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SOIL EXPLORATION AND FOUNDATION REPORT

FOR THE PROPOSED BUILDING AT

Plot No.2 &3, New Door No.3,Old Door No.1, Judge Jumbulingam Road, Mylapore, Chennai 600004 ,Comprised in R.S.No.1063/23(as per Document), R.S.No.1063/60(As per Patta), Block No.22 of Mylapore Village within the limit of Greater Chennai Corporation.

PROJECT NO. TJE/002790/2023

T.J.ENGINEERS

SOIL EXPLORATION AND FOUNDATION DESIGN DIVISION
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EXPLORATION REPORT

PROJECT NO. TJE/002790/2023

1.INTRODUCTION:

Mr. N. KANNAN, GPA Holder Mrs. A. PL. NACHAMMAI has proposed to construct a Stilt Floor + Five Floors Building at Survey No. 1063/60, New Door No. 3, Judge Jambulingam Road, Mylapore, Chennai. The soil investigation 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 two bore holes were bored up to maximum depth of 21.00m 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. The bore holes were terminated in the Very Dense Gravel-(Disintegrated 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. 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-1. 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 is given in Fig No. 2&3. Borehole location is given in Fig-1.

6.0. LABORATORY TEST RESULTS

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

7.0. GROUND WATER TABLE

The ground water table was **encountered at the depth of 3.00m** below the existing ground level at the time of soil exploration. It was noticed from the existing well at the site.

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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 location.

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

i. Filled Up Soil, 0.00m to 1.30m

ii. Loose to Medium Dense Silty Sand, 1.30m to 6.80m SPT's N = 8-20

iii. Soft to Medium Stiff Sandy Silty Clay, 6.80m to 15.90m SPT's N = 4-7

iv. Medium Dense Silty Clayey Sand, 15.90m to 17.30m SPT's N = 23

v. Very Dense Gravelly Silty Clayey Sand, 17.30m to 18.70m SPT's N = >100

vi. Very Dense Gravel, 18.70m to 21.00m SPT's N = >100

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

i. Filled Up Soil, 0.00m to 1.20m

ii. Medium Stiff Sandy Silty Clay, 1.20m to 2.50m SPT's N = 6

iii. Medium Dense Silty Sand, 2.50m to 6.90m SPT's N = 11-22

iv. Soft to Medium Stiff Sandy Silty Clay, 6.90m to 15.70m SPT's N = 4-7

v. Medium Dense Silty Clayey Sand, 15.70m to 17.20m SPT's N = 21

vi. Very Dense Gravelly Silty Clayey Sand, 17.20m to 18.70m SPT's N = >100

vii. Very Dense Gravel, 18.70m to 21.00m SPT's N = >100

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

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9.0. FOUNDATION ANALYSISAND DESIGN

From the bore log data at the top from 0.00m to 1.30m filled up soil is present. From 1.30m to 6.90m loose to medium dense Silty Sand layer is present.

In BH-02 location from 1.20m to 2.20m medium stiff Sandy Silty Clay layer is present, this layer has got swelling character, and this layer is not present in BH-01 location.

From 6.90m to 15.90m soft to medium stiff Sandy Silty Clay layer is present, this layer also has got swelling character. From 15.90m to 17.30m medium dense Gravelly Silty Clayey Sand/Silty Clayey Sand layer is present. From 17.30m to 18.70m very dense Gravelly Silty Clayey Sand/Gravel layer is present. Below 18.70m very dense Gravel-(Disintegrated Rock) layer is seen, this layer is fair to rest the pile foundation for heavy loaded structure.

The layer up to 15.90m is the critical zone for open foundation system, with in the critical zone, soft to medium stiff Clayey and loose to medium dense Sand layers are present, and the Clayey layer has got swelling character. For light loaded structure open foundation of **Isolated Footing Foundation** or **Continues Strip Raft Footing** or **Raft Foundation** can be adopted. The open foundation can be placed at the minimum **depth of 2.40m** below the existing ground level. The existing ground level was same as the road level at the time of soil investigation.

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 foundation should be terminated at the minimum **depth of 20.00m (Including Anchorage Depth)** below existing ground

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level. The pile should be anchored into the very dense Gravel-(Disintegrated Rock) layer for minimum of 1.00m depth.

9.1. COMPUTATION OF THE SAFE BEARING CAPACITY AT 2.40m DEPTH

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

$qu = \gamma\ Df\ Nq + 0.4\ \gamma'\ B\ N\gamma$

The observed N-Value is taken as 11 from Fig. 2&3.

