau of Indian Standards	**Report Date**	: 10/07/2021
Sample Receipt Date	: 07/07/2021	**Test Report Pages**	: One Page

Table-2.5 Laboratory Classification of Soil Samples from BH-05

Sample Depth (m)	SPT- "N" Value	Type of Sample	Fine Grained (FG)										Specific Gravity AS PER IS 2720 (P-III, SEC-1) - 1980, RA-2010	Coarse Grained (CG)														
			Moisture Content (%) AS PER IS 2720 (P-II) - 1973, RA-2015	LIQUID LIMIT (%) AS PER IS 2720 (P-V) - 1985, RA-2015	PLASTIC LIMIT (%) AS PER IS 2720 (P-V) - 1985, RA-2015	Plasticity Index (I_p= LL-PL)	Consistency Index (I_c=LL-NMC/I_p)	SHRINKAGE LIMIT (%) AS PER IS 2720 (P-VI) - 1972, RA-2011	FREE SWELL INDEX (%) AS PER IS 2720 (P-XL) - 1977, RA-2011	Consistancy	Position With Respect to A-Aline	IS:Notation		GRAIN SIZE ANALYSIS AS PER IS 2720 (P-IV) - 1985, RA-2015						D_{10} (mm)	D_{30}(mm)	D_{60} (mm)	Uniformity Co-Efficient $C_U=D_{60}/D_{10}$	Co-Efficient of Curvature $C_c=D_{30}^2/(D_{10}xD_{60})$	Relative Density	IS-Notation	
														Gravel (%)	Coarse (%)	Medium (%)	Fine (%)	Silt (%)	Clay (%)							Gravel	Sand
1.0	>100	SS	13.0	46.2	17.0	29.2	1.1	-	36.8	CG>50%	Above	-	-	0.0	2.0	21.3	28.3	40.0	8.4	-	-	-	-	-	V.Dense	<50%	SC
2.0	25	SS	15.2	37.9	16.6	21.3	1.1	17.0	87.5	CG>50%	Above	-	-	0.0	2.4	25.5	28.8	43.3		-	-	-	-	-	M.Dense	<50%	SC
3.0	31	SS	16.9	42.6	21.2	21.4	1.2	-	57.9	CG>50%	Above	-	-	0.0	3.3	31.3	29.7	35.7		-	-	-	-	-	Dense	<50%	SC
4.0	59	SS	-	-	-	-	-	-	13.6	CG>50%	-	-	-	0.0	5.7	36.2	29.2	28.9		-	-	-	-	-	V.Dense	<50%	SM
5.0	48	SS	15.5	37.6	19.7	17.9	1.2	17.5	40.0	CG>50%	Above	-	-	0.0	0.0	17.4	42.0	40.6		-	-	-	-	-	Dense	<50%	SC
6.0	70	SS	-	-	-	-	-	-	-	-	-	-	-	0.0	1.2	28.3	40.6	29.9		-	-	-	-	-	V.Dense	<50%	SM
7.5	>100	SS	-	-	-	-	-	-	-	CG>50%	-	-	-	0.0	0.9	30.2	39.1	29.9		-	-	-	-	-	V.Dense	<50%	SM

** END OF REPORT**

Terms and Conditions
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(3) Any correction in this reports invalidates the reports

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Table-2.6 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	3.50	7.29	144	113	2.0	7.16	83	62
2	BH-02	4.70	7.32	137	117	2.0	7.21	77	69
3	BH-03	2.50	7.24	133	124	1.0	7.12	86	64
4	BH-04	2.70	7.31	148	134	2.0	7.19	79	59
5	BH-05	2.50	7.28	135	129	1.0	7.24	82	68

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CHAPTER-3

GEOLOGY & SUB-SURFACE STRATIFICATION

3.0 Preamble:

Geotechnical investigation carried out at a specific site provides location specific sub surface engineering characteristics. However in major project sites where the construction activities spread over a very large area location specific sub surface strata characteristics are studied together with the geological mapping data.

