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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**.



4/3/2024

(A. MEGANATHAN)
Superintendent

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SOIL EXPLORATION AND FOUNDATION REPORT

FOR THE PROPOSED BUILDING

AT

NEW DOOR NO. 6, OLD DOOR NO. 32

1ST MAIN ROAD, KARPAGAM GARDEN

BESANT AVENUE, ADYAR

CHENNAI-600 020

PROJECT NO. TJE/003305/2024

T.J.ENGINEERS

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EXPLORATION REPORT

PROJECT NO. TJE/003305/2024

1.INTRODUCTION:

M/S DHURGA CONSTRUCTION COMPANY has proposed to construct a Stilt Floor + Five Floors Building at New Door No. 6, Old Door No. 32, 1st Main Road, Karpagam Garden, Besant Avenue, Adyar, Chennai-600 020. 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 two bore holes were bored up to maximum depth of 20.00m 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 Sandy 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-2&3. Bore hole 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 6.00m**, 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 the sub soil is basically made-up of eight distinctive layers.

i. Filled Up Soil 0.00m to 1.30m

ii. Medium Stiff to Stiff Sandy Silty Clay, 1.30m to 4.00m SPT's N= 7-10

iii. Loose to Medium Dense Silty Sand, 4.00m to 7.00m SPT's N= 9-17

iv. Loose to Medium Dense Clayey Silty Sand, 7.00m to 12.00m SPT's N= 7-12

v. Medium Dense Silty Sand, 12.00m to 16.00m SPT's N= 12-15

vi. Very Dense Silty Clayey Gravelly Sand, 16.00m to 17.00m SPT's N= 55

vii. Very Dense Clayey Silty Sand, 17.00m to 19.00m SPT's N= >100

viii. Very Dense Sandy Gravel-(Disintegrated Rock), 19.00m to 20.00m SPT's N= >100

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

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9.0 FOUNDATION ANALYSIS

From the bore log data from 0.00m to 1.30m filled up soil is present. From 1.30m to 4.00m medium stiff to stiff Sandy Silty Clay layer is present, this layer has got swelling character. From 4.00m to 7.00m loose to medium dense Silty Sand layer is present. From 7.00m to 12.00m loose to medium dense Clayey Silty Sand layer is present. From 12.00m to 16.00m medium dense Silty Sand layer is present. From 16.00m to 17.00m very dense Silty Clayey Gravelly Sand layer is present. From 17.00m to 19.00m very dense Clayey Silty Sand layer is present. Below 19.00m very dense Sandy Gravel-(Disintegrated Rock) layer is seen, this layer is fair to rest pile foundation for heavy loaded structure.

The layer up to 12.00m is the critical zone for open foundation system, within the critical zone medium stiff to stiff Clayey and loose to medium dense Sandy layers are present, and the Clayey layer has got swelling character. For light loaded structure with column positions are symmetrical and short span, open foundation of **Isolated Footing Foundation** can be adopted. For light loaded structure with column positions are un symmetrical long span sensitive for differential settlement, open foundation of **Continues Strip Raft Footing or Raft Foundation** can be adopted. The open foundation can be placed at the minimum **depth of 2.10m** below the existing ground level. The existing ground level was 0.60m higher than the road level at the time of soil investigation. The Safe Bearing Capacity (SBC) at 2.10m depth has been worked out and given below.

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.

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

9.1. COMPUTATION OF THE SAFE BEARING CAPACITY AT 2.10m 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 7 from Fig. 2&3.

The corresponding bearing capacity factors are,

$Nc = 5.7$

$N_q = 1$

Where,

C = Un drained shear strength = 4.10 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 = 2.10 m

D_w = Depth of water table = 6.00 m

Substitute all the above values in the formula,

$q_u = 1.2 \times 4.10 \times 5.7 + 1.50 \times 2.10 \times 1$

$= 28.044 + 3.15 = 31.194\ t/m^2$

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

Hence, safe bearing capacity $q_s = 31.194/2.50 = 12.477\ t/m^2$. Say 12.50 t/m^2.

