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NAME OF PROJECT

GEOTECHNICAL INVESTIGATION FOR THE PROPOSED CONSTRUCTION OF
RESIDENTIAL BUILDING CONSISTING OF 1 OR 2 BASEMENT + 1 OR 2 STILT + 16 OR 18
FLOORS SITUATED AT T.S.NOS.22/4-1A, 22/4-1B, 22/5A, 22/5B, 22/B-2, 23/2A2, 23/3, 23/4,
23/5, 24/5, 24/6-1, 24/6-2, 24/6-3, 27/13A2, BLOCK NO.25, WARD - C & T.S.NOS.31, 33/1,
33/2, 34, 61/2, 92, BLOCK NO.26, WARD – C OF ZAMIN PALLAVARAM VILLAGE,
PALLAVARAM TALUK, TAMBARAM CORPORATION.

CLIENT

M/s NCC URBAN INFRASTRUCTURE LIMITED,
SREE MALOLAM, PLOT NO. 5,
VALLAKOTTAI MURUGAN STREET, RAJAMANICKAM NAGAR,
KEELKATTALAI, CHENNAI – 600 017.

TITLE

GEOTECHNICAL INVESTIGATION REPORT

REPORT NO.: GT- 2149(A)



DATE	REVISION	DESCRIPTION		AUTHORISED SIGNATORY
16/05/2022	FIRST SUBMISSION	SUBMISSION OF FINAL GEOTECHNICAL REPORT	SIGN	
			DATE	16/05/2022
			DESIGNATION	MANAGING DIRECTOR
			NAME	DR. C.V.PRASAD

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REPORT TEXT

INTRODUCTION

1.0 PROJECT INFORMATION MATRIX:

NATURE OF PROJECT: **MULTISTOREY RESIDENTIAL BUILDING**

(**1 OR 2 BASEMENT + 1 OR 2 STILT + 15 OR 18 UPPER FLOORS**)

PROJECT OWNER : **M/S NCC URBAN INFRASTRUCTURE LIMITED**

PROJECT LOCATION : **PERUMAL NAGAR, RADIAL ROAD, PALLIKARANAI**

JOB CODE : **GT-2149(A)**

1.1 SCOPE OF WORK:

1.1.1 FIELD WORK:

- ❖ Conducting seven 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 and beyond SPT is conducted at every 2.0m depth interval
 - In case of rock formation core drilling shall be conducted and checked at every 1.5m or 1.0m depth interval
- ❖ 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 limits
- ❖ Grain Size Analysis
- ❖ Strength test on rock core samples
- ❖ 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
- ❖ Liquefaction aspects
- ❖ Foundation System
- ❖ Recommendation
- ❖ Annexure

INVESTIGATION METHODOLOGY & TEST RESULTS

2.0 PREAMBLE:

Seven 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. During the period of investigation, due to monsoon rains water stagnation is observed above the existing ground level hence ground water table is mentioned as E.G.L.

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

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 2.7. The graphical representation of grain size distribution curve for the representative samples in each bore is presented in Fig. 2.9 to 2.15.

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 2.7. The graphical representation of hydrometer analyses curve for the representative samples in each bore is presented in Fig. 2.16 to 2.24.

2.2.3 CHEMICAL ANALYSIS TESTS:

On representative soil-water extract and ground water samples chemical analysis tests were conducted to estimate pH, Chloride and Sulphates and these results are presented in Table- 2.8.

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 2.7.

The cross section variation of sub soil strata in both lateral and vertical is presented in Fig. 2.8.

SITE PLAN

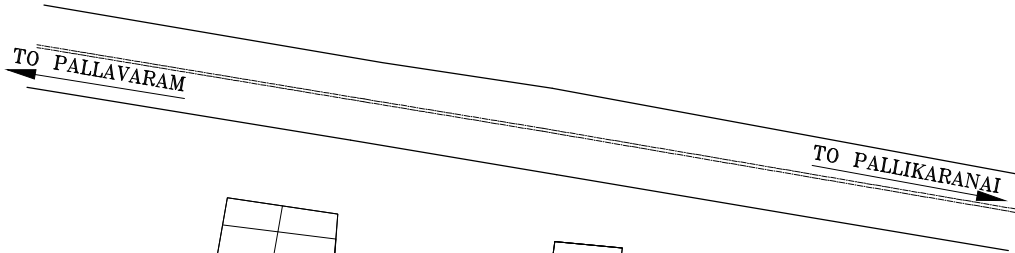
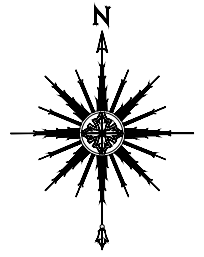
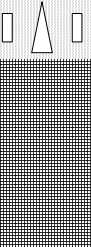
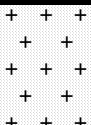
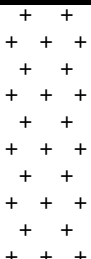
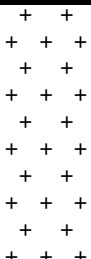
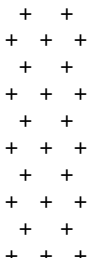
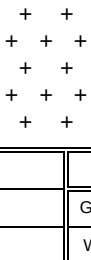


FIG.2.0 SHOWING THE LOCATION OF FIELD INVESTIGATION POINTS AT PALLAVARAM, CHENNAI.

SOIL PROFILES

		SITE INVESTIGATION RECORD						BORE HOLE No.		BH-01								
PROJECT NAME		PROPOSED CONSTRUCTION OF A RESIDENTIAL BUILDING						SHEET		1 OF 2								
LOCATION		Perumal Nagar,Radial Road, Pallavaram		MACHINE No.		-		CHAINAGE (m)		-		DIA OF BORE HOLE		150mm NX				
STRUCTURE		1 Basement + 2 Stilt + 15 Upper Floors		DRILLING METHOD		Rotary		CO-ORDINATES		N -		BORE START DATE		03/12/2020				
JOB CODE		GT-2149		FLUSHING MEDIUM		Bentonite		E -		BORE END DATE		05/12/2020		TOTAL DRILL DAYS				
TOTAL DRILL DAYS		2																
Depth below E.G.L. (m)	Drilling progress per metre		Type of Drill Bit (SC / TCB / DB)	Core Details		SPT Details			Sample Details				Layer Data					
	Time			Total Core Recovery %	R.Q.D %	Blows/cm.			SPT 'N' Value	Depth	No.	Type	RL (m)	Legend	No	Depth	Geotechnical Description	
	Hr.	Min.				0-15	15-30	30-45										
03/12/2020	14	54	SC	-	-	4	6	12	18	1.00	1	SS	-1.0		L1	2.0	Brown Grey,,Moist,Very Stiff,Silty CLAY (CL) With Sand Pockets at times Lean Clay of Low Plasticity 0.5m Filled Up to Facilitate Drilling	
	14	55	SC	-	-	3	7	18	25	1.45	2	SS	-2.0					
	15	09	SC	-	-	40	10Cm Penet for 62Blows			>100	2.00	2	SS	-2.0		L2	3.0	Grey,Pale Brown Shades,Moist,Fine to Coarse Sand Grain Fraction With Gravels,Medium Dense, Residual Soil - Grade VI Weathering (Descent from Hypersthene Granite)
	15	21	SC	-	-	18	16	28	44	2.45	3	SS	-3.0					
	15	23	SC	-	-	5Cm Penet for 52Blows				>100	3.00	3	SS	-3.0		L3	5.0	Yellow Brown,Brown Grey,Moist,Fine to Coare Sand Grain Fraction With Gravels,Dense to Very Dense, Residual Soil & Completely Weathered Rock Mix - Grade W5 Weathering Disintegrated Hypersthene Granitic Rock
	15	35	SC	-	-	5.00				>100	3.25	4	SS	-4.0				
	15	37	SC	-	-	6.00				>100	4.00	4	SS	-4.0		L3	5.0	Grey,Grey Brown Shades,Medium to Coarse Grains Structure,Highly Fractured,Completely & Highly Weathered Rock - Grade W5 & W4 Hypersthene Granitic Rock
	15	51	SC	-	-	5.00				>100	4.45	5	SS	-5.0				
	16	16	DB	8	0	-	-	-	-	-	5.00	5	SS	-5.0		L3	5.0	Grey,Grey Brown Shades,Medium to Coarse Grains Structure,Highly Fractured,Completely & Highly Weathered Rock - Grade W5 & W4 Hypersthene Granitic Rock
	16	40	DB	8	0	-	-	-	-	-	5.05	6	CS	-6.0				
05/12/2020	09	29	DB	0	0	-	-	-	-	6.00	6	CS	-6.0		L3	5.0	Grey,Grey Brown Shades,Medium to Coarse Grains Structure,Highly Fractured,Completely & Highly Weathered Rock - Grade W5 & W4 Hypersthene Granitic Rock	
	09	31	DB	0	0	-	-	-	-	7.50	7	WS	-7.5					
	10	57	DB	3	0	-	-	-	-	9.00	8	CS	-9.0					
	11	25	DB	3	0	-	-	-	-	9.00	8	CS	-9.0					
11	37	DB	7	0	-	-	-	-	-	9.00	8	CS	-9.0		L3	5.0	Grey,Grey Brown Shades,Medium to Coarse Grains Structure,Highly Fractured,Completely & Highly Weathered Rock - Grade W5 & W4 Hypersthene Granitic Rock	
12	03	DB	7	0	-	-	-	-	-	-	-	-						

CS - Core Sample	DS - Disturbed Sample	LOGGED	K.Loganathan	PROJECT SITE DETAILS		REMARKS
SS - Split Spoon Sample	SC - Soil Cutter	DATE	05/12/2020	GROUND LEVEL (m)	0.00	
UDS- Undisturbed Sample	TCB - Tungsten Carbide Bit	CHECKED	A.Vinoth	WATER TABLE (m)	E.G.L	
WS - Wash Sample	DB - Diamond Bit	DATE	10/12/2020	CASING DEPTH (m)	0.00	

		SITE INVESTIGATION RECORD										BORE HOLE No.		BH-01																				
PROJECT NAME		PROPOSED CONSTRUCTION OF A RESIDENTIAL BUILDING										SHEET		2 OF 2																				
LOCATION		Perumal Nagar, Radial Road, Pallavaram		MACHINE No.		-		CHAINAGE (m)		-		DIA OF BORE HOLE		150mm NX																				
STRUCTURE		1 Basement + 2 Stilt + 15 Upper Floors		DRILLING METHOD		Rotary		CO-ORDINATES		N -		BORE START DATE		03/12/2020																				
JOB CODE		GT-2149		FLUSHING MEDIUM		Bentonite		E -		-		BORE END DATE		05/12/2020																				
												TOTAL DRILL DAYS		2																				
Depth below E.G.L. (m)	Drilling progress per metre			Type of Drill Bit (SC / TCB / DB)	Core Details		SPT Details			Sample Details				Layer Data																				
	Date	Time			Total Core Recovery %	R.Q.D %	Blows/cm.			SPT 'N' Value	Depth	No.	Type	RL (m)	Legend	No	Depth	Geotechnical Description																
		Hr.	Min.				0-15	15-30	30-45																									
11	05/12/2020	12	16	DB	10	0	-	-	-	-	10.50	9	CS	-10.5	+ +	L4	12.0	Grey, Grey Brown Shades, Medium to Coarse Grains Structure, Highly Fractured, Completely & Highly Weathered Rock - Grade W5 & W4 Hypersthene Granitic Rock																
12	12	48	13																47	DB	57	25	-	-	-	-	12.00	10	CS	-12.0	+ +	L5	14.0	Grey, Greyish Brown Shades, Medium to Coarse Grain Structure, Fractured at Times, Moderately Weathered Rock - Grade W3 Formation Hypersthene Granite Rock
13	13	25	14																25															
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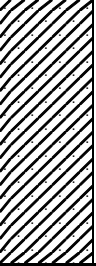
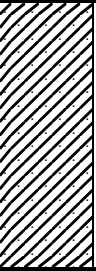
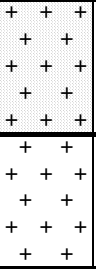
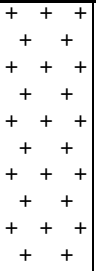
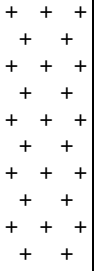
CS - Core Sample		DS - Disturbed Sample		LOGGED		K. Loganathan		PROJECT SITE DETAILS		REMARKS	
SS - Split Spoon Sample		SC - Soil Cutter		DATE		05/12/2020		GROUND LEVEL (m)		0.00	
UDS - Undisturbed Sample		TCB - Tungsten Carbide Bit		CHECKED		A. Vinoth		WATER TABLE (m)		E.G.L	
WS - Wash Sample		DB - Diamond Bit		DATE		10/12/2020		CASING DEPTH (m)		0.00	

Borehole terminated at 14 m depth below E.G.L
FIG.2.1 Sub Soil Profile at BH-01 Location

		SITE INVESTIGATION RECORD						BORE HOLE No.		BH-02								
PROJECT NAME		PROPOSED CONSTRUCTION OF A RESIDENTIAL BUILDING						SHEET		1 OF 1								
LOCATION		Perumal Nagar, Radial Road, Pallavaram		MACHINE No.		-		CHAINAGE (m)		-								
STRUCTURE		1 Basement + 2 Stilt + 15 Upper Floors		DRILLING METHOD		Rotary		CO-ORDINATES		N -								
JOB CODE		GT-2149		FLUSHING MEDIUM		Bentonite		E -		BORE START DATE								
										05/12/2020								
										BORE END DATE								
										07/12/2020								
										TOTAL DRILL DAYS								
										2								
Depth below E.G.L. (m)	Drilling progress per metre		Type of Drill Bit (SC / TCB / DB)	Core Details		SPT Details			Sample Details				Layer Data					
	Date	Time		Total Core Recovery %	R.Q.D %	Blows/cm.			SPT 'N' Value	Depth	No.	Type	RL (m)	Legend	No	Depth	Geotechnical Description	
		Hr.				Min.	0-15	15-30										30-45
1	05/12/2020	11:40 To 11:44	SC	-	-	5	6	12	18	1.00	1	SS	-1.0				Brown, Moist, Poorly Graded, Fine to Coarse Grains Sand Fraction, Medium Dense, Clayey Silty SAND (SC) 0.5m Filled Up to Facilitate Drilling	
2		12:01 To 12:03	SC	-	-	4	8	12	20	1.45 ↓	2	SS	-2.0		L1	2.0		
3		12:20 To 12:23	SC	-	-	25	15Cm Penet for 58Blows			>100	3	SS	-3.0		L2	3.0	Pale Grey & Offwhite at Times, Moist, Fine to Medium Sand Grain Fraction, Medium Dense, Residual Soil - Grade W5 Rock/ Clayey Sand Disintegrated Hypersthene Granite Rock	
4		12:40 To 12:54	SC	-	-	SPT Hammer Rebounded			>100	4.00 ↓	4	WS	-4.0				Greyish Pink to Brown, Fine to Coarse Grain Sand Fraction With Gravels, Very Dense, Completely Weathered Rock - Grade W5 Rock Disintegrated Hypersthene Granitic Rock	
5		14:00 To 14:35	TCB	-	-	-	-	-	-	5.50 ↓	5	WS	-5.5		L3	5.5		
6		14:55 To 16:55	DB	45	0	-	-	-	-	7.00 ↓	6	CS	-7.0				Grey, Greyish Pink Shades, Medium to Coarse Grain Structure, Fractured at Times, Moderately Weathered Rock - Grade III Weathering (Descent from Hypersthene Granite)	
7		Total Drilling Time 3Hrs 27min		DB	59	23	-	-	-	8.50 ↓	7	CS	-8.5		L4	8.5		
8	07/12/2020																	
9		14:50 To 17:20	DB	97	97	-	-	-	-	10.00 ↓	8	CS	-10.0		L5	10.0	Grey, Greyish Pink Shades, Medium to Coarse Grain Structure, Strong, Fresh Rock - Grade W1 Hypersthene Granite	
10																		

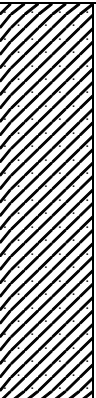
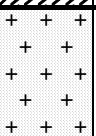
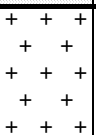
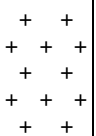
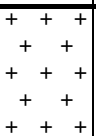
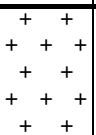
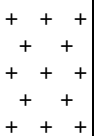
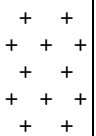
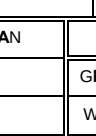
CS - Core Sample	DS - Disturbed Sample	LOGGED	K.Sivasankaran	PROJECT SITE DETAILS		REMARKS
SS - Split Spoon Sample	SC - Soil Cutter	DATE	07/12/2020	GROUND LEVEL (m)	0.00	
UDS- Undisturbed Sample	TCB - Tungsten Carbide Bit	CHECKED	A.Vinoth	WATER TABLE (m)	E.G.L	
WS - Wash Sample	DB - Diamond Bit	DATE	10/12/2020	CASING DEPTH (m)	0.00	

Borehole terminated at 10 m depth below E.G.L
FIG.2.2 Sub Soil Profile at BH-02 Location

		SITE INVESTIGATION RECORD						BORE HOLE No.		BH-03								
PROJECT NAME		PROPOSED CONSTRUCTION OF A RESIDENTIAL BUILDING						SHEET		1 OF 2								
LOCATION		Perumal Nagar,Radial Road, Pallavaram		MACHINE No.		-		CHAINAGE (m)		-		DIA OF BORE HOLE		150mm ☒ NX ☒				
STRUCTURE		1 Basement + 2 Stilt + 15 Upper Floors		DRILLING METHOD		Rotary		CO-ORDINATES		N - E -		BORE START DATE		18/04/2022				
JOB CODE		GT-2149		FLUSHING MEDIUM		Bentonite				E -		BORE END DATE		19/04/2022				
												TOTAL DRILL DAYS		2				
Depth below E.G.L. (m)	Drilling progress per metre			Type of Drill Bit (SC / TCB / DB)	Core Details		SPT Details			Sample Details				Layer Data				
	Time		Total Core Recovery %		R.Q.D %	Blows/cm.			SPT 'N' Value	Depth	No.	Type	RL (m)	Legend	No	Depth	Geotechnical Description	
	Hr.	Min.				0-15	15-30	30-45										
1	16	00	To	SC	-	-	0	1	2	3	1.00	1	SS	-1.0		L1	2.0	Grey,Moist,Poorly Graded, Fine & Medium Grains Sands,Very Loose,Clayey Silty SAND (SC)
	16	04	To	SC	-	-	3	4	5	9	1.45	2	SS	-2.0				
2	16	18	To	SC	-	-	3	5	8	13	2.00	3	SS	-3.0		L2	4.0	Grey,Offwhite at Times,Moist,Poorly Graded, Fine & Medium Grains Sands,Loose & Medium Dense,Clayey Silty SAND (SC)
	16	20	To	SC	-	-	2	15	65	80	2.45	4	SS	-4.0				
3	16	38	To	SC	-	-	12cm Penet for 55Blows			>100	3.00	5	SS	-5.0		L3	5.0	Grey Brown,Offwhite Lime Mix,Fine to Coarse Sand Size Particles,Very Dense, Residual Soil/Completely Weathered Rock - W5 Rock Disintegrated Hypersthene Granite Rock
	16	42	To	SC	-	-					3.45	6	CS	-6.0				
4	16	59	To	SC	-	-					4.00	7	CS	-7.5		L4	6.0	Grey,Greyish Brown,,Medium to Coarse Grain Structure,Highly Fractured & Disintegrated,Highly Weathered Rock - Grade W4 Rock Formation Hypersthene Granitic Rock
	17	07	To	DB	15	0					4.45	8	CS	-9.0				
5	15	25	To	SC	-	-					5.00	9	CS	-10.0		L5	10.0	Grey,Grey Brown at Times,Medium to Coarse Grain Structure,Strong to Very Strong,Highly Fractured, Moderately Weathered Rock - Grade III Rock Formation Hypersthene Granitic Rock
	15	35	To	DB	37	0					5.12							
6	09	55	To	DB	15	0					6.00							
7	10	00	To	DB	37	0					7.50							
8	10	15	To	DB	52	12					9.00							
9	11	05	To	DB	65	0					10.00							
10	14	05	To	DB	65	0												
	15	05	To	DB	65	0												

CS - Core Sample	DS - Disturbed Sample	LOGGED	K.SIVASANKARAN	PROJECT SITE DETAILS		REMARKS
SS - Split Spoon Sample	SC - Soil Cutter	DATE	19/04/2022	GROUND LEVEL (m)	0.00	
UDS- Undisturbed Sample	TCB - Tungsten Carbide Bit	CHECKED	A.VINOTH	WATER TABLE (m)	1.10	
WS - Wash Sample	DB - Diamond Bit	DATE	07/05/2022	CASING DEPTH (m)	0.00	

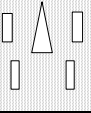
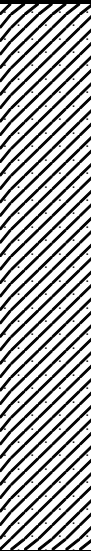
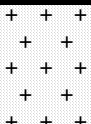
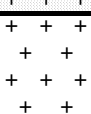
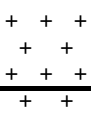
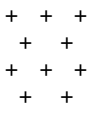
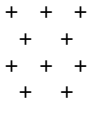
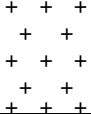
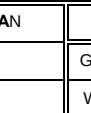
		SITE INVESTIGATION RECORD										BORE HOLE No.		BH-03						
PROJECT NAME		PROPOSED CONSTRUCTION OF A RESIDENTIAL BUILDING										SHEET		2 OF 2						
LOCATION		Perumal Nagar, Radial Road, Pallavaram		MACHINE No.		-		CHAINAGE (m)		-		DIA OF BORE HOLE		150mm NX ☒						
STRUCTURE		1 Basement + 2 Stilt + 15 Upper Floors		DRILLING METHOD		Rotary		CO-ORDINATES		N -		BORE START DATE		18/04/2022						
JOB CODE		GT-2149		FLUSHING MEDIUM		Bentonite		E -		BORE END DATE		19/04/2022		TOTAL DRILL DAYS						
TOTAL DRILL DAYS		2																		
Depth below E.G.L. (m)	Drilling progress per metre			Type of Drill Bit (SC / TCB / DB)	Core Details		SPT Details			Sample Details				Layer Data						
	Date	Time			Total Core Recovery %	R.Q.D %	Blows/cm.			SPT 'N' Value	Depth	No.	Type	RL (m)	Legend	No	Depth	Geotechnical Description		
		Hr.	Min.				0-15	15-30	30-45											
11	19/04/2022	15 To 17	15 05	DB	80	68	-	-	-	-	11.00	10	CS	-11.0	+	+	+	L6	11.0	Grey, Grey Pink, Medium to Coarse Grain Structure, Very Strong to Extreme Strong, Fractured at Times, Slightly Weathered Rock to Fresh Rock - Grade W2 & Grade W1 Hynersthene Granitic Rock
12																				
13																				
14																				
15																				
16																				
17																				
18																				
19																				
20																				
CS - Core Sample				DS - Disturbed Sample				LOGGED		K.SIVASANKARAN				PROJECT SITE DETAILS				REMARKS		
SS - Split Spoon Sample				SC - Soil Cutter				DATE		19/04/2022				GROUND LEVEL (m)		0.00				
UDS- Undisturbed Sample				TCB - Tungsten Carbide Bit				CHECKED		A.VINOTH				WATER TABLE (m)		1.10				
WS - Wash Sample				DB - Diamond Bit				DATE		07/05/2022				CASING DEPTH (m)		0.00				
Borehole terminated at 11 m depth below E.G.L FIG.2.3 Sub Soil Profile at BH-03 Location																				

		SITE INVESTIGATION RECORD						BORE HOLE No.		BH-04							
PROJECT NAME		PROPOSED CONSTRUCTION OF A RESIDENTIAL BUILDING						SHEET		1 OF 2							
LOCATION		Perumal Nagar, Radial Road, Pallavaram		MACHINE No.		-		CHAINAGE (m)		-							
STRUCTURE		1 Basement + 1 Stilt + 18 Upper Floor		DRILLING METHOD		Rotary		CO-ORDINATES		N -							
JOB CODE		GT-2149		FLUSHING MEDIUM		Bentonite		E -		TOTAL DRILL DAYS							
BORE START DATE		20/04/2022		BORE END DATE		21/04/2022		DIA OF BORE HOLE		150mm ✓ NX ✓							
Depth below E.G.L. (m)	Drilling progress per metre		Type of Drill Bit (SC / TCB / DB)	Core Details		SPT Details			Sample Details				Layer Data				
	Time			Total Core Recovery %	R.Q.D %	Blows/cm.			SPT 'N' Value	Depth	No.	Type	RL (m)	Legend	No	Depth	Geotechnical Description
	Hr.	Min.				0-15	15-30	30-45									
1	11:00 To 11:04	SC	-	-	3	4	5	9	1.00	1	SS	-1.0		L1	3.0	Grey, Grey Brown, Moist, Poorly Graded, Fine & Medium Grains Sands With Gravels, Loose to Medium Dense, Clayey Silty SAND (SC) With Gravels	
2	11:17 To 11:20	SC	-	-	4	6	6	12	2.00	2	SS	-2.0					
3	11:35 To 11:40	SC	-	-	6	18	50	68	3.00	3	SS	-3.0					
4	11:58 To 12:06	SC	-	-	15cm Penet for 58Blows			>100	4.00	4	SS	-4.0		L2	4.0	Grey Brown, Offwhite Lime mix, Fine to Coarse Sand Size Particles, Very Dense, Residual Soil/Completely Weathered Rock - W5 Rock Disintegrated Hypersthene Granite Rock	
	12:15 To 12:28	SC	-	-	SPT Hammer Rebounded			>100	4.15	4	SS	-4.0					
	12:45 To 13:06	DB	0	0	SPT Hammer Rebounded			>100	5.00	-	WS	-5.0		L3	6.0	Grey Pink to Brown, Fine to Coarse Sand Size Particles, Very Dense, Completely Weathered Rock - Grade W5 Rock Disintegrated Hypersthene Granitic Rock	
	14:00 To 14:46	DB	18	0	SPT Hammer Rebounded			>100	6.00	-	WS	-6.0					
7	15:00 To 16:00	DB	94	27	-	-	-	-	7.00	5	CS	-7.0		L4	7.0	Grey Pink, Grey Brown at Times, Medium to Coarse Grain Structure, Highly Fractured, Highly Weathered Rock - Grade W4 Rock Formation	
8	16:15 To 17:00	DB	79	40	-	-	-	-	8.00	6	CS	-8.0					
9	17:00 To 18:15	DB	92	52	-	-	-	-	9.00	7	CS	-9.0					
10	18:08 To 19:00	DB	92	52	-	-	-	-	10.00	8	CS	-10.0				Grey, Grey Pink, Medium to Coarse Grain Structure, Very Strong to Extreme Strong, Fractured at Times, Slightly Weathered Rock to Fresh Rock - Grade W2 & Grade W1 Hypersthene Granitic Rock	
CS - Core Sample			DS - Disturbed Sample			LOGGED		K.SIVASANKARAN		PROJECT SITE DETAILS			REMARKS				
SS - Split Spoon Sample			SC - Soil Cutter			DATE		21/04/2022		GROUND LEVEL (m)		0.00					
UDS- Undisturbed Sample			TCB - Tungsten Carbide Bit			CHECKED		A.VINOTH		WATER TABLE (m)		1.00					
WS - Wash Sample			DB - Diamond Bit			DATE		07/05/2022		CASING DEPTH (m)		0.00					