This is required to incorporate the impact of any documented macro-level geological characteristics of the region on the foundation design, irrespective of the location specific sub surface strata characteristics.

In view on the above, though it is beyond the scope of the present study to carry out macro-level geological investigation the regional geology based on the published data is presented and discussed.

3.1 Climate and Rainfall:

The study area receives the rain under the influence of both southeast and northeast monsoons. Predominantly northeast monsoon contributes rainfall and most of the precipitation occurs in the form of cyclonic storm caused due to the depressions in Bay of Bengal. The north east monsoon occurs between October & December. The southwest monsoon rainfall is highly erratic and summer rains are negligible.

The normal annual rainfall over the study area varies from 1100 mm to 1200mm.

3.2 Geomorphology:

Chennai district forms part of coastal plains of northern Tamil Nadu. Major part of the district is having flat topography with very gentle slope towards east. The altitudes of land surface vary from 10 m above MSL in the west to sea level in the east.

Fluvial, marine and erosional landforms are noticed in the district. Marine transgression and regressions and neo-tectonic activity during the recent past have influenced the morphology and resulted in various present landforms.

Meandering streams with small sand bars are present along the course of Adyar River. The pediment and buried pediment in Guindy area in and around the reserved forest, is the only area where the ecological system is less disturbed, while the other areas are completely disturbed by built up area with large-scale human interference and pollution.

3.3 Geology of chennai district:

Chennai district is underlain by various geological formations from ancient Archaean to the Recent Alluvium. The geological formations of the district can be grouped into three units, namely

i) Archaean crystalline rocks

ii) Gondwana (Consolidated Clay/Clayey Silt) and Tertiary sediments and

iii) Recent Alluvium.

The Archaean crystalline rocks of the district comprise chiefly of Charnockite, gneisses and the associated basic and ultra-basic intrusive dykes.

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3.4 Geological Order of the Study Area:

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. 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 borehole investigation, which confirms that the present site does not depict any surprising geological features that are different from that of the region.

3.5 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:					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/m³	Shear Parameters	
	Top BGL	Bottom BGL	Thickness							(Cu) kPa	(ϕ) Deg.
1.0	0.00	3.00	3.00	Silty Clay	Brown	10	-	Stiff	17.5	67	-
2.0	3.00	4.00	1.00	Silty Fine Sand	Greyish Brown	51	Very Dense	-	20.5	-	41.15
3.0	4.00	6.00	2.00	Clayey Silty Sand	Greyish Brown	>100	Very Dense	-	21	-	42.5
4.0	6.00	9.00	3.00	Clayey Silty Sand	Greyish Brown	41	Dense	-	20	-	38.98
5.0	9.00	10.80	1.80	Clayey Silty Sand	Greyish Brown	>100	Very Dense	-	21	-	42.5

REFERENCE BORE HOLE-BH:					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/m³	Shear Parameters	
	Top BGL	Bottom BGL	Thickness							(Cu) kPa	(ϕ) Deg.
1.0	0.00	3.00	3.00	Silty Clay	Greyish Brown	9	-	Stiff	17	60	-
2.0	3.00	6.00	3.00	Clayey Silty Sand	Greyish Brown	18	Medium Dense	-	18	-	32.4
3.0	6.00	10.60	4.60	Clayey Silty Sand	Greyish Brown	>100	Very Dense	-	21	-	42.5

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REFERENCE BORE HOLE-BH:					BH-03	Ref R.L. of G.L. (m):			0.00		
Layer No.	Layer Thk. (m)			Type of Strata	Colour	Ave. Design SPT	Relative Density	Consistency	(γ) kN/m³	Shear Parameters	
	Top BGL	Bottom BGL	Thickness							(Cu) kPa	(ϕ) Deg.
1.0	0.00	2.00	2.00	Silty Clay	Brown	12	-	Stiff	18.5	80	-
2.0	2.00	4.00	2.00	Clayey Silty Sand	Greyish Brown	24	Medium Dense	-	18.5	-	34.2
3.0	4.00	6.00	2.00	Clayey Silty Sand	Greyish Brown	47	Dense	-	20	-	40.33
4.0	6.00	7.80	1.80	Silty Sand	Greyish Brown	>100	Very Dense	-	21	-	42.5