The corresponding bearing capacity factors are,

$Nq = 9.59$

$N\gamma = 6.99$

Where,

γ = Bulk density = 1.50 t/m 3

γ' = Submerged density = 0.50 t/m 3

Df = Depth of footing = 2.40 m.

Dw = Depth of water table = 3.00m

B = Breadth of the footing = Consider minimum of 1.00m.

Substitute all the above values in the formula,

Qu = 1.50 x 2.40 x 9.59 + 0.4 x 0.50 x 1.00 x 6.99

= 34.524 + 1.398

= 35.922 t/m ^{2}

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

Hence, safe bearing capacity q s = 35.922 / 2.50 = 14.368 t/m ^{2}. Say 14.00 t/m ^{2}.

Therefore, Safe Bearing Capacity of the soil at the depth of 2.40m is 14.00 t/m ^{2}

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9.2. SETTLEMENT ANALYSIS FOR THE LOADING INTENSITY OF 14.00 t/m^2

LAYER -1, SANDY SILTY CLAY

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

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

Where

C_c = Coefficient of compression index
= 0.35

e_0 = The initial void ratio
= 1.80

H =The thickness of the compressible clay layer
= 13.50m

σ'_0 = The original effective over burden pressure at the centre of the clay layer
= 7.575 t/m^2

$\Delta\sigma$ = The stress increases at the centre of the clay layer due to foundation loads (or) pressure
= 0.135 t/m^2

S_I = (0.35/1+1.80) 13.50 Log_{10} (7.575 +0.135 /7.575)
= 0.125x 13.50 x 0.00766
= 12.929 x 10^{-3}m
= 12.929mm

TOTAL SETTLEMENT

= **12.929mm < 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.**

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9.3. LOAD CARRYING CAPACITY OF THE CONVENTIONAL PILE FOR THE DEPTH OF 20.00m

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

$$\mathbf{Qu = Qb + Qs}$$

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 = 9.75 t/m^2

δ = angle of wall friction = 32

D = Dia meter of pile = 0.40m

L = Length of individual layer = 1.00m

= 0.471 x 9.75 x 0.624 x 3.14 x 0.40 x 1.00

= 3.599 t

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

where

Nq = Bearing Capacity Factor = 120

σ'_{vo} = effective overburden pressure at the toe = 10.00 t/m^2

Ab = Cross sectional area at the base

D = Dia of Pile = 0.40m

= 120 x 10.00 x 3.14 x 0.40^2 /4

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= 150.72 t

Qu = Qb + Qs

= 150.72 + 3.599 = 154.319 t

Q safe = Qu/F.S = 154.319/2.5 = 61.727 **say 62.00 t**

The safe load carrying capacity for five different diameter of piles for the **depth of 20.00m** are worked and are given below.

Dia of Pile	Depth of Pile	Safe Vertical Load (Tones)
400mm	20.00m	62
450mm	20.00m	78
500mm	20.00m	96
600mm	20.00m	138
750mm	20.00m	215

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 light loaded structure open foundation of **Isolated Footing Foundation** or **Continues Strip Raft Footing** or **Raft Foundation** can be adopted.
3. The open foundation can be placed at the minimum **depth of 2.40m** below the existing ground level. The existing ground level was same as the road level at the time of soil investigation.
4. The Safe Bearing Capacity of the soil at the **depth of 2.40m is 14.00 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. The shallow foundation should rest on natural un disturbed layer.
7. All the foundation should rest on 100 mm thick 1:4:8 concrete mat, over 100m thick river sand or M sand layer.
8. **If Isolated Footing provided** it is advisable to make the structure as rigid as possible by providing two layers of grade beam one at the top of the footing and other one at plinth level, continues Sill Slab at sill level and continues lintel connecting monolithically with column.
9. **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 foundation should be terminated at the minimum **depth of 20.00m (Including Anchorage Depth)** below existing ground level. The pile should be anchored into the very dense Gravel-(Disintegrated Rock) layer for minimum of 1.00m depth.

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10. The **Safe Vertical load** carrying capacity for five different diameters of piles for the **depth of 20.00m** are worked and are given below.

Dia of Pile	Depth of Pile	Safe Vertical Load (Tones)
400mm	20.00m	62
450mm	20.00m	78
500mm	20.00m	96
600mm	20.00m	138
750mm	20.00m	215

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)

11. The pile boring should be done with **Percussion** drilling or **Hydraulic** Rotary Drilling, with DMC method.

12. 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.