		SITE INVESTIGATION RECORD						BORE HOLE No.		BH-04								
PROJECT NAME		PROPOSED CONSTRUCTION OF A RESIDENTIAL BUILDING						SHEET		2 OF 2								
LOCATION		Perumal Nagar, Radial Road, Pallavaram		MACHINE No.		-		CHAINAGE (m)		-								
STRUCTURE		1 Basement + 1 Stilt + 18 Upper Floor		DRILLING METHOD		Rotary		CO-ORDINATES		N -								
JOB CODE		GT-2149		FLUSHING MEDIUM		Bentonite		E -		TOTAL DRILL DAYS								
BORE START DATE		20/04/2022		BORE END DATE		21/04/2022		DIA OF BORE HOLE		150mm NX								
Depth below E.G.L. (m)	Drilling progress per metre		Type of Drill Bit (SC / TCB / DB)	Core Details		SPT Details			Sample Details				Layer Data					
	Date	Time		Total Core Recovery %	R.Q.D %	Blows/cm.			SPT 'N' Value	Depth	No.	Type	RL (m)	Legend	No	Depth	Geotechnical Description	
		Hr.				Min.	0-15	15-30										30-45
21/04/2022	09	15	DB	77	57	-	-	-	-	11.00	9	CS	-11.0	+	+	+	Grey, Grey Pink, Medium to Coarse Grain Structure, Very Strong to Extreme Strong, Fractured at Times, Slightly Weathered Rock to Fresh Rock - Grade W2 & Grade W1 Hynersthene Granitic Rock	
	To	00																
11																		
12																		
13																		
14																		
15																		
16																		
17																		
18																		
19																		
20																		
CS - Core Sample		DS - Disturbed Sample		LOGGED		K.SIVASANKARAN		PROJECT SITE DETAILS				REMARKS						
SS - Split Spoon Sample		SC - Soil Cutter		DATE		21/04/2022		GROUND LEVEL (m)				0.00						
UDS- Undisturbed Sample		TCB - Tungsten Carbide Bit		CHECKED		A.VINOTH		WATER TABLE (m)				1.00						
WS - Wash Sample		DB - Diamond Bit		DATE		07/05/2022		CASING DEPTH (m)				0.00						
Borehole terminated at 11 m depth below E.G.L FIG.2.4 Sub Soil Profile at BH-04 Location																		

		SITE INVESTIGATION RECORD						BORE HOLE No.		BH-05								
PROJECT NAME		PROPOSED CONSTRUCTION OF A RESIDENTIAL BUILDING						SHEET		1 OF 2								
LOCATION		Perumal Nagar, Radial Road, Pallavaram		MACHINE No.		-		CHAINAGE (m)		-		DIA OF BORE HOLE		150mm ☒ NX ☒				
STRUCTURE		1 Basement + 1 Stilt + 18 Upper Floor		DRILLING METHOD		Rotary		CO-ORDINATES		N - E		BORE START DATE		22/04/2022				
JOB CODE		GT-2149		FLUSHING MEDIUM		Bentonite		E -		-		BORE END DATE		22/04/2022				
TOTAL DRILL DAYS		1																
Depth below E.G.L. (m)	Drilling progress per metre			Type of Drill Bit (SC / TCB / DB)	Core Details		SPT Details			Sample Details				Layer Data				
	Date	Time			Total Core Recovery %	R.Q.D %	Blows/cm.			SPT 'N' Value	Depth	No.	Type	RL (m)	Legend	No	Depth	Geotechnical Description
		Hr.	Min.				0-15	15-30	30-45									
1	22/04/2022	09	10	SC	-	-												Filled Up/ Debris of Building Materials to Facilitate Drilling Rig Placement
2		To	14	SC	-	-	5	4	4	8	2.00	1	SS	-0.9				Grey, Moist, Poorly Graded, Fine & Medium Grains Sands, Loose, Clayey Silty SAND (SC)
3		09	30	SC	-	-	0	0	1	1	2.45	2	SS	-1.9				Grey, Offwhite Grey, Moist, Poorly Graded, Fine & Medium Grains Sands With Gravels, Very Loose, Clayey Silty SAND (SC)
4		To	33	SC	-	-	3	9	6	15	3.00	3	SS	-2.9				Grey Brown, Moist, Poorly Graded, Fine to Coarse Sand With Gravels, Medium Dense, Clayey Silty SAND (SC)
5		09	47	SC	-	-	15	49	54	103	3.45	4	SS	-3.9				Grey Brown, Offwhite Lime Mix, Fine to Coarse Sand Size Particles, Very Dense, Residual Soil/ Completely Weathered Rock - W5 Rock
6		09	51	SC	-	-	SPT Hammer Rebounded			>100	5.45	5	-	-4.9				Disintegrated Hypersthene Granite Rock
7		To	19	DB	-	-					6.00	6	CS	-6.4				Grey, Grey Pink, Grey Brown at Times, Medium to Coarse Grain Structure, Highly Fractured & Disintegrated, Highly Weathered Rock - Grade W4 Rock Formation Hypersthene Granitic Rock
8		10	07	DB	-	-					7.50	7	CS	-7.9				Grey, Grey Brown at Times, Medium to Coarse Grain Structure, Strong to Very Strong, Highly Fractured, Moderately Weathered Rock - Grade III Rock Formation Hypersthene Granitic Rock
9		To	15	DB	61	15					9.00	8	CS	-8.9				Grey, Grey Pink, Medium to Coarse Grain Structure, Very Strong to Extreme Strong, Fractured at Times, Slightly Weathered Rock to Fresh Rock - Grade W2 & Grade W1 Hypersthene Granitic Rock
10		15	15	DB	83	56					10.00							
CS - Core Sample		DS - Disturbed Sample		LOGGED		K.SIVASANKARAN		PROJECT SITE DETAILS		REMARKS								
SS - Split Spoon Sample		SC - Soil Cutter		DATE		22/04/2022		GROUND LEVEL (m)		1.10		*(F) - Sample Failed						
UDS- Undisturbed Sample		TCB - Tungsten Carbide Bit		CHECKED		A.VINOTH		WATER TABLE (m)		1.20								
WS - Wash Sample		DB - Diamond Bit		DATE		07/05/2022		CASING DEPTH (m)		0.00								

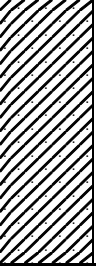
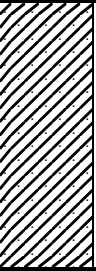
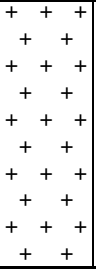
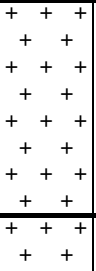
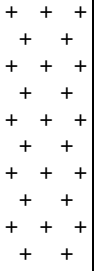
		SITE INVESTIGATION RECORD										BORE HOLE No. BH-05							
												SHEET		2	OF	2			
PROJECT NAME		PROPOSED CONSTRUCTION OF A RESIDENTIAL BUILDING										DIA OF BORE HOLE		150mm					
LOCATION		Perumal Nagar, Radial Road, Pallavaram		MACHINE No.		-		CHAINAGE (m)		-		BORE START DATE		22/04/2022					
STRUCTURE		1 Basement + 1 Stilt + 18 Upper Floor		DRILLING METHOD		Rotary		CO-ORDINATES		N	-	BORE END DATE		22/04/2022					
JOB CODE		GT-2149		FLUSHING MEDIUM		Bentonite		CO-ORDINATES		E	-	TOTAL DRILL DAYS		1					
Depth below E.G.L. (m)	Drilling progress per metre		Type of Drill Bit (SC / TCB / DB)	Core Details		SPT Details			Sample Details				Layer Data						
	Date	Time		Total Core Recovery %	R.Q.D %	Blows/cm.			SPT 'N' Value	Depth	No.	Type	RL (m)	Legend	No	Depth	Geotechnical Description		
		Hr.				Min.	0-15	15-30										30-45	
11	22/04/2022	16 To 17	10 00	DB	90	59	-	-	-	-	11.00	10	CS	-9.9	+ + + + + + + + + + + +	L8	11.0	Grey, Grey Pink, Medium to Coarse Grain Structure, Very Strong to Extreme Strong, Fractured at Times, Slightly Weathered Rock to Fresh Rock - Grade W2 & Grade W1 Hynersthene Granitic Rock	
12																			
13																			
14																			
15																			
16																			
17																			
18																			
19																			
20																			
CS - Core Sample				DS - Disturbed Sample				LOGGED		K.SIVASANKARAN				PROJECT SITE DETAILS				REMARKS	
SS - Split Spoon Sample				SC - Soil Cutter				DATE		22/04/2022				GROUND LEVEL (m)		1.10			
UDS- Undisturbed Sample				TCB - Tungsten Carbide Bit				CHECKED		A.VINOTH				WATER TABLE (m)		1.20			
WS - Wash Sample				DB - Diamond Bit				DATE		07/05/2022				CASING DEPTH (m)		0.00			
Borehole terminated at 11 m depth below E.G.L FIG.2.5 Sub Soil Profile at BH-05 Location																			

		SITE INVESTIGATION RECORD						BORE HOLE No.		BH-06								
								SHEET		1	OF	2						
PROJECT NAME		PROPOSED CONSTRUCTION OF A RESIDENTIAL BUILDING						DIA OF BORE HOLE		150mm		✓						
		NX		✓														
LOCATION		Perumal Nagar, Radial Road, Pallavaram		MACHINE No.		-		CHAINAGE (m)		-		BORE START DATE		25/04/2022				
STRUCTURE		2 Basement + 1 Stilt + 18 Upper Floors		DRILLING METHOD		Rotary		CO-ORDINATES		N		-		BORE END DATE		26/04/2022		
JOB CODE		GT-2149		FLUSHING MEDIUM		Bentonite				E		-		TOTAL DRILL DAYS		2		
Depth below E.G.L. (m)	Drilling progress per metre			Type of Drill Bit (SC / TCB / DB)	Core Details		SPT Details			Sample Details				Layer Data				
	Date	Time			Total Core Recovery %	R.Q.D %	Blows/cm.			SPT 'N' Value	Depth	No.	Type	RL (m)	Legend	No	Depth	Geotechnical Description
		Hr.	Min.				0-15	15-30	30-45									
25/04/2022		12	00	SC	-	-	0	1	5	6	1.00	1	SS	-0.1		L1	0.9	Filled Up/ Debris of Building Materials
		12	03															
		12	15	SC	-	-	2	4	4	8	2.00	2	SS	-1.1		L2	5.0	Grey, Moist, Poorly Graded, Fine & Medium Grains Sands, Loose, Clayey Silty SAND (SC)
		12	18															
		12	40	SC	-	-	4	5	4	9	3.00	3	SS	-2.1		L3	6.0	Grey Brown, Offwhite Lime Mix, Fine to Coarse Sand Size Particles, Dense, Residual Soil/Completely Weathered Rock - W5 Rock
		12	45															
		12	57	SC	-	-	2	3	6	9	4.00	4	SS	-3.1		L4	7.5	Grey, Grey Brown at Times, Medium to Coarse Grain Structure, Strong to Very Strong, Highly Fractured, Moderately Weathered Rock - Grade III Rock Formation
		13	00															
		14	00	SC	-	-	9	22	18	40	5.00	5	SS	-4.1		L4	7.5	Hypersthene Granitic Rock
		14	06															
	14	19	DB	-	-	9cm Penet for 58Blows			>100	6.00	6	SS	-5.1		L3	6.0	Disintegrated Hypersthene Granite Rock	
	14	28																
	14	45	DB	22	0	-	-	-	-	6.09	7	CS	-6.6		L4	7.5	Grey, Grey Pink, Medium to Coarse Grain Structure, Very Strong to Extreme Strong, Fractured at Times, Slightly Weathered Rock to Fresh Rock - Grade W2 & Grade W1	
	15	35																
26/04/2022		15	50	DB	80	26	-	-	-	-	9.00	8	CS	-8.1				Hypersthene Granitic Rock
		16	40															
		09	08	DB	73	25	-	-	-	-	10.00	9	CS	-9.1				
	09	50																
CS - Core Sample				DS - Disturbed Sample				LOGGED		K.SIVASANKARAN		PROJECT SITE DETAILS		REMARKS				
SS - Split Spoon Sample				SC - Soil Cutter				DATE		26/04/2022		GROUND LEVEL (m)		0.90				
UDS- Undisturbed Sample				TCB - Tungsten Carbide Bit				CHECKED		A.VINOTH		WATER TABLE (m)		1.20				
WS - Wash Sample				DB - Diamond Bit				DATE		07/05/2022		CASING DEPTH (m)		0.00				

		SITE INVESTIGATION RECORD										BORE HOLE No.		BH-06				
PROJECT NAME		PROPOSED CONSTRUCTION OF A RESIDENTIAL BUILDING										SHEET		2 OF 2				
LOCATION		Perumal Nagar, Radial Road, Pallavaram		MACHINE No.		-		CHAINAGE (m)		-		DIA OF BORE HOLE		150mm NX				
STRUCTURE		2 Basement + 1 Stilt + 18 Upper Floors		DRILLING METHOD		Rotary		CO-ORDINATES		N -		BORE START DATE		25/04/2022				
JOB CODE		GT-2149		FLUSHING MEDIUM		Bentonite		E -		BORE END DATE		26/04/2022		TOTAL DRILL DAYS				
TOTAL DRILL DAYS		2																
Depth below E.G.L. (m)	Drilling progress per metre			Type of Drill Bit (SC / TCB / DB)	Core Details		SPT Details			Sample Details				Layer Data				
	Date	Time			Total Core Recovery %	R.Q.D %	Blows/cm.			SPT 'N' Value	Depth	No.	Type	RL (m)	Legend	No	Depth	Geotechnical Description
		Hr.	Min.				0-15	15-30	30-45									
26/04/2022	10	05	DB	74	60	-	-	-	-	11.00	10	CS	-10.1	+	+	+	Grey, Grey Pink, Medium to Coarse Grain Structure, Very Strong to Extreme Strong, Fractured at Times, Slightly Weathered Rock to Fresh Rock - Grade W2 & Grade W1 Hynersthene Granitic Rock	
11		10	55															
12																		
13																		
14																		
15																		
16																		
17																		
18																		
19																		
20																		

CS - Core Sample		DS - Disturbed Sample		LOGGED		K.SIVASANKARAN		PROJECT SITE DETAILS		REMARKS	
SS - Split Spoon Sample		SC - Soil Cutter		DATE		26/04/2022		GROUND LEVEL (m)		0.90	
UDS- Undisturbed Sample		TCB - Tungsten Carbide Bit		CHECKED		A.VINOTH		WATER TABLE (m)		1.20	
WS - Wash Sample		DB - Diamond Bit		DATE		07/05/2022		CASING DEPTH (m)		0.00	

Borehole terminated at 11 m depth below E.G.L
FIG.2.6 Sub Soil Profile at BH-06 Location

		SITE INVESTIGATION RECORD						BORE HOLE No.		BH-07								
								SHEET		1	OF	2						
PROJECT NAME		PROPOSED CONSTRUCTION OF A RESIDENTIAL BUILDING						DIA OF BORE HOLE		150mm NX								
LOCATION		Perumal Nagar,Radial Road, Pallavaram		MACHINE No.		-		CHAINAGE (m)		-								
STRUCTURE		2 Basement + 1 Stilt + 18 Upper Floors		DRILLING METHOD		Rotary		CO-ORDINATES		N - E -								
JOB CODE		GT-2149		FLUSHING MEDIUM		Bentonite		BORE START DATE		27/04/2022								
								BORE END DATE		27/04/2022								
								TOTAL DRILL DAYS		1								
Depth below E.G.L. (m)	Drilling progress per metre			Type of Drill Bit (SC / TCB / DB)	Core Details		SPT Details			Sample Details				Layer Data				
	Date	Time			Total Core Recovery %	R.Q.D %	Blows/cm.			SPT 'N' Value	Depth	No.	Type	RL (m)	Legend	No	Depth	Geotechnical Description
		Hr.	Min.				0-15	15-30	30-45									
09 55 To 10 00				SC	-	-	0	2	3	5	1.00	1	SS	-1.0		L1	2.0	Grey,Moist,Poorly Graded, Fine & Medium Grains Sands,Loose,Clayey Silty SAND (SC)
10 12 To 10 15				SC	-	-	4	7	9	16	2.00	2	SS	-2.0				
10 28 To 10 34				SC	-	-	5	7	10	17	3.00	3	SS	-3.0		L2	4.0	Grey,Moist,Poorly Graded, Fine & Medium Grains Sands,Medium Dense,Clayey Silty SAND (SC)
10 50 To 10 55				SC	-	-	15cm Penet for 58Blows			>100	4.00	4	SS	-4.0				
11 10 To 11 20				SC	-	-	SPT Hammer Rebounded			>100	5.00	-	WS	-5.0		L3	6.0	Grey to Grey Brown,Fine to Coarse Sand Size Particles With Gravels,Very Dense,Completely Weathered Rock - Grade W5 Rock Disintegrated Hypersthene Granitic Rock
11 33 To 11 56				TCB	0	0	SPT Hammer Rebounded			>100	6.00	-	WS	-6.0				
12 10 To 12 50				DB	25	7	-	-	-	-	7.50	5	CS	-7.5		L4	7.5	Grey,Grey Brown at Times,Medium to Coarse Grain Structure,Strong to Very Strong,Highly Fractured,Moderately Weathered Rock - Grade III Rock Formation Hypersthene Granitic Rock
14 00 To 14 49				DB	97	87	-	-	-	-	9.00	6	CS	-9.0				
15 00 To 15 40				DB	100	100	-	-	-	-	10.00	7	CS	-10.0				Grey,Grey Pink,Medium to Coarse Grain Structure,Very Strong to Extreme Strong,Fractured at Times,Slightly Weathered Rock to Fresh Rock - Grade W2 & Grade W1 Hypersthene Granitic Rock
CS - Core Sample				DS - Disturbed Sample				LOGGED		K.SIVASANKARAN		PROJECT SITE DETAILS		REMARKS				
SS - Split Spoon Sample				SC - Soil Cutter				DATE		00-01-00		GROUND LEVEL (m)		0.00				
UDS- Undisturbed Sample				TCB - Tungsten Carbide Bit				CHECKED		A.VINOTH		WATER TABLE (m)		1.20				
WS - Wash Sample				DB - Diamond Bit				DATE		07/05/2022		CASING DEPTH (m)		0.00				

		SITE INVESTIGATION RECORD										BORE HOLE No. BH-07							
												SHEET		2	OF	2			
PROJECT NAME		PROPOSED CONSTRUCTION OF A RESIDENTIAL BUILDING										DIA OF BORE HOLE		150mm					
LOCATION		Perumal Nagar, Radial Road, Pallavaram		MACHINE No.		-		CHAINAGE (m)		-		BORE START DATE		27/04/2022					
STRUCTURE		2 Basement + 1 Stilt + 18 Upper Floors		DRILLING METHOD		Rotary		CO-ORDINATES		N	-	BORE END DATE		27/04/2022					
JOB CODE		GT-2149		FLUSHING MEDIUM		Bentonite		CO-ORDINATES		E	-	TOTAL DRILL DAYS		1					
Depth below E.G.L. (m)	Drilling progress per metre		Type of Drill Bit (SC / TCB / DB)	Core Details		SPT Details			Sample Details				Layer Data						
	Date	Time		Total Core Recovery %	R.Q.D %	Blows/cm.			SPT 'N' Value	Depth	No.	Type	RL (m)	Legend	No	Depth	Geotechnical Description		
		Hr.				Min.	0-15	15-30										30-45	
11	27/04/2022	15 To 16	50 35	DB	100	100	-	-	-	-	11.00	10	CS	-11.0	+ + + + + + + + + + + +	L5	11.0	Grey, Grey Pink, Medium to Coarse Grain Structure, Very Strong to Extreme Strong, Fractured at Times, Slightly Weathered Rock to Fresh Rock - Grade W2 & Grade W1 Hynersthene Granitic Rock	
12																			
13																			
14																			
15																			
16																			
17																			
18																			
19																			
20																			
CS - Core Sample				DS - Disturbed Sample				LOGGED		K.SIVASANKARAN				PROJECT SITE DETAILS				REMARKS	
SS - Split Spoon Sample				SC - Soil Cutter				DATE		27/04/2022				GROUND LEVEL (m)		0.00			
UDS- Undisturbed Sample				TCB - Tungsten Carbide Bit				CHECKED		A.VINOTH				WATER TABLE (m)		1.20			
WS - Wash Sample				DB - Diamond Bit				DATE		07/05/2022				CASING DEPTH (m)		0.00			
Borehole terminated at 11 m depth below E.G.L FIG.2.7 Sub Soil Profile at BH-07 Location																			