REFERENCE BORE HOLE-BH:					BH-04	Ref R.L. of G.L. (m):			0.00		
Layer No.	Layer Thk. (m)			Type of Strata	Colour	Ave. Design SPT	Relative Density	Consistency	(γ) kN/m³	Shear Parameters	
	Top BGL	Bottom BGL	Thickness							(Cu) kPa	(ϕ) Deg.
1.0	0.00	2.00	2.00	Silty Clay	Brown	15	-	Stiff	20	100	-
2.0	2.00	3.00	1.00	Silty Clay	Grey	26	-	Very Stiff	20.5	173	-
3.0	3.00	5.00	2.00	Clayey Silty Sand	Greyish Brown	42	Dense	-	20	-	39.2
4.0	5.00	7.80	2.80	Silty Sand	Greyish Brown	>100	Very Dense	-	21	-	42.5

REFERENCE BORE HOLE-BH:					BH-05	Ref R.L. of G.L. (m):			0.00		
Layer No.	Layer Thk. (m)			Type of Strata	Colour	Ave. Design SPT	Relative Density	Consistency	(γ) kN/m³	Shear Parameters	
	Top BGL	Bottom BGL	Thickness							(Cu) kPa	(ϕ) Deg.
1.0	0.00	2.00	2.00	Clayey Silty Sand	Brownish Red	>100	Very Dense	-	21	-	42.5
2.0	2.00	4.00	2.00	Clayey Silty Sand	Greyish Brown	28	Medium Dense	-	19	-	35.4
3.0	4.00	6.00	2.00	Clayey Silty Sand	Greyish Brown	54	Very Dense	-	20.5	-	41.6
4.0	6.00	7.80	1.80	Silty Sand	Greyish Brown	85	Very Dense	-	21	-	42.5

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FOUNDATION SYSTEM



CHAPTER-4

FOUNDATION SYSTEM

4.0 PREAMBLE:

In the design of foundation system, the stress-strain compatibility of the super structure, sub structure and the bearing strata should be satisfied both individually and as a combined system. In view of this, the following data are needed for the design of foundation system, defined in terms of the type of sub structure and the bearing strata characteristics.

- The super structure characteristics along with the loading pattern on the sub structure
- The sub soil characteristics that define the required substructure configuration for a safe transfer of super-structural loads to the bearing strata

Considering the above aspects of the foundation design, the suitable type of foundation system is presented below.

4.1 PROPOSED STRUCTURES:

An understanding of the proposed construction and the order of loads on the foundations is needed for choosing the appropriate foundation system. In the present case, the proposed structure is configured with ground and one or two upper floor (residential villas).

For this kind of structure, the column loads could vary between 500 kN to 750 kN depending upon the spacing of columns and spans.

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:

The sub soil in the project site is classified as two layered system based on the characteristics of the sub soil formation encountered in the investigation location. The stratification of the project site is as given below

Layer-I	0.0m to 2.0m/ 3.0m	Stiff to Very Stiff, Silty Clay
Layer-II	2.0m/3.0 to 8.0m	Dense to Very Dense, Clayey Sand/Silty Sand W/binder

4.2 FOUNDATION SYSTEM:

For the kind of proposed construction and sub soil condition shallow foundation can be adopted. In the project site, though the sub soil is good from shear strength consideration from soil volume change considerations (high to moderate free swell index in the top 3.0m), it is recommended to adopt soil replacement technique within the foundation trench.

In the present case, isolated column footing can be located at a depth of 1.05m over a well compacted sand-gravel (1:1) mix or quarry dust of 450mm thickness. Thus the overall depth of foundation excavation will be 1.5m below the existing ground level.

The allowable net safe bearing pressure at 1.5m below the existing ground level borehole wise is given in Table- 4.1. The schematic arrangement of foundation is presented in Fig. 4.1.