13. 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.

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14. For foundation design stress due to any eccentricity and horizontal force should be considered and stability should be checked.

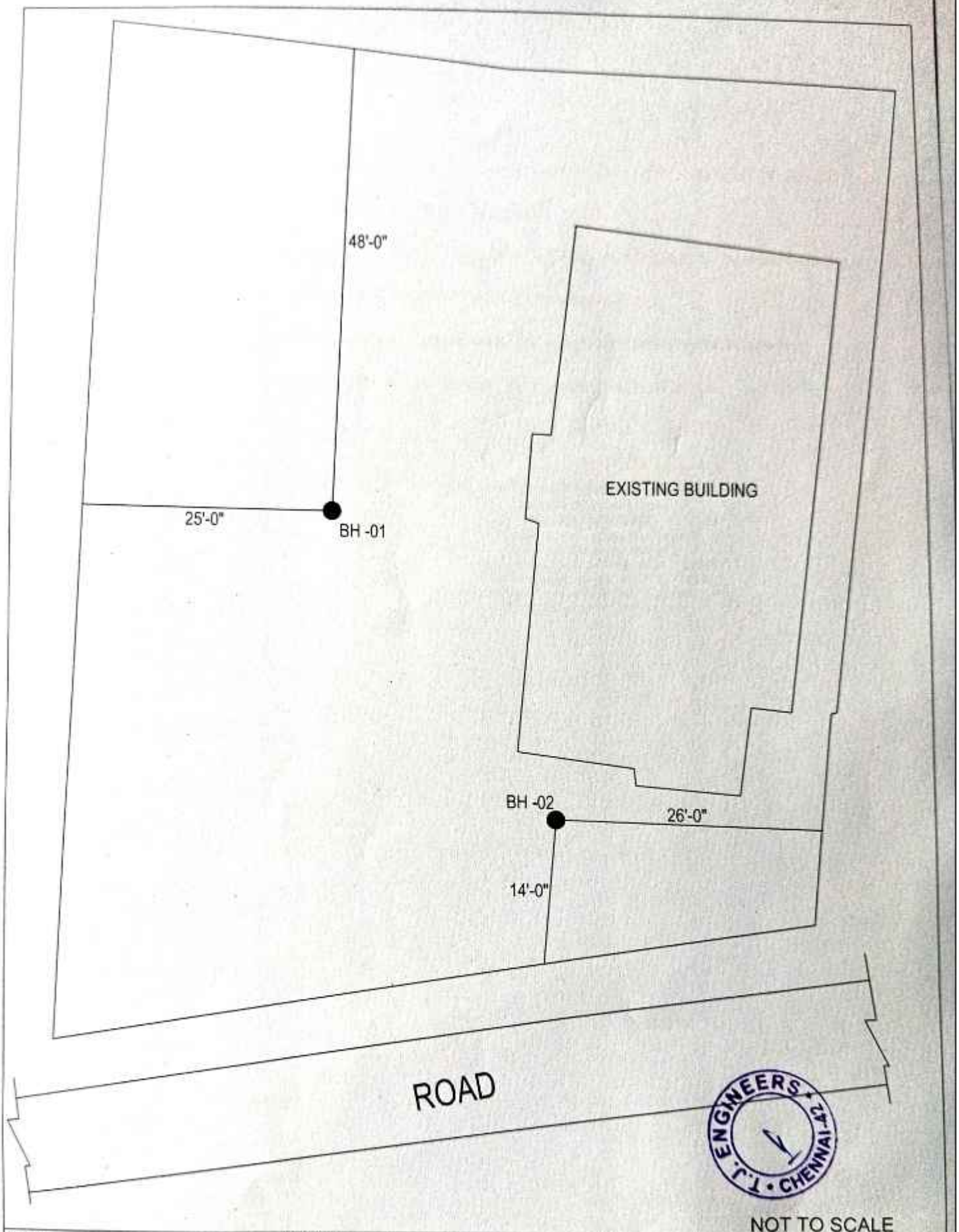
15. It is advisable not to mix deep foundation and shallow foundation in same building individually. Combined Pile cum Raft Can be adopted.

16. All suggested foundation recommendations and precautions should be adopted while undertaking the design aspects and construction activities.