Therefore, safe bearing capacity of the soil at 2.10m is 12.50 t/m^2

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9.2. SETTLEMENT ANALYSIS FOR THE LOADING INTENSITY OF 12.50 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

= 0.33

e_0 = The initial void ratio

= 1.65

H =The thickness of the compressible clay layer

= 9.90m

σ'_0 = The original effective over burden pressure at the centre of the clay layer

= 9.525 t/m^2

$\Delta\sigma$ = The stress increases at the centre of the clay layer due to foundation loads (or) pressure

= 0.192 t/m^2

S_1 = (0.33 /1+1.65) 9.90 Log_{10} (9.525 + 0.192 /9.525)

= 0.124 x 9.90 x 8.667

= 0.010639m

= 10.639mm

TOTAL SETTLEMENT

= 10.639mm < 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

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

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

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 = 9.50 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 x 9.50 x 0.624 x 3.14 x 0.40 x 2.00

= 7.013 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 + 7.013 = 157.733 t

Q safe = Qu/F.S = 157.733/2.5 = 63.093 say 63.00 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 Load (Tones)
400mm	**20.00m**	**63**
450mm	**20.00m**	**79**
500mm	**20.00m**	**98**
600mm	**20.00m**	**140**
750mm	**20.00m**	**217**

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 with column positions are symmetrical and short span, open foundation of **Isolated Footing Foundation** can be adopted. For light loaded structure with column positions are un symmetrical long span sensitive for differential settlement, open foundation of **Continues Strip Raft Footing or Raft Foundation** can be adopted.
3. The open foundation can be placed at the minimum **depth of 2.10m** below the existing ground level. The existing ground level was 0.60m lower than the road level at the time of soil investigation.
4. The **Safe Bearing Capacity** of the soil at **2.10m depth** is **12.50 t/m ^{2}**
5. All the foundation should rest on 100 mm thick river sand or M Sand and 100mm thick 1:4:8 concrete mat.
6. The foundation bed should be well compacted by ramming before laying PCC.
7. If open foundation provided of Isolated Footing provided, it is advisable to make the structure as rigid as possible by providing continues plinth beam connecting column on both direction at plinth level, **Continues Sill Slab** and **Continues Lintel Beam connecting monolithically with column.**
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.** The pile foundation can be **Bored Cast in situ pile**. The pile foundation can be terminated at the minimum depth of **20.00m (Including anchorage depth)** below existing ground level, existing ground level at the time of soil investigation.
9. 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 Load (Tones)
400mm	20.00m	59

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450mm	**20.00m**	**74**
500mm	**20.00m**	**91**
600mm	**20.00m**	**131**
750mm	**20.00m**	**203**