CROSS SECTION PROFILE

GRAIN SIZE DISTRIBUTION CURVE

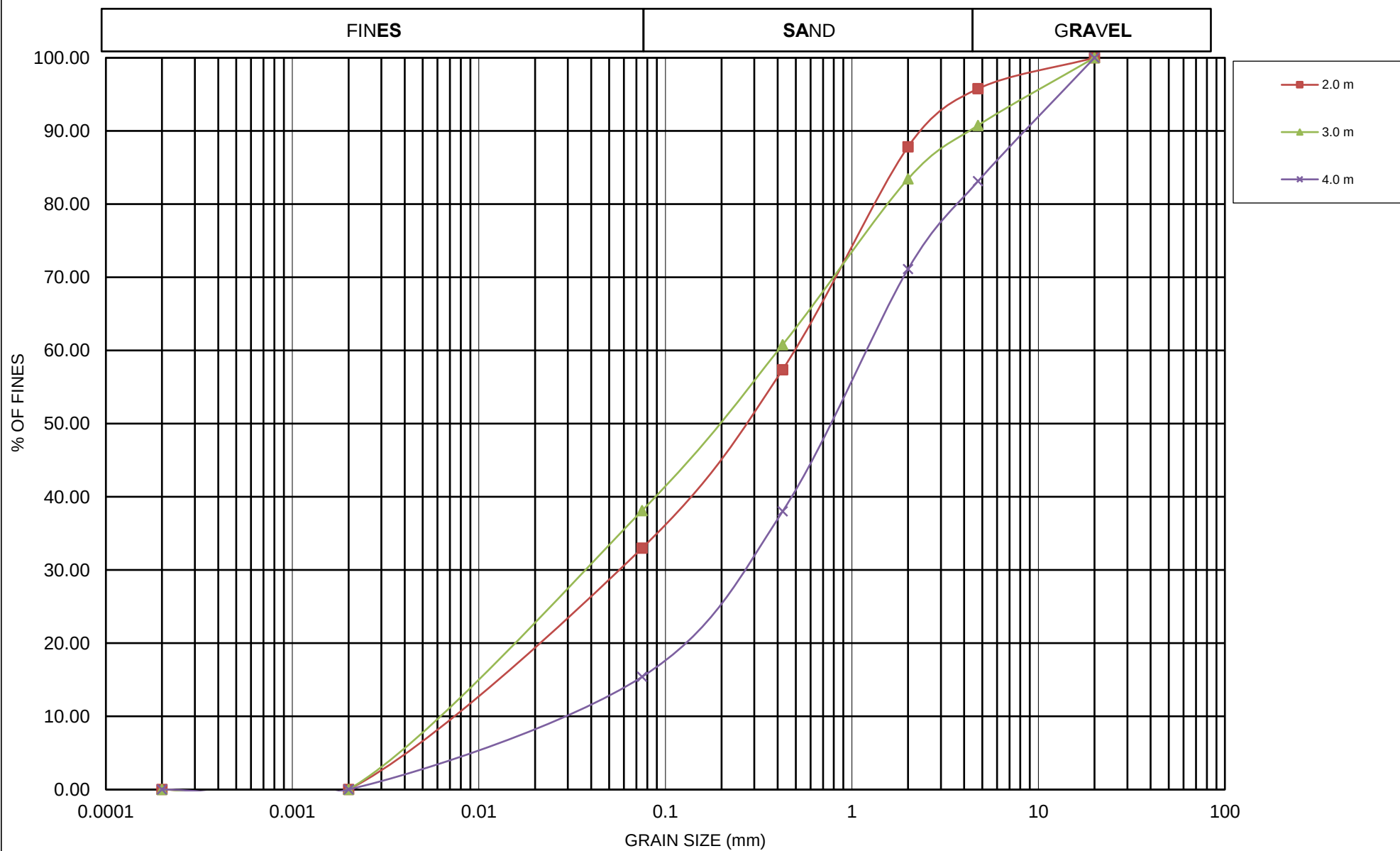


Fig. 2.9 GRAIN SIZE DISTRIBUTION CURVE - BH-01

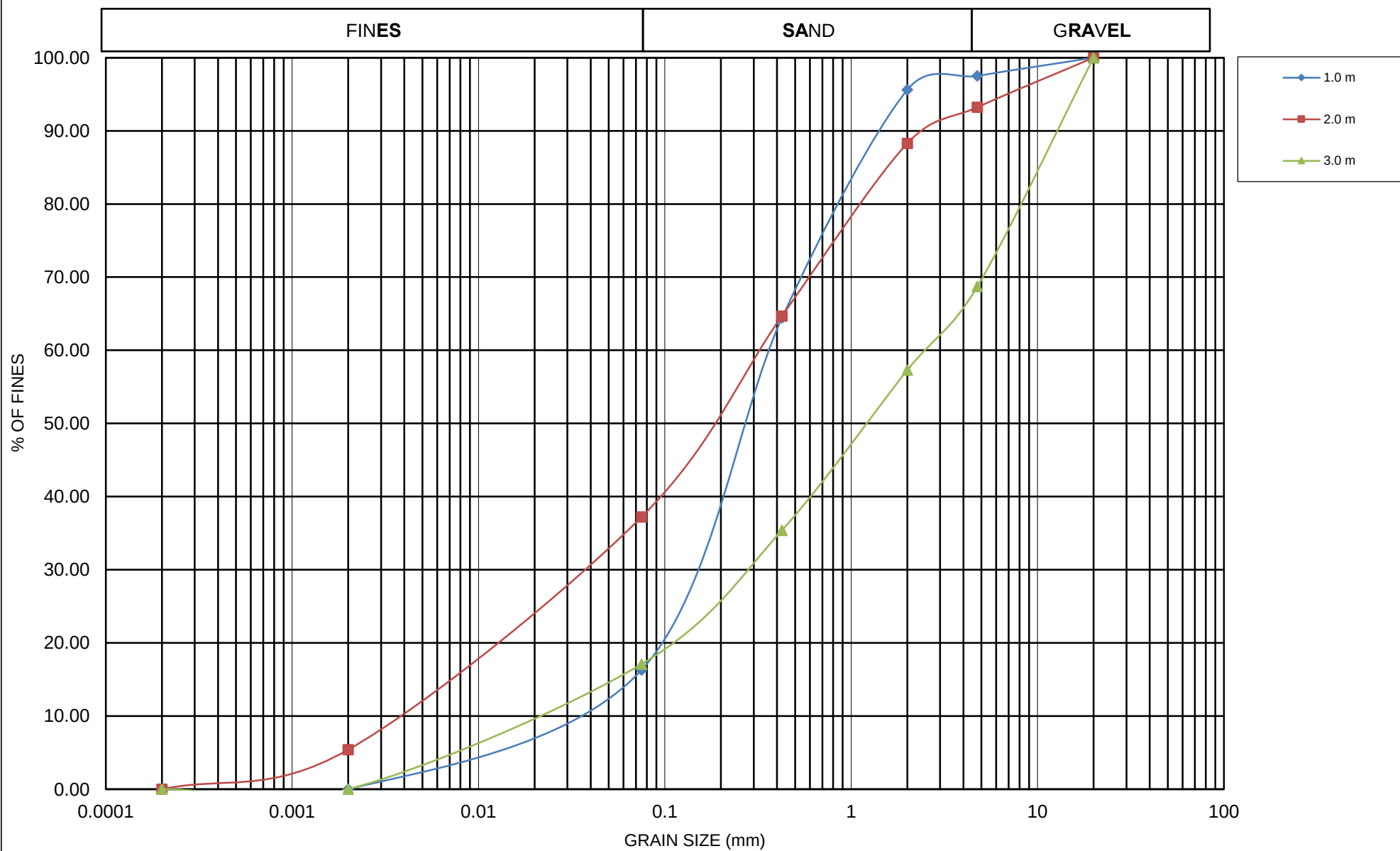


Fig. 2.10 **GRAIN SIZE DISTRIBUTION CURVE - BH-02**

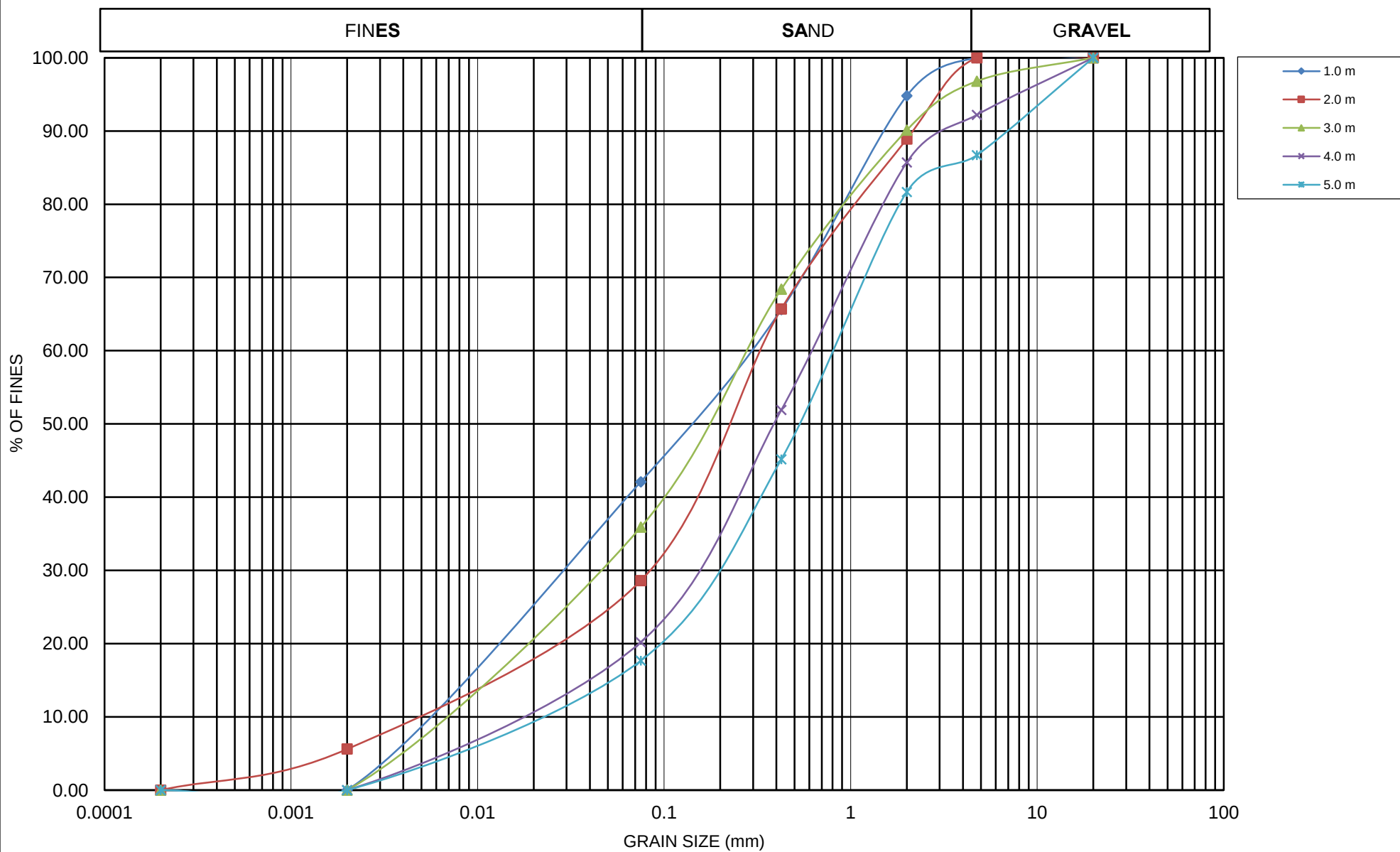


Fig. 2.11 GRAIN SIZE DISTRIBUTION CURVE - BH-03

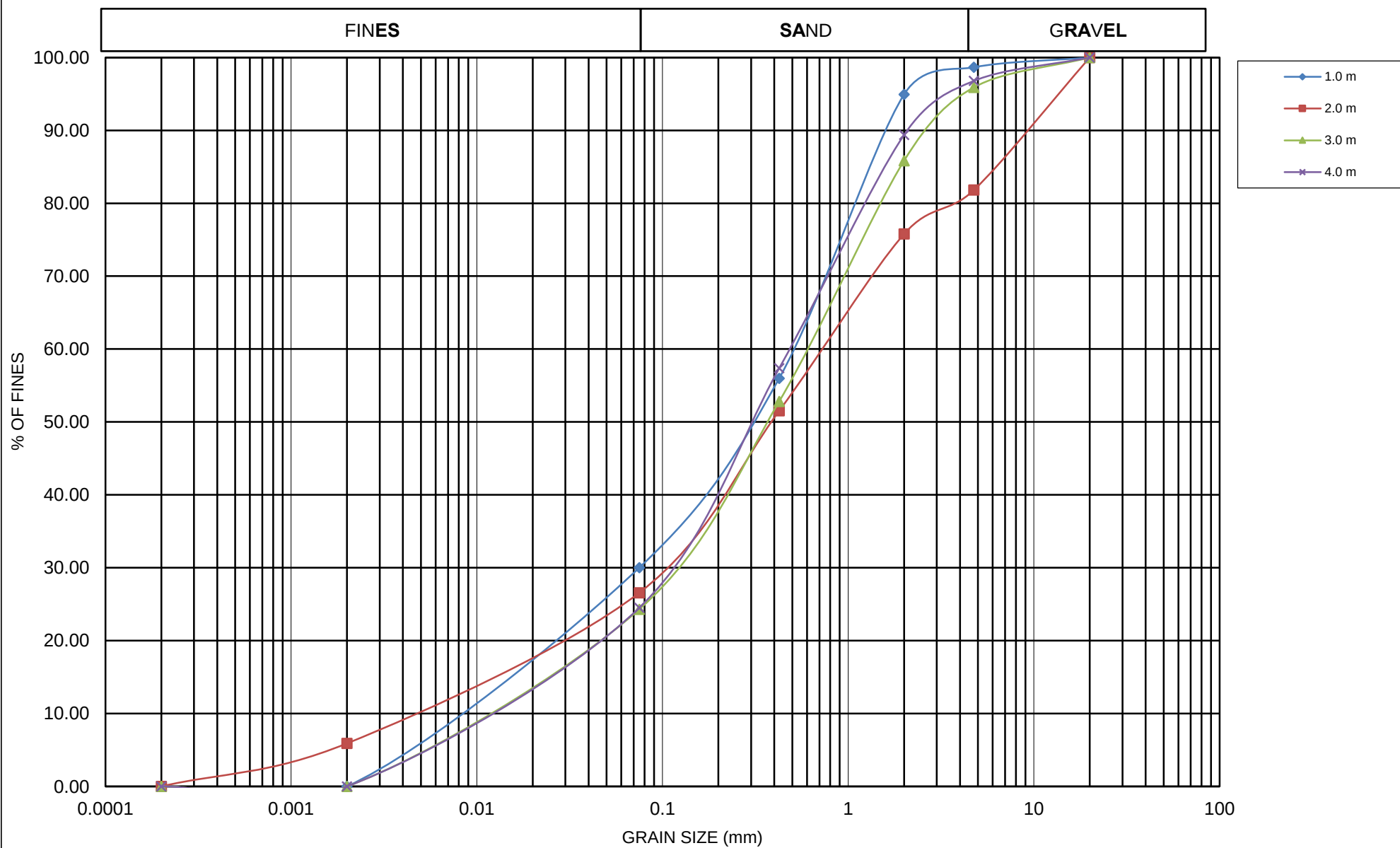


Fig. 2.12 **GRAIN SIZE DISTRIBUTION CURVE - BH-04**

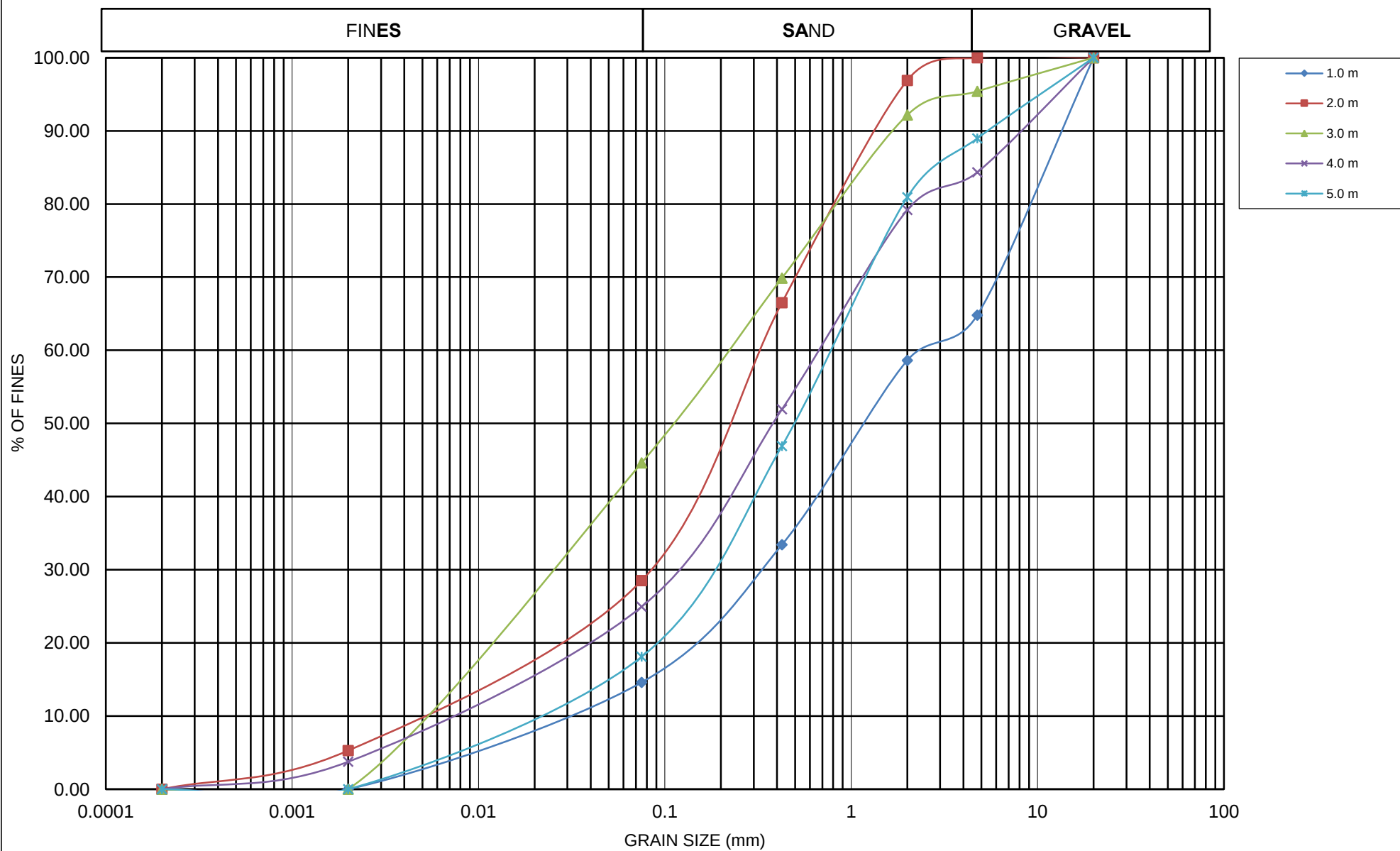


Fig. 2.13 GRAIN SIZE DISTRIBUTION CURVE - BH-05

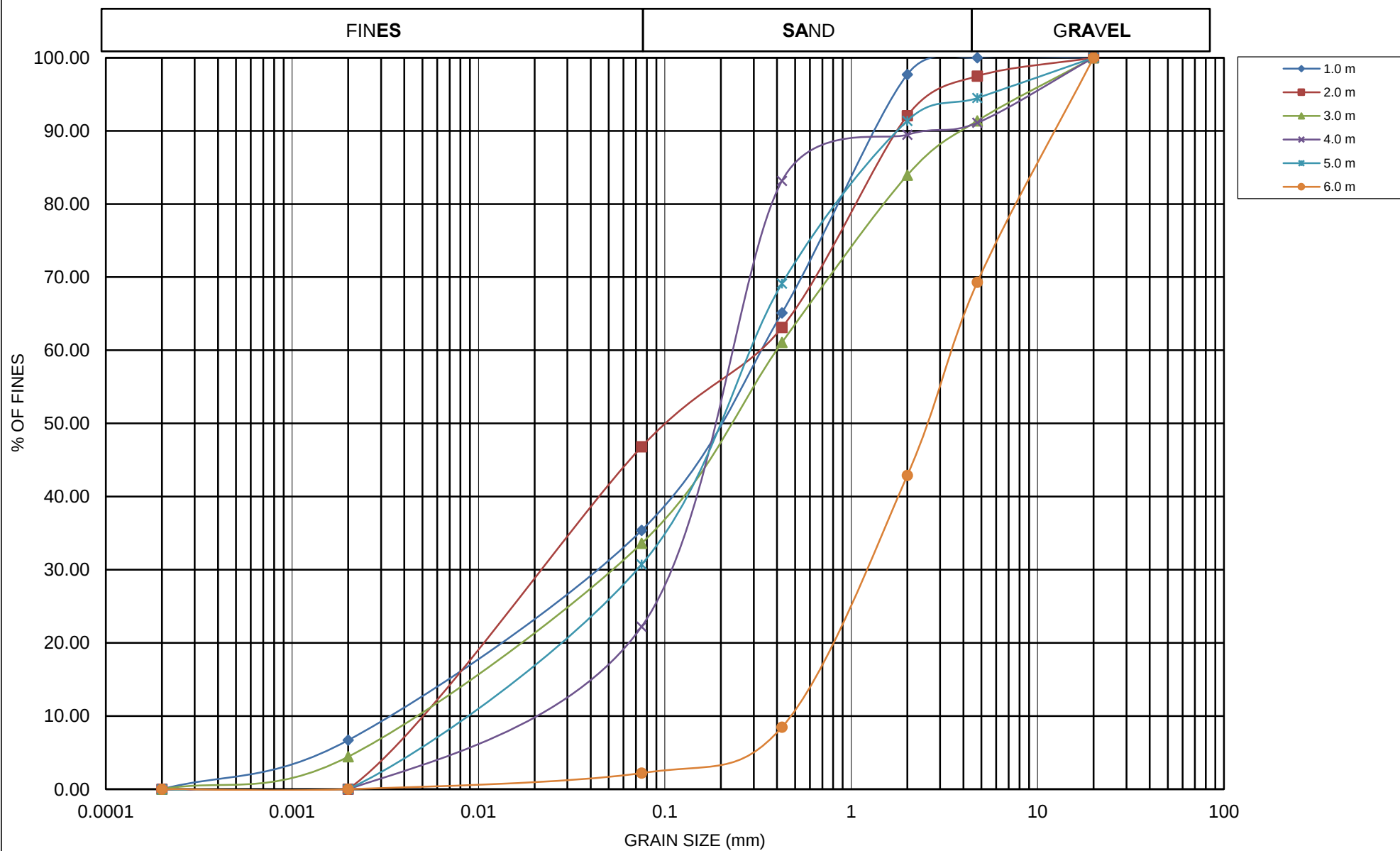


Fig. 2.14 **GRAIN SIZE DISTRIBUTION CURVE - BH-06**

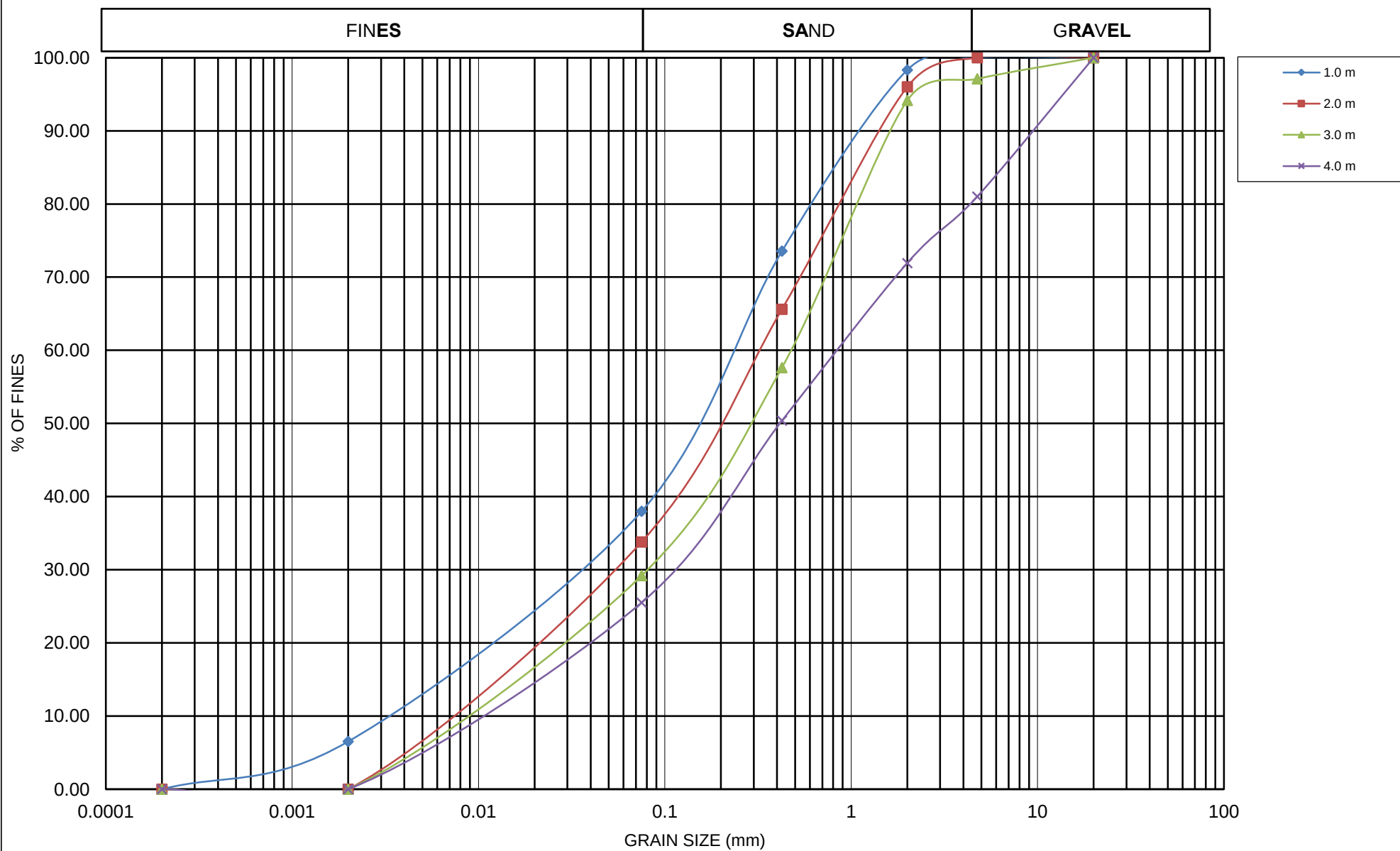


Fig. 2.15 **GRAIN SIZE DISTRIBUTION CURVE - BH-07**

HYDROMETER ANALYSIS CURVE

◆ Bore Hole No: 1 Depth: 1.00m

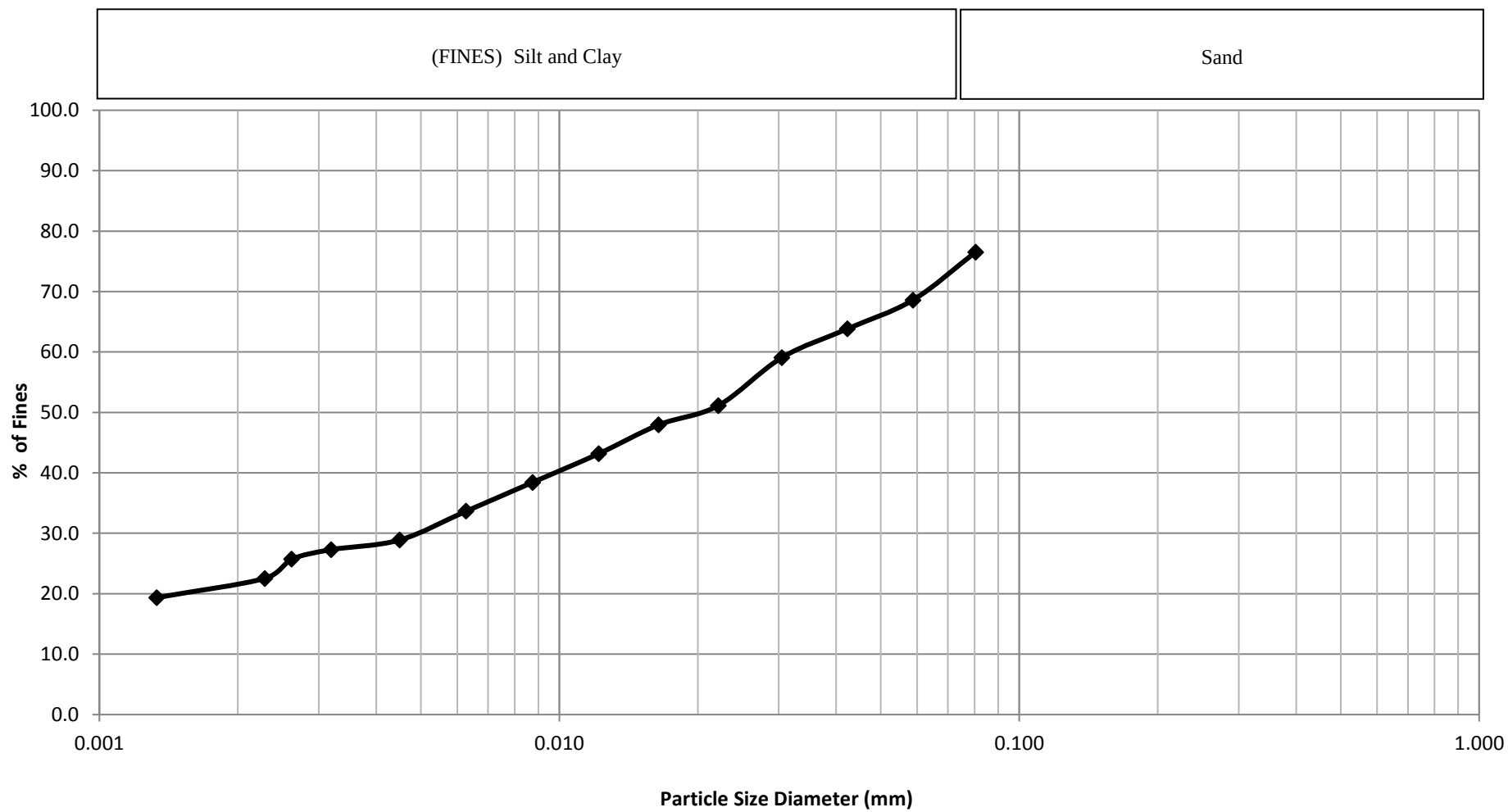


Fig 2.16 Hydrometer Analysis Master Curve

◆ Bore Hole No: 2 Depth: 2.00m

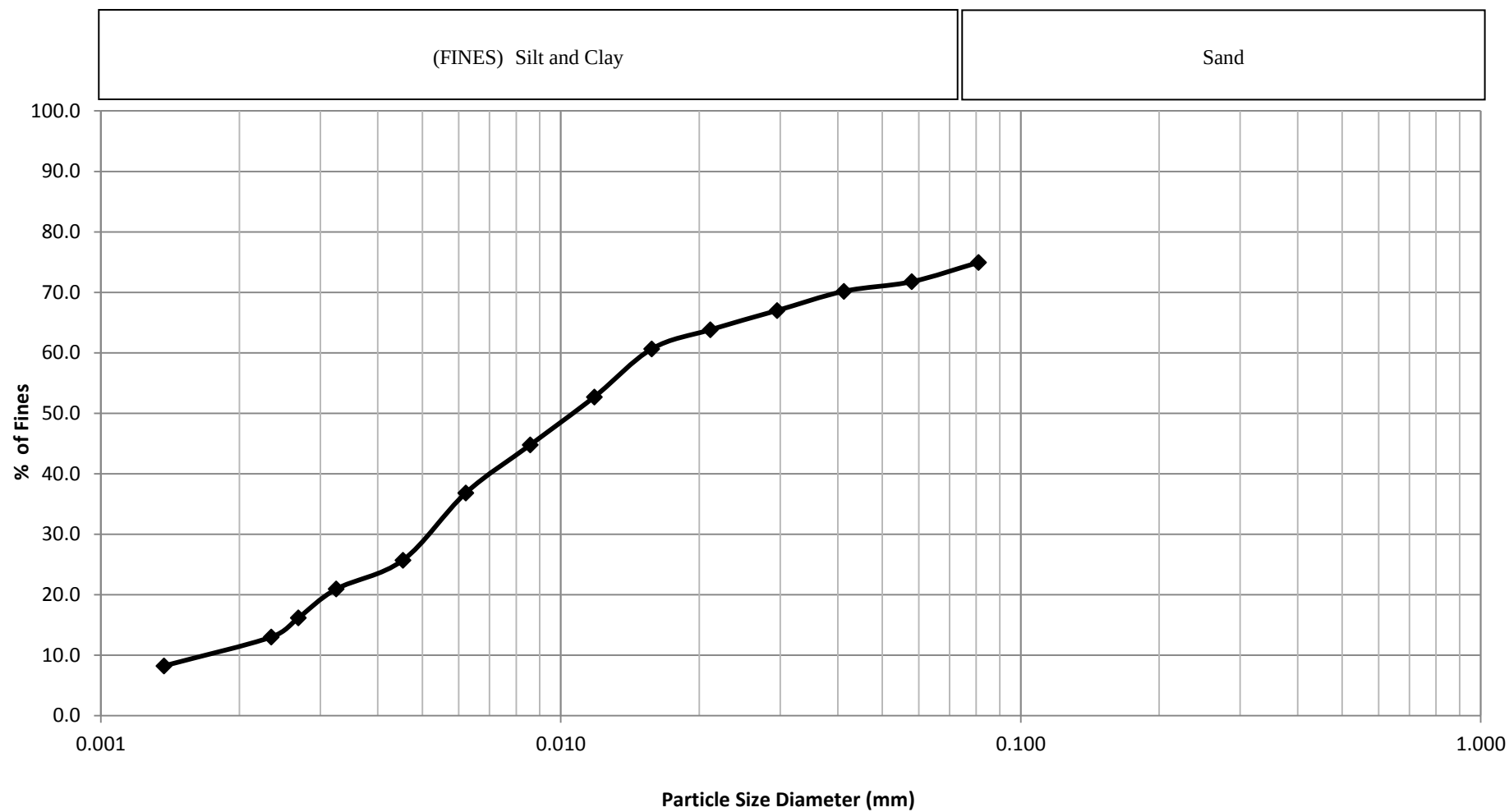


Fig 2.17 Hydrometer Analysis Master Curve

◆ Bore Hole No: 3 Depth: 2.00m

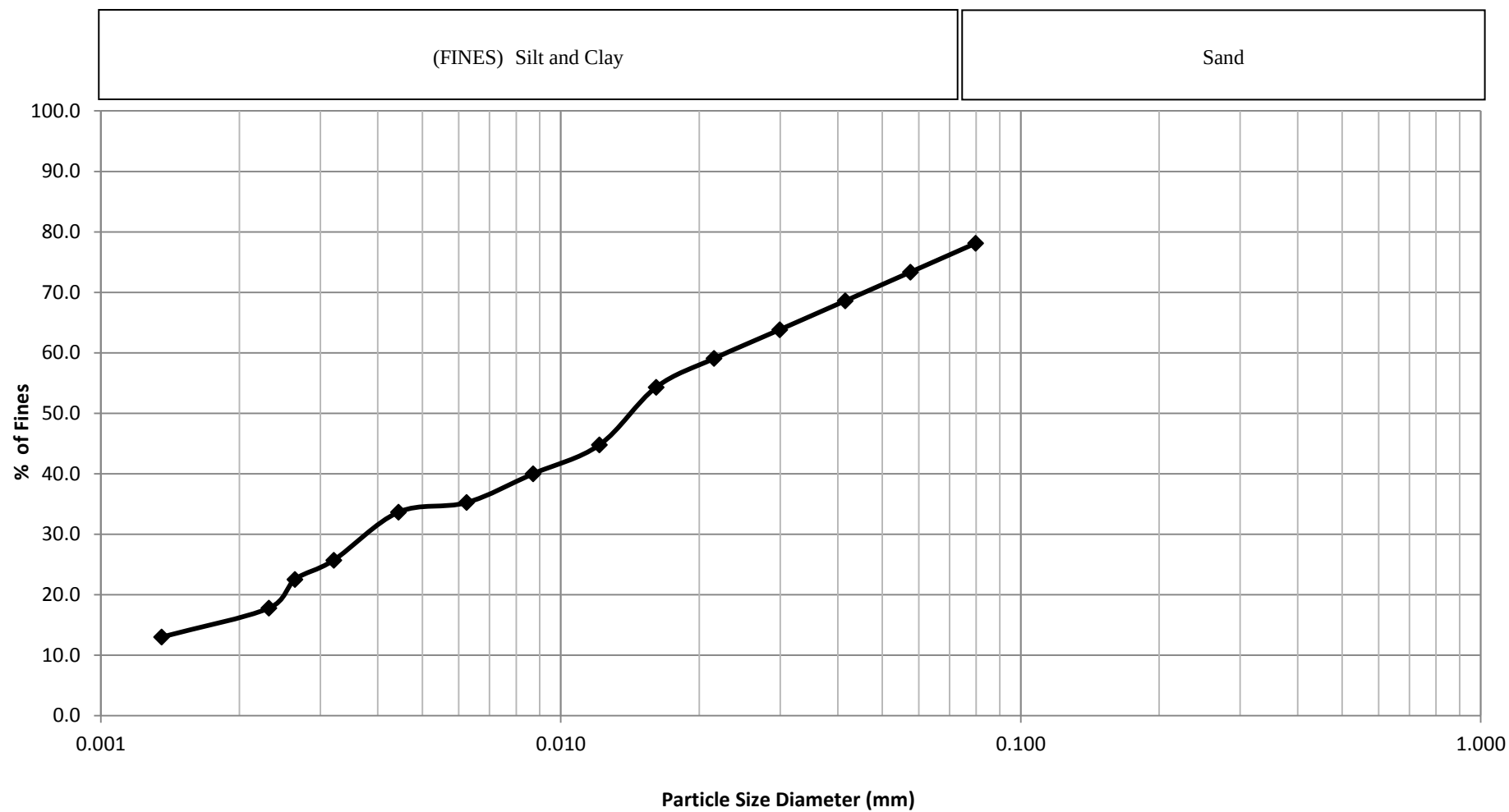


Fig 2.18 Hydrometer Analysis Master Curve

◆ Bore Hole No: 4 Depth: 2.00m

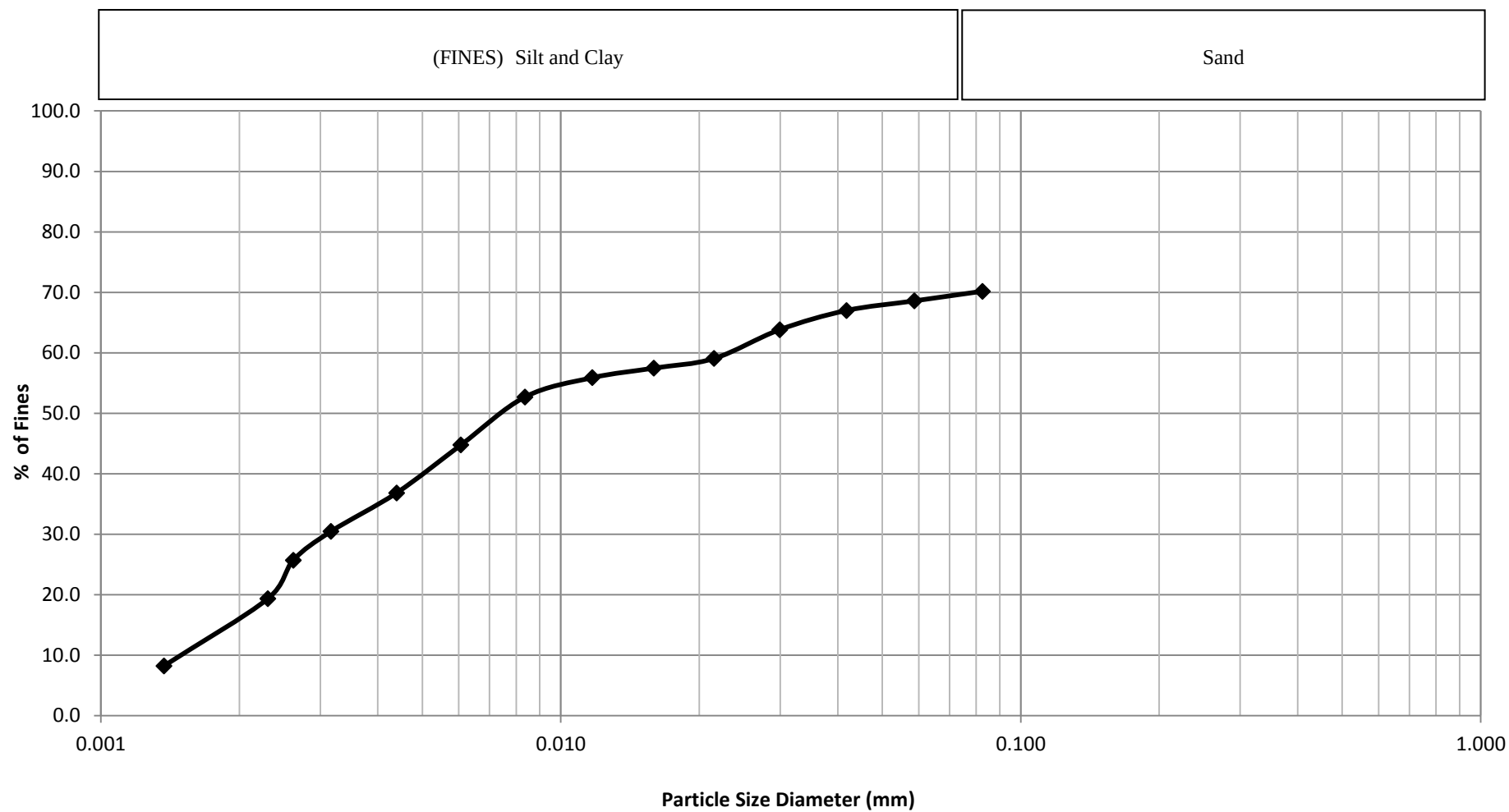


Fig 2.19 Hydrometer Analysis Master Curve

◆ Bore Hole No: 5 Depth: 2.00m

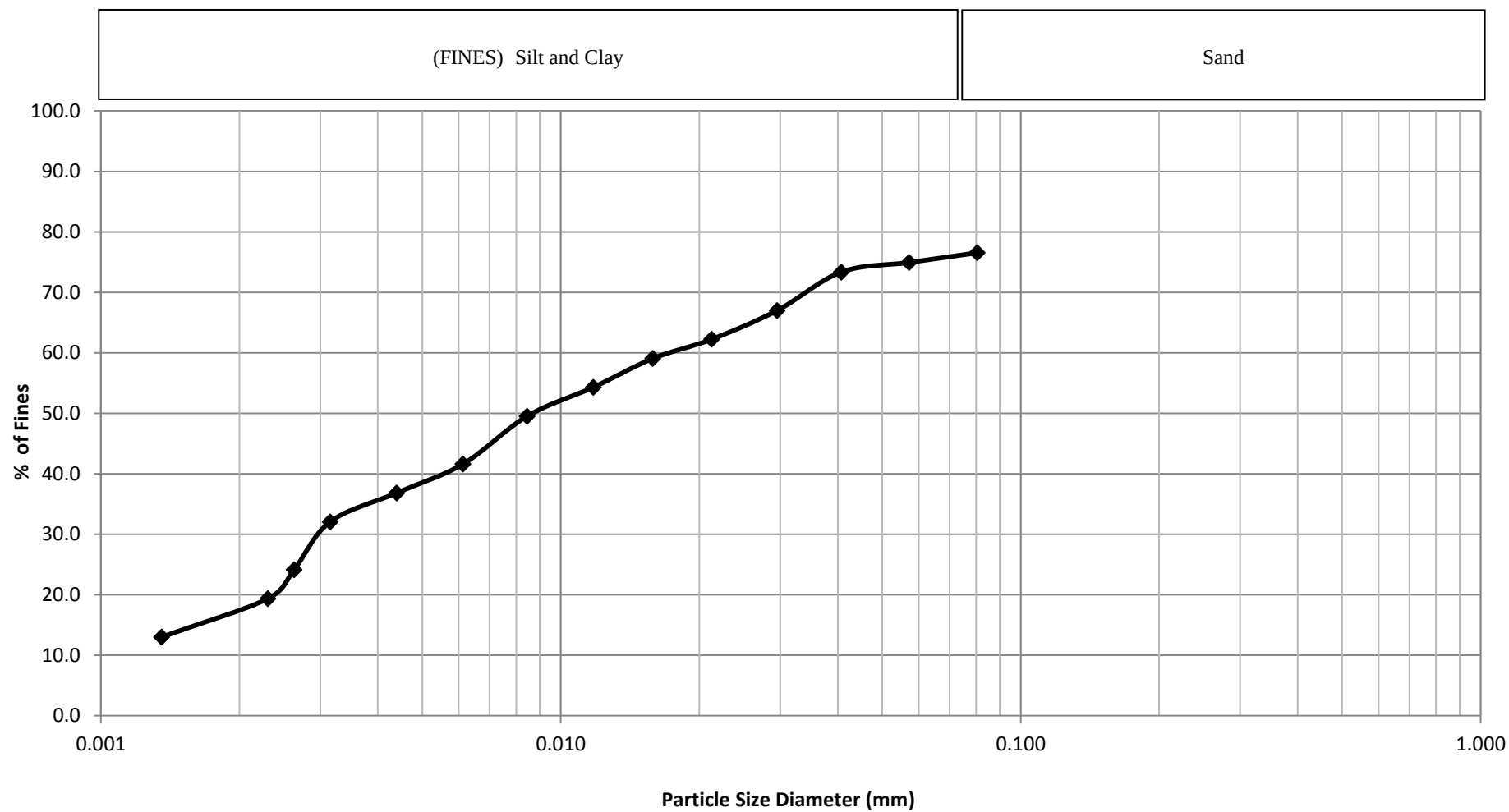


Fig 2.20 Hydrometer Analysis Master Curve

◆ Bore Hole No: 5 Depth: 4.00m

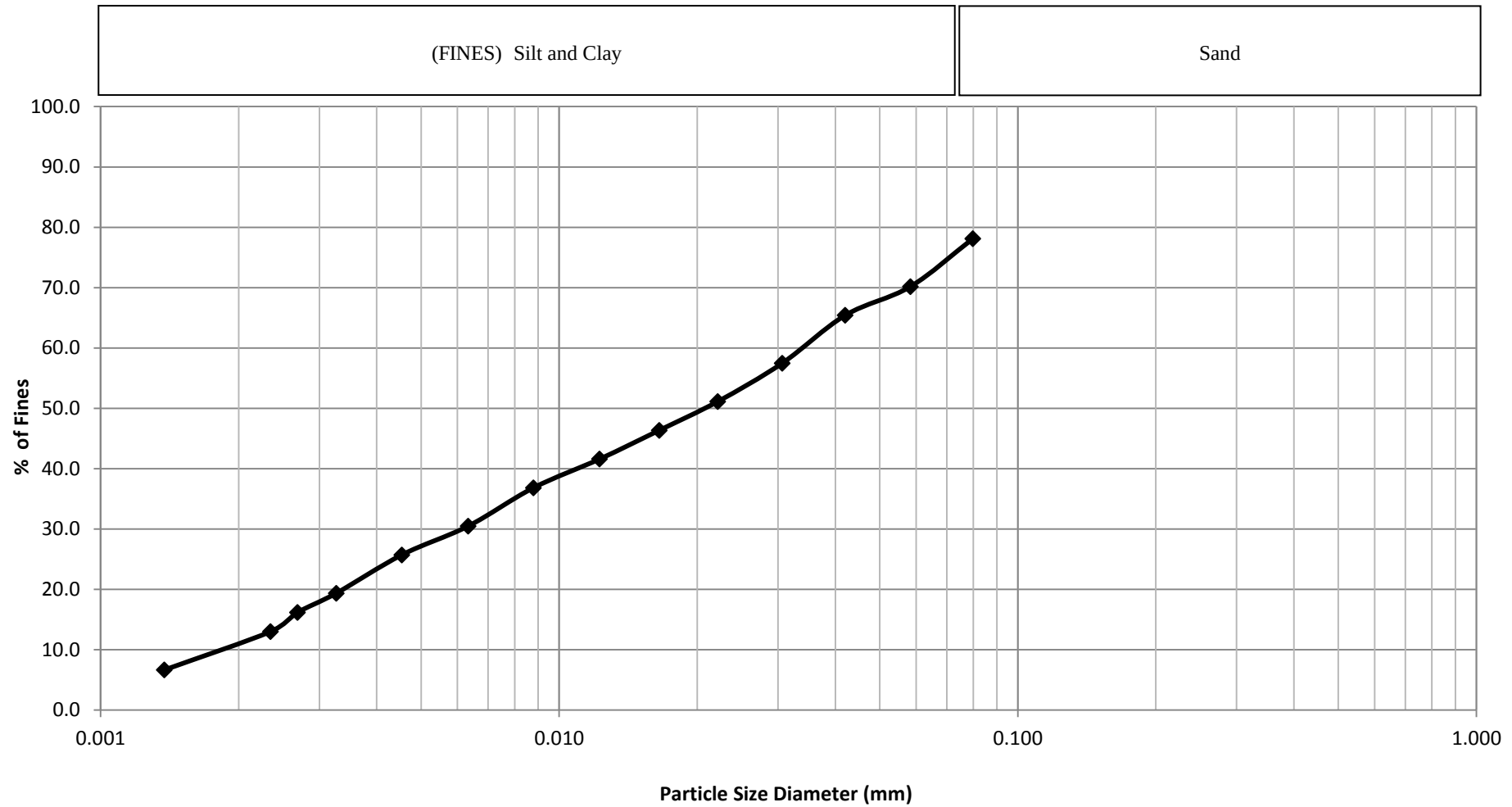


Fig 2.21 Hydrometer Analysis Master Curve

◆ Bore Hole No: 6 Depth: 1.00m

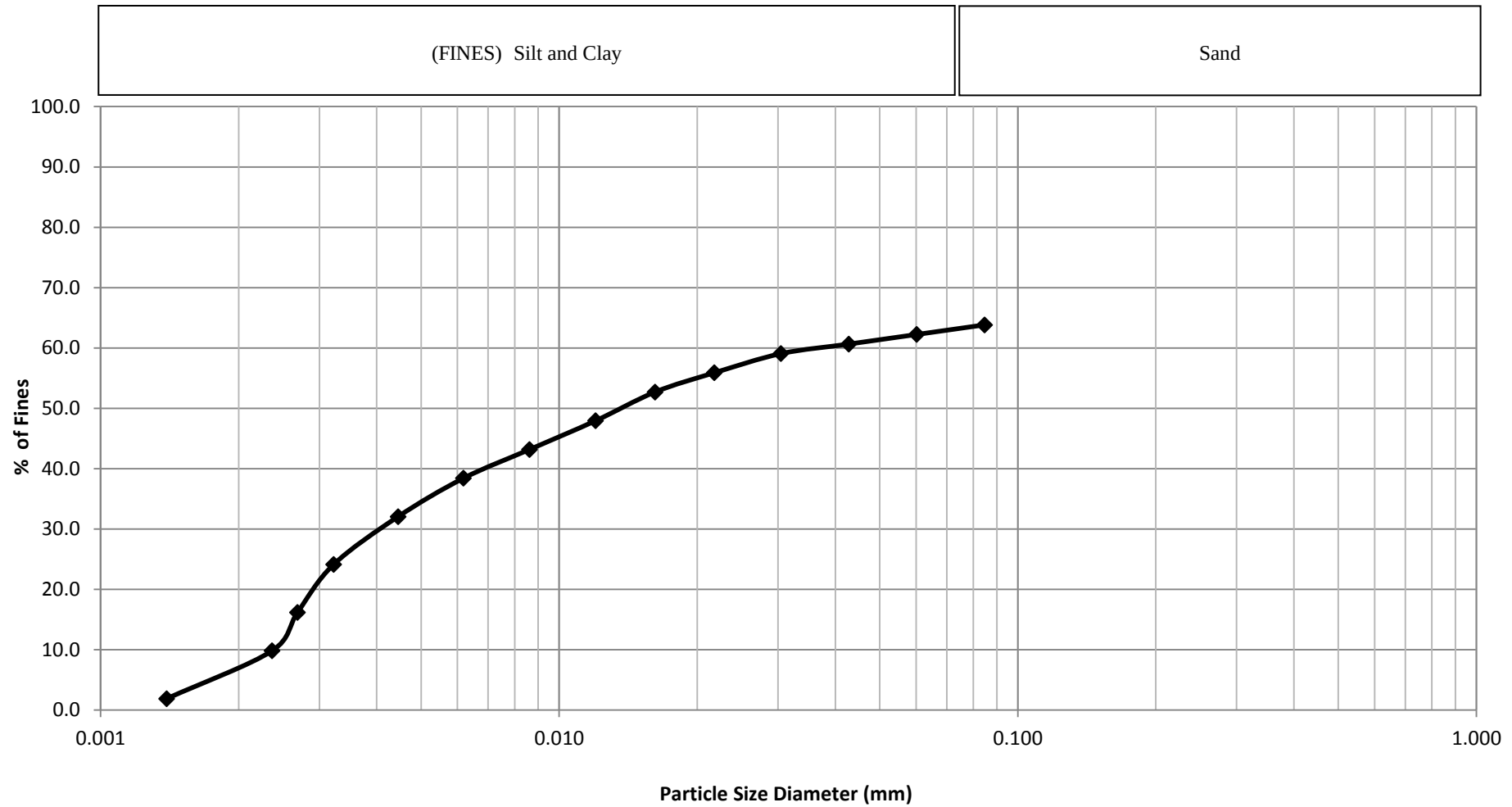


Fig 2.22 Hydrometer Analysis Master Curve

◆ Bore Hole No: 6 Depth: 3.00m

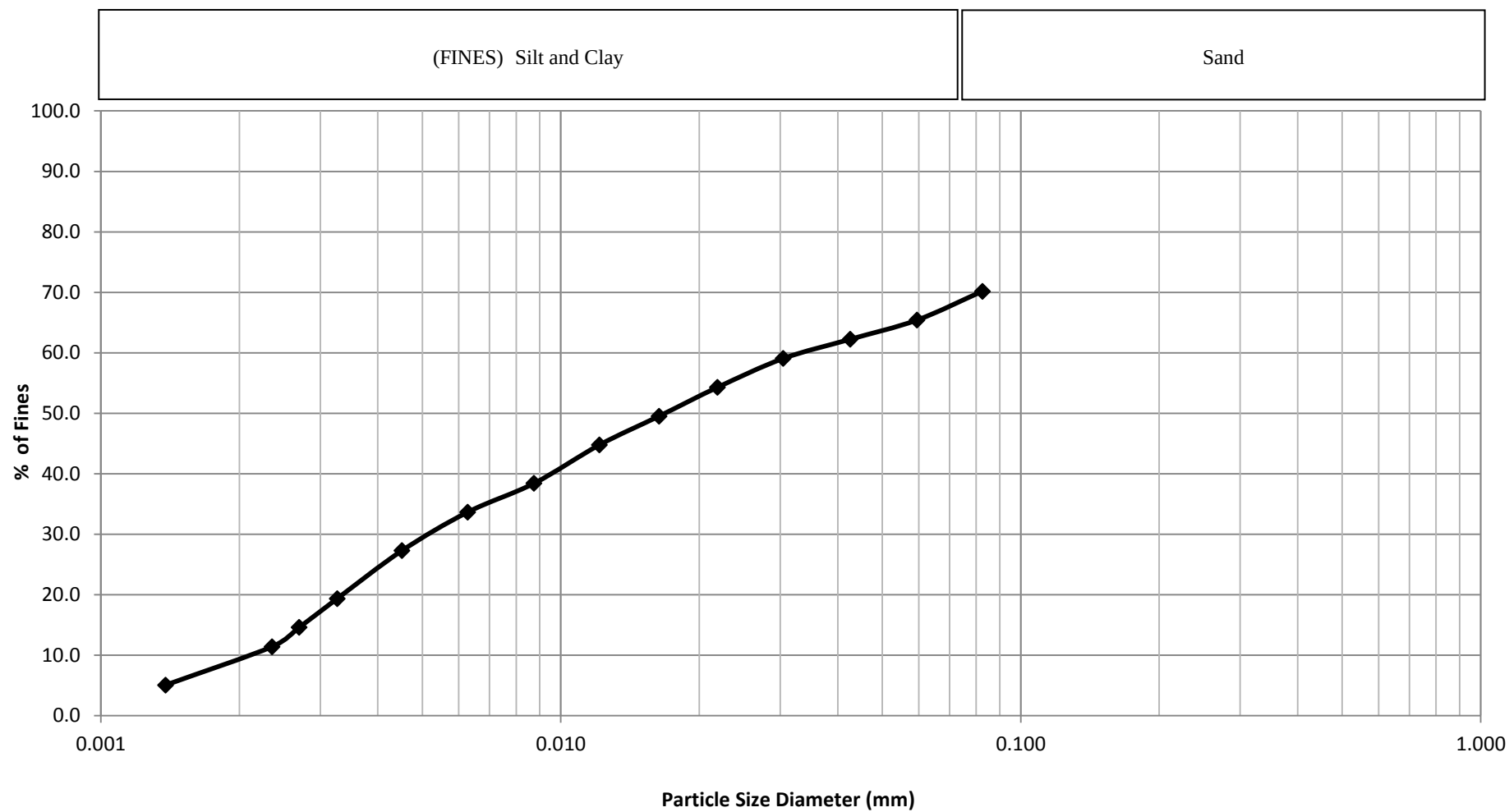


Fig 2.23 Hydrometer Analysis Master Curve

◆ Bore Hole No: 7 Depth: 1.00m

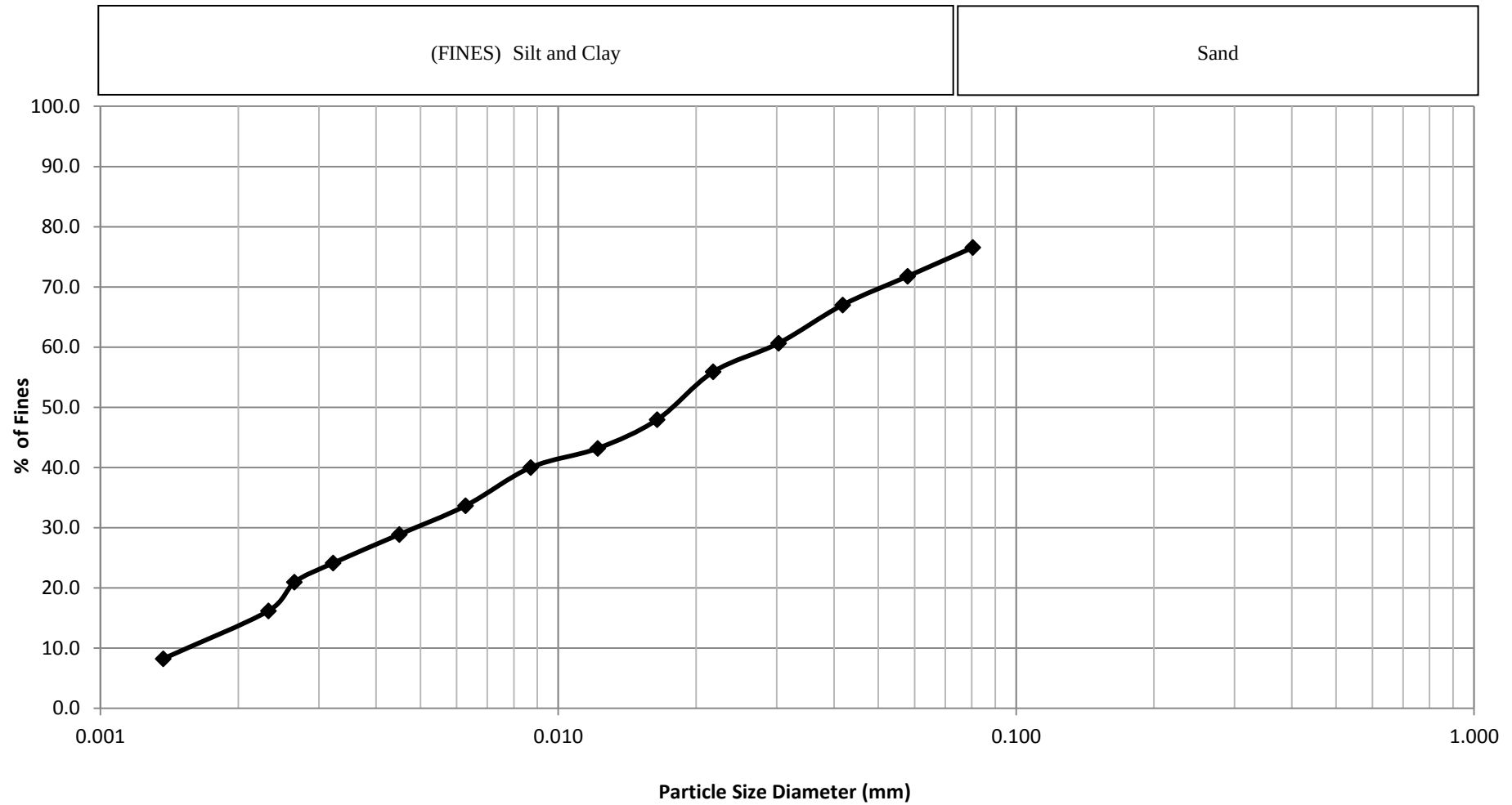


Fig 2.24 Hydrometer Analysis Master Curve

LABORATORY TEST RESULTS

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 NCC URBAN INFRASTRUCTURE LIMITED
Sample Description : Soil Sample
Source of Sample : Customer Supplied- Borehole No. BH-01
Sample Condition : Satisfactory
Test Method : As per Bureau of Indian Standards
Sample Receipt Date : 08/12/2020

Customer Reference : By Email
Period of Testing : 09/12/2020 to 11/12/2020
Sample Identification Number : SS/GMC/122020/226/BH01
Test Report No. : GT-2149/BH-01
Report Date : 20/12/2020
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-II, 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-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 x D ₆₀)	Relative Density	IS-Notation	
														Gravel (%)	Coarse (%)	Medium (%)	Fine (%)	Silt (%)	Clay (%)							Gravel	Sand
1.0	18	SS	15.9	33.9	16.2	17.7	1.0	-	0.0	V.Stiff	Above	CL	-	-	-	-	77.5	22.5	-	-	-	-	-	-	FG>50%	FG>50%	FG>50%
2.0	25	SS	Little to Non- Plastic Fines Binder						0.0	CG>50%	Above	-	-	4.24	7.94	30.46	24.4	33.0	-	-	-	-	-	-	M.Dense	<50%	SC
3.0	>100	SS							-	-	-	-	-	-	CG>50%	Above	-	-	9.24	7.32	22.65	22.66	38.1	-	-	-	-
4.0	44	SS	-	-	-	-	-	-	CG>50%	-	-	-	16.87	12.01	33.11	22.6	15.4	-	-	-	-	-	-	Dense			
5.0	>100	WS	No Penetration of SPT						CG>50%	Above	-	-	81.65	13.86	3.34	0.55	0.6	-	-	-	-	-	-	V.Dense			
7.5	-	WS							CG>50%	Above	-	-	18.66	23.15	54.01	4.47	4.2	-	-	-	-	-	-	-	-	-	-

**** 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)

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 NCC URBAN INFRASTRUCTURE LIMITED**
 Sample Description : Soil Sample
 Source of Sample : Customer Supplied- Borehole No. BH-02
 Sample Condition : Satisfactory
 Test Method : As per Bureau of Indian Standards
 Sample Receipt Date : 08/12/2020

Customer Reference : By Email
 Period of Testing : 09/12/2020 to 11/12/2020
 Sample Identification Number : SS/GMC/122020/226/BH02
 Test Report No. : GT-2149/BH-02
 Report Date : 20/12/2020
 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)														
			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		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 = $D_{30}^2/(D_{10} \times D_{60})$	Relative Density	IS-Notation		
														Gravel (%)	Coarse (%)	Medium (%)	Fine (%)	Silt (%)								Clay (%)	Gravel	Sand
1.0	18	SS	-	-	-	-	-	-	-	CG>50%	-	-	2.5	1.9	31.2	48.12	16.3		-	-	-	-	-	-	M.Dense	<50%	SM	
2.0	20	SS	24.9	38.1	15.0	23.1	0.6	17.6	20.0	CG>50%	Above	-	-	6.42	5.3	23.6	24.08	35.3	5.3	-	-	-	-	-	-	M.Dense	<50%	SC
3.0	>100	SS	-	-	-	-	-	-	-	CG>50%	-	-	-	31.31	11.43	21.9	18.3	17.1		-	-	-	-	-	-	V.Dense	Residual Soil to Completely Weathered Rock	
4.0	>100	WS	No Penetration of SPT							CG>50%	Above	-	-	39.04	22.93	31	7.01	0.0		-	-	-	-	-	V.Dense			
5.5	-	WS	No Penetration of SPT							CG>50%	Above	-	-	7.66	9.56	69.66	12.2	0.9		-	-	-	-	-	-	V.Dense		

** 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)

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 NCC URBAN INFRASTRUCTURE LIMITED
Sample Description : Soil Sample
Source of Sample : Customer Supplied- Borehole No. BH-03
Sample Condition : Satisfactory
Test Method : As per Bureau of Indian Standards
Sample Receipt Date : 29/04/2022

Customer Reference : By Email
Period of Testing : 10/05/2022 to 14/05/2022
Sample Identification Number : SS/GMC/042022/226/BH03
Test Report No. : GT-2149/BH-03
Report Date : 14/05/2022
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)										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-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 = $D_{30}^2/(D_{10} \times D_{60})$	Relative Density	IS-Notation	
														Gravel (%)	Coarse (%)	Medium (%)	Fine (%)	Silt (%)	Clay (%)							Gravel	Sand
1.0	3	SS	24.7	37.3	17.8	19.5	0.6	16.7	21.8	CG>50%	Above	-	-	0.0	5.2	29.2	23.5	42.1		-	-	-	-	-	V.Loose	<50%	SC
2.0	9	SS	16.7	43.5	22.5	21.0	1.3	17.0	29.5	CG>50%	Above	-	-	0.0	11.1	23.2	33.1	26.8	5.8	-	-	-	-	-	Loose	<50%	SC
3.0	13	SS	14.8	31.3	16.5	14.8	1.1	18.0	19.0	CG>50%	Above	-	-	3.2	6.7	21.7	32.5	35.9		-	-	-	-	-	M.Dense	<50%	SC
4.0	80	SS	-	-	-	-	-	-	-	CG>50%	-	-	-	7.8	6.5	33.8	31.7	20.2		-	-	-	-	-	V.Dense	<50%	SM
5.0	>100	SS	-	-	-	-	-	-	-	CG>50%	-	-	-	13.3	5.0	36.5	27.5	17.7		-	-	-	-	-	V.Dense	<50%	SM

** END OF REPORT**

Terms and Conditions

- (1) The test results furnished corresponds to the sample received
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- (3) Any correction in this reports invalidates the reports

Authorised Signatory


A. VINOTH
(Technical Manager)

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 NCC URBAN INFRASTRUCTURE LIMITED
Sample Description : Soil Sample
Source of Sample : Customer Supplied- Borehole No. BH-04
Sample Condition : Satisfactory
Test Method : As per Bureau of Indian Standards
Sample Receipt Date : 29/04/2022

Customer Reference : By Email
Period of Testing : 10/05/2022 to 14/05/2022