For T.J. Engineers

20- 06 - 2023

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DTCP Reg. No: CGLRGN/RGTE/2019/07/010
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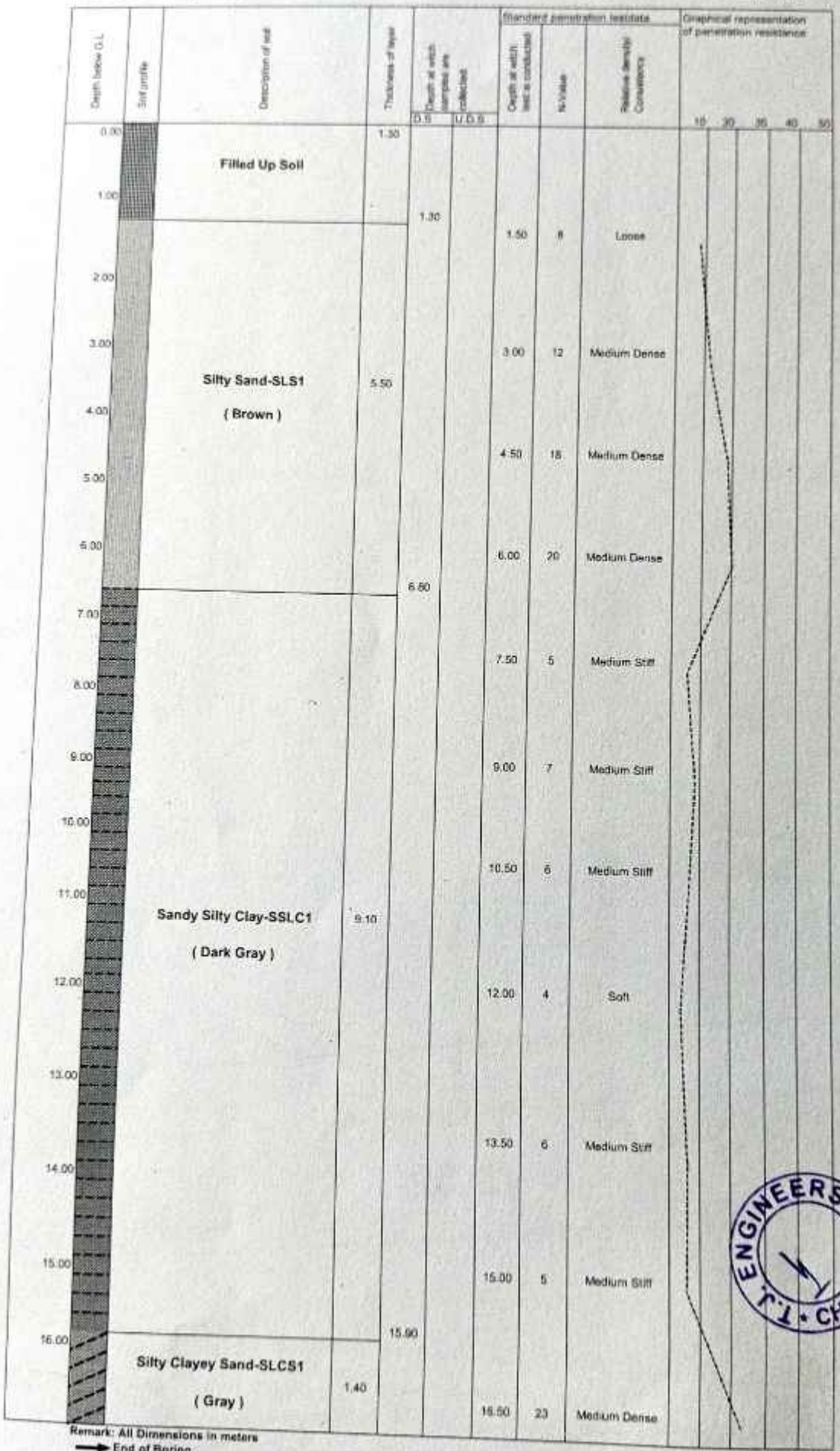
NOT TO SCALE

CLIENT:-	PROJECT:-		
Mr. N. KANNAN, GPA Holder Mrs. A. PL. NACHAMMAI CHENNAI.	PROPOSED BUILDING AT SURVEY NO. 1063/60, NEW DOOR NO. 3, JUDGE JAMBULINGAM ROAD, MYLAPORE, CHENNAI.	SITE PLAN FIG.1	T.J. ENGINEERS soil investigation and foundation design division T.J. HOUSE PLOT NO. A, ANNA NAGAR, 1ST STREET, VELACHERY, CHENNAI-42. tjengineers1998@gmail.com OFF: 044-42334204