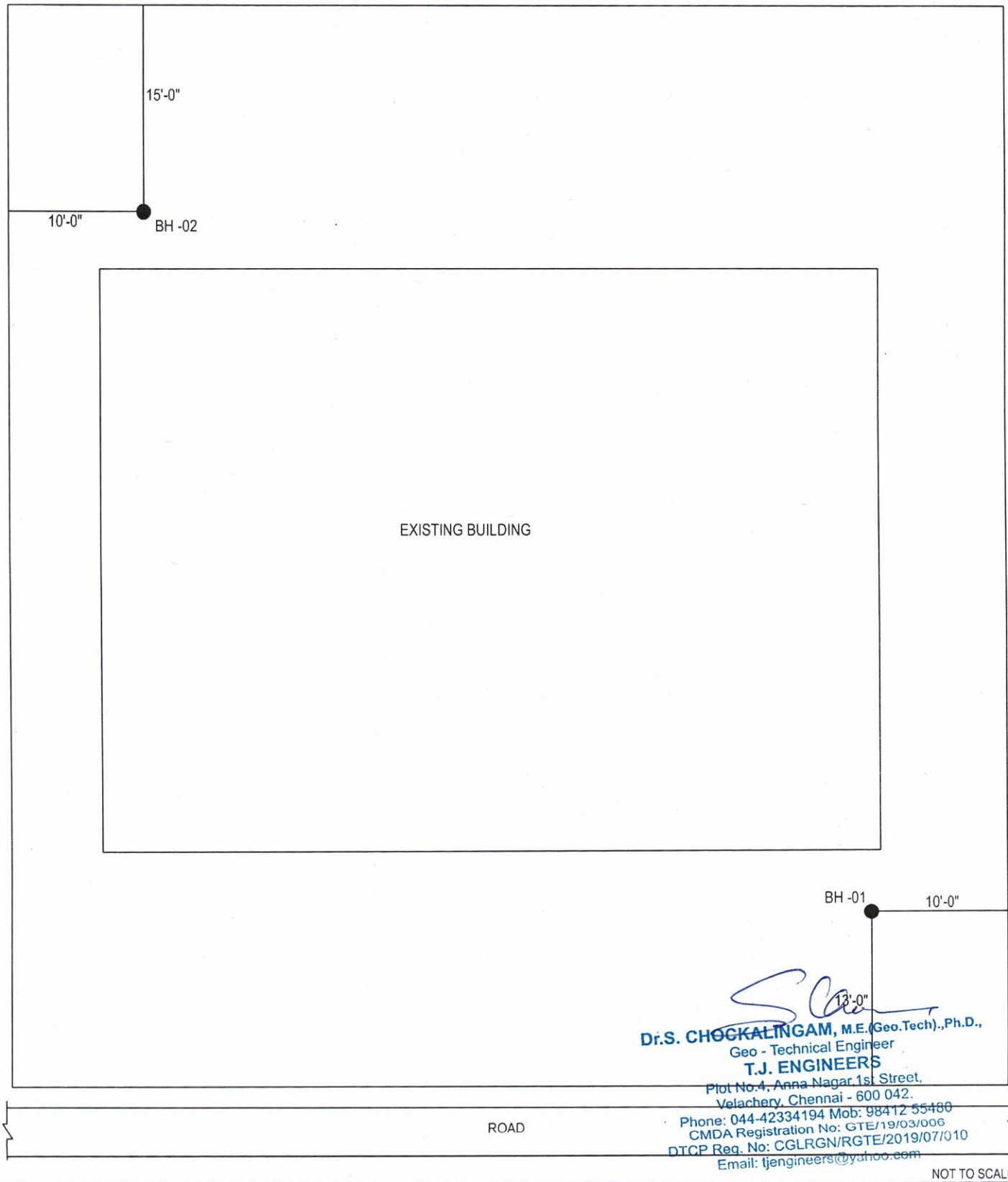
The above safe loads are provisional and shall be confirmed by conducting pile load test as per the guide line laid down in IS: 2911 (Part: IV)

10. The **pile should be anchored** in to the very dense Sandy Gravel-(**Disintegrated Rock) layer** for **minimum 1.00m depth**.
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.
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. Combined Raft cum Pile 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

15 – 05 – 2024

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NOT TO SCALE

CLIENT:-	PROJECT:-		
M/S DHURGA CONSTRUCTION COMPANY CHENNAI	PROPOSED BUILDING AT NEW DOOR NO. 6, OLD DOOR NO. 32, 1ST MAIN ROAD, KARPAGAM GARDEN, BESANT AVENUE, ADYAR, CHENNAI-600 020.	SITE PLAN FIG.1	T.J. ENGINEERS soil investigation and foundation design division

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BORE LOG

PROJECT : Proposed Building at New Door No. 6, Old Door No. 32, 1st Main Road, Karpagam Garden, Besant Avenue, Adyar, Chennai-600 020.

