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SOIL EXPLORATION AND FOUNDATION REPORT

FOR THE PROPOSED BUILDING

AT

PLOT NO. 154, 158 & 160

7TH MAIN ROAD

RAM NAGAR SOUTH EXTENSION

PALLIKARANAI VILLAGE

CHENNAI

PROJECT NO. TJE/002816/2023

T.J.ENGINEERS

SOIL EXPLORATION AND FOUNDATION DESIGN DIVISION
T.J.HOUSE
NO.4, ANNA NAGAR, 1ST STREET,
VELACHERY, CHENNAI-42.
tjengineers@yahoo.com
tjengineers1998@gmail.com
Ph : 42 33 41 94.

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EXPLORATION REPORT

PROJECT NO. TJE/002816/2023

1.INTRODUCTION:

M/S BBCL DEVELOPERS INDIA PRIVATE LIMITED has proposed to construct a Stilt Floor + Five Floors Building at Plot Nos. 154, 158 &160, 7th Main Road, Ram Nagar South Extension, Pallikaranai Village, Chennai-600 091. The work was entrusted to T.J. Engineers by the promoter. The location is shown in Fig No.1. The object of the soil exploration work done is to determine the soil properties of the proposed area and to arrive at a most suitable type of foundation system for the proposed structure.

2.0 SCOPE OF WORK

The Scope of Work includes the following

Boreholes

- Drilling of borehole at the proposed borehole locations as per the direction of the client.
- Collection of disturbed and undisturbed soil samples and carrying out the relevant laboratory test on soils.
- Conducting of standard penetration test (SPT) within the borehole at every 1.50m depth interval or as required.
- Collection of soil sample from bore hole.
- Preparation of geotechnical investigation Report.

3.0. LOCATION & NUMBER OF BORE HOLES

For this purpose three bore holes were bored up to maximum depth of 15.00m below existing ground level. The bore hole location is shown in Fig No.1 and bore log details

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are given in Fig No. 2,3&4. The bore holes were terminated in the Very Dense Rock layer.

4.0. GEOTECHNICAL INVESTIGATIONS

4.1. Filed Investigations of Boreholes

Rotary drilling boring technique was adopted for boring in this area. The Standard penetration tests were conducted at change of layers and at specified intervals, commencing the test at 1.50m below the existing ground level. The relative density of different soil layers obtained from the N-Values are given in the Fig No. 2,3&4. Disturbed and un disturbed samples were collected from all the layers for visual observation, classification tests and strength characteristics of the soil layers.

Standard Penetration Test (SPT)

Standard Penetration Tests were conducted using a split spoon sampler, as per relevant codal provision (IS: 2131 – 1981). The SPT is generally conducted in sandy and completely weathered rock strata till 45 cm penetration with number of blows recorded for every 15 cm penetration. The number of blows required for first 15 cm in neglected. The blows for last 30 cm penetration or refusal 'N' value of 100 whichever is earlier is taken as the 'N' value. In the clayey strata, when driving of sampling tube is not possible, SPT was conducted to know the consistency of the soil strata and to retrieve the disturbed soil sample. The soil samples obtained in the split spoon sampler are carefully packed in polythene bags for testing in the laboratory. The SPT values obtained at every 1.50m interval are given in the bore logs.

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4.2. Grain Size Analysis

Combined sieve and hydrometer analyses were conducted on the various samples collected. The results are given in Table-1a, 1b, 1c. Based on the proportion of the different soil constituents, the soil is classified.

4.3. Laboratory Tests for Borehole samples

The following laboratory tests were conducted on collected Soil Samples.

I. Moisture Content as per IS: 2720 (Part 2)

II. Specific Gravity as per IS: 2720 (Part 2)

III. Sieve Analysis as per IS: 2720 (Part 4)

IV. Hydrometer Analysis as per IS: 2720 (Part 4)

V. Liquid Limit as per IS: 2720 (Part 5)

VI. Plastic Limit as per IS: 2720 (Part 5)

VII. Swelling Index as per IS: 2720 (Part 40)

5.0. BORE LOG DATA

The Summary of bore hole log data for BH-01, BH-02 & BH-03 is given in Fig-2,3&4. Bore hole location is given in Fig.1.

6.0. LABORATORY TEST RESULTS

The laboratory test results of boreholes samples are presented in Table-1a, 1b, 1c and Table-2a, 2b, 2c.

7.0. GROUND WATER TABLE

The ground water table was encountered at the **depth of 0.90m**, below the existing ground level at the time of soil exploration.

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8.0. SUB SOIL PROFILE

From the visual identification from field test results, it is concluding that soil strata is not similar in BH-01, BH-02 & BH-03 location.

In BH-01 Location the soil strata is made-up of seven distinctive layers.

i. Filled Up Soil, 0.00m to 1.00m

ii. Soft to Medium Stiff Sandy Silty Clay, 1.00m to 4.00m SPT's N = 4-5

iii. Stiff to Very Stiff Sandy Silty Clay, 4.00m to 7.50m SPT's N = 12-23

iv. Very Dense Clayey Silty Gravelly Sand, 7.50m to 8.50m SPT's N = >100

v. Very Dense Sandy Gravel, 8.50m to 9.30m SPT's N = >100

vi. Very Dense Gravel, 9.30m to 10.00m SPT's N = >100

vii. Very Dense Rock, 10.00m to 13.00m SPT's N = >100

In BH-02 Location the soil strata is made-up of six distinctive layers.

i. Filled Up Soil, 0.00m to 1.00m

ii. Soft Sandy Silty Clay, 1.00m to 4.20m SPT's N = 3-4

iii. Loose to Medium Dense Silty Clayey Sand, 4.20m to 7.50m SPT's N = 10-16

iv. Very Dense Clayey Silty Gravelly Sand, 7.50m to 9.50m SPT's N = >100

v. Very Dense Sandy Gravel, 9.50m to 10.00m SPT's N = >100

vi. Very Dense Rock, 10.00m to 13.00m SPT's N = >100

In BH-03 Location the soil strata is made-up of six distinctive layers.

i. Filled Up Soil, 0.00m to 1.00m

ii. Soft Sandy Silty Clay, 1.00m to 4.00m SPT's N = 4

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iii. Loose to Medium Dense Silty Clayey Sand, 4.00m to 7.50m

SPT's N = 7-12

iv. Very Dense Clayey Silty Gravelly Sand, 7.50m to 10.00m SPT's N = >100

v. Very Dense Sandy Gravel, 10.00m to 12.00m SPT's N = >100

vi. Very Dense Rock, 12.00m to 15.00m SPT's N = >100

The soil profile details are presented in the Bore logs, Presented in Fig. 2,3&4.