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BORE LOG

PROJECT: Proposed Building at Survey No. 1063/80, New Door No. 3, Judge Jambulingam Road, Mylapore, Chennai.
BORE HOLE NO: B.H.01
TYPE OF BORING: Rotary Drilling
DATE OF COMMENCEMENT: 12 - 06 - 2023
DATE OF COMPLETION: 12 - 06 - 2023
G.W.L: 3.00m (Well)



Remark: All Dimensions in meters
→ End of Boring

FIG: 2

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BORE LOG

PROJECT: Proposed Building at Survey No. 1563/1B, New Door No. 3, Judge Jambulingam Road, Mylapore, Chennai
BORE HOLE NO: B.H:01
TYPE OF BORING: Rotary Drilling
DATE OF COMMENCEMENT: 12 - 06 - 2023
DATE OF COMPLETION: 12 - 06 - 2023
G.W.L: 3.00m (Well)

Depth below G.L	Soil profile	Description of soil	Thickness of layer	Depth at which samples are collected D.S	Depth at which samples are collected U.D.S	Standard penetration test data: Depth at which test is conducted	N-Value	Relative density/ Consistency	Graphical representation of penetration resistance (10 20 30 40 50)
17.00				17.30					
18.00		Gravelly Silty Clayey Sand-GSLCS1 (Whitish Brown)	1.40			18.00	>100	Very Dense	
19.00				18.70					
20.00		Gravel (Disintegrated Rock) (Yellowish Brown White)				20.00	>100	Very Dense	
21.00						21.00	>100	Very Dense	
22.00									
23.00									
24.00									
25.00									
26.00									
27.00									
28.00									
29.00									
30.00									

Remark: All Dimensions in meters
→ End of Boring

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FIG: 2

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BORE LOG

PROJECT: Proposed Building at Survey No. 106/1B, New Door No. 3, Judge Jambulingam Road, Mylapore, Chennai.

BORE HOLE NO: B.H-02

TYPE OF BORING: Rotary Drilling

DATE OF COMMENCEMENT: 13 - 06 - 2023

DATE OF COMPLETION: 13 - 06 - 2023

G.W.L: 3.00m (Well)

Depth below G.L	Soil profile	Description of soil	Thickness of layer	Depth at which samples are collected D.S	Depth at which test is conducted	N-Value	Relative density/ Consistency	Graphical representation of penetration resistance (10 20 30 40 50)
0.00			1.20					
		Filled Up Soil		1.20	1.50	6	Medium Stiff	
1.20								
		Sandy Silty Clay-SSLC1 (Brown)	1.00					
2.20				2.20				
3.00					3.00	11	Medium Dense	
4.00								
		Silty Sand-SLS1 (Brown)	4.70		4.50	16	Medium Dense	
5.00								
6.00					6.00	22	Medium Dense	
				6.90				
7.00					7.50	6	Medium Stiff	
8.00								
9.00					9.00	4	Soft	
10.00								
					10.50	7	Medium Stiff	
11.00		Sandy Silty Clay-SSLC2 (Dark Gray)	8.80					
12.00					12.00	8	Medium Stiff	
13.00								
					13.50	5	Medium Stiff	
14.00								
15.00					15.00	4	Soft	
				15.70				
16.00		Silty Clayey Sand-SLCS1 (Gray)	1.50		16.50	21	Medium Dense	

Remark: All Dimensions in meters

End of Boring

FIG: 3

cont....

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BORE LOG

PROJECT: Proposed Building at Survey No. 1063/60, New Door No. 3, Judge Jambulingam Road, Mylapore, Chennai.

BORE HOLE NO: B.H:02

TYPE OF BORING: Rotary Drilling

DATE OF COMMENCEMENT: 13 - 06 - 2023

DATE OF COMPLETION: 13 - 06 - 2023

G.W.L: 3.00m (Well)

Depth below G.L	Soil profile	Description of soil	Thickness of layer	Depth at which samples are collected		Standard penetration test data			Graphical representation of penetration resistance
				D.S	U.D.S	Depth at which test is conducted	N-Value	Relative density/ Consistency	10 20 30 40 50
17.00				17.20					
18.00		Gravelly Silty Clayey Sand-GSLCS1 (Whitish Brown)	1.50			18.00	>100	Very Dense	
19.00				18.70					
20.00		Gravel (Disintegrated Rock) (Yellowish Brown White)				20.00	>100	Very Dense	
21.00						21.00	>100	Very Dense	
22.00									
23.00									
24.00									
25.00									
26.00									
27.00									
28.00									
29.00									
30.00									