BORE HOLE NO : B.H:01

TYPE OF BORING : Rotary Drilling

DATE OF COMMENCEMENT : 10 - 05 - 2024

DATE OF COMPLETION : 11 - 05 - 2024

G.W.L : 6.00m

Depth below G.L	Soil profile	Description of soil	Thickness of layer	Depth at witch samples are collected D.S	Depth at witch samples are collected U.D.S	Standard penetration testdata: Depth at witch test is conducted	N-Value	Relative density/ Consistency
0.00		Filled Up Soil	1.30					
1.00				1.30				
						1.50	7	Medium Stiff
2.00		Sandy Silty Clay-SSLC1	2.70					
3.00		(Brown)				3.00	8	Medium Stiff
4.00				4.00				
						4.50	9	Loose
5.00								
6.00		Silty Sand-SLS1	5.00			6.00	16	Medium Dense
7.00		(Whitish Yellowish Brown)						
						7.50	17	Medium Dense
8.00								
9.00				9.00		9.00	7	Loose
10.00		Clayey Silty Sand-CSLS1	3.00					
		(Grayish Brown)				10.50	6	Loose
11.00								
12.00				12.00		12.00	15	Medium Dense
13.00								
		Silty Sand-SLS2	4.00			13.50	13	Medium Dense
14.00		(Yellowish Whitish Brown)						
15.00						15.00	12	Medium Dense
16.00				16.00				

Graphical representation of penetration resistance

10 20 30 40 50

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BORE LOG

PROJECT : Proposed Building at New Door No. 6, Old Door No. 32, 1st Main Road, Karpagam Garden, Besant Avenue, Adyar, Chennai-600 020.
BORE HOLE NO : B.H:01
TYPE OF BORING : Rotary Drilling

DATE OF COMMENCEMENT : 10 - 05 - 2024
DATE OF COMPLETION : 11 - 05 - 2024
G.W.L : 6.00m

Depth below G.L	Soil profile	Description of soil	Thickness of layer	Depth at witch samples are collected		Standard penetration testdata			Graphical representation of penetration resistance
				D.S	U.D.S	Depth at witch test is conducted	N-Value	Relative density/ Consistency	10 20 30 40 50
		Silty Clayey Gravelly Sand-SLCGS1 (Brown Whitish Gray)	1.00						
17.00				17.00					
		Clayey Silty Sand-CSLS2 (Gray Brown)	2.00			18.00	>100	Very Dense	
18.00									
19.00				19.00		19.00	>100	Very Dense	
		Sandy Gravel-SG1 (Disintegrated Rock) (Brown Whitish Gray)							
20.00						20.00	>100	Very Dense	
21.00									
22.00									
23.00									
24.00									
25.00									
26.00									
27.00									
28.00									
29.00									
30.00									

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BORE LOG

PROJECT : Proposed Building at New Door No. 6, Old Door No. 32, 1st Main Road, Karpagam Garden, Besant Avenue, Adyar, Chennai-600 020.

BORE HOLE NO : B.H:02

TYPE OF BORING : Rotary Drilling

DATE OF COMMENCEMENT: 11 - 05 - 2024

DATE OF COMPLETION : 11 - 05 - 2024

G.W.L : 6.00m

Depth below G.L	Soil profile	Description of soil	Thickness of layer	Depth at witch samples are collected D.S	Depth at witch samples are collected U.D.S	Standard penetration testdata: Depth at witch test is conducted	N-Value	Relative density/ Consistency	Graphical representation of penetration resistance
0.00									10 20 30 40 50
		Filled Up Soil	1.30						
1.00				1.30		1.50	7	Medium Stiff	
2.00		**Sandy Silty Clay-SSLC1**	2.70						
3.00		**(Brown)**				3.00	10	Stiff	
4.00				4.00		4.50	12	Medium Dense	
5.00		**Silty Sand-SLS1**	3.00						
6.00		**(Whitish Yellowish Brown)**				6.00	16	Medium Dense	
7.00				7.00		7.50	10	Loose	
8.00		**Clayey Silty Sand-CSLS1**							
9.00		**(Grayish Brown)**				9.00	8	Loose	
10.00									
10.50						10.50	12	Medium Dense	
11.00									
12.00									
13.00									
14.00									
15.00									
16.00									

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Project: Proposed Building at New Door No. 6, Old Door No. 32, 1st Main Road, Karpagam Garden, Besant Avenue, Adyar, Chennai-600 020.