9.0. FOUNDATION ANALYSIS

From the bore log data soil strata is not similar in all the three locations. At the top from 0.00m to 1.00m Filled Up Soil layer is present. From 1.00m to 4.20m soft to medium stiff Sandy Silty Clay layer is present, this layer has got swelling character. From 4.20m to 7.50m stiff to very stiff Sandy Silty Clay and loose to medium dense Silty Clayey Sand layers are present, and the Sandy Silty Clay layer has got swelling character. From 7.50m to 8.50m/10.00m very dense Clayey Silty Gravelly Sand layer is present. From 8.50m/10.00m to 12.00m very dense Sandy Gravel layer is present. Below 10.00m/12.00m very dense Rock layer is seen and core sample was collected. The **Core Recovery (CR)** from 10.00m/12.00m to 13.00m is between 20% to 60%, from 13.00m to 14.00m is between 27% to 48%, and from 14.00m to 15.00m is between 21%. The **Rock Quality Designation (RQD)** value from 10.00m/12.00m to 13.00m is between 0% to 23%, from 13.00m to 14.00m is 0%, and from 14.00m to 15.00m is 21%. Based on the core recovery the soundness and degree of weathering of the rock is soft to medium rock. This rock layer is fair to rest pile foundation for heavy loaded structure.

The layer up to 7.50m is the critical zone for open foundation system, with in the critical zone soft to very stiff Clayey layer and loose to medium dense Sandy layers are

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present and the Clayey layer has got swelling character. For light loaded structure **Continuous Strip Footing** (or) **Raft Foundation.** The open foundation can be placed at the minimum depth of 2.00m below the existing ground level. Existing ground level was same as the road level. The SBC at 2.00m depth has been worked out and given below.

For heavy loaded structure, if the SBC is not sufficient for the expected loading intensity, structure sensitive for differential settlement, it is advisable to provide deep foundation of **Pile Foundations**. The pile foundation can be Bored Cast in situ pile. The pile foundation should be terminated at the minimum depth 14.00m. The pile should be anchored into the soft to medium dense Rock layer for minimum of 1.00m depth.

9.1. COMPUTATION OF THE SAFE BEARING CAPACITY AT 2.00m DEPTH

Based on the standard penetration test value the ultimate net bearing capacity (q_u) could be calculated from the following formula.

$q_u = 1.2\ C\ Nc + \gamma'\ D_f\ N_q$

The minimum observed N-Value is taken as 4 from Fig. 2,3&4.

The corresponding bearing capacity factors are,

$Nc = 5.7$

$N_q = 1$

Where,

C = Un drained shear strength = 2.46 t/m^2

γ = Unit weight of the soil = 1.50 t/m^3

γ' = Submerged unit weight of the soil = 0.50 t/m^3

D_f = Depth of footing = 2.00 m

D_w = Depth of water table = 0.90 m

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Substitute all the above values in the formula,

$q_u = 1.2 \times 2.46 \times 5.7 + (1.50 \times 0.90 + 0.50 \times 1.10) \times 1$

$= 16.826 + 1.90 = 18.726\ t/m^2$

Safe bearing capacity could be considered with a factor of safety of 2.5

Hence, safe bearing capacity $q_s = 18.726/2.50 = 7.490\ t/m^2$. Say $7.50\ t/m^2$.

Therefore, safe bearing capacity of the soil at 2.00m is 7.50 t/m ^{2}

9.2. SETTLEMENT ANALYSIS FOR THE LOADING INTENSITY OF 7.50 t/m^2

LAYER -1, SANDY SILTY CLAY

The Consolidation Settlement of the Clay layer can be calculated using the following formula.

$$S_1 = (C_c / 1 + e_0)\, H \quad \text{Log}_{10}\, (\sigma'_0 + \Delta\sigma / \sigma'_0)$$

Where

C_c = Coefficient of compression index
= 0.36

e_0 = The initial void ratio
= 1.82

H =The thickness of the compressible clay layer
= 5.50m

σ'_0 = The original effective over burden pressure at the centre of the clay layer
= $3.275\ t/m^2$

$\Delta\sigma$ = The stress increases at the centre of the clay layer due to foundation loads (or) pressure
= $0.226\ t/m^2$

S_1 = $(0.36 /1+1.82)\ 5.50\ \text{Log}_{10}\ (3.275 + 0.226 /3.275)$
= $0.127 \times 5.50 \times 0.0289$

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$= 0.020243 \times 10^{-3}$m

= 20.243mm

TOTAL SETTLEMENT

= 20.243mm < 50mm

The maximum allowable settlement as per IS: 1904-1986 for R.C.C structure with Isolated footing foundation is 50mm. **The settlement is within the permissible limit. Hence it is Safe.**

9.3. LOAD CARRYING CAPACITY OF THE CONVENTIONAL PILE

Based on the standard penetration test value the ultimate load carrying capacity (q_u) could be calculated from the following formula.

Qu = Qb + Qs

Qs = Ultimate unit skin friction on an individual layer

$= Ks\ \sigma'_{vo} \tan\delta\ \pi\ D\ L$

Where

Ks = Co-efficient of horizontal soil stress = 0.471

σ'_{vo} = average effective overburden pressure $= 6.50\ t/m^2$

δ = angle of wall friction = 32

D = Dia meter of pile = 0.40m

L = Length of individual layer = 2.00m

$= 0.471 \times 6.50 \times 0.624 \times 3.14 \times 0.40 \times 2.00$

= 4.798 t

$q_b = Nq\ \sigma'_{vo}\ Ab$

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where

Nq = Bearing Capacity Factor = 140

σ'_{vo} = effective overburden pressure at the toe = 7.00 t/m^2

Ab = Cross sectional area at the base

D = Dia of Pile = 0.40m

= 140 x 7.00 x 3.14 x 0.40 ^{2}/4

= 123.088 t

Qu = Qb + Qs

= 123.088+4.798= 127.886 t

Q safe = Qu/F.S = 127.886/2.5 = 51.154 t Say 51.00 t

The safe load carrying capacity for five different diameter of piles for the **depth of 14.00m** are worked and are given below.

Dia of Pile	Depth of Pile	Safe Load (Tones)
400mm	14.00m	51
450mm	14.00m	64
500mm	14.00m	79
600mm	14.00m	114
750mm	14.00m	177

The above safe loads are provisional and shall be confirmed by conducting pile load test as per the guide line laid down in IS: 2911 (Part: IV).