Sample Identification Number : SS/GMC/042022/226/BH04
Test Report No. : GT-2149/BH-04
Report Date : 14/05/2022
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)										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-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	9	SS	21.5	37.7	18.5	19.2	0.8	19.0	29.9	CG>50%	Above	-	-	1.4	3.7	39.0	26.0	30.0		-	-	-	-	-	Loose	<50%	SC
2.0	12	SS	23.8	45.3	21.0	24.3	0.9	18.5	36.4	CG>50%	Above	-	-	17.1	7.1	24.3	20.6	24.9	6.0	-	-	-	-	-	M.Dense	<50%	SC
3.0	68	SS	-	-	-	-	-	-	-	CG>50%	-	-	-	4.1	10.1	33.0	28.5	24.3		-	-	-	-	-	V.Dense	Residual Soil to Completely Weathered Rock	
4.0	>100	SS	-	-	-	-	-	-	-	CG>50%	-	-	-	3.2	7.4	32.0	32.8	24.5		-	-	-	-	-	V.Dense		
5.0	>100	WS	-	-	-	-	-	-	-	CG>50%	-	-	-	17.6	42.1	35.7	3.7	1.0		-	-	-	-	-	V.Dense		
6.0	>100	WS	-	-	-	-	-	-	-	CG>50%	-	-	-	14.0	33.2	42.2	10.2	0.3		-	-	-	-	-	V.Dense		

** END OF REPORT**

Terms and Conditions

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(Technical Manager)

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 NCC URBAN INFRASTRUCTURE LIMITED**
Sample Description : Soil Sample
Source of Sample : Customer Supplied- Borehole No. BH-05
Sample Condition : Satisfactory
Test Method : As per Bureau of Indian Standards
Sample Receipt Date : 29/04/2022

Customer Reference : By Email
Period of Testing : 10/05/2022 to 14/05/2022
Sample Identification Number : SS/GMC/042022/226/BH05
Test Report No. : GT-2149/BH-05
Report Date : 14/05/2022
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 (Ip= LL-PL)	Consistency Index (Ic=LL-NMCIp)	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		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	IS-Notation		
														Gravel (%)	Coarse (%)	Medium (%)	Fine (%)	Silt (%)	Clay (%)							Gravel	Sand	
1.0	-	DS	Building Debris/ Filled Up										-	35.21	6.19	25.22	18.83	14.6		-	-	-	-	-	-	V.Dense	<50%	SM
2.0	8	SS	15.1	29.0	14.1	15.0	0.9	19.0	16.7	CG>50%	Above	-	-	0	3.1	30.4	34.22	27.0	5.3	-	-	-	-	-	-	Loose	<50%	SC
3.0	1	SS	21.3	41.1	14.1	27.0	0.7	17.8	30.4	CG>50%	Above	-	-	4.6	3.24	22.3	25.28	44.6		-	-	-	-	-	-	V.Loose	<50%	SC
4.0	15	SS	17.5	29.5	13.8	15.7	0.8	20.0	19.9	CG>50%	Above	-	-	15.08	5.74	27.26	24.1	24.2	3.6	-	-	-	-	-	-	M.Dense	<50%	SC
5.0	103	SS	-	-	-	-	-	-	-	CG>50%	-	-	-	11.04	8.05	34.02	28.83	18.1		-	-	-	-	-	-	V.Dense	Residual Soil to Completely Weathered Roc	
6.0	>100	WS	No Penetration of SPT							CG>50%	Above	-	-	1.54	5.5	66.3	25.36	1.3		-	-	-	-	-	V.Dense			

** END OF REPORT**

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A. VINOTH
(Technical Manager)

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 NCC URBAN INFRASTRUCTURE LIMITED
Sample Description : Soil Sample
Source of Sample : Customer Supplied- Borehole No. BH-06
Sample Condition : Satisfactory
Test Method : As per Bureau of Indian Standards
Sample Receipt Date : 29/04/2022

Customer Reference : By Email
Period of Testing : 10/05/2022 to 14/05/2022
Sample Identification Number : SS/GMC/042022/226/BH06
Test Report No. : GT-2149/BH-06
Report Date : 14/05/2022
Test Report Pages : One Page

Table-2.6 Laboratory Classification of Soil Samples from BH-06

Sample Depth (m)	SPT- "N" Value	Type of Sample	Fine Grained (FG)										SPECIFIC GRAVITY AS PER IS 2720 (P-II, 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-NMCI/ 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		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	IS-Notation	
														Gravel (%)	Coarse (%)	Medium (%)	Fine (%)	Silt (%)	Clay (%)							Gravel	Sand
1.0	6	SS	16.6	35.7	14.4	21.2	0.9	18.5	40.0	CG>50%	Above	-	-	0.0	2.3	32.6	25.4	33.0	6.7	-	-	-	-	-	Loose	<50%	SC
2.0	8	SS	18.1	34.8	17.3	17.6	1.0	19.0	23.5	CG>50%	Above	-	-	2.5	5.4	29.0	16.3	46.8		-	-	-	-	-	Loose	<50%	SC
3.0	9	SS	16.2	27.8	15.2	12.6	0.9	18.2	9.5	CG>50%	Above	-	-	8.3	7.8	22.9	24.5	32.1	4.4	-	-	-	-	-	Loose	<50%	SC
4.0	9	SS	Binder							CG>50%	Above	-	-	8.9	1.6	6.3	60.9	22.2		-	-	-	-	-	Loose	<50%	-
5.0	40	SS	-	-	-	-	-	-	-	CG>50%	-	-	-	5.5	3.1	22.3	38.4	30.7		-	-	-	-	-	Dense	Residual Soil & Completely Weathered Rock	
6.0	>100	SS	-	-	-	-	-	-	-	CG>50%	-	-	-	30.7	26.4	34.4	6.3	2.2		-	-	-	-	-	V.Dense		

**** END OF REPORT****

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A. VINOTH
(Technical Manager)

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 NCC URBAN INFRASTRUCTURE LIMITED
Sample Description : Soil Sample
Source of Sample : Customer Supplied- Borehole No. BH-07
Sample Condition : Satisfactory
Test Method : As per Bureau of Indian Standards
Sample Receipt Date : 29/04/2022

Customer Reference : By Email
Period of Testing : 10/05/2022 to 14/05/2022
Sample Identification Number : SS/GMC/042022/226/BH07
Test Report No. : GT-2149/BH-07
Report Date : 14/05/2022
Test Report Pages : One Page

Table-2.7 Laboratory Classification of Soil Samples from BH-07

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-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 $C_c=D_{30}^2/(D_{10} \times D_{60})$	Relative Density	IS-Notation		
														Gravel (%)	Coarse (%)	Medium (%)	Fine (%)	Silt (%)	Clay (%)							Gravel	Sand	
1.0	5	SS	19.4	31.6	15.3	16.3	0.7	16.9	27.3	CG>50%	Above	-	-	0.0	1.7	24.8	31.5	35.2	6.8	-	-	-	-	-	Loose	<50%	SC	
2.0	16	SS	15.0	33.7	16.0	17.7	1.1	16.5	37.5	CG>50%	Above	-	-	0.0	4.0	30.4	31.8	33.8		-	-	-	-	-	M.Dense	<50%	SC	
3.0	17	SS	14.3	34.3	17.1	17.2	1.2	18.0	11.5	CG>50%	Above	-	-	2.9	3.0	36.5	28.5	29.2		-	-	-	-	-	M.Dense	<50%	SC	
4.0	>100	SS	-	-	-	-	-	-	-	CG>50%	-	-	-	19.0	9.1	21.6	24.9	25.5		-	-	-	-	-	V.Dense	Residual Soil & Completely Weathered Rock		
5.0	>100	WS	No Penetration of SPT							CG>50%	Above	-	-	2.4	8.3	70.5	18.2	0.7		-	-	-	-	-	V.Dense			
6.0	>100	WS								CG>50%	Above	-	-	0.0	9.6	72.2	17.6	0.6		-	-	-	-	-	V.Dense			

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(Technical Manager)

Table-2.8 Results of Chemical Analysis

SL No.	Bore HoleNo.	Water				Soil (2:1)			
		Depth of Sample (m)	pH	Chlorides (ppm)	Sulphates (ppm)	Depth of Sample (m)	pH	Chlorides (ppm)	Sulphates (ppm)
1.0	BH-01	E.G.L	7.14	1251	124	1.0	6.89	373	122
2.0	BH-02	E.G.L	7.19	1131	138	1.0	7.13	391	89
3.0	BH-03	1.10	7.21	1529	123	1.0	6.94	352	68
4.0	BH-04	1.00	7.18	1854	115	2.0	7.12	495	100
5.0	BH-05	1.20	7.15	1436	158	2.0	7.21	322	103
6.0	BH-06	1.20	7.19	1075	172	2.0	7.09	291	74
7.0	BH-07	1.20	7.13	1442	135	3.0	6.92	268	69

TABLE - 2.9 ROCK TEST RESULTS

S.No.	Borehole Number	Depth (m)	Point Load Index Is(50) (mPa)	Unconfined Compressive Strength (mPa)
1	BH - 01	13.00 to 14.00	3.20	-
2	BH - 02	8.50 to 10.00	4.21	50.30
3	BH - 03	10.00 to 11.00	3.72	40.12
4	BH - 04	10.00 to 11.00	3.31	37.11
5	BH - 05	9.00 to 10.00	5.50	56.94