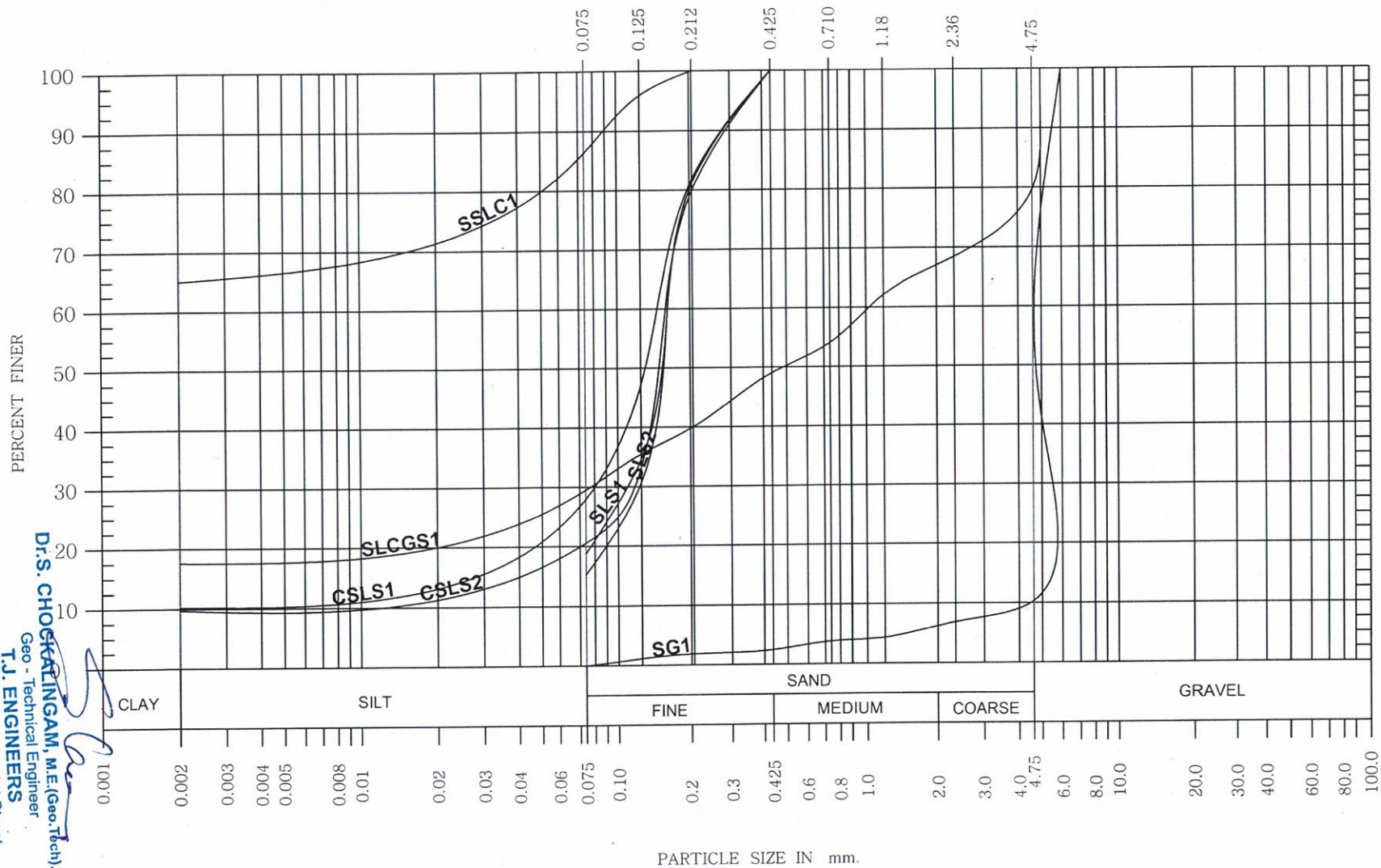


FIG. 4 GRAIN SIZE DISTRIBUTION CURVE-BH-01