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10.0. CONCLUSIONS

1. Soil in the shallow depth is fair to adopt open foundation system for light loaded structure.
2. For very light loaded structure open foundation of **Continuous Strip Footing** (or) **Raft Foundation can be adopted.**
3. The open foundation can be placed at the minimum **depth of 2.00m** below the existing ground level. Existing ground level was same as the road level.
4. The **Safe Bearing Capacity** of the soil at the **depth of 2.00m is 7.50 t/m ^{2}**
5. The minimum width of footing should be maintained as 1.00m to avoid any punching shear failure and to achieve suggested SBC.
6. All the foundation should rest on 100 mm thick 1:4:8 concrete mat, over 100mm thick River Sand or M Sand layer.
7. The shallow foundation should rest on natural un disturbed layer.
8. **For heavy loaded structure,** if the SBC is not sufficient for the expected loading intensity, it is advisable to provide deep foundation of **pile foundations**. The pile foundation can be Bored Cast in situ pile. The pile should be terminated at the minimum **depth of 14.00m (Including Anchorage Depth)** below existing ground level.
9. The load carrying capacity for five different diameter of pile for the **minimum depth of 14.00m** are worked out and given below.

Dia of Pile	Depth of Pile	Safe Load (Tones)
400mm	**14.00m**	**51**

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450mm	**14.00m**	**64**
500mm	**14.00m**	**79**
600mm	**14.00m**	**114**
750mm	**14.00m**	**177**

The above safe loads are provisional and shall be confirmed by conducting pile load test as per the guide line laid down in IS: 2911 (Part: IV)

10. The pile should be anchored into the soft to medium Rock layer for minimum of 1.00m depth.
11. Proper precaution should be taken while boring the pile against sliding of bore hole, by maintaining the proper dense bentonite slurry or providing temporary casing or permanent casing and pile concreting should be done as soon as boring is over.
12. The bore hole should be flushed properly before laying concrete. It has to be ensured by comparing the depth of pile bore hole and Tremie Pipe. The depth of Tremie Pipe lowered can be 300mm less than borehole depth. If the gap between bore hole bottom and Tremie Pipe bottom is more than 300mm, there is a possibility of slush deposit in the bore hole.
13. The bore hole should be flushed properly before laying concrete.
14. The pile boring should be done with **Percussion** drilling or **Hydraulic Rotary** Drilling with DMC method.
15. For foundation design, **Stress due to any eccentricity, stress due to horizontal force** should be considered, and **stability** should be checked.
16. All suggested foundation recommendations and precautions should be adopted while undertaking the design aspects and construction activities.

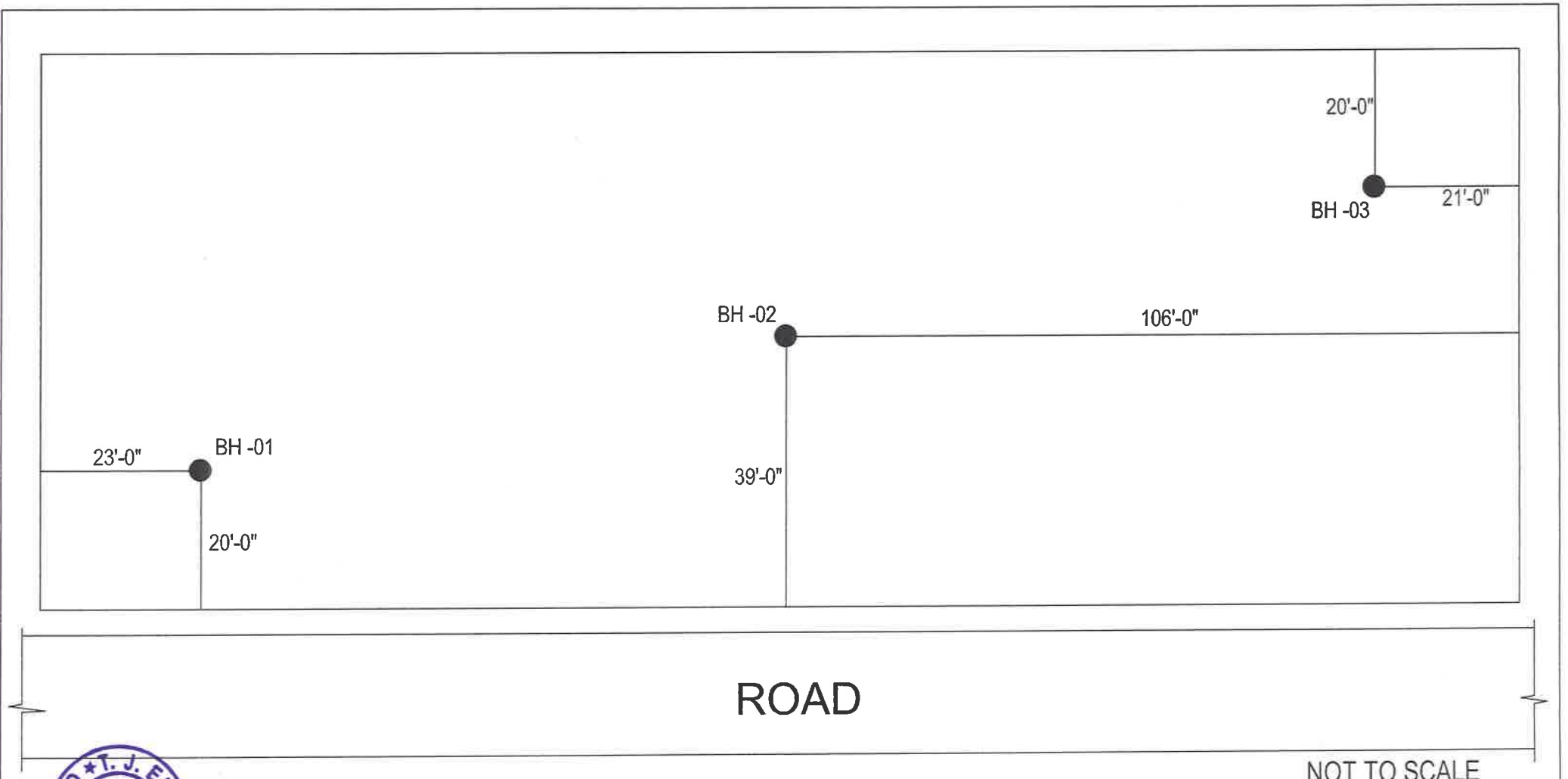
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For T.J. Engineers

05 – 07 - 2023

Dr. S.CHOCKALINGAM, M.E. (Geo-Tech)., Ph.D.,
Geo - Technical Engineer
T.J. ENGINEERS
Plot No:4, Anna Nagar, 1st Street,
Velachery, Chennai-600 042.
Phone: 044-42334194 Mob: 9841255460
CMDA Registration No: GTE/19/03/006
DTCP Reg. No: CGLRGN/RGTE/2019/07/010

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NOT TO SCALE

CLIENT:-

M/S BEST DEVELOPERS INDIA PRIVATE LIMITED
CHENNAI.