6	BH - 06	10.00 to 11.00	4.36	52.40
7	BH - 07	7.50 to 9.00	6.23	65.58

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:

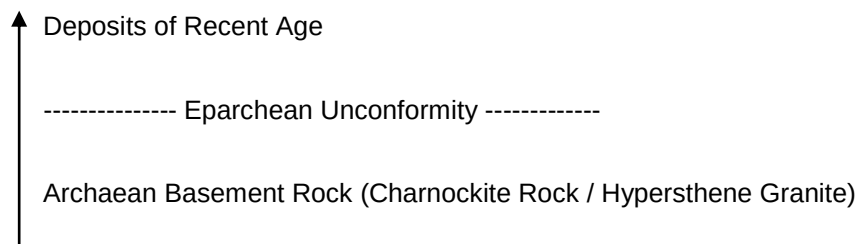
Chennai district is underlain by various geological formations from ancient Archaean to the Recent Alluvium. The geological formations of the district can be grouped into three units, namely

- 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.

3.4 GEOLOGICAL ORDER OF THE STUDY AREA:

The stratigraphy of the study area can be classified as recent formation which is underlain by basement rock of meta-igneous origin (hypersthene granite/ Charnockite rock)



In the present investigation site, the formation in the top 2.0m to 4.0m is recent deposit predominantly consisting of clayey sand formation (or silty sand with clay binder) which rest on the Archean formation of hypersthene granite (Charnockite rock)

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-01	Ref R.L. of G.L. (m):			0.00			
Layer No.	Layer Thk. (m)			Type of Strata	Colour	Ave. Design SPT	Relative Density	Consistency	(γ) kN/m ³	Shear Parameters	
	Top BGL	Bottom BGL	Thickness							(C _u) kPa	(ϕ) Deg.
1.0	0.00	2.00	2.00	Silty Clay	Brown Grey	18	-	Very Stiff	20	120	-
2.0	2.00	3.00	1.00	Residual Soil	Grey, Brown	25	Medium Dense	-	18.5	-	34.5
3.0	3.00	5.00	2.00	Completely Weathered Rock	Yellow Brown	60	Very Dense	-	20.5	-	42.5
4.0	5.00	12.00	7.00	Completely to Highly Weathered Rock	Grey, Grey Brown	CRR-Nil to 10% & RQD-Nil					
5.0	12.00	14.00	2.00	Moderately Weathered Rock	Grey, Grey Brown	CRR-57% to 78% & RQD-25% to 30%					

REFERENCE BORE HOLE				BH-02	Ref R.L. of G.L. (m):			0.00			
Layer No.	Layer Thk. (m)			Type of Strata	Colour	Ave. Design SPT	Relative Density	Consistency	(γ) kN/m ³	Shear Parameters	
	Top BGL	Bottom BGL	Thickness							(C _u) kPa	(φ) Deg.
1.0	0.00	2.00	2.00	Clayey Silty Sand	Brown	18	Medium Dense	-	18	-	32.4
2.0	2.00	3.00	1.00	Residual Soil	Grey	20	Medium Dense	-	18	-	33
3.0	3.00	5.50	2.50	Completely Weathered Rock	Grey, Grey Pink	>100	Very Dense	-	21	-	42.5
4.0	5.50	8.50	3.00	Moderately Weathered Rock	Grey, Grey Pink	CRR-45% to 59% & RQD-0% to 23%					
5.0	8.50	10.00	1.50	Fresh Rock	Grey, Grey Pink	CRR-97% & RQD-97%					

REFERENCE BORE HOLE				BH-03	Ref R.L. of G.L. (m):			0.00			
Layer No.	Layer Thk. (m)			Type of Strata	Colour	Ave. Design SPT	Relative Density	Consistency	(γ) kN/m ³	Shear Parameters	
	Top BGL	Bottom BGL	Thickness							(C _u) kPa	(φ) Deg.
1.0	0.00	2.00	2.00	Clayey Silty Sand	Grey	3	Very Loose	-	13	-	20.067
2.0	2.00	4.00	2.00	Clayey Silty Sand	Grey	11	Medium Dense	-	15.5	-	30.3
3.0	4.00	5.00	1.00	Residual Soil	Grey Brown	80	Very Dense	-	21	-	42.5
4.0	5.00	6.00	1.00	Highly Weathered Rock	Grey, Grey Brown	CRR-15% & RQD-0%					
5.0	6.00	10.00	4.00	Moderately Weathered Rock	Grey, Grey Brown	CRR-37% to 65% & RQD-0% to 12%					
6.0	10.00	11.00	1.00	Slightly Weathered Rock	Grey, Grey Pink	CRR-80% & RQD-68%					

REFERENCE BORE HOLE				BH-04	Ref R.L. of G.L. (m):			0.00			
Layer No.	Layer Thk. (m)			Type of Strata	Colour	Ave. Design SPT	Relative Density	Consistency	(γ) kN/m ³	Shear Parameters	
	Top BGL	Bottom BGL	Thickness							(C _u) kPa	(φ) Deg.
1.0	0.00	3.00	3.00	Clayey Silty Sand	Grey, Grey Brown	11	Medium Dense	-	15.5	-	30.3
2.0	3.00	4.00	1.00	Residual Soil	Grey Brown	68	Very Dense	-	21	-	42.5
3.0	4.00	6.00	2.00	Completely Weathered Rock	Grey, Grey Brown	>100	Very Dense	-	21	-	42.5
4.0	6.00	7.00	1.00	Highly Weathered Rock	Grey, Grey Pink	CRR-18% & RQD-0%					
5.0	7.00	11.00	4.00	Slightly Weathered Rock	Grey, Grey Pink	CRR-77% to 94% & RQD-27% to 57%					

REFERENCE BORE HOLE				BH-05	Ref R.L. of G.L. (m):			0.00			
Layer No.	Layer Thk. (m)			Type of Strata	Colour	Ave. Design SPT	Relative Density	Consistency	(γ) kN/m ³	Shear Parameters	
	Top BGL	Bottom BGL	Thickness							(C _u) kPa	(φ) Deg.
1.0	0.00	1.10	1.10	Filled Up	Building Debris to Facilitate Drilling						
2.0	1.10	3.00	1.90	Clayey Silty Sand	Grey	8	Loose	-	14.5	-	29.6
3.0	3.00	4.00	1.00	Clayey Silty Sand	Grey	1	Very Loose	-	12	-	19.761
4.0	4.00	5.00	1.00	Clayey Silty Sand	Grey Brown	15	Medium Dense	-	17.5	-	31.5
5.0	5.00	6.00	1.00	Residual Soil	Greyish Brown	103	Very Dense	-	21	-	42.5
6.0	6.00	7.50	1.50	Highly Weathered Rock	Grey	CRR-12% & RQD-0%					
7.0	7.50	9.00	1.50	Moderately Weathered Rock	Grey	CRR-61% & RQD-15%					
8.0	9.00	11.00	2.00	Slightly Weathered Rock	Grey	CRR-83% to 90% & RQD-56% to 59%					

REFERENCE BORE HOLE				BH-06	Ref R.L. of G.L. (m):			0.00			
Layer No.	Layer Thk. (m)			Type of Strata	Colour	Ave. Design SPT	Relative Density	Consistency	(γ) kN/m ³	Shear Parameters	
	Top BGL	Bottom BGL	Thickness							(C _u) kPa	(ϕ) Deg.
1.0	0.00	0.90	0.90	Filled Up	Building Debris to Facilitate Drilling						
2.0	0.90	5.00	4.10	Clayey Silty Sand	Grey	8	Loose	-	14.5	-	29.6
3.0	5.00	6.00	1.00	Clayey Silty Sand	Grey Brown	40	Dense	-	20	-	38.75
4.0	6.00	7.50	1.50	Moderately Weathered Rock	Grey, Grey Brown	CRR-22% & RQD-0%					
5.0	7.50	11.00	3.50	Slightly Weathered Rock	Grey, Grey Pink	CRR-73% to 80% & RQD-25% to 60%					

REFERENCE BORE HOLE				BH-07	Ref R.L. of G.L. (m):			0.00			
Layer No.	Layer Thk. (m)			Type of Strata	Colour	Ave. Design SPT	Relative Density	Consistency	(γ) kN/m ³	Shear Parameters	
	Top BGL	Bottom BGL	Thickness							(C _u) kPa	(φ) Deg.
1.0	0.00	2.00	2.00	Clayey Silty Sand	Grey	5	Loose	-	14	-	20.374
2.0	2.00	4.00	2.00	Clayey Silty Sand	Grey	17	Medium Dense	-	18	-	32.1
3.0	4.00	6.00	2.00	Completely Weathered Roc	Grey, Grey Brown	>100	Very Dense	-	21	-	42.5
4.0	6.00	7.50	1.50	Moderately Weathered Rock	Grey, Grey Brown	CRR-25% & RQD-7%					
5.0	7.50	11.00	3.50	Slightly Weathered Rock	Greyish Brown	CRR-97% to 100% & RQD-87% to 100%					

LIQUEFACTION EVALUATION**4.0 PHENOMENA:**

Liquefaction has historically been used in conjunction with a variety of phenomena that involve soil deformations caused by monotonic, transient, or repeated disturbance of saturated cohesion-less soils under un-drained conditions. The generation of excess pore water pressure under un-drained loading conditions is a hallmark of all liquefaction phenomena. When saturated cohesion-less soils subjected to rapid loading resulting in undrained conditions undergo densification generates excess pore pressures and decreases effective stresses, eventually leading to excess deformation failures, commonly known as liquefaction. Liquefaction phenomena that result from this process is generally divided in two main groups: flow liquefaction and cyclic mobility. Both flow liquefaction and cyclic mobility are very important and any evaluation of liquefaction hazards should carefully consider both.