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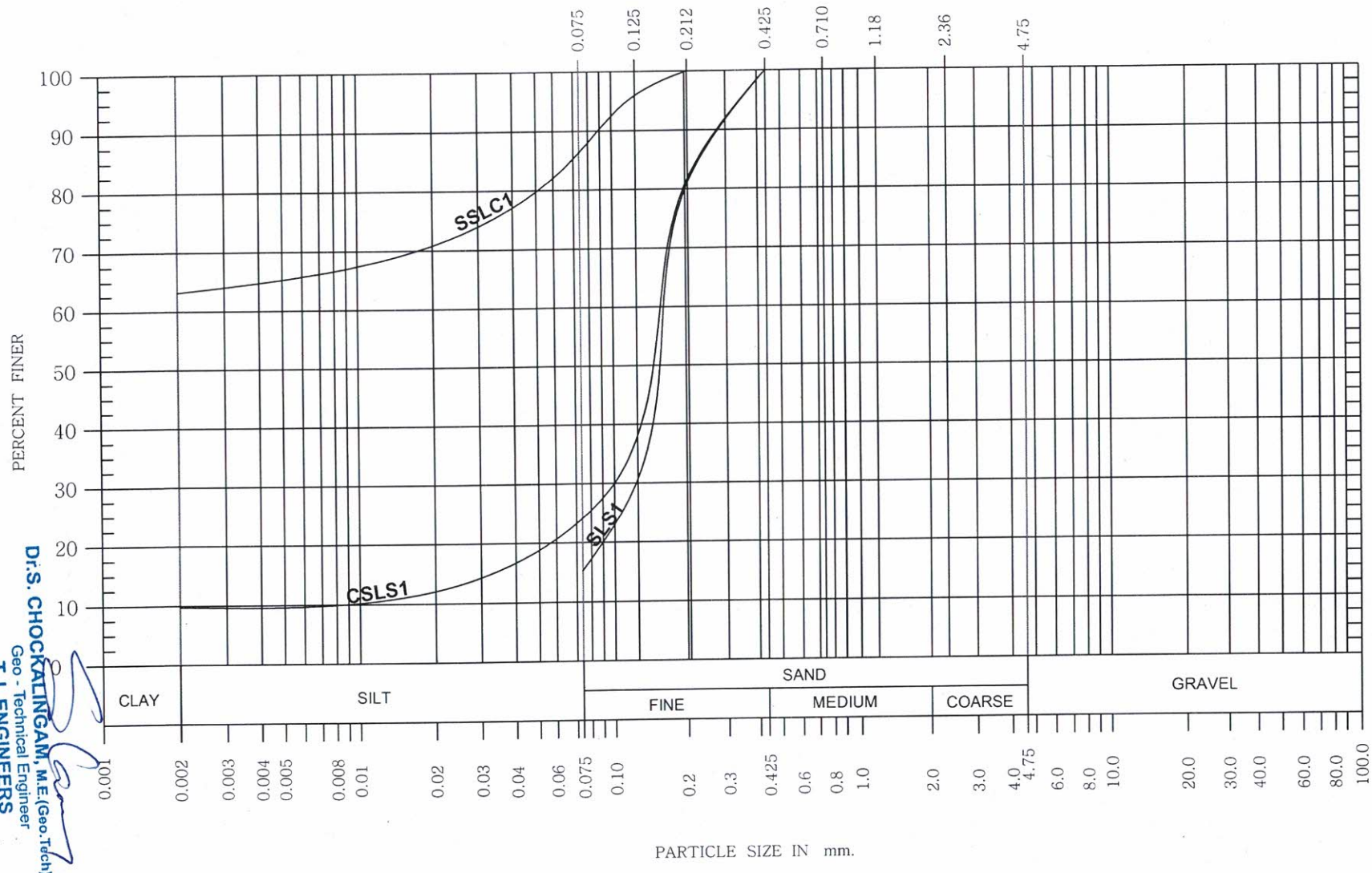