PROJECT:-

PROPOSED BUILDING AT
PLOT NOS. 154, 158 &160, 7TH MAIN ROAD,
RAM NAGAR SOUTH EXTENSION,
PALLIKARANAI VILLAGE, CHENNAI-600 091.

SITE PLAN
FIG.1

T.J. ENGINEERS
soil investigation and foundation design division
T.J. HOUSE
PLOT NO. 4, ANNA NAGAR,
1ST STREET, VELACHERY, CHENNAI-42,
tjengineers@yahoo.com
tjengineers1998@gmail.com
OFF: 044-42334194

BORE LOG

PROJECT: Proposed Building at at Plot Nos. 154, 158 &160, 7th Main Road, Ram Nagar South Extension, Pallikaranai Village, Chennai-600 091.

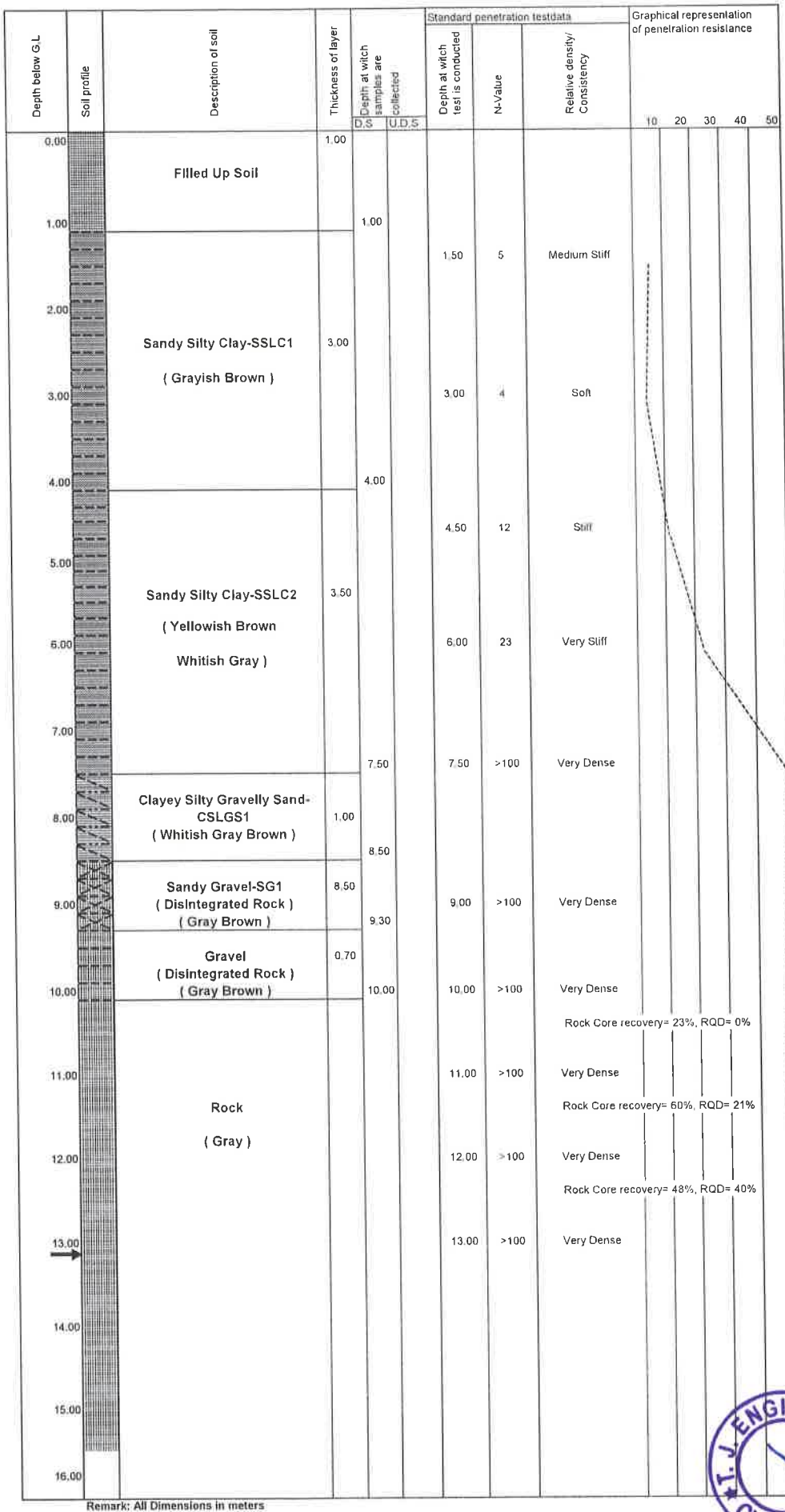
BORE HOLE NO: B.H:01

TYPE OF BORING: Rotary Drilling

DATE OF COMMENCEMENT: 24 - 06 - 2023

DATE OF COMPLETION: 25 - 06 - 2023

G.W.L: 0.90m



Remark: All Dimensions in meters

→ End of Boring

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FIG: 2

BORE LOG

PROJECT: Proposed Building at at Plot Nos. 154, 158 &160, 7th Main Road, Ram Nagar South Extension, Pallikaranai Village, Chennai-600 091.