Typical computations are presented in Annexure-I.

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TABLE-4.1 RECOMMENDED ALLOWABLE SAFE BEARING PRESSURE						
S.No.	Ref Borehole	Depth of Foundation Excavation below E.G.L (D_e) (m)	Thickness of Soil Replacement (m)	Depth of Foundation from E.G. (D_f) (m)	Safe Bearing Capacity (kPa)	Elastic Settlement (mm)
1.0	BH-01 & BH-02	1.5	0.45	1.05	100	9.38
2.0	BH-03, BH-04 & BH-05			1.05	200	2.24

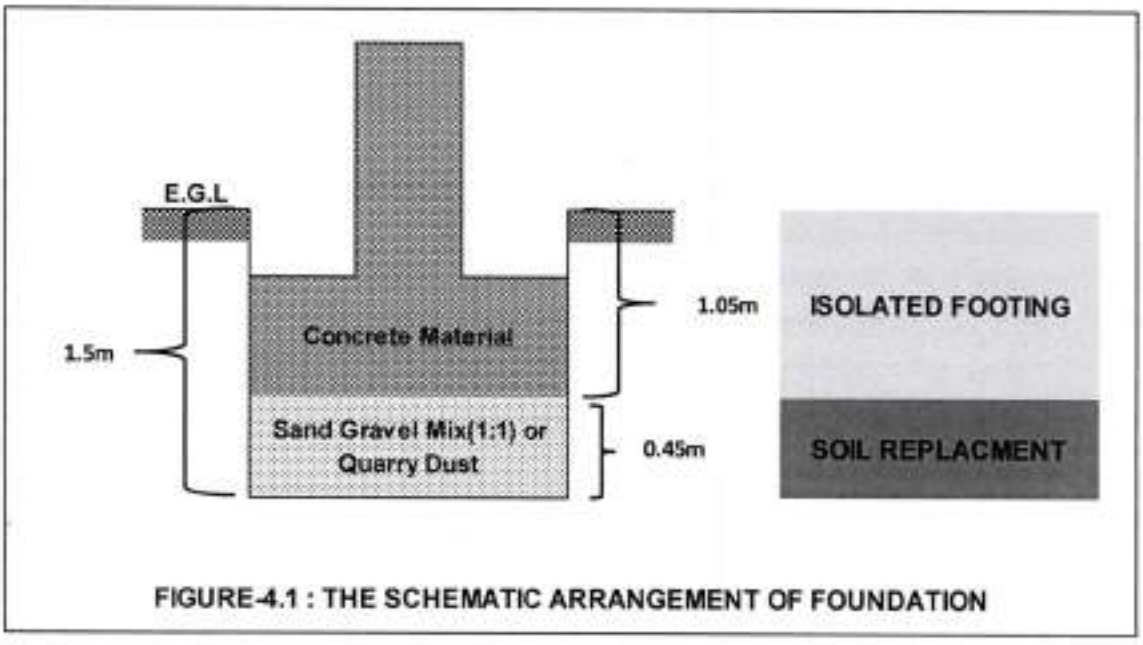


FIGURE-4.1 : THE SCHEMATIC ARRANGEMENT OF FOUNDATION

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RECOMMENDATIONS

CHAPTER-5

RECOMMENDATIONS

- For the kind of sub soil conditions open foundation system coupled with soil replacement type of ground improvement technique within the foundation can be adopted.
- The depth of foundation excavation can be 1.5m below the existing ground level and shall be back filled with either sand-gravel mix (1:1) or quarry dust of 450mm thickness laid in non-compacted layers of thickness not more than 150mm and compacted at optimum moisture content using a plate vibrator.
- The footings can be located at 1.05m over the prepared bed and can be designed for an allowable net safe bearing pressure presented in Table 4.1.
- All columns shall be connected with grade beams in both the directions irrespective of column grid.
- The ground floor shall be minimum 1.0m above the natural ground and the plinth shall be filled with sand-gravel (1:1) mix / quarry dust. This height is recommended to contain the influence of soil volume change on the flooring. In case floor is not raised the ground floor shall be constructed as a suspended R.C.C. slab.
- The chlorides content in ground water & soil-water extract is less than the permissible limit of 500 mg/l as per IS 456 Table 1.0. No special steel is required for the construction.
- Corresponding to the sulphate content in 2:1 Water-Soil extract and ground water use Table 4.0 of IS 456 Clause 2.0 for minimum cement content and maximum water cement ratio. No special cement is required and ordinary Portland cement can be adopted for the construction.