Remark: All Dimensions in meters

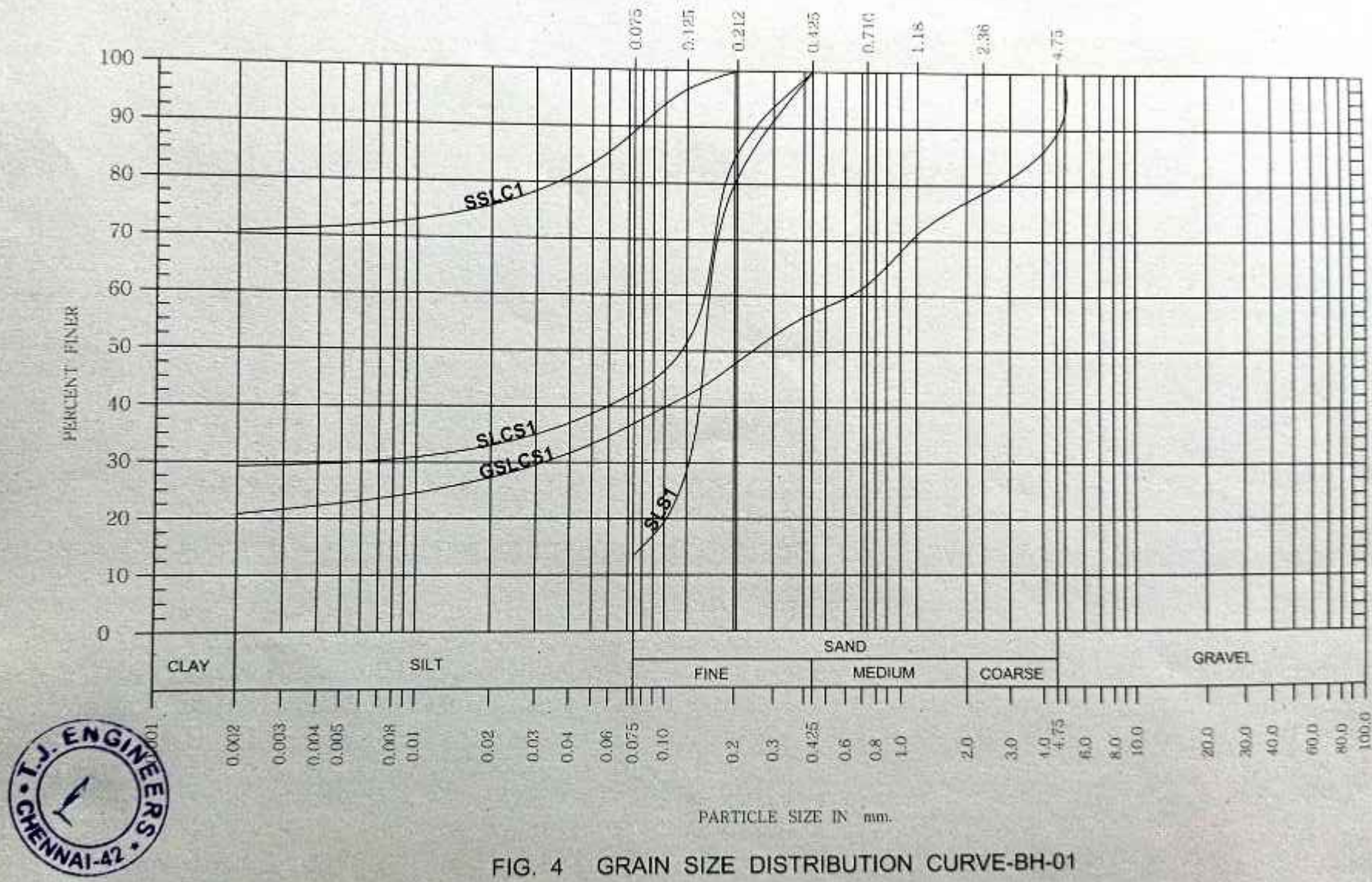
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FIG: 3

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Project: Proposed Building at Survey No. 1063/60, New Door No. 3, Judge Jambulingam Road, Mylapore, Chennai.