4.1 LIQUEFACTION SUSCEPTIBILITY:

Not all soils susceptible to liquefaction; consequently, the first step in a liquefaction hazard evaluation is the evaluation of liquefaction susceptibility. There are several criteria by which liquefaction susceptibility can be judged, and some are different for flow liquefaction and cyclic mobility. These include Historical, Geologic, Compositional, and State Criteria (Initial stress state before liquefaction).

Of the above four criteria, except the state criteria, the other three provide a qualitative evaluation of the liquefaction susceptibility of a deposit. The state criteria provide an analytical approach to quantify the liquefaction susceptibility with respect to the stress-strain response of the deposit against the environmental loading conditions.

The evaluation of liquefaction susceptibility based on state criteria is an independent and involved elaborate laboratory monotonic and cyclic loading testing programme and this is beyond the scope of present investigation. However, the liquefaction susceptibility pertinent to the present site sub surface characteristics are qualitatively outlined in the following sections. Further, based on the published correlation with respect to the corrected SPT-values, an attempt is made to provide a basic and guideline analysis on the liquefaction potential pertinent to ZONE-III earthquake coefficient.

4.2 QUALITATIVE APPROACH:**4.2.1 HISTORICAL CRITERIA:**

Historically, the present site location never documented any post-earthquake generated soil flows or local liquefaction related effects.

4.2.2 GEOLOGIC CRITERIA:

Geologic process that sort soils into uniform grain size distribution and deposit them in loose states produce soil deposits with high liquefaction susceptibility. Similarly, the older geological formations are less susceptible to liquefaction compared to the recent deposits like Fluvial, Colluvial and Aeolian deposits.

FORMATION CHARACTERISTICS:

In the project site, the formation from the existing ground level up to a depth of 2.0m or 4.0m is Very Loose to Loose, Clayey Silty Sand followed by Dense & Very Dense Residual Soil to Completely Weathered Rock.

However, the formation beyond 5.0m is fractured rock to Strong to Very Strong & Extreme Strong Intact Rock up to the termination depth of 11.0m to 14.0m depth.

4.2.3 COMPOSITION CRITERIA:

Since liquefaction requires the development of excess pore pressure, liquefaction susceptibility is influenced by the compositional characteristics that influence volume change behaviour. These characteristics include particle size, shape and gradation. No specific Indian Standards are available to arrive at the potential particle size that chiefly contributes to the liquefaction. Further, well graded soils are less susceptible to liquefaction than poorly graded soils. Similarly rounded particles are more susceptible than angular particles as they tend to density. In general, the composition of particles that is susceptible to liquefaction is encountered in loose state of deposition in alluvial and fluvial environment.

4.3 QUANTITATIVE APPROACH:

4.3.1 FLOW LIQUEFACTION:

Flow liquefaction can occur, when the shear stress required for static equilibrium of a soil mass (the static shear stress) is greater than the shear strength of the soil in its liquefied state. Flow liquefaction can occur either under monotonic or under cyclic loading conditions. In this failure, the cyclic stresses bring the soil to an unstable state at which its strength drops sufficiently to allow the static stresses to produce the flow. The flow liquefaction is characterised by sudden nature of occurrence and speed of occurrence.

The cyclic mobility can develop when the static shear stress is smaller than the steady-state shear strength and can occur in both loose and dense soils. A combination of static and cyclic loading generally produces cyclic mobility. However, no cyclic testing programme is carried out as it is beyond the scope of present investigation.

In the absence of cyclic testing programme a basic analysis based on the published data using in situ test results (SPT) is presented below to characterize the Liquefaction Resistance of the sub surface deposits encountered in the present site.

Further, as a first order of approximation and in the absence of rigours testing programme focusing on liquefaction steady, it is pressured that the clayey strata are non-susceptible to liquefaction and analysis is limited to sandy strata.

4.3.1.1 LIQUEFACTION RESISTANCE CHARACTERIZATION USING IN SITU TEST RESULTS

(Ref. "GEOTECHNICAL EARTHQUAKE ENGINEERING" by Steven L. Kramer, University of Washington, Prentice-Hall International Series in Civil Engineering and Engineering Mechanics, 2005, Page 77-381.

Seed et al (1975) developed a relationship between cyclic stress ratios (CSR) causing liquefaction and corrected SPT-values (N_{160}) for silty sands in $M=7.5$ earthquakes. Further a magnitude correction factor for cyclic stress approach for different earthquake magnitudes is also developed.

The above relationships are reproduced in Figs.4.1 and Table-4.1. Based on this method, for the present site, the following approach is adopted to arrive at Liquefaction Resistance Characterization of the sub surface deposits encountered in the present site.

Step-1: Using the Zone Factor (Z), Importance Factor (I), Response reduction factor and Average response acceleration coefficient (S_a/g) pertinent to Zone-III, the design horizontal and vertical seismic coefficients are estimated as per IS:1893.

Step-2: Using the design seismic coefficient, compute the design seismic shear for corresponding to effective vertical stress (cyclic shear stress) due to overburden is computed.

Step-3: Using the average corrected design SPT-value arrive at the design angle of shearing resistance compute the effective shear strength (static strength)

Step-4: Arrive at the CSR value of the deposit by dividing the cyclic shear stress with the effective shear strength.

Step-4: Based on the CSR- N_{160} relation from Fig.4.1 and using the magnitude correction factor corresponding to Zone-III ($M=6$), the probable liquefaction/no-liquefaction characterization is arrived at and the details are given below:

Table 9-2 Magnitude Correction Factors for Cyclic Stress Approach	
Magnitude, M	$CSR_M / CSR_{M=7.5}$
$5 \frac{1}{4}$	1.50
6	1.32
$6 \frac{3}{4}$	1.13
$7 \frac{1}{2}$	1.00
$8 \frac{1}{4}$	0.80

TABLE-4.1 MAGNITUDE CORRECTION FACTORS FOR CYCLIC STRESS APPROACH

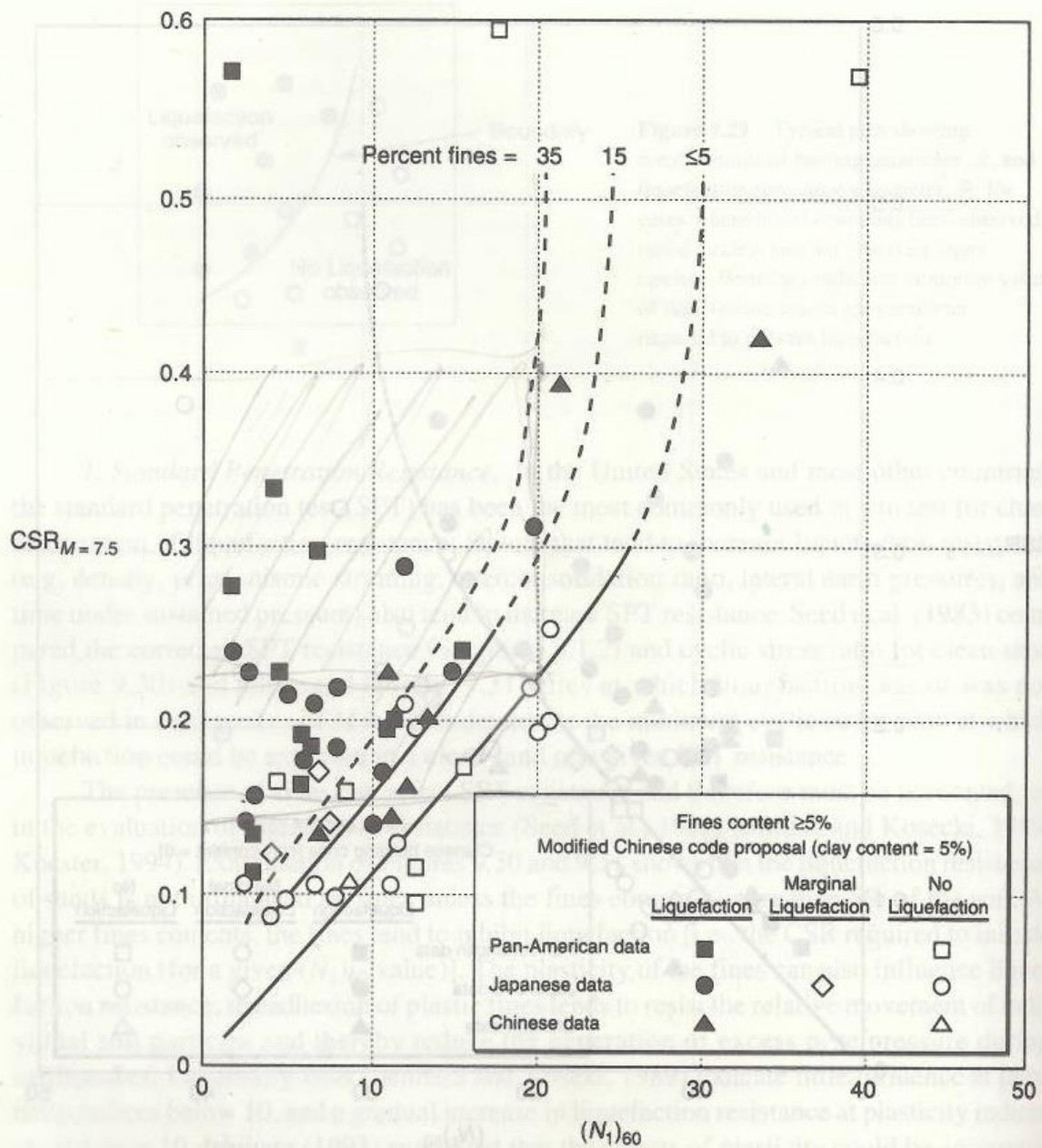


Figure 9.31 Relationship between cyclic stress ratios causing liquefaction and $(N_1)_{60}$ values for silty sands in $M = 7.5$ earthquakes. (After Seed et al. (1975). Influence of SPT procedures in soil liquefaction resistance evaluations, *Journal of Geotechnical Engineering*, Vol. 111, No. 12. Reprinted by permission of ASCE.)

FIG 4.1: RELATIONSHIP BETWEEN CYCLIC STRESS RATIOS OF LIQUEFACTION

4.4 **SUSCEPTIBILITY TO LIQUEFACTION:**

Liquefaction is a phenomenon occurs in sand and silts having relative density loose to very loose formation. Further the phenomenon can occurs in soft to very soft, clays of low plastic nature. The low plastic nature indirectly infers the predominant percentage of silt size particle which are highly susceptible to liquefaction.

In the project site no silt and sand with relative density having neither very loose nor very soft to soft low plastic clay strata exists within the investigation depth.

- ❖ ***The present project site falls in Seismic Zone-III, as per IS 1893 (Part-I).***
- ❖ ***Though the strata is clayey sand in the top 3.0m, since the relative density is loose to very loose the formation in the top 3.0m is susceptible to liquefaction.***
- ❖ ***The liquefaction analysis is presented in Annexure-II***

FOUNDATION SYSTEM

DESIGN OF FOUNDATION SYSTEM, EXCAVATION & DEWATERING

5.1 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.

5.2 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

- 1 Basement + 1 or 2 Stilt + 15 or 18 Upper Floors
- 2 Basement + Stilt + 18 Upper Floors

and is meant for residential use. For this kind of structure, the column loads could vary between 5000 kN to 7000 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.

5.3 Sub Soil Stratification

The generalised sub soil profile of the project area is discussed below:

0.0m to 2.0m or 4.0m	-	Very Loose to Loose, Clayey Sand
2.0m/4.0m to 5.0m	-	Dense to Very Dense, Residual Soil & Completely Weathered Rock – Grade W5 Rock formation
5.0m to 11.0m or 14.0	-	Hypersthene Granitic Rock With degree of weathering ranging from W4 (Highly Weathered Rock) to Slightly Weathered & Fresh Rock-Grade W3 to W1

5.4 FOUNDATION SYSTEM:

5.4.1 SITE LEVELS & PROPOSED CONSTRUCTION:

It proposed to construct multistoried residential apartments, having both single and double basement floors and the number of upper floors is Stilt + 18 Floors. The clear height of basement floor is 4.1m with respect to the adjoining road level.

The existing ground level is sloping from north to south with 2.5m below road level in the northern boundary region.

5.4.2 BEARING STRATUM:

For the kind of proposed structure, it is ideal to consider the underlying weathered rock as a bearing stratum and this option optimizes the foundation design. In the project location, at 5.0m and below the existing ground level at all the investigation location refusal strata exists, hence adopt 4.5m as the depth of foundation.

5.4.3 FOUNDATION SYSTEM:

For the kind of proposed construction, the foundation depth (bottom of footing or raft) can be minimum 4.5m below the existing ground level. For different sizes of Isolated Footing the allowable net safe bearing pressure is worked out as per IS 6403 & presented in Table 5.1, however R.C.C Raft can be designed for an allowable net safe bearing pressure of 1500 kPa. Typical computation is presented in the Annexure-I.

LOAD TRANSFER THROUGH BEARING STRATUM AND FOUNDATION SETTLEMENT:

The bearing stratum at founding level is predominantly completely weathered rock to highly weathered rock and is modelled as coarse grain soil (very dense granular soil). In the present case, though ground water table is encountered at existing ground level during the period of investigation the sub soil can get saturated but submerged condition doesn't exists as the formation up to the foundation depth is very dense completely weathered rock. However, for the estimation of bearing capacity as a conservative approach submerged condition is considered and the bearing strata is modelled as very dense, coarse grain formation.

Since the formation beyond the foundation depth being rock formation for the analysis of settlements only elastic immediate settlement is considered.

TABLE 5.1 RECOMMENDED ALLOWABLE SAFE BEARING PRESSURE						
S.No.	MINIMUM DEPTH OF FOUNDATION BELOW EGL (m)	TYPE OF FOUNDATION	SIZE OF FOUNDATION (m)		RECOMMENDED ALLOWABLE NET SAFE BEARING PRESSURE (kPa)	ESTIMATED ELASTIC SETTLEMENT (mm)
			WIDTH (B)	LENGTH (L)		
1.0	4.5	ISOLATED FOOTING	1.0	1.0	1000	2.81
2.0			2.0	2.0	1300	7.3
3.0			3.0	3.0	1500	12.63
4.0			4.0	4.0		16.84
5.0			5.0	5.0		21.05
6.0	4.5	RAFT	10.0	10.0	1500	42.09

5.5 **EXCAVATION:**

For carrying out the open excavation adopt short contiguous of 5.5m length from the existing ground level into the underlying weathered rock formation. In the present case, design the contiguous pile as a fixed cantilever piles.

The clear gap between the piles shall be 50mm further, the surface of the piles shall be shotcrete to prevent ingress of water between the pile gaps.

EXCAVATABILITY:

For carrying out excavation up to 4.5m deep, conventional mechanical excavator like JCB or Poclain is suitable for the successful completion.

However, if the requirement of excavation depth is about 7.0m from the existing ground level a combination of Mechanical Excavator attached with Rock breaker beyond 5.5m is a requirement and in case of outcrop of hard rock diamond saw cutting in lieu of rock breaker is a requirement.

No chemical spitting works due to presence of high moisture & high dissolved solids in the ground water.

5.6 **EXCAVATION GROUND WATER LOWERING:**

Though the water level during the period of investigation exists at 1.0m below the existing ground level, however based on the sub soil characteristics the ground water lowering can be carried out by conventional collection pit pumping system, with water training shallow ditches connecting the collection pit at the bottom of excavation.

In case the excavation goes beyond 5.5m and if ground water seepage is high peripheral borehole up to a depth of 10.0m provides a solution for dewatering. Hence provides peripheral boreholes at 25m Centre to Centre in between contiguous piles & boundary wall and the boreholes shall be connected a common header and the pumped water shall be discharged away from the site to an unobjectionable location. Since the design of dewatering is not in the present scope the same is not presented.

5.7 **DESIGN OF BASEMENT SLAB FOR UPLIFT:**

Check the basement floor for uplift considering the deeper of the two, hence estimation of hydrostatic pressure can be either from bottom of footing or tip of contiguous piles. Enhance the static hydrostatic pressure to 25% to account for the local built up of hydrostatic pressure due to development around the proposed site.

Further, the ingress of surface water below the basement slab through the gaps shall be prevented by providing a payment connected to the retaining wall.

RECOMMENDATIONS

RECOMMENDATIONS

6.1 RECOMMENDATIONS FOR FOUNDATION:

- ❖ For the kind of sub soil conditions, the foundation system as described in Chapter-5, Section 5.4 can be adopted
- ❖ For the proposed construction, isolated footing with stitch slab or R.C.C Raft can be provided with the bottom of foundation located at a minimum depth of 4.5m from the existing ground level.
- ❖ At 4.5m and below, for different width of foundation the recommended allowable net safe bearing pressure is presented in Table 5.1. In case of raft foundation, the recommended net allowable safe bearing pressure is 1500 kPa.
- ❖ Since the formation at the founding level being rock formation, the settlement will be of immediate in nature and the estimated settlement for the corresponding safe bearing pressure is within the permissible limit as per IS 1904
- ❖ For carrying out soil-structure interaction analysis, the recommended modulus of sub grade reaction beyond 4.5m is 2,00,000 kN/m²/m

6.2 RECOMMENDATIONS FOR EXCAVATION AND DEWATERING:

- ❖ For basement excavation, the excavation method as discussed in Section 5.5, Chapter-5.0 can be adopted
- ❖ For lowering the ground water table, the scheme discussed in section 5.6, Chapter-5.0 can be adopted

6.3 SPECIAL RECOMMENDATION:

- ❖ Since the chloride level in the ground water sample is higher than the permissible limit of 500mg/l, the reinforcement may be either corrosion resistance steel (CRS) or the reinforcement shall be coated with anticorrosion coatings.
- ❖ 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. In the project location, the sulphate content in both ground water & soil-water is within the permissible limit of 400 mg/l hence no special cement is required for the construction and ordinary Portland cement is suitable for the construction.
- ❖ The lower basement slab shall be checked for uplift considering the deeper of the two, either from bottom of footing or tip of contiguous piles. Enhance the static hydrostatic pressure to 25% to account for the local built up of hydrostatic pressure due to development around the proposed site.
- ❖ The present project site fall in seismic zone-III as per IS 1893-P-I and based on the liquefaction analysis the sub soil formation beyond 3.0m to 5.0m below the existing ground level is not susceptible to liquefaction.
- ❖ Excavated soil is suitable for backfilling purposed.

- ❖ *For confirm the safe bearing pressure it is recommended to conduct 2 plate load test as per IS 1888 and the geotechnical consultant shall identify the bearing strata before laying the PCC.*
- ❖ *Before excavation is started a workshop shall be conducted including the Owner, Architect, Structural Engineer, Geotechnical Engineer and Execution agency to ensure the proposal given by the contractor is workable and safe.*
- ❖ *Before construction activities are initiated, a scientific due-diligence of the condition of the neighbouring structures shall be carried out and authenticated. This is required to ensure that no undue claims or interpretations are made by the neighbourhood that the construction activities cause damages to their structures*

AUTHORISED SIGNATORY

Dr. C.V. PRASAD,
GEO MARINE CONSULTANTS PVT LTD.,

ANNEXURE-I

TYPICAL BEARING CAPACITY COMPUTATIONS FOR SHALLOW FOUNDATION

1.0 COMPUTATION OF BEARING CAPACITY AS PER IS:6403

1.1 Geometrical Data :

Shape of the Foundation	Square
Depth of Foundation Below E.G.L "D _f " (m):	4.50
Depth of one basement floor below E.G.L "D _b "(m):	1.60
Depth of Embedment below the basement floor "D _e "(m):	2.90
Breadth of Footing "B" (m):	5.00
Length of Footing "L" (m):	5.00
L/B	1.00
Inclination of Vertical Load with the Vertical (α)	0.00

1.2 Soil Data :

Type of Effective Bearing Strata :	Completely Weathered Rock
Type of Shear Failure:	General
SPT "N" of the Bearing Strata :	100
Angle of Shearing Resistance	42.50

1.3 Design Parameters:

Bulk Density of Soil above the foundation depth (γ_{bulk})	18	kN/m ³
Water Table Correction Factor (w')	0.50	
Effective overburden pressure at foundation level (q)	23.20	kN/m ²
Bearing Capacity Factors:		
N_c	N/A	
N_q	99.54	
N_g	190.59	
Shape Factors:		
S_c	-	
S_q	1.20	
S_g	0.80	
Depth Factors :		
D_c	-	
D_q	1.00	
D_g	1.00	
Inclination Factor:		
I_c	1.00	
I_q	1.00	
I_g	1.00	

1.4 Ultimate Bearing Capacity (Q_u) :

$$Q_u = q \cdot (N_q - 1) \cdot S_q \cdot D_q \cdot I_q + 0.5 \cdot B \cdot g \cdot N_g \cdot S_g \cdot D_g \cdot I_g \cdot w' \quad 6198.14 \quad \text{kPa}$$

(g should be read as γ_a)

1.5 Safe Bearing Capacity (Q_{safe}) :

Factor of Safety (F.S.) :	2.50
Q _{safe} :	2479.26 kPa
Say Q_{safe}	1500 kPa

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

The immediate elastic settlement (S _i)= $qB(1-\mu^2)/E_s$		
q= bearing pressure	1500.00	kPa
Poisson'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)	260000	
Size of footing considered for maximum settlement(m)	5.00	
Influence factor	0.95	
Rigidity Factor	0.80	
Elastic Settlement (DH _i)	21.05	mm
	<50	mm

TYPICAL BEARING CAPACITY COMPUTATIONS FOR SHALLOW FOUNDATION

1.0 COMPUTATION OF BEARING CAPACITY AS PER IS:6403

1.1 Geometrical Data :

Shape of the Foundation Raft
 Depth of Foundation Below E.G.L "D_f" (m): 4.50
 Depth of one basement floor below E.G.L "D_b"(m): 1.60
 Depth of Embedment below the basement floor "D_e"(m): 2.90
 Breadth of Footing "B" (m): 10.00
 Length of Footing "L" (m): 10.00
 L/B 1.00
 Inclination of Vertical Load with the Vertical (α) 0.00

1.2 Soil Data :

Type of Effective Bearing Strata : Completely
 Weathered Rock
 Type of Shear Failure: General
 SPT "N" of the Bearing Strata : 100
 Angle of Shearing Resistance 42.50

1.3 Design Parameters:

Bulk Density of Soil above the foundation depth (γ_{bulk}) 18 kN/m³
 Water Table Correction Factor (w') 0.50
 Effective overburden pressure at foundation level (q) 23.20 kN/m²
 Bearing Capacity Factors:
 $N_c = N/A$
 $N_q = 99.54$
 $N_g = 190.59$
 Shape Factors:
 $S_c = -$
 $S_q = 1.20$
 $S_g = 0.60$
 Depth Factors :
 $D_c = -$
 $D_q = 1.00$
 $D_g = 1.00$
 Inclination Factor:
 $I_c = 1.00$
 $I_q = 1.00$
 $I_g = 1.00$

1.4 Ultimate Bearing Capacity (Q_u) :

$Q_u = q \cdot (N_q - 1) \cdot S_q \cdot D_q \cdot I_q + 0.5 \cdot B \cdot g \cdot N_g \cdot S_g \cdot D_g \cdot I_g \cdot w'$ 7904.65 kPa
 (g should be read as gamma)

1.5 Safe Bearing Capacity (Q_{safe}) :

Factor of Safety (F.S.) : 2.50
 $Q_{safe} = 3161.86$ kPa
Say Q_{safe} 1500 kPa

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

The immediate elastic settlement (S_i)= $qB(1-m^2)/E_s$
 q = bearing pressure 1500.00 kPa
 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) 260000
 Size of footing considered for maximum settlement(m) 10.00
 Influence factor 0.95
 Rigidity Factor 0.80
 Elastic Settlement (DH_i) 42.09 mm
 < 75 mm