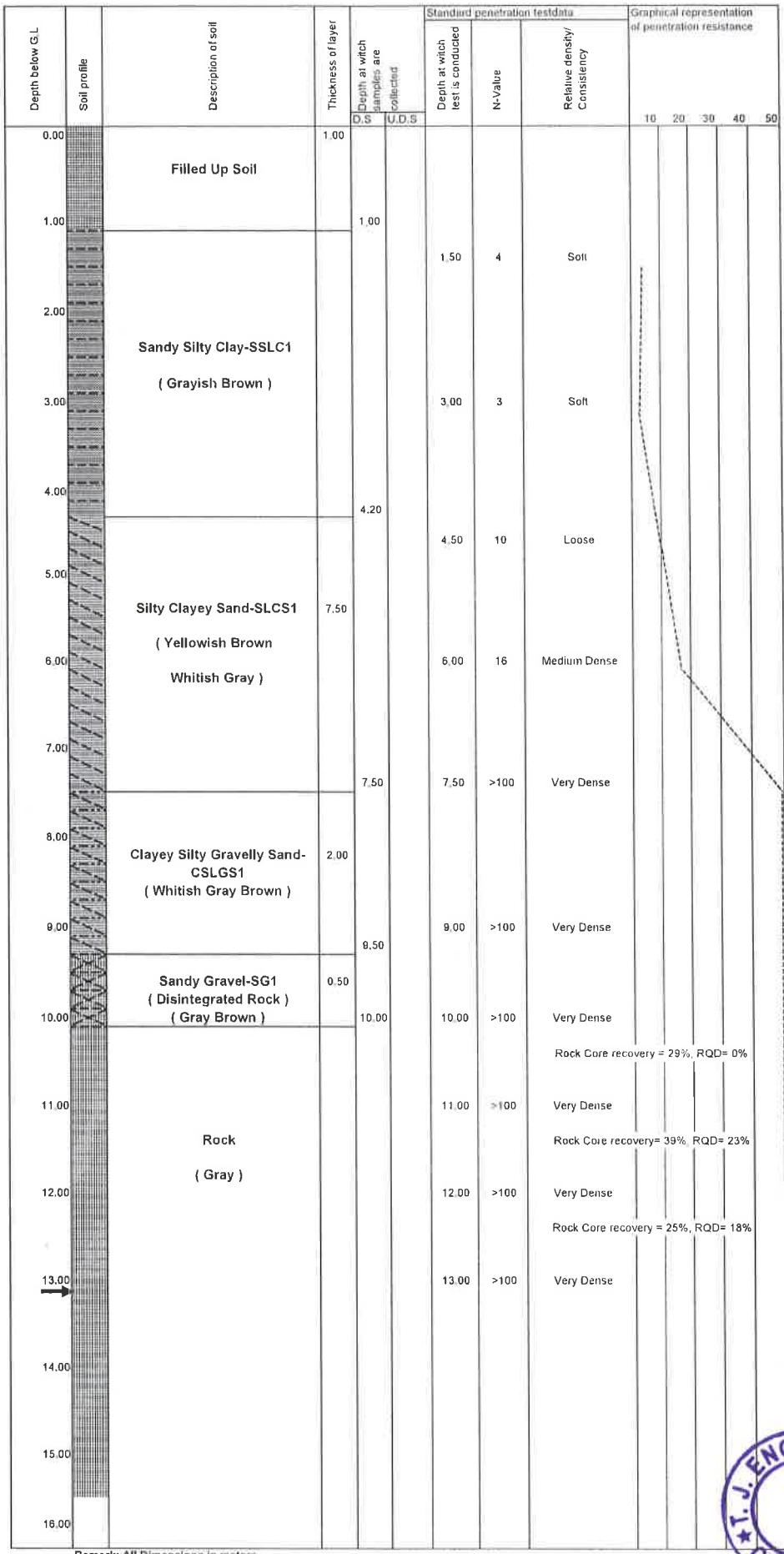
BORE HOLE NO: B.H:02

TYPE OF BORING: Rotary Drilling

DATE OF COMMENCEMENT: 25 - 06 - 2023

DATE OF COMPLETION: 25 - 06 - 2023

G.W.L: 0.90m



Remark: All Dimensions in meters

End of Boring

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FIG: 3

BORE LOG

PROJECT: Proposed Building at at Plot Nos. 154, 158 &160, 7th Main Road, Ram Nagar South Extension, Pallikaranai Village, Chennai-600 091.