FIG. 5 GRAIN SIZE DISTRIBUTION CURVE-BH-02

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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				Rema
			DS / SPT	UDS			Clay	Silt	Sand	Gravel	
	m		m	m		%	%	%	%	%	
1	0.00 - 1.30	Filled Up Soil	–	–	–	–	–	–	–	–	–
	1.30 - 4.00	Sandy Silty Clay-SSLC1	1.50	–	2.65	34	65	21	14	0	–
	4.00 - 9.00	Silty Sand-SLS1	4.50	–	2.63	–	0	18	82	0	–
	9.00 - 12.00	Clayey Silty Sand-CSLS1	9.00	–	2.64	–	11	16	73	0	–
	12.00 - 16.00	Silty Sand-SLS2	12.00	–	2.63	–	0	16	84	0	–
	16.00 - 17.00	Silty Clayey Gravelly Sand-SLCGS1	16.50	–	2.64	–	17	12	50	21	–
	17.00 - 19.00	Clayey Silty Sand-CSLS2	18.00	–	2.64	–	9	12	79	0	–
	19.00 - 20.00	Sandy Gravel-SG1	20.00	–	2..63	–	0	0	11	89	–
2	0.00 - 1.30	Filled Up Soil	–	–	–	–	–	–	–	–	–
	1.30 - 4.00	Sandy Silty Clay-SSLC1	1.50	–	2.65	34	64	22	14	0	–
	4.00 - 7.00	Silty Sand-SLS1	6.00	–	2.63	–	0	16	84	0	–
	7.00 - 10.50	Clayey Silty Sand-CSLS1	10.50	–	2.64	–	9	14	77	0	–

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LABORATARY TEST RESULTS

TABLE -2

B.H No	Layer thickness m	Soil classification	Depth of sample collected DS / SPT m	Depth of sample collected UDS m	LL %	PL %	Bulk density t/m^3	Consolidation Parameters e_o	Consolidation Parameters Cc	Shear Strength Parmeters Cu t/m^2	Shear Strength Parmeters φ degree	Remarks
1	0.00 - 1.30	Filled Up Soil	–	–	–	–	–	–	–	–	–	–
	1.30 - 4.00	Sandy Silty Clay-SSLC1	1.50	–	64	23	1.50	1.65	0.33	4.10	–	–
	4.00 - 9.00	Silty Sand-SLS1	4.50	–	–	–	1.53	–	–	–	32	–
	9.00 - 12.00	Clayey Silty Sand-CSLS1	9.00	–	–	–	1.51	–	–	–	28	–
	12.00 - 16.00	Silty Sand-SLS2	12.00	–	–	–	1.55	–	–	–	33	–
	16.00 - 17.00	Silty Clayey Gravelly Sand-SLCGS1	16.50	–	–	–	1.57	–	–	–	37	–
	17.00 - 19.00	Clayey Silty Sand-CSLS2	18.00	–	–	–	1.59	–	–	–	38	–
	19.00 - 20.00	Sandy Gravel-SG1	20.00	–	–	–	1.62	–	–	–	42	–
2	0.00 - 1.30	Filled Up Soil	–	–	–	–	–	–	–	–	–	–
	1.30 - 4.00	Sandy Silty Clay-SSLC1	1.50	–	63	23	1.50	1.65	0.33	4.15	–	–
	4.00 - 7.00	Silty Sand-SLS1	6.00	–	–	–	1.54	–	–	–	33	–
	7.00 - 10.50	Clayey Silty Sand-CSLS1	10.50	–	–	–	1.52	–	–	–	29	–

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