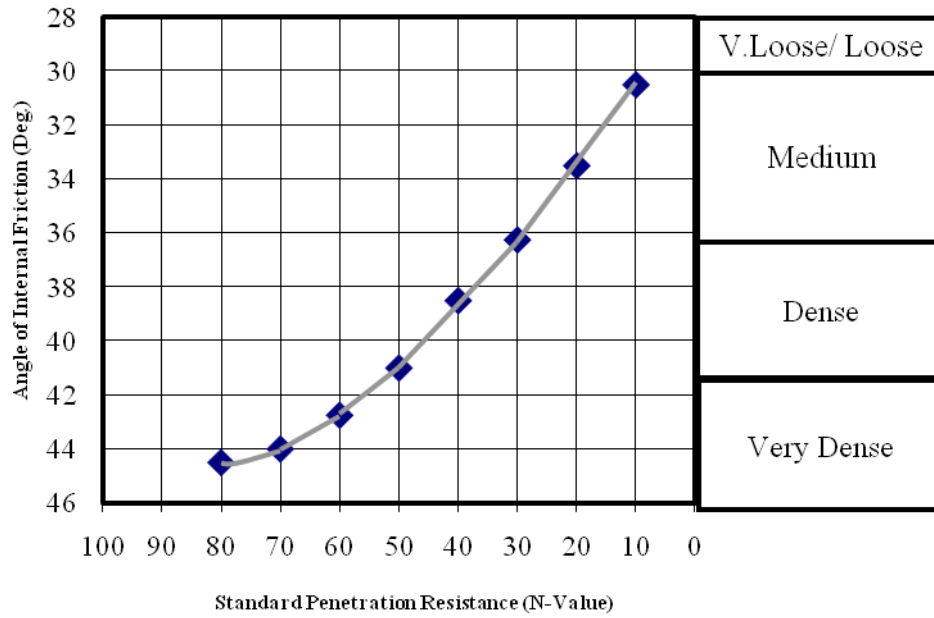


FIG. A1 Relation Ship between Angle of Internal Friction & N-value (Reproduced from IS:6403-1981)

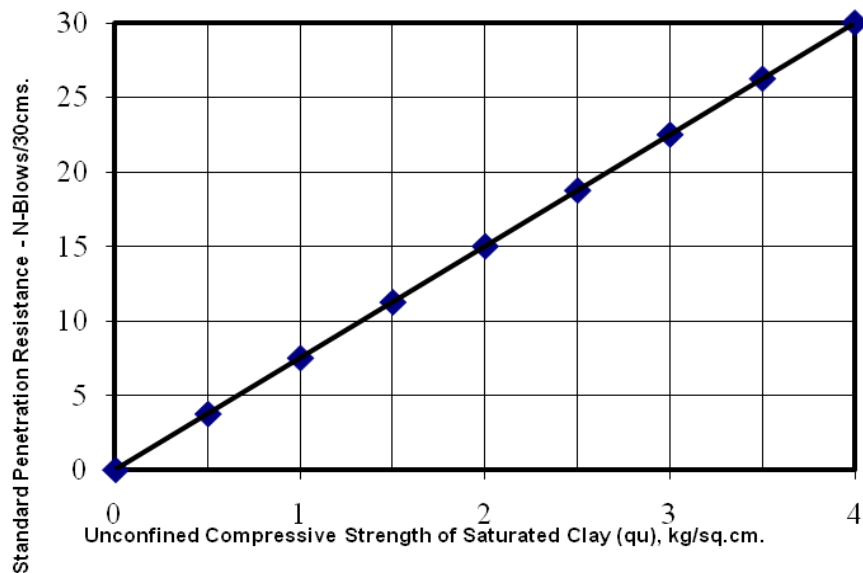


FIG. A2 : Relationship between UCC & SPT-Value (N) of Saturated Clay (After Terzaghi & Peck, 1948)

ANNEXURE-II

ANNEXURE-III

GEO MARINE THE SPIRIT OF ENGINEERING		SITE INVESTIGATION RECORD						BORE HOLE No. 01							
PROJECT NAME		N.C.C. Pallavaram (Radial Road)						PAGE No. 01							
LOCATION		MACHINE No.		CHAINAGE (m)		BORE START DATE 03/12/2020		DIA OF BORE HOLE 150mm 17 100mm							
STRUCTURE B + 28ft + 14		DRILLING METHOD Rotary		CO-ORDINATES		BORE END DATE 05/12/2020		TOTAL DRILLING DAYS 2							
JOB CODE		FLUSHING MEDIUM Bentonite													
Depth below G.L. (m)	Drilling progress per metre			Type of Drill Bit (SC / TCB / DB)	Core Details		SPT Details			Sample Details			Layer Data		
	Date	Time			Total Core Recovery %	R.Q.D %	Blows/cm.			SPT 'N' Value	Depth	No.	Type	Depth (m)	Geotechnical Description
		Hr.	Min				0-15	15-30	30-45						
1	03	2:59	2:55												Filled up soil
2	12	3:09	3:10												Brownish very stiff silty clay with sand particles
3	12	3:21	3:23												Whitish Brown medium dense clayey lime soil
4	12	3:35	3:37												Whitish Brown very dense lime stone
5	12	3:51	3:57												Brownish dense completely weathered rock
6	12	4:16	4:40	DB											Greyish Brown very weak completely weathered rock
7	05	9:29	9:51		8% 0%										Whitish Grey weak completely weathered rock
8	12	10:57	11:25		0% 0%										Greyish Brown very weak completely weathered rock
9	12	11:37	12:03		3% 0%										Do
10	12	11:37	12:03		7% 0%										Do

CS - Core Sample	DS - Disturbed Sample	SUPERVISOR NAME	M. Loganathan	PROJECT SITE DETAILS	
SS - Split Spoon Sample	SC - Soil Cutter	SIGNATURE		GROUND LEVEL (m)	
UDS - Undisturbed Sample	TCB - Tungsten Carbide Bit	DATE	05/12/2020	WATER TABLE (m)	
WS - Wash Sample	DB - Diamond Bit	CLIENT IN-CHARGE		CASING DEPTH (m)	

 THE SPIRIT OF ENGINEERING		SITE INVESTIGATION RECORD										BORE HOLE No. 01			
												PAGE No. 02			
PROJECT NAME		NCC Pallavaram - Radial Road										DIA OF BORE HOLE			
												150mm		100mm	
LOCATION						MACHINE No.		CHAINAGE (m)		BORE START DATE		3/12/2020			
STRUCTURE		B+2st + 14 F				DRILLING METHOD		Rotary		BORE END DATE		05/12/2020			
						FLUSHING MEDIUM		Bentonite		CO-ORDINATES		N		E	
JOB CODE															
Depth below F.G.L. (m)	Drilling progress per metre			Type of Drill Bit (SC / TCB / DB)	Core Details		SPT Details			Sample Details			Layer Data		
	Date	Time			Total Core Recovery %	R.Q.D %	Blows/cm.			SPT 'N' Value	Depth	No.	Type	Depth (m)	Geotechnical Description
		Hr.	Min				0-15	15-30	30-45						
1	05/12	12	16												
2	12/12	12	48												
3															
4															
5															
6															
7															
8															
9															
10															

DB 10% 0%

DB 57/25%

DB 78/30%

12:00 10 LS

13:00 11 CS

14:00 12 CS

Greyish Brown Very Weakly Completely Weathered Rock

Greyish Brown Strong Slightly Weathered Rock

Brownish Grey Strong Slightly Weathered Rock

Bore hole Terminated at 14.00m Depth below F.G.L.

PROJECT SITE DETAILS	
CS - Core Sample SS - Split Spoon Sample UDS - Undisturbed Sample WS - Wash Sample	DS - Disturbed Sample SC - Soil Cutter TCB - Tungsten Carbide Bit DB - Diamond Bit
SUPERVISOR NAME Mr. Loganathan SIGNATURE [Signature] DATE 05/12/2020 CLIENT IN-CHARGE	
GROUND LEVEL (m) WATER TABLE (m) CASING DEPTH (m)	

GEOMARINE THE SPIRIT OF ENGINEERING		SITE INVESTIGATION RECORD										BORE HOLE No. 02		
PROJECT NAME NCC												PAGE No. 1		
LOCATION Palanaram		MACHINE No.		CHAINAGE (m)		BORE START DATE 5/12/2020		DIA OF BORE HOLE 150mm		100mm				
STRUCTURE		DRILLING METHOD Rotary		CO-ORDINATES N		BORE END DATE 7/12/2020								
JOB CODE		FLUSHING MEDIUM Bentonite		E		TOTAL DRILLING DAYS								
Depth below E.G.L. (m)	Drilling progress per metre		Type of Drill Bit (SC / TCB / DB)	Core Details		SPT Details			Sample Details			Layer Data		
	Date	Time		Total Core Recovery %	R.Q.D %	Blows/cm.			SPT 'N' Value	Depth	No.	Type	Depth (m)	Geotechnical Description
						0-15	15-30	30-45						
1	5/12/2020	11:40	SC			5	6	12	18	1		SS		m-dense, Brown, Fin-medium grains CLAYEY SAND.
2		12:01	SC			4	8	12	20	2		SC		v-stiff, moist, sky blue - white (mix) compact silty clay
3		12:20	SC			25	50	1500		3		SC		v-weak, greyish-pinkish (mix) medium coarse grains COMPLETELY WEATHERED ROCK
4		12:40	SC			HAMMERS				4		LS		v-weak, pinkish, medium-coarse grains. COMPLETELY WEATHERED ROCK
5		2:00	TCB							5		HS		v-weak, grey-pinkish (mix) medium coarse grains. COMPLETELY WEATHERED ROCK
6		2:35	TCB							6				
7		4:55	DB	45/01						7		CS		moderate - strong, grey-pinkish (mix) medium coarse grains. SLIGHTLY WEATHERED ROCK
8		09:15	DB	59/23						7.5				
9		14:50	DB	97/97						8.10		CS		Strong - Very Strong greyish Moderately Weathered Rock
10		17:20	DB	97/97						9		CS		Very Strong, greyish slightly weathered FRESH ROCK
Bore Hole Terminated depth 10.00 m														
CS - Core Sample		DS - Disturbed Sample		SUPERVISOR NAME K. G. V. Sankaran		PROJECT SITE DETAILS								
SS - Split Spoon Sample		SC - Soil Cutter		SIGNATURE K. G. V. Sankaran		GROUND LEVEL (m)								
UDS - Undisturbed Sample		TCB - Tungsten Carbide Bit		DATE		WATER TABLE (m)								
WS - Wash Sample		DB - Diamond Bit		CLIENT IN-CHARGE		CASING DEPTH (m)								

SITE INVESTIGATION RECORD

BORE HOLE No.	3
PAGE No.	1
DIA OF BORE HOLE	150mm
	100mm
BORE START DATE	18/4/2022
BORE END DATE	19/4/2022
TOTAL DRILLING DAYS	

PROJECT NAME	NCC - Urban.			
LOCATION	Pallavaram	MACHINE No.		CHAINAGE (m)
STRUCTURE	B/ST/18F	DRILLING METHOD	Rotary	CO-ORDINATES
JOB CODE		FLUSHING MEDIUM	Bentonite	

Depth below G.L. (m)	Drilling progress per metre		Type of Drill Bit (SC /TCB /DB)	Core Details		SPT Details			Sample Details			Layer Data			
	Date	Time		Total Core Recovery %	R.Q.D %	Blows/cm.			SPT 'N' Value	Depth	No.	Type	Depth (m)	Geotechnical Description	
		Hr.				Min	0-15	15-30							30-45
1						0	1	2	3	1					Soft, greyish-lime whitish compact clay with kankar
2						3	4	5	9	2					Stiff, greyish-lime whitish compact clay with kankar
3						3	5	8	13	3					Loose, greyish-lime whitish clayey sand with kankar
4						2	15	65	80	4					V. dense, fine-medium coarse Brownish, RESIDUAL SOIL
5						55	(x100)			5					Lime whitish - Brownish fine-medium coarse grained COMPLETELY WEATHERED ROCK
						12cm									
6					DB 15/10%					6					Weak - Brownish-Pinkish, med coarse grained - HIGHLY - MODERATELY WEATHERED ROCK
7															
					DB 37/10%					7.5					Moderate - strong medium - coarse grained Pinkish SLIGHTLY WEATHERED ROCK
8															
9					DB 52/12%					9					Strong, coarse, medium - coarse grained - SLIGHTLY WEATHERED ROCK
10					DB 65/10%					10					SLIGHTLY WEATHERED ROCK

Split spoon samplers

CS - Core Sample	DS - Disturbed Sample	SUPERVISOR NAME	K. Sivakumar	PROJECT SITE DETAILS	
SS - Split Spoon Sample	SC - Soil Cutter	SIGNATURE	K. G. ...	GROUND LEVEL (m)	
UDS - Undisturbed Sample	TCB - Tungsten Carbide Bit	DATE	19/4/2022	WATER TABLE (m)	1.10m
WS - Wash Sample	DB - Diamond Bit	CLIENT IN-CHARGE		CASING DEPTH (m)	

GEO MARINE THE SPIRIT OF ENGINEERING		SITE INVESTIGATION RECORD										BORE HOLE No. <u>3</u>		
PROJECT NAME <u>NCC Urban.</u>												PAGE No. <u>2</u>		
LOCATION <u>Pallavaram.</u>		MACHINE No.		CHAINAGE (m)		BORE START DATE <u>18/4/2022</u>		DIA OF BORE HOLE 150mm 100mm		BORE END DATE <u>19/4/2022</u>				
STRUCTURE <u>B/S/T/18F</u>		DRILLING METHOD Rotary		CO-ORDINATES N E		TOTAL DRILLING DAYS								
JOB CODE		FLUSHING MEDIUM Bentonite												
Depth below E.G.L. (m)	Drilling progress per metre		Type of Drill Bit (SC / TCB / DB)	Core Details		SPT Details			Sample Details			Layer Data		
	Date	Time Hr. Min		Total Core Recovery %	R.Q.D %	Blows/cm.			SPT 'N' Value	Depth	No.	Type	Depth (m)	Geotechnical Description
						0-15	15-30	30-45						
1		3.15 5.05												strong, waxy, medium-coarse grained. SLIGHTLY WEATHERED ROCK (Grade II)
2														
3														
4														
5														
6														
7														
8														
9														
0														

DB 8068

CS

Bores terminated at 11 mb depth.

CS - Core Sample	DS - Disturbed Sample	SUPERVISOR NAME	K. Sivasankaran	PROJECT SITE DETAILS	
SS - Split Spoon Sample	SC - Soil Cutter	SIGNATURE	[Signature]	GROUND LEVEL (m)	
UDS - Undisturbed Sample	TCB - Tungsten Carbide Bit	DATE		WATER TABLE (m)	
WS - Wash Sample	DB - Diamond Bit	CLIENT IN-CHARGE		CASING DEPTH (m)	

GEOMARINE THE SPIRIT OF ENGINEERING		SITE INVESTIGATION RECORD						BORE HOLE No.		4					
PROJECT NAME		NCC Urban.						PAGE No.		1					
LOCATION		MACHINE No.		CHAINAGE (m)				DIA OF BORE HOLE		150mm 100mm					
STRUCTURE		DRILLING METHOD		Rotary		CO-ORDINATES		BORE START DATE		20/4/2022					
JOB CODE		FLUSHING MEDIUM		Bentonite				BORE END DATE		21/4/2022					
								TOTAL DRILLING DAYS		7					
Depth below E.G.L. (m)	Drilling progress per metre			Type of Drill Bit (SC / TCB / DB)	Core Details		SPT Details			Sample Details			Layer Data		
	Date	Time			Total Core Recovery %	R.Q.D %	Blows/cm.			SPT 'N' Value	Depth	No.	Type	Depth (m)	Geotechnical Description
		Hr.	Min				0-15	15-30	30-45						
1	11.00			SC			3	4	5	9	1	SS		Loose, fine-medium coarse grain, greyish-brownish clayey sand.	
2	11.04			SC			4	6	6	12	2	SS		Stiff - greyish-lime whitish sandy clay with kankar pebbles.	
3	11.17			SC			6	18	50	62	3	SS		V. dense, lime whitish-greyish-brownish fine-medium coarse grain residual soil.	
4	11.20			SC			58	(>>100)			4	[BS]		V. weak-brownish-pinkish medium coarse grain completely weathered rock.	
5	11.35			SC			HAMMAN RES			5	[HS]		COMPLETELY WEATHERED ROCK		
6	11.40			DB			(>>100) HAMMAN RES			6	[HS]		Pinkish, medium-coarse grain highly weathered fractured rock.		
7	11.58			DB	18%	0%	-	-	-	-	7	[CS]		Weak-moderate pinkish-grey medium coarse grain moderately weathered rock.	
8	12.06			DB	94%	27%	-	-	-	-	8	[CS]		Strong, grey-medium-coarse grain slightly weathered rock (Grade II).	
9	12.15			DB	79%	40%	-	-	-	-	9	[CS]		Grade - II	
10	12.28			DB	92%	52%	-	-	-	-	10	[CS]			

GEO MARINE THE SPIRIT OF ENGINEERING		SITE INVESTIGATION RECORD						BORE HOLE No.		4	
								PAGE No.		2	
PROJECT NAME		NCC Urban						DIA OF BORE HOLE		150mm	
LOCATION		Pallavaram		MACHINE No.				CHAINAGE (m)			
STRUCTURE		B / ST / 18 Floor		DRILLING METHOD		Rotary		CO-ORDINATES		N	
JOB CODE				FLUSHING MEDIUM		Bentonite				E	
								BORE START DATE		20/4/2022	
								BORE END DATE		21/4/2022	
								TOTAL DRILLING DAYS			
Depth below G.L. (m)		Drilling progress per metre		Type of Drill Bit (SC / TCB / DB)		Core Details		SPT Details		Sample Details	
		Time									
		Date									
		Hr. Min									
				Total Core Recovery %		R.Q.D %		Blows/cm.		SPT 'N' Value	
								0-15 15-30 30-45		Depth No. Type	
										Geotechnical Description	
1		9.15		DS-1757				11		Grade-II CRN = 77% RQD = 57% HARD ROCK. Heavy - medium coarse grained slightly weathered rock	
2		10.00									
3											
4											
5											
6											
7											
8											
9											
10											
CS - Core Sample		DS - Disturbed Sample		SUPERVISOR NAME		A. Siva Kumar		PROJECT SITE DETAILS			
SS - Split Spoon Sample		SC - Soil Cutter		SIGNATURE		[Signature]		GROUND LEVEL (m)			
UDS - Undisturbed Sample		TCB - Tungsten Carbide Bit		DATE		21/4/2022		WATER TABLE (m)			
WS - Wash Sample		DB - Diamond Bit		CLIENT IN-CHARGE				CASING DEPTH (m)			

GEO MARINE THE SPIRIT OF ENGINEERING		SITE INVESTIGATION RECORD										BORE HOLE No. 5		
PROJECT NAME		NCC URBAN										PAGE No. 1		
LOCATION		MACHINE No.		CHAINAGE (m)		BORE START DATE		DIA OF BORE HOLE		150mm				
STRUCTURE		DRILLING METHOD		CO-ORDINATES		BORE END DATE		100mm		22/4/2022				
JOB CODE		FLUSHING MEDIUM		Bentonite		TOTAL DRILLING DAYS								
Depth below E.G.L. (m)	Drilling progress per metre		Type of Drill Bit (SC / TCB / DB)	Core Details		SPT Details			Sample Details			Layer Data		
	Date	Time		Total Core Recovery %	R.Q.D %	Blows/cm.			SPT 'N' Value	Depth	No.	Type	Depth (m)	Geotechnical Description
						0-15	15-30	30-45						
1						5	12	15	27	1		TOP		Filling material: (0.00 TO 1.10) Reddish-Whitish Bricks & BUILDING MATERIALS.
2	9.10		SC			5	4	4	8	2		SS		m stiff, grey, moist, compact. CLAY
3	9.30		SC			0	0	1	1	3		SS		V-soft greyish-lim Whitish CLAY WITH lim Pebble / kankar.
4	9.51		SC			3	9	6	15	4		SS		greyish Brownish, compact SANDY CLAY WITH kankar pebbles
5	10.07		SC			15	49	54	103	5		SS		V-dense, grey-greenish, fine-medium grain. RESIDUAL SOIL
6	10.40		7 (D)			7 (100) HAMMER TEST				6		NS		greenish blackish-medium coarse grain. COMPLETELY WEATH. ROC
7	12.15													
8	12.50		DB	12%						7.5		TCB		LEAK - Brown-Pinkish-grey medium coarse grain. HIGHLY WEATHERED FRACTURE R
9	2.00													
10	3.00													Strong grey medium coarse grain Moderately weathered Rock (under)
11	3.15		DB	61%						9		TCB		
12	4.00		DB	83%	56					10		TCB		Strong, grey, medium coarse grain SLIGHTLY WEATHERED ROCK

CS - Core Sample	DS - Disturbed Sample	SUPERVISOR NAME	K. Anirudh		PROJECT SITE DETAILS	
SS - Split Spoon Sample	SC - Soil Cutter	SIGNATURE	K. Anirudh		GROUND LEVEL (m)	
UDS - Undisturbed Sample	TCB - Tungsten Carbide Bit	DATE	22/4/2022		WATER TABLE (m)	1.20m
WS - Wash Sample	DB - Diamond Bit	CLIENT IN-CHARGE			CASING DEPTH (m)	

SITE INVESTIGATION RECORD

BORE HOLE No. **5**

PAGE No. **2**

PROJECT NAME

NCC URBAN

DIA OF BORE HOLE

150mm

100mm

LOCATION

Pallavaram

MACHINE No.

CHAINAGE (m)

BORE START DATE

22/4/2022

STRUCTURE

B St 1st Floor

DRILLING METHOD

Rotary

CO-ORDINATES

N

BORE END DATE

22/4/2022

JOB CODE

FLUSHING MEDIUM

Bentonite

TOTAL DRILLING DAYS

Depth below E.G.L. (m)	Drilling progress per metre		Type of Drill Bit (SC / TCB / DB)	Core Details		SPT Details			Sample Details			Layer Data	
	Date	Time		Total Core Recovery %	R.Q.D %	Blows/cm.			Depth	No.	Type	Depth (m)	Geotechnical Description
		Hr. Min				0-15	15-30	30-45					
1	4.10	5.00	DB 90/59						11m		CS		Strong, Grey - medium coarse grain. SLIGHTLY WEATH. (Grade II)
2													C _{cu} = 90% R _{qp} = 59%
3													
4													
5													
6													
7													
8													
9													
10													

Borehole terminated at 11.11m depth

CS - Core Sample

DB - Disturbed Sample

SUPERVISOR NAME

K. S. Srinivasan

PROJECT SITE DETAILS

SS - Split Spoon Sample

SC - Soil Cutter

SIGNATURE

K. S. Srinivasan

GROUND LEVEL (m)

UDS - Undisturbed Sample

TCB - Tungsten Carbide Bit

DATE

22/4/2022

WATER TABLE (m)

WS - Wash Sample

DB - Diamond Bit

CLIENT IN-CHARGE

CASING DEPTH (m)

GEO MARINE THE SPIRIT OF ENGINEERING		SITE INVESTIGATION RECORD										BORE HOLE No. 06			
PROJECT NAME		NCC URBAN.										PAGE No. 1			
LOCATION		MACHINE No.		CHAINAGE (m)		BORE START DATE		BORE END DATE		TOTAL DRILLING DAYS					
STRUCTURE		DRILLING METHOD		CO-ORDINATES		BORE END DATE		BORE END DATE		TOTAL DRILLING DAYS					
JOB CODE		FLUSHING MEDIUM		Bentonite		CO-ORDINATES		BORE END DATE		TOTAL DRILLING DAYS					
Depth below G.L. (m)	Drilling progress per metre		Type of Drill Bit (SC / TCB / DB)	Core Details		SPT Details			Sample Details			Layer Data			
	Date	Time		Total Core Recovery %	R.Q.D. %	Blows/cm.			SPT 'N' Value	Depth	No.	Type	Depth (m)	Geotechnical Description	
						0-15	15-30	30-45							
1	12.00	12.03	SC			0	1	5	6	1				9.00	Filling material - whitish redish. Bricks with Building materials. Soft m. stiff, usayish, compact. CLAY
2	12.15	12.18	SC			2	4	4	8	2					m. stiff, usayish - Hm. Whitish (m ix) compact. CLAY with bank pebbles.
3	12.40	12.45	SC			4	5	4	9	3					CLAY with bank pebbles
4	12.57	1.00	SC			2	3	1	9	4					m. stiff. usayish, compact SILT/CLAY
5	2.00	2.06	SC			9	22	18	40	5					Dense, fine-medium grains usayish, RESIDUAL SOIL
6	2.19	2.28	SC			HAMMERED									X. WEAK - Pinkish-greenish, medium-coarser grains. COMPLETELY WEATHERED ROCK
7	2.45	3.35													WEAK - moderate - Pinkish-greenish (m ix) medium-coarser grains. Moderately weathered rock (Grade III)
8	3.50	4.40													moderate - strong, medium-coarse grains. Pinkish-greenish (m ix) Moderately - slightly weathered (Grade III - II)
9	9.08	9.50													
10															

CS - Core Sample	DS - Disturbed Sample	SUPERVISOR NAME	K. S. Sankaran		PROJECT SITE DETAILS	
SS - Split Spoon Sample	SC - Soil Cutter	SIGNATURE	K. S. Sankaran		GROUND LEVEL (m)	
UDS - Undisturbed Sample	TCB - Tungsten Carbide Bit	DATE	26/4/2022		WATER TABLE (m)	1.20
WS - Wash Sample	DB - Diamond Bit	CLIENT IN-CHARGE			CASING DEPTH (m)	

GEOMARINE THE SPIRIT OF ENGINEERING		SITE INVESTIGATION RECORD										BORE HOLE No. 06		
PROJECT NAME		NCC Urban										PAGE No. 2		
LOCATION		MACHINE No.		CHAINAGE (m)		BORE START DATE		DIA OF BORE HOLE		150mm				
STRUCTURE		DRILLING METHOD		Rotary		BORE END DATE		100mm		25/4/2022				
JOB CODE		FLUSHING MEDIUM		Bentonite		CO-ORDINATES		N		26/4/2022				
TOTAL DRILLING DAYS														
Depth below E.G.L. (m)	Drilling progress per metre		Type of Drift Blt (SC / TCB / DB)	Core Details		SPT Details			Sample Details			Layer Data		
	Date	Time		Total Core Recovery %	R.Q.D. %	Blows/cm.			SPT 'N' Value	Depth	No.	Type	Depth (m)	Geotechnical Description
						0-15	15-30	30-45						
1	10-05	10-55	DB	74.60%	-	-	-	-	11	125				Strong medium to coarse grained grey to brown silty LEATHERED ROCK (Grade II)
2														
3														
4														
5														
6														
7														
8														
9														
0														