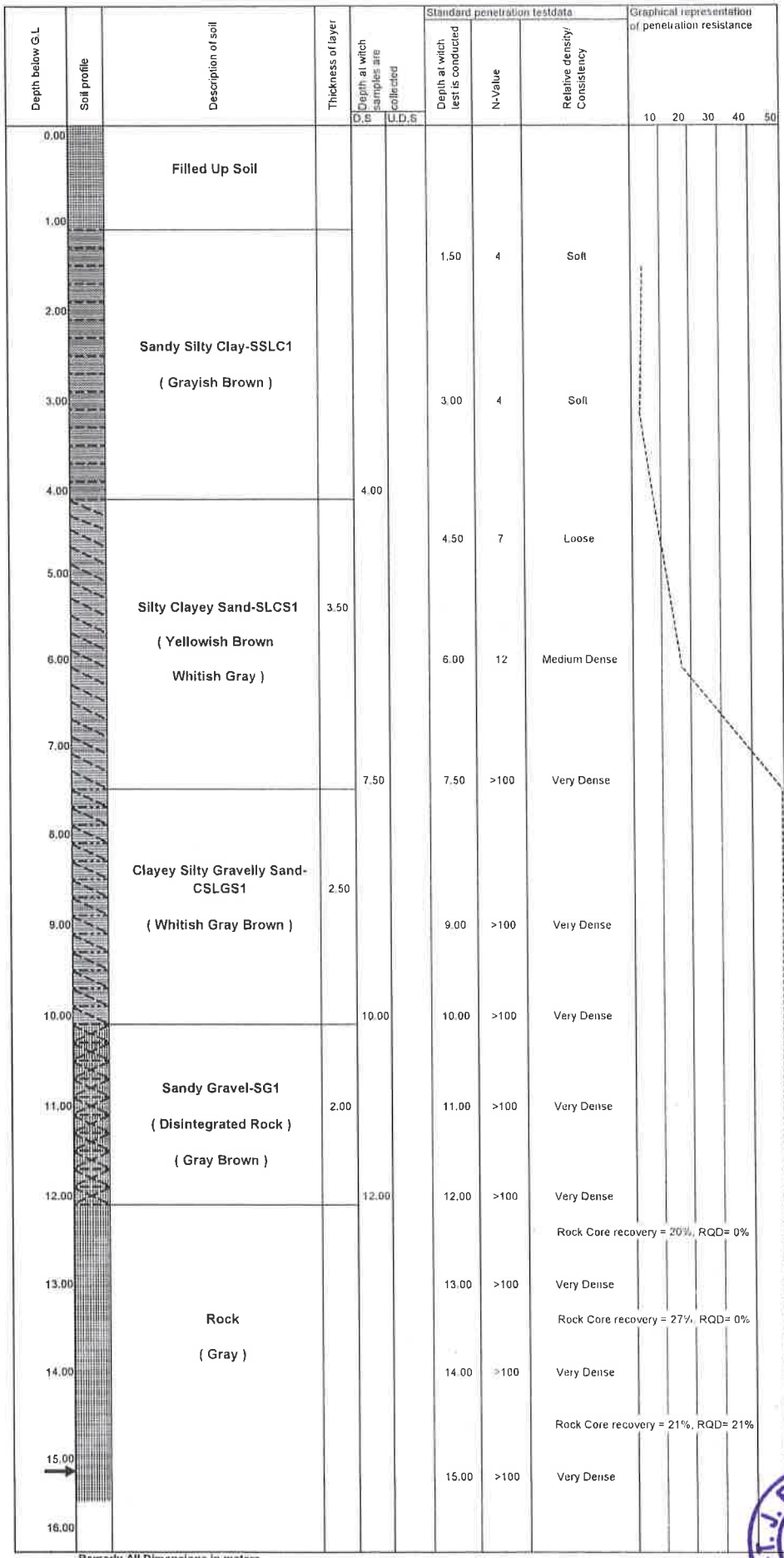
BORE HOLE NO: B.H:03

TYPE OF BORING: Rotary Drilling

DATE OF COMMENCEMENT: 26 - 06 - 2023

DATE OF COMPLETION: 26 - 06 - 2023

G.W.L: 0.90m



Remark: All Dimensions in meters

End of Boring

FIG: 4

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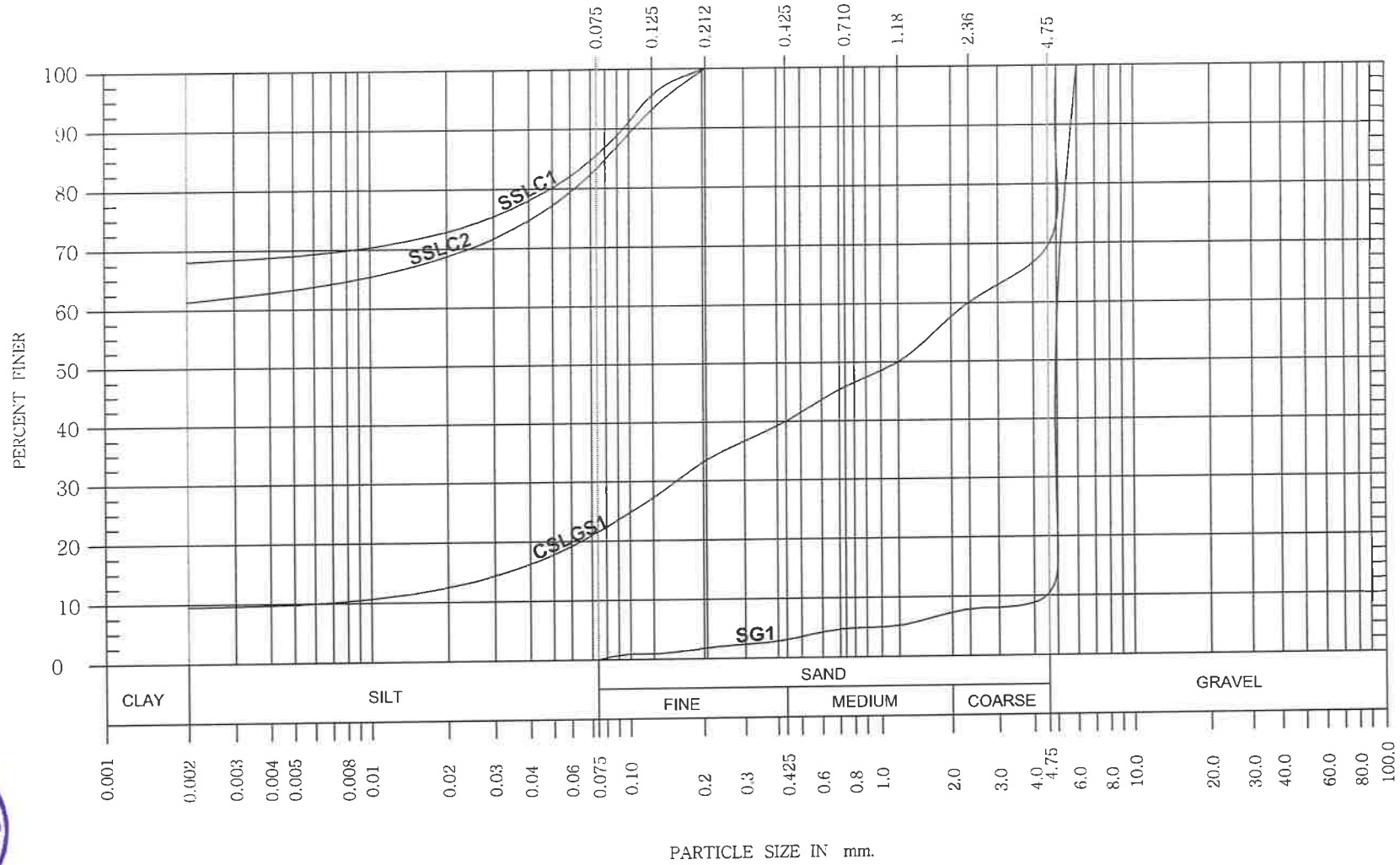