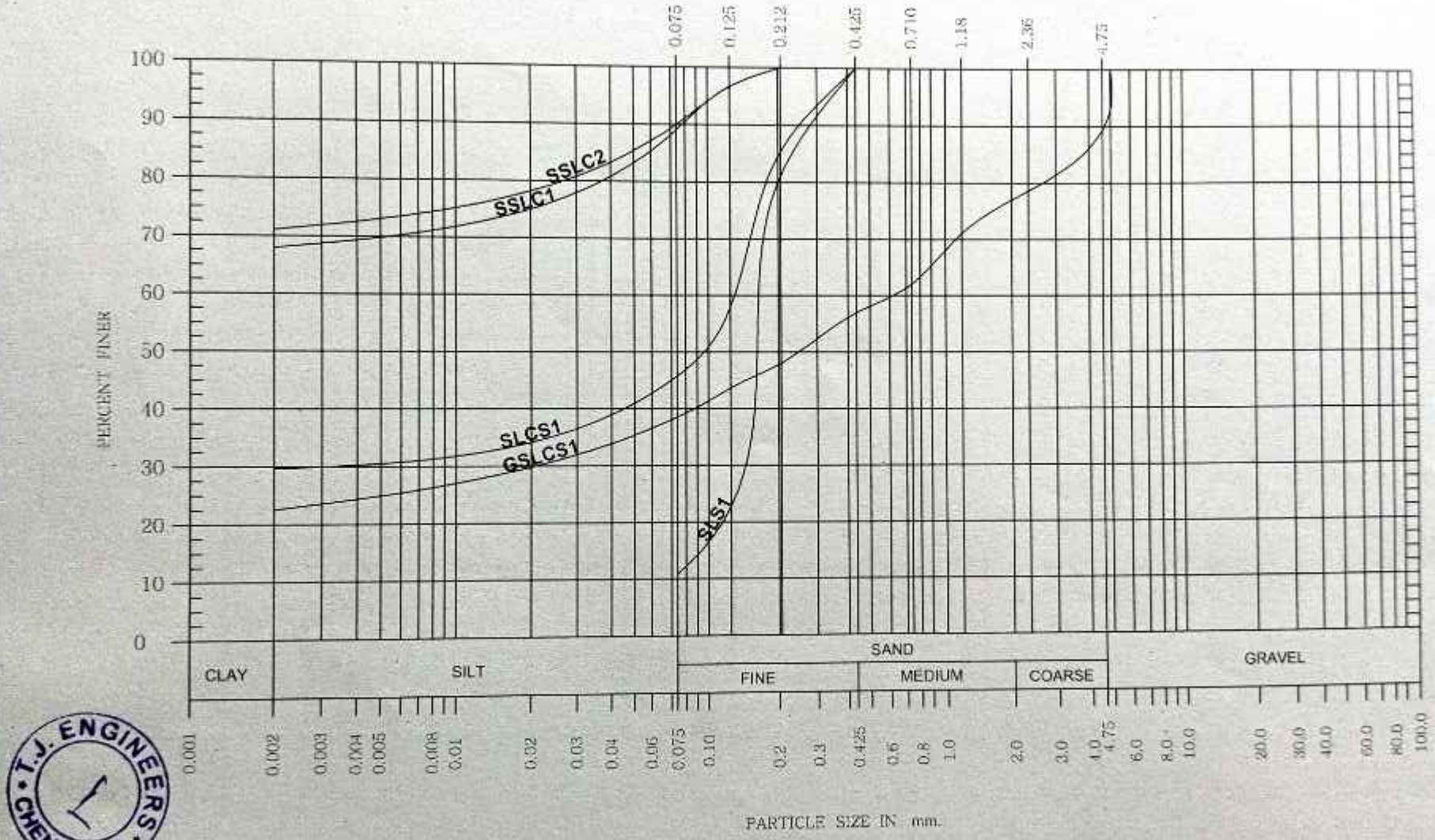


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FIG. 4 GRAIN SIZE DISTRIBUTION CURVE-BH-01

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FIG. 5 GRAIN SIZE DISTRIBUTION CURVE-BH-02