AUTHORISED SIGNATORY

GEO MARINE CONSULTANTS PVT. LTD. CHENNAI-41.

DR. C. V. PRASAD

GEOMARINE CONSULTANTS PRIVATE LIMITED

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ANNEXURE-I

GEO MARINE

TYPICAL BEARING CAPACITY COMPUTATIONS FOR SHALLOW FOUNDATIONS

1.0 COMPUTATION OF BEARING CAPACITY AS PER IS:6403

Ref Borehole BH-01 & BH-02

1.1 Geometrical Data :

Shape of the Foundation	Square
Depth of foundation excavation below E.G.L (m)	1.50
Soil Replacement with Sand-Gravel Mix or Quarry Dust (m)	0.45
Depth of footing "D_f" (m)	1.05
Breadth of Footing "B" (m)	3.00
Length of Footing "L" (m)	3.00
B/L	1.00
Inclination of Vertical Load with the Vertical (a)	0.00

1.2 Soil Data :

Type of Effective Bearing Strata :	Clay
Design SPT "N" of the Bearing Stratum:	7.00
Type of Shear Failure:	General
Undrained Shear Strength (Cu)	46.67

1.3 Design Parameters:

Bulk Density of Soil above the foundation depth (γ_{bulk})	18.00
Water Table Correction Factor (w')	0.50
Effective Overburden pressure at foundation level (q)	12.00
Bearing Capacity Factors:	
N_c =	5.14
N_q =	-
N_g =	-
Shape Factors:	
S_c =	1.30
S_q =	-
S_g =	-
Depth Factors :	
D_c =	1.10
D_q =	-
D_g =	-
Inclination Factor:	
I_c =	1.00
I_q =	-
I_g =	-

1.4 Ultimate Bearing Capacity (Qu) :

Qu=Cu*Nc*Sc*Dc*Ic	343.01	kPa

1.5 Safe Bearing Capacity (Qsafe) :

Factor of Safety (F.S.) :	2.50	
Qsafe :	137.20	kPa
Say Q_{safe}	**100**	**kPa**

2 Computation of Settlement for Maximum Pressure and Size of Footing: (as per IS:8009-Part-I-Ref. Eq.11) (Elastic Analysis)

The immediate elastic settlement (S_i)= $qB(1-m^2)*I/E_s$

q= bearing pressure	100.00	
Poission's Ratio (μ)	0.20	
Modulus of Elasticity (E_s)(Ref. Joseph E Bowels,1996,page316,Table5.6, Japanese design standards)		
Modulus of Elasticity (E_s)	23333	
Size of footing considered for maximum settlement(m)	3.00	
Influence factor	0.95	
Rigidity Factor	0.80	
Elastic Settlement (DH_i)	9.38	mm
	<50	mm

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TYPICAL BEARING CAPACITY COMPUTATIONS FOR SHALLOW FOUNDATIONS

1.0 COMPUTATION OF BEARING CAPACITY AS PER IS:6403

Ref Borehole BH-05

1.1 Geometrical Data :

Shape of the Foundation	Square
Depth of foundation excavation below E.G.L (m)	1.50
Soil Replacement with Sand-Gravel Mix or Quarry Dust (m)	0.45
Depth of footing "D_f" (m)	1.05
Breadth of Footing "B" (m)	1.00
Length of Footing "L" (m)	1.00
B/L	1.00
Inclination of Vertical Load with the Vertical (a)	0.00

1.2 Soil Data :

Type of Effective Bearing Strata :	Clayey Sand
Design SPT "N" of the Bearing Stratum:	25.00
Type of Shear Failure:	General
Angle of Shearing Resistance	34.50