FIG. 5 GRAIN SIZE DISTRIBUTION CURVE-BH-01

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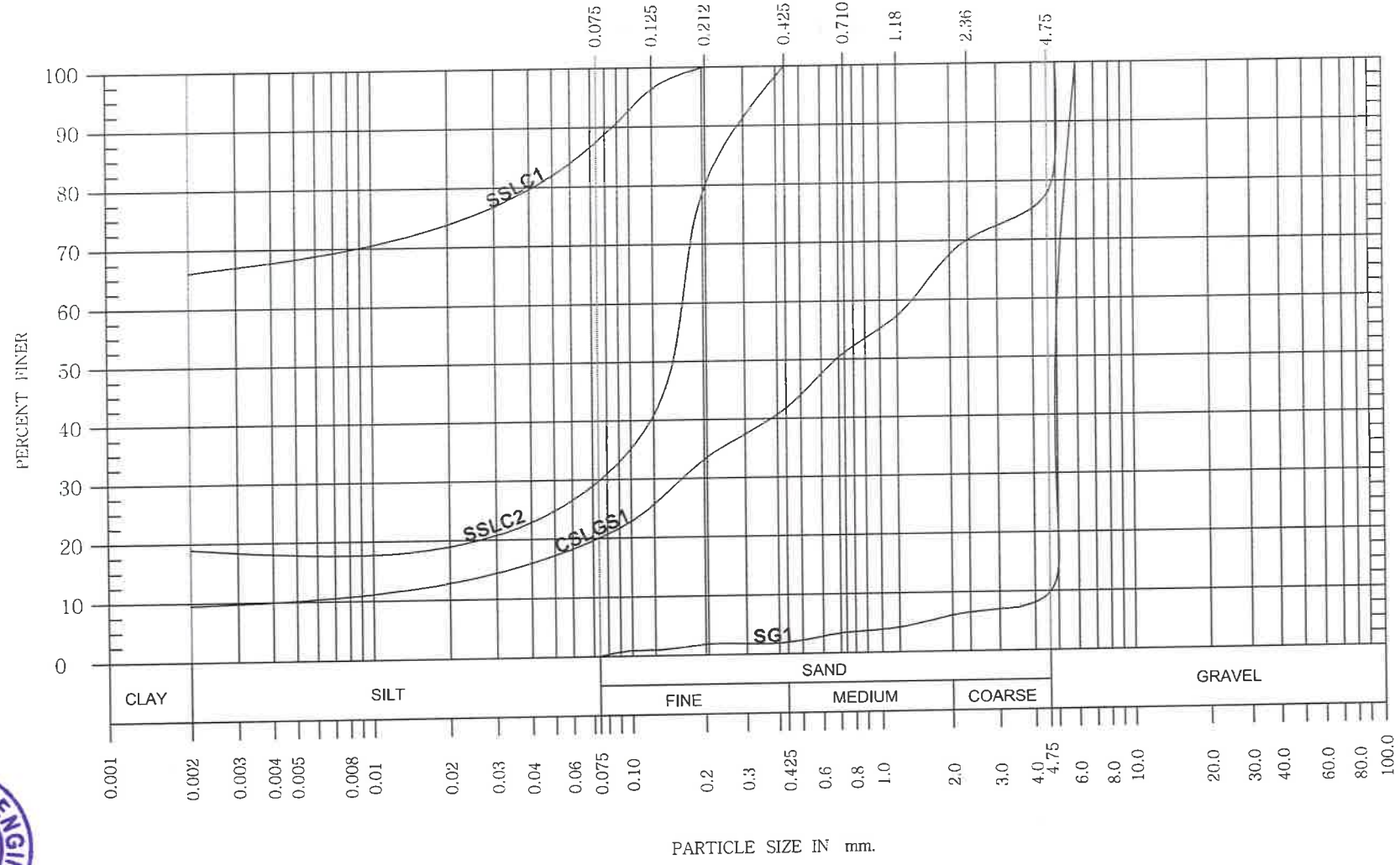


FIG. 6 GRAIN SIZE DISTRIBUTION CURVE-BH-02

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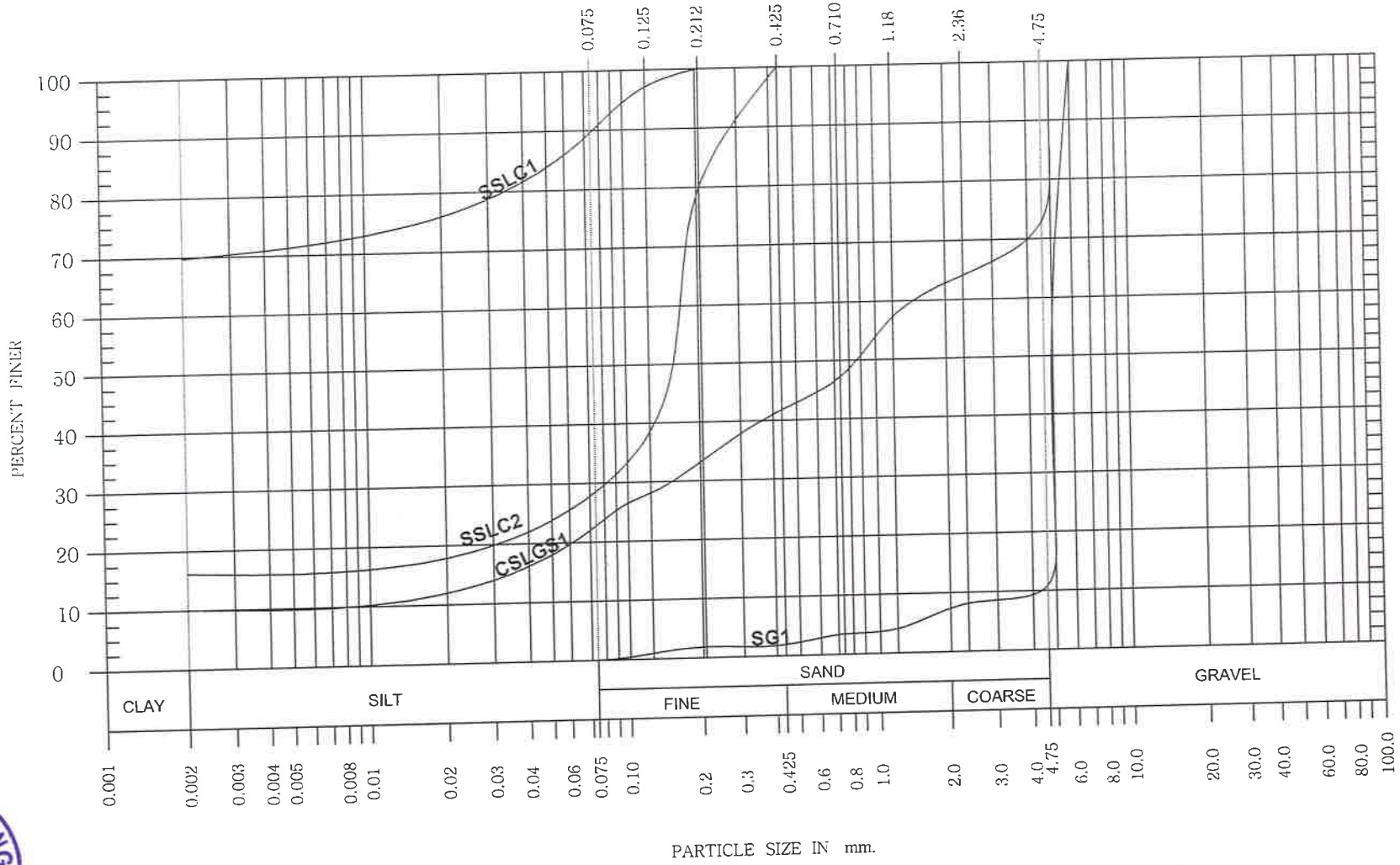