Borehole terminated at 11 m depth

PROJECT SITE DETAILS	
GROUND LEVEL (m)	
WATER TABLE (m)	1.20
CASING DEPTH (m)	

GEOMARINE THE SPIRIT OF ENGINEERING		SITE INVESTIGATION RECORD										BORE HOLE No. 07		
PROJECT NAME		NCC - Urban										PAGE No. 1		
LOCATION		MACHINE No.		CHAINAGE (m)		BORE START DATE		BORE END DATE		TOTAL DRILLING DAYS				
STRUCTURE		DRILLING METHOD		CO-ORDINATES		BORE START DATE		BORE END DATE		TOTAL DRILLING DAYS				
JOB CODE		FLUSHING MEDIUM		Bentonite		BORE START DATE		BORE END DATE		TOTAL DRILLING DAYS				
Depth below E.G.L. (m)	Drilling progress per metre		Type of Drill Bit (SC / TCS / DB)	Core Details		SPT Details			Sample Details			Layer Data		
	Date	Time		Total Core Recovery %	R.Q.D. %	Blows/cm.			SPT 'N' Value	Depth	No.	Type	Depth (m)	Geotechnical Description
						0-15	15-30	30-45						
1	9.55	10.00				0	2	3	5	1		TS		Soft-m. stff, greyish compact clay
2	10.12	10.15				4	7	9	16	2		TS		stff - Brownish-greyish mix SANDY CLAY with pebbles compact
3	10.28	10.36				5	7	10	17	3		TS		greyish-whitish (mix) compact SANDY CLAY with kankar pebbles
4	10.50	10.55				58 (x100) 15cm				4		TS		Pinkish-Brownish, fine-medium COARSE GRAIN. COMPLETELY WEATHERED ROCK
5	11.10	11.20				HAMMERED				5		TS		x. HEAVY - medium - coarse grain BROWNISH-PINKISH HIGHLY WEATHERED ROCK
6	12.33	11.56				HAMMERED				6		TS		HIGHLY WEATH-FRACTURE ROCK
7	12.10	12.50								7.5		TS		HEAVY - moderate, medium-coarse grain. Moderately weathered rock
8	2.00	2.49								9		TS		strong, grey, medium-coarse grain. SLIGHTLY WEATH-ROCK (Grade II)
9	3.00	3.40								10		TS		(Grade I) CRP=100%. RQD=100%.
10										10.50		TS		

CS - Core Sample	DS - Disturbed Sample	SUPERVISOR NAME	K. Sivarajan	
SS - Split Spoon Sample	SC - Soil Cutter	SIGNATURE	K. Sivarajan	
UDS - Undisturbed Sample	TCS - Tungsten Carbide Bit	DATE		
WS - Wash Sample	DB - Diamond Bit	CLIENT IN-CHARGE		

PROJECT SITE DETAILS	
GROUND LEVEL (m)	
WATER TABLE (m)	1.20
CASING DEPTH (m)	

GEOMARINE THE SPIRIT OF ENGINEERING		SITE INVESTIGATION RECORD						BORE HOLE No.		07					
								PAGE No.		2					
PROJECT NAME		NCC Urban						DIA OF BORE HOLE		150mm					
LOCATION		Pallanaram	MACHINE No.			CHAINAGE (m)			BORE START DATE		27/4/2022				
STRUCTURE		R/S + 18 ft	DRILLING METHOD		Rotary	CO-ORDINATES		N	BORE END DATE		27/4/2022				
JOB CODE			FLUSHING MEDIUM		Bentonite			E	TOTAL DRILLING DAYS		1/1/1				
Depth below E.G.L. (m)	Drilling progress per metre			Type of Drill Bit (SC / TCB / DB)	Core Details		SPT Details			Sample Details			Layer Data		
	Date	Time			Total Core Recovery %	R.Q.D %	Blows/cm.			SPT 'N' Value	Depth	No.	Type	Depth (m)	Geotechnical Description
		Hr.	Min				0-15	15-30	30-45						
1		3.50	4.35		100%	100%	-	-	-	-	11		CS		Strong, grey, medium coarse grain. SLIGHTLY HEAVY. R.O.C
2															
3															
4															
5															
6															
7															
8															
9															
0															

CRP = 100%
ROD = 98%
(Grade II)

Borehole terminated at - 11mts depth
+ COME

PROJECT SITE DETAILS	
GROUND LEVEL (m)	
WATER TABLE (m)	1.20
CASING DEPTH (m)	

BH-01 12.00 to 13.00



PROJECT NAME :- N/C

LOCATION NAME :- PALLAVARAM

S. NO	BH NO	DEPTH (m)	CRR %	RQD %
1.	BH-03	5 TO 6.00 m	15%	0%
2.		6 TO 7.50 m	37%	0%
3.		7.50 TO 9.00	52%	12%
4.		9.00 TO 10.00	65%	0%
5.		10.00 TO 11.00	80%	68%



PROJECT NAME :- NCC Urban

LOCATION NAME :- Pallavaram

S.NO	BHNO	DEPTH(M)	CRR %	RQD %
1.	BHNO-04	6 TO 7.00	18%	0%
2.		7 TO 8.00	94%	27%
3.		8 TO 9.00	79%	40%
4.		9 TO 10.00	92%	52%
5.		10 TO 11.00	77%	57%

PROJECT NAME:- NCC Urban

LOCATION NAME:- Pallaveram

S.NO	BH NO	DEPTH (m)	CRR %	RQD %
1.	BH-05	6 TO 7.50m	12%	0%
2.		7.50 TO 9.00m	61%	15%
3.		9 TO 10.00m	83%	56%
4.		10 TO 11.00m	90%	59%



PROJECT NAME :- NCC Urban

LOCATION NAME :- Pallavaram

S. NO	BH NO	DEPTH (M)	CRR %	RQD %
1.	BHNO-06	5.00 TO 7.50	22%	0%
2.		7.50 TO 9.00	80%	20%
3.		9.00 TO 10.00	73%	25%
4.		10.00 TO 11.00	74%	60%
5.				



PROJECT NAME :- NCC - Urban

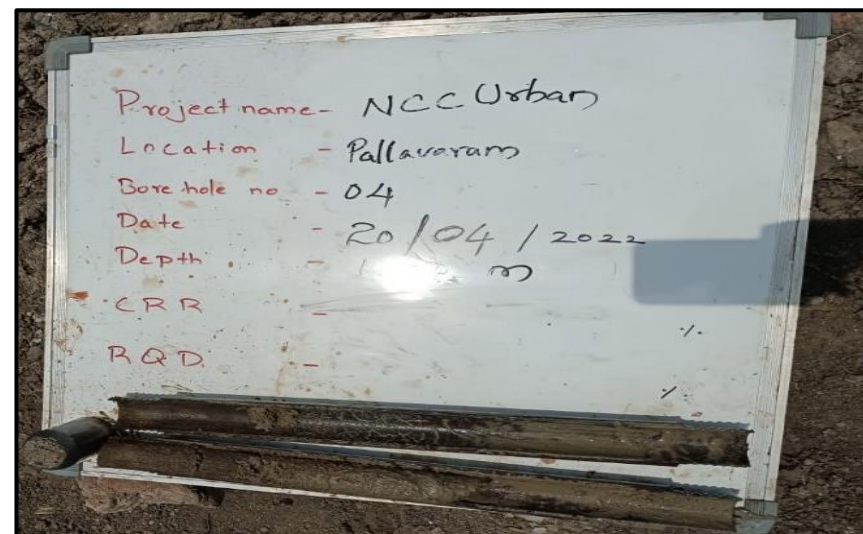
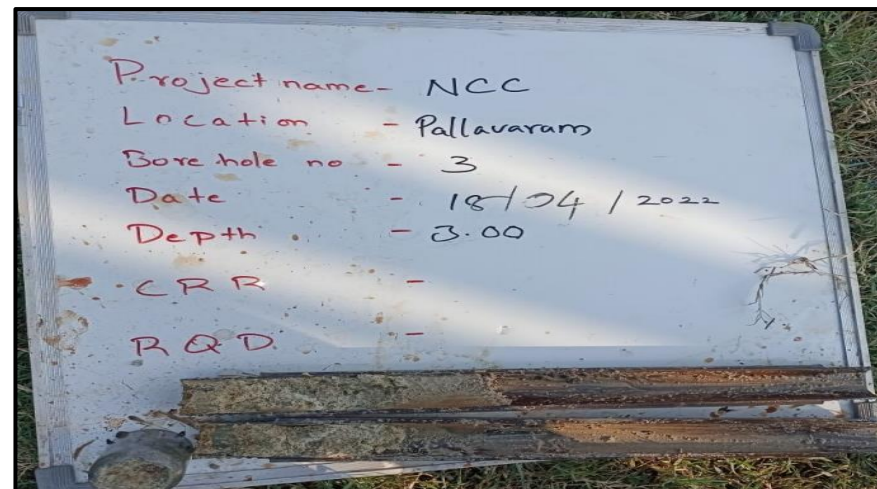
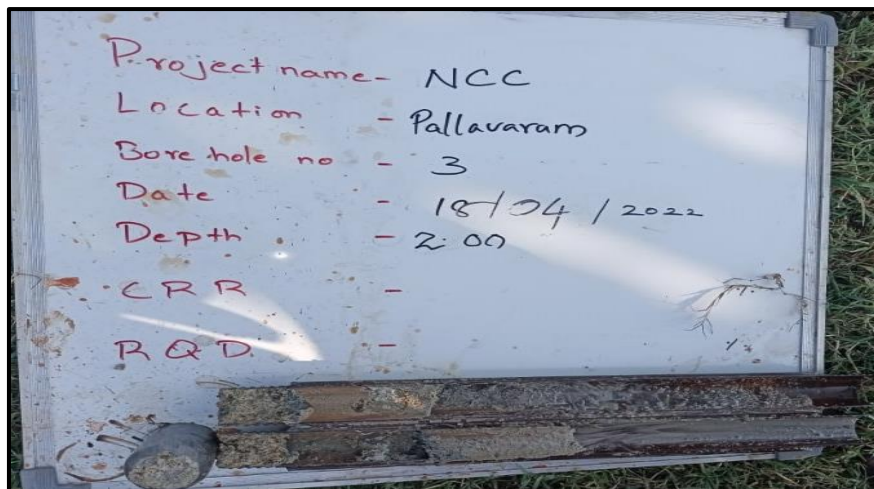
LOCATION NAME :- Pallavaram

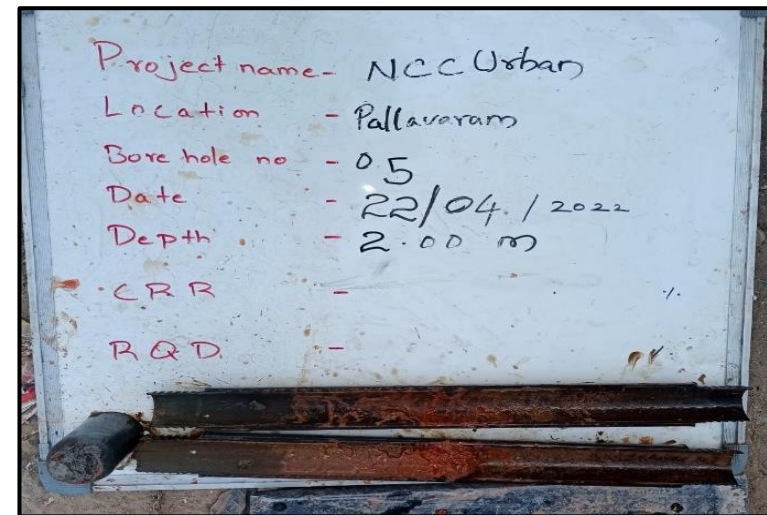
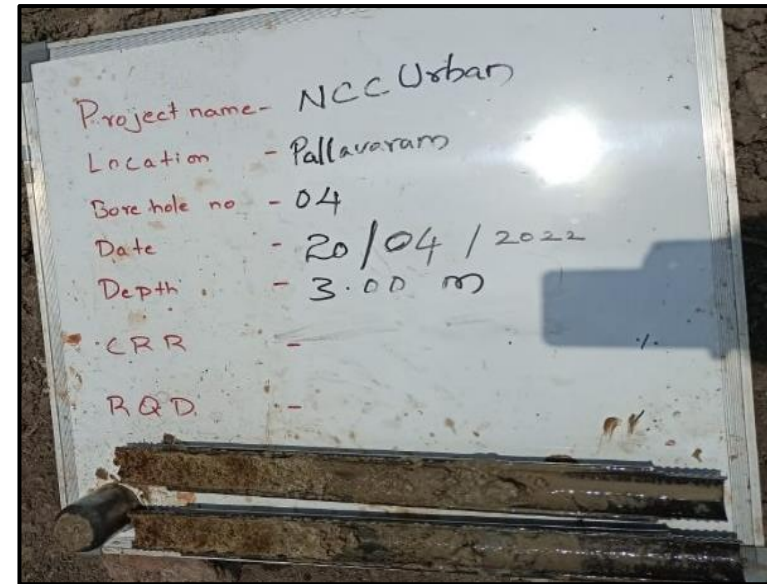
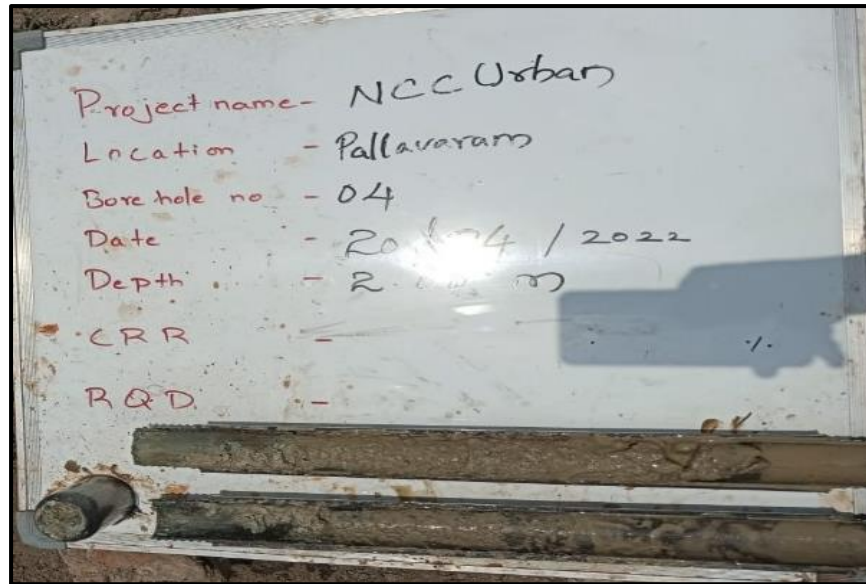
S. NO	BHNO	DEPTH (m)	CRR %	RQD %
1.	BHNO 07	6.00 TO 7.50	25%	7%
2.		7.50 TO 9.00	97%	89%
3.		9.00 TO 10.00	100%	100%
4.		10.00 TO 11.00	100%	95%
5.				

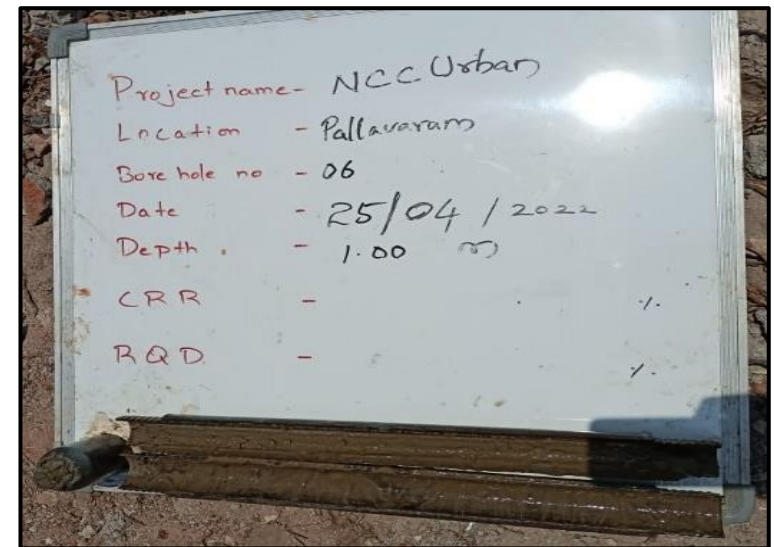
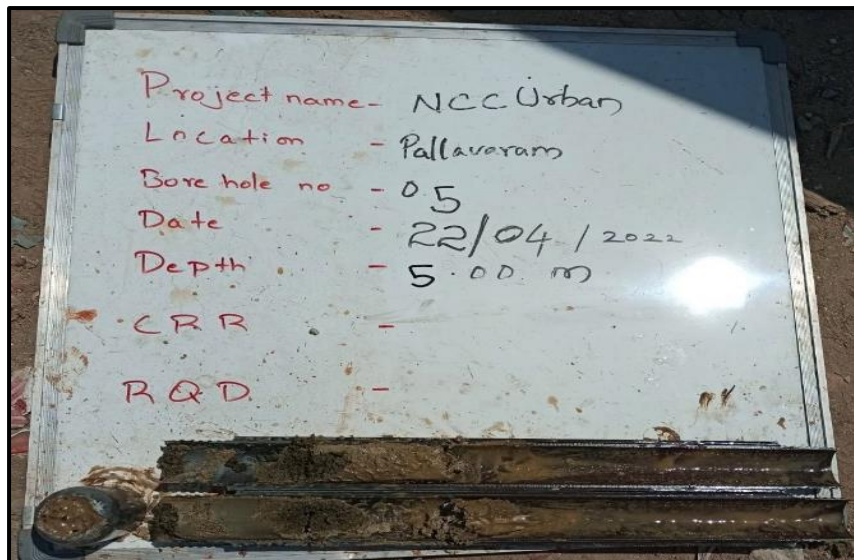
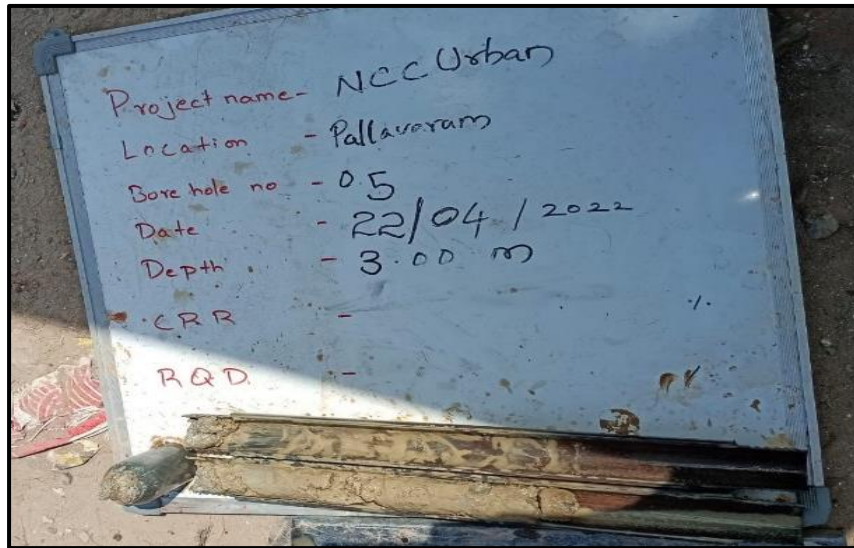










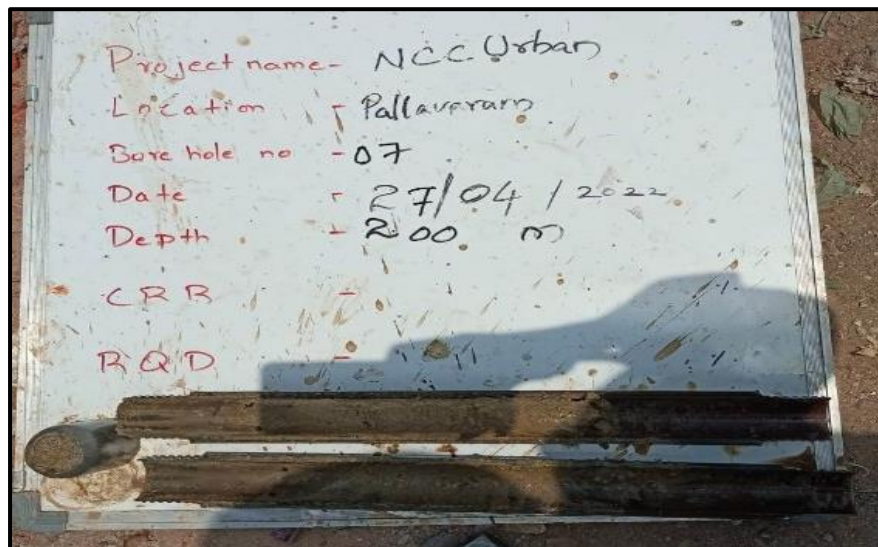
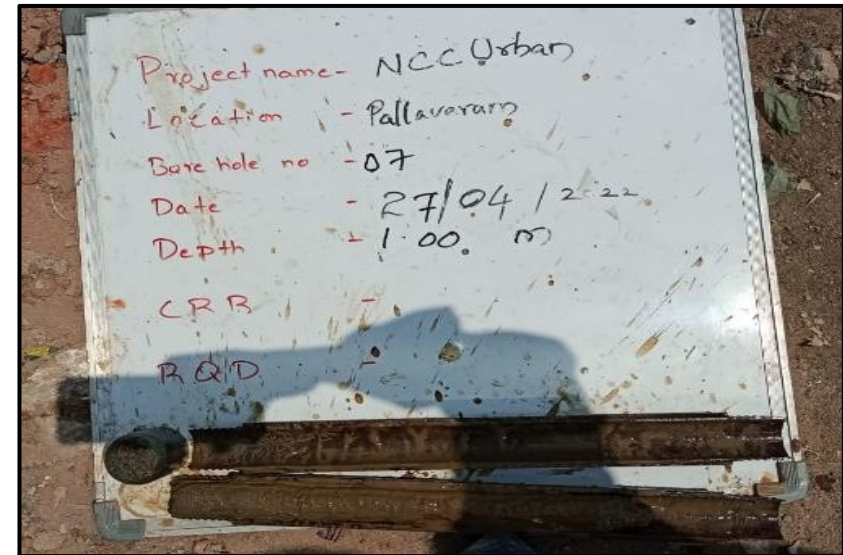
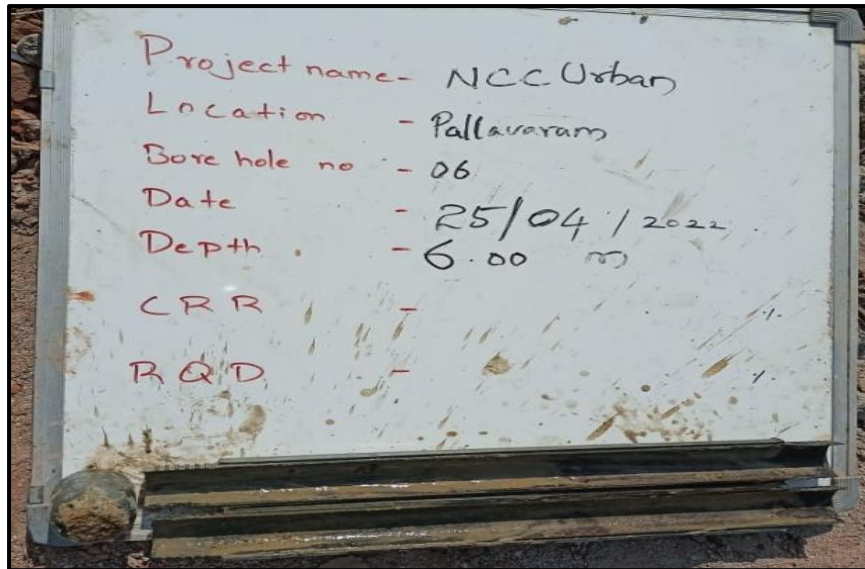


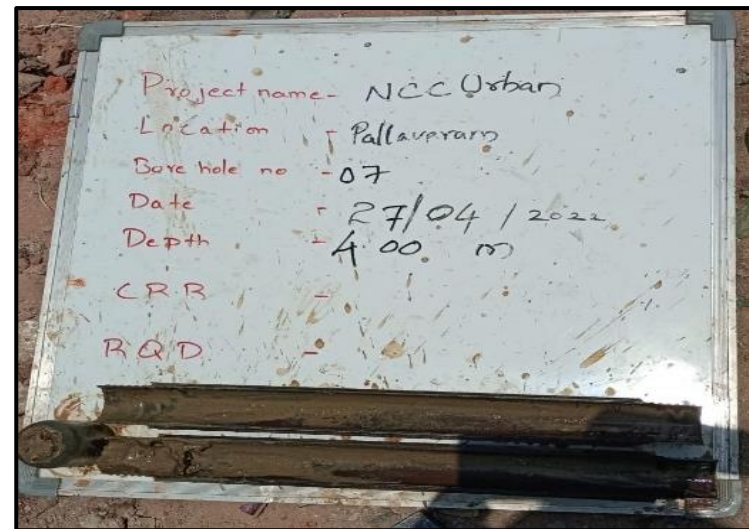
Project name- NCC Urban
Location - Pallavaram
Bore hole no - 06
Date - 25/04 / 2022
Depth - 2.00 m
CRR -
RQD -

Project name- NCC Urban
Location - Pallavaram
Bore hole no - 06
Date - 25/04 / 2022
Depth - 3.00 m
CRR -
RQD -

Project name- NCC Urban
Location - Pallavaram
Bore hole no - 06
Date - 25/04 / 2022
Depth - 4.00 m
CRR -
RQD -

Project name- NCC Urban
Location - Pallavaram
Bore hole no - 06
Date - 25/04 / 2022
Depth - 5.00 m
CRR -
RQD -









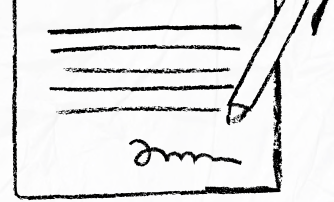


NCC URBAN BH-05









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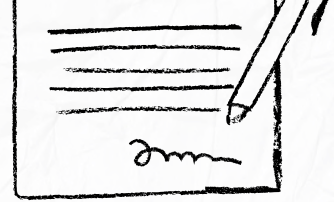
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