1.3 Design Parameters:

Bulk Density of Soil above the foundation depth (γ_{bulk})	18.00
Water Table Correction Factor (w')	0.50
Effective Overburden pressure at foundation level (q)	12.00
Bearing Capacity Factors:	
N_c =	N/A
N_q =	31.81
N_g =	45.47
Shape Factors:	
S_c =	-
S_q =	1.20
S_g =	0.80
Depth Factors :	
D_c =	-
D_q =	1.03
D_g =	1.03
Inclination Factor:	
I_c =	1.00
I_q =	1.00
I_g =	1.00

1.4 Ultimate Bearing Capacity (Qu) :

Qu=q'(Nq-1)'Sq'Dq'Iq + 0.5'B'g'Ng'Sg'Dg'Ig'w' 624.23 kPa

(g should be read as gama)

1.5 Safe Bearing Capacity (Qsafe) :

Factor of Safety (F.S.) :	2.50	
Qsafe :	249.69	kPa
Say Q_{safe}	**200**	**kPa**

2 Computation of Settlement for Maximum Pressure and Size of Footing: (as per IS:8009-Part-I-Ref. Eq.11) (Elastic Analysis)

The immediate elastic settlement (S_i)= $qB(1-m^2)'I/E_s$

q= bearing pressure	200.00	
Poission's Ratio (μ)	0.20	
Modulus of Elasticity (E_s)(Ref. Joseph E Bowels,1996,page316,Table5.6, Japanese design standards)		
Modulus of Elasticity (E_s)	65000	
Size of footing considered for maximum settlement(m)	1.00	
Influence factor	0.95	
Rigidity Factor	0.80	
Elastic Settlement (DH_i)	2.24	mm
	<50	mm

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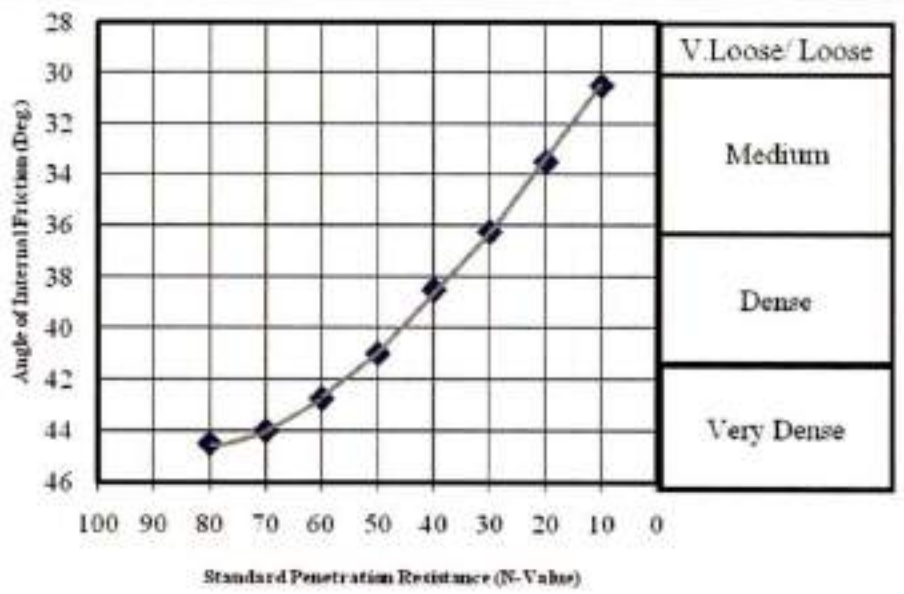


FIG. A1 Relation Ship between Angle of Internal Friction & N-value (Reproduced from IS:6403-1981)