FIG. 7 GRAIN SIZE DISTRIBUTION CURVE-BH-03

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LABORATARY TEST RESULTS

TABLE-1a

B.H No	Layer thickness	Soil classification	Depth of sample collected		SP. gravity	%of free swell	Grain size distribution				Remarks
			DS / SPT	UDS			Clay	Silt	Sand	Gravel	
	m		m	m		%	%	%	%	%	
1	0.00 - 1.00	Filled Up Soil	–	–	–	–	–	–	–	–	–
	1.00 - 4.00	Sandy Silty Clay-SSLC1	1.50	–	2.66	36	67	19	14	0	–
	4.00 - 7.50	Sandy Silty Clay-SSLC2	4.50	–	2.65	32	62	22	16	0	–
	7.50 - 8.50	Clayey Silty Gravelly Sand-CSLGS1	7.50	–	2.64	–	9	13	47	31	–
	8.50 - 9.30	Sandy Gravel-SG1	9.00	–	2.64	–	0	0	11	89	–
	9.30 - 10.00	Gravel	9.30	–	2.64	–	0	0	0	100	–
	10.00 - 13.00	Rock	13.00	–	2.61	–	0	0	0	100	–

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LABORATARY TEST RESULTS

TABLE-1b

B.H No	Layer thickness	Soil classification	Depth of sample collected		SP. gravity	%of free swell	Grain size distribution				Remarks
			DS / SPT	UDS			Clay	Silt	Sand	Gravel	
	m		m	m		%	%	%	%	%	
2	0.00 - 1.00	Filled Up Soil	–	–	–	–	–	–	–	–	–
	1.00 - 4.20	Sandy Silty Clay-SSLC1	1.50	–	2.66	35	66	21	13	0	–
	4.20 - 7.50	Silty Clayey Sand-SLCS1	4.50	–	2.65	–	17	12	71	0	–
	7.50 - 9.50	Clayey Silty Gravelly Sand-CSLGS1	7.50	–	2.64	–	9	11	57	23	–
	9.50 - 10.00	Sandy Gravel-SG1	9.50	–	2.64	–	0	0	9	91	–
	10.00 - 13.00	Rock	13.00	–	2.61	–	0	0	0	100	–

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LABORATARY TEST RESULTS

TABLE-1c

B.H No	Layer thickness	Soil classification	Depth of sample collected		SP. gravity	%of free swell	Grain size distribution				Remarks
			DS / SPT	UDS			Clay	Silt	Sand	Gravel	
	m		m	m		%	%	%	%	%	
3	0.00 - 1.00	Filled Up Soil	–	–	–	–	–	–	–	–	–
	1.00 - 4.00	Sandy Silty Clay-SSLC1	1.50	–	2.66	34	69	20	11	0	–
	4.00 - 7.50	Silty Clayey Sand-SLCS1	4.50	–	2.65	–	16	11	73	0	–
	7.50 - 10.00	Clayey Silty Gravelly Sand-CSLGS1	9.00	–	2.64	–	10	13	50	27	–
	10.00 - 12.00	Sandy Gravel-SG1	11.00	–	2.64	–	0	0	11	89	–
	12.00 - 15.00	Rock	15.00	–	2.61	–	0	0	0	100	–

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LABORATARY TEST RESULTS

TABLE -2a

B.H No	Layer thickness	Soil classification	Depth of sample collected		LL	PL	Bulk density	Consolidation Parameters		Shear Strength Parmeters		Remarks
			DS / SPT	UDS				e_o	Cc	Cu	Ø	
	m		m	m	%	%	t/m^3			t/m^2	degree	
1	0.00 - 1.00	Filled Up Soil	–	–	–	–	–	–	–	–	–	–
	1.00 - 4.00	Sandy Silty Clay-SSLC1	1.50	–	66	24	1.50	1.50	0.35	3.10	–	–
	4.00 - 7.50	Sandy Silty Clay-SSLC2	4.50	–	59	22	1.53	1.60	0.30	7.44	–	–
	7.50 - 8.50	Clayey Silty Gravelly Sand-CSLGS1	7.50	–	–	–	1.57	–	–	–	38	–
	8.50 - 9.30	Sandy Gravel-SG1	9.00	–	–	–	1.58	–	–	–	39	–
	9.30 - 10.00	Gravel	9.30	–	–	–	1.36	–	–	–	42	–
	10.00 - 13.00	Rock	13.00	–	–	–	2.20	–	–	–	45	–

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LABORATARY TEST RESULTS

TABLE -2b

B.H No	Layer thickness	Soil classification	Depth of sample collected		LL	PL	Bulk density	Consolidation Parameters		Shear Strength Parmeters		Remarks
			DS / SPT	UDS				e_o	Cc	Cu	Ø	
	m		m	m	%	%	t/m^3			t/m^2	degree	
2	0.00 - 1.00	Filled Up Soil	–	–	–	–	–	–	–	–	–	–
	1.00 - 4.20	Sandy Silty Clay-SSLC1	1.50	–	65	23	1.50	1.82	0.36	2.46	–	–
	4.20 - 7.50	Silty Clayey Sand-SLCS1	4.50	–	–	–	1.53	–	–	–	32	–
	7.50 - 9.50	Clayey Silty Gravelly Sand-CSLGS1	7.50	–	–	–	1.58	–	–	–	38	–
	9.50 - 10.00	Sandy Gravel-SG1	9.50	–	–	–	1.90	–	–	–	42	–
	10.00 - 13.00	Rock	13.00	–	–	–	2.20	–	–	–	45	–

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LABORATARY TEST RESULTS

TABLE -2c

B.H No	Layer thickness	Soil classification	Depth of sample collected		LL	PL	Bulk density	Consolidation Parameters		Shear Strength Parmeters		Remarks
			DS / SPT	UDS				e_o	Cc	Cu	Ø	
	m		m	m	%	%	t/m^3			t/m^2	degree	
3	0.00 - 1.00	Filled Up Soil	–	–	–	–	–	–	–	–	–	–
	1.00 - 4.00	Sandy Silty Clay-SSLC1	1.50	–	66	23	1.50	1.52	0.36	2.46	–	–
	4.00 - 7.50	Silty Clayey Sand-SLCS1	4.50	–	–	–	1.52	–	–	–	29	–
	7.50 - 10.00	Clayey Silty Gravelly Sand-CSLGS1	9.00	–	–	–	1.58	–	–	–	38	–
	10.00 - 12.00	Sandy Gravel-SG1	11.00	–	–	–	1.62	–	–	–	41	–
	12.00 - 15.00	Rock	15.00	–	–	–	2.20	–	–	–	45	–

T. J. ENGINEERS CHENNAI-42



our services doesn't just end there

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Property Development & Approvals

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NRI & Investment Services

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Compliance & Special Services

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



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

Ownership, Compliance & Legal Verification

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

Zoning & Land Use Analysis

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

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3/350/2 Mettukuppam,
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hello@verified.realestate
+91 9996 12 9996
www.verified.realestate