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LABORATARY TEST RESULTS

TABLE-1

B.H No	Layer thickness	Soil classification	Depth of sample collected		SP. gravity	%of free swell	Grain size distribution				Remarks
	m		DS / SPT m	UDS m			Clay %	Silt %	Sand %	Gravel %	
1	0.00 - 1.30	Filled Up Soil	–	–	–	–	–	–	–	–	–
	1.30 - 6.80	Silty Sand-SLS1	1.50	–	2.63	–	0	14	86	0	–
	6.80 - 15.90	Sandy Silty Clay-SSLC1	12.00	–	2.70	45	71	17	12	0	–
	15.90 - 17.30	Silty Clayey Sand-SLCS1	16.50	–	2.64	–	28	15	57	0	–
	17.30 - 18.70	Gravelly Silty Clayey Sand-GSLCS1	18.00	–	2.64	–	21	16	52	11	–
	18.70 - 21.00	Gravel	21.00	–	2.63	–	0	0	0	100	–
2	0.00 - 1.20	Filled Up Soil	–	–	–	–	–	–	–	–	–
	1.20 - 2.50	Sandy Silty Clay-SSLC1	1.50	–	2.64	38	67	21	12	0	–
	2.50 - 6.90	Silty Sand-SLS1	3.00	–	2.63	–	0	12	88	0	–
	6.90 - 15.70	Sandy Silty Clay-SSLC1	9.00	–	2.70	46	72	18	10	0	–
	15.70 - 17.20	Silty Clayey Sand-SLCS1	16.50	–	2.64	–	29	17	54	0	–
	17.20 - 18.70	Gravelly Silty Clayey Sand-GSLCS1	18.00	–	2.64	–	23	15	50	12	–
	18.70 - 21.00	Gravel	21.00	–	2.63	–	0	0	0	100	–

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LABORATARY TEST RESULTS

TABLE -2

B.H No	Layer thickness	Soil classification	Depth of sample collected		LL	PL	Bulk density	Consolidation Parameters		Shear Strength Parmeters		Remarks
	m		DS / SPT m	UDS m	%	%	t/m^3	e_o	Cc	Cu t/m^2	ø degree	
1	0.00 - 1.30	Filled Up Soil	–	–	–	–	–	–	–	–	–	–
	1.30 - 6.80	Silty Sand-SLS1	1.50	–	–	–	1.53	–	–	–	29	–
	6.80 - 15.90	Sandy Silty Clay-SSLC1	12.00	–	69	27	1.50	1.80	0.35	3.62	–	–
	15.90 - 17.30	Silty Clayey Sand-SLCS1	16.50	–	–	–	1.56	–	–	–	34	–
	17.30 - 18.70	Gravelly Silty Clayey Sand-GSLCS1	18.00	–	–	–	1.58	–	–	–	38	–
	18.70 - 21.00	Gravel	21.00	–	–	–	1.62	–	–	–	41	–
	0.00 - 1.20	Filled Up Soil	–	–	–	–	–	–	–	–	–	–
	1.20 - 2.50	Sandy Silty Clay-SSLC1	1.50	–	66	24	1.50	1.77	0.34	3.63	–	–
	2.50 - 6.90	Silty Sand-SLS1	3.00	–	–	–	1.52	–	–	–	31	–
	6.90 - 15.70	Sandy Silty Clay-SSLC1	9.00	–	71	27	1.50	1.80	0.35	3.62	–	–
	15.70 - 17.20	Silty Clayey Sand-SLCS1	16.50	–	–	–	1.54	–	–	–	34	–
	17.20 - 18.70	Gravelly Silty Clayey Sand-GSLCS1	18.00	–	–	–	1.58	–	–	–	38	–
	18.70 - 21.00	Gravel	21.00	–	–	–	1.61	–	–	–	41	–

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'ThalamuthuNatarajan Building', No.1, Gandhi Irwin Road,
Egmore, Chennai-600 008.

PROFESSIONAL REGISTRATION CERTIFICATE

This is to certify that the **Thiru. S. CHOCKALINGAM** has enrolled as **Registered Geo-Technical Engineer (RGTE)** with Chennai Metropolitan Development Authority (CMDA) who has the qualification of **M.E.,(Geo-Tech.)** and experience in the relevant field for **28years**.

He has been given the Registration No.**GTE/2024/03/006 on 04.03.2024.** He shall be required to comply with the duties and responsibilities prescribed by the Government of Tamil Nadu in Part-V, "Registration of Professionals", Tamil Nadu Combined Development and Building Rules, 2019 approved vide G.O.(Ms) No.18 MAWS (MA1) Dept. dated 04.02.2019.

This Registration is valid upto **03.03.2029**.



4/3/24

(A. MEGANATHAN)
Superintendent

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Zoning & Land Use Analysis

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