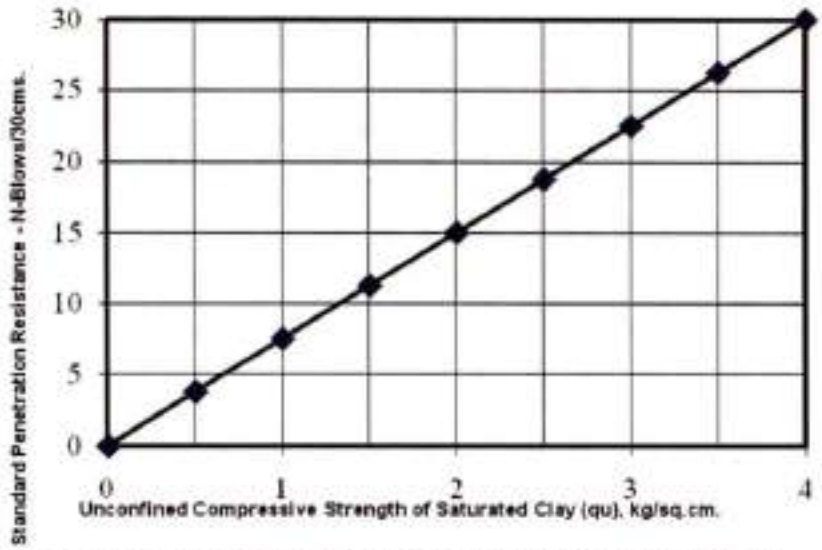


FIG. A2 : Relationship between UCC & SPT-Value (N) of Saturated Clay (AfterTerzhagi & Peck, 1948)

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ANNEXURE-II

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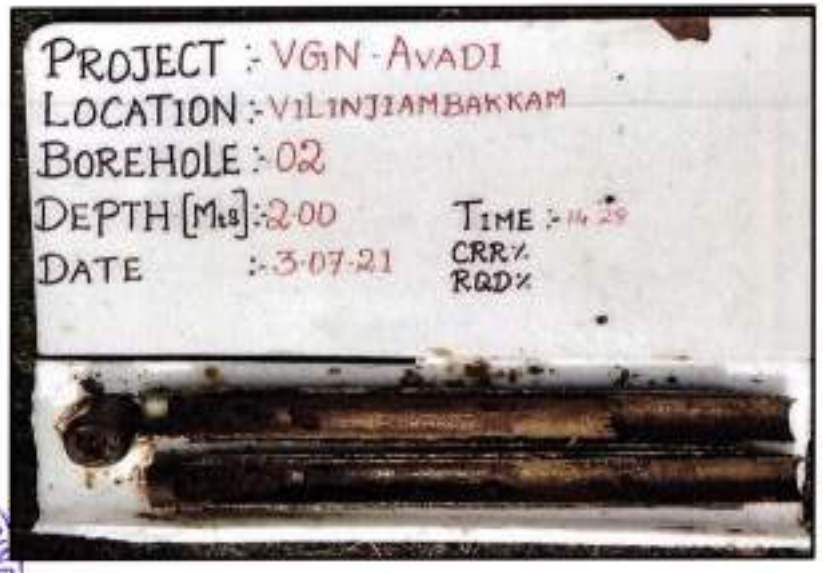


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PROJECT :- VGN - AVADI
LOCATION :- VILINJIAMBAKKAM
BOREHOLE :- 02
DEPTH [Mts] :- 4.00
TIME :- 14.55
DATE :- 3-07-21
CRR%
RQD%


PROJECT :- VGN - AVADI
LOCATION :- VILINJIAMBAKKAM
BOREHOLE :- 02
DEPTH [Mts] :- 5.00
TIME :-
DATE :- 3-07-21
CRR%
RQD%


PROJECT :- VGN - AVADI
LOCATION :- VILINJIAMBAKKAM
BOREHOLE :- 02
DEPTH [Mts] :- 6.00
TIME :- 15.20
DATE :- 3-07-21
CRR%
RQD%


PROJECT :- VGN - AVADI
LOCATION :- VILINJIAMBAKKAM
BOREHOLE :- 02
DEPTH [Mts] :- 7.50
TIME :- 16.40
DATE :- 3-07-21
CRR%
RQD%

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