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SOIL EXPLORATION AND FOUNDATION REPORT

FOR THE PROPOSED BUILDING

AT

NO. 8

HANUMANTHA ROAD

ROYAPETTAH

CHENNAI-600 014

PROJECT NO. TJE/002981/2023

T.J.ENGINEERS

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EXPLORATION REPORT

PROJECT NO. TJE/002981/2023

1.INTRODUCTION:

M/S RPN CONSTRUCTIONS PRIVATE LIMITED has proposed to construct a Stilt Floor + Five Floors Building at No. 8, Hanumantha Road, Royapettah, Chennai-600 014. 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 23.00m 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-(Dis-integrated 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 3.00m**, 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 soil strata is not similar in BH-01 & BH-02 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. Silty Clayey Sand, 1.00m to 1.40m

iii. Medium Dense Silty Sand, 1.40m to 5.40m SPT's N=16-25

iv. Stiff Sandy Silty Clay, 5.40m to 6.50m SPT's N= 9

v. Medium Dense to Dense Silty Sand, 6.50m to 15.90m SPT's N=21-36

vi. Medium Dense to Dense Clayey Silty Sand, 15.90m to 20.70m SPT's N=27-41

vii. Very Dense Sandy Gravel, 20.70m to 23.00m 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 0.70m

ii. Stiff Silty Clay, 0.70m to 2.40m SPT's N= 9

iii. Medium Dense Silty Sand, 2.40m to 5.70m SPT's N= 24-26

iv. Very Stiff Sandy Silty Clay, 5.70m to 7.00m SPT's N= 9

v. Medium Dense Silty Sand, 7.00m to 8.70m SPT's N= 22

vi. Medium Dense Silt Sand, 8.70m to 10.50m SPT's N= 17-22

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 1.00m Filled Up Soil is present. From 1.00m to 1.40m/2.40m stiff Silty Clay and Silty Clayey Sand layers are present, and the Silty Clayey layer has got swelling character. From 1.40m/2.40m to 5.70m medium dense Silty Sand layer is present. From 5.70m to 7.00m stiff to very stiff Sandy Silty Clay layer is present, this layer also has got swelling character. From 7.00m to 15.90m medium dense to dense Silty Sand layer is present. From 15.90m to 20.70m medium dense to dense Silty Clayey Sand layer is present. Below 20.70m Very Dense Sandy Gravel (Dis-integrated Rock) layer is seen, this layer is fair to rest pile foundation for heavy loaded structure.

The layer up to 7.00m is the critical zone for open foundation system, within the critical zone stiff to very stiff Clayey layer and medium dense Sandy layers are present, and the Clayey layer has got swelling character. For the proposed Stilt Floor + Five Floors structure, if the column positions are symmetrical and short span, open foundation of **Isolated Footing Foundation** can be adopted, and if the 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 2.40m** below the existing ground level. The existing ground level is 0.30m higher than 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 23.00m** below existing ground level. The pile should be anchored into the very dense Sandy Gravel (Dis-integrated Rock) layer for minimum of 1.00m depth.

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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 16 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 = Considered minimum of 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 14.25 t/m ^{2}

Therefore, Safe Bearing Capacity of the soil at the depth of 2.40m is 14.25 t/m ^{2}

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9.2. SETTLEMENT ANALYSIS FOR THE LOADING INTENSITY OF 14.25 t/m^2

LAYER -1, SANDY SILTY CLAY

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

$$S_1 = (C_c / 1 + e_0)H \quad Log(\sigma'_0 + \Delta\sigma / \sigma'_0)$$

Where

C_c = Coefficient of compression index
= 0.32

e_0 = The initial void ratio
= 1.62

H =The thickness of the compressible clay layer
= 4.60m

σ'_0 =The original effective over burden pressure at the centre of the clay layer
= 5.35 t/m^2

$\Delta\sigma$ = The stress increases at the centre of the clay layer due to foundation loads (or) pressure
= 0.438 t/m^2

S_1 = (0.32 /1+1.62) 4.60 Log(5.35 + 0.438 /5.35)
= 0.122 x 4.60 x 0.0338
= 0.018968 m x 10^{-3}
= 18.968mm

TOTAL SETTLEMENT

= **18.968mm < 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 = 10.25 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 10.25 x 0.624 x 3.14 x 0.40 x 1.00

= 3.783 t

q_b = Nq σ'_{vo} Ab

where

Nq = Bearing Capacity Factor = 120

σ'_{vo} = effective overburden pressure at the toe = 10.50 t/m^2

Ab = Cross sectional area at the base

D = Dia of Pile = 0.40m

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= 120 x 10.50 x 3.14 x 0.40 ^{2}/4

= 158.256 t

Qu = Qb + Qs

= 158.256 + 3.783 = 162.039 t

Q safe = Qu/F.S = 162.039/2.5 = 64.815say 65.00 t

The safe load carrying capacity for five different diameter of piles for the **depth of 23.00m** are worked and are given below.

Dia of Pile	Depth of Pile	Safe Load (Tones)
400mm	23.00m	65
450mm	23.00m	82
500mm	23.00m	101
600mm	23.00m	145
750mm	23.00m	225

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 the proposed Stilt Floor + Five Floors structure, if the column positions are symmetrical and short span, open foundation of **Isolated Footing Foundation** can be adopted, and if the 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 2.40m** below the existing ground level. The existing ground level 0.30m higher than the road level at the time of soil investigation.
4. The **Safe Bearing Capacity** of the soil at **2.40m depth is 14.25 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 of 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 another one 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 **23.00m** 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 23.00m** are worked and are given below.

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Dia of Pile	Depth of Pile	Safe Load (Tones)
400mm	23.00m	65
450mm	23.00m	82
500mm	23.00m	101
600mm	23.00m	145
750mm	23.00m	225

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 Gavel-(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. The bore hole should be flushed properly before laying concrete.
13. Proper precaution should be taken against sliding of bore hole by maintaining proper dense bentonite slurry or providing temporary casing or permanent casing.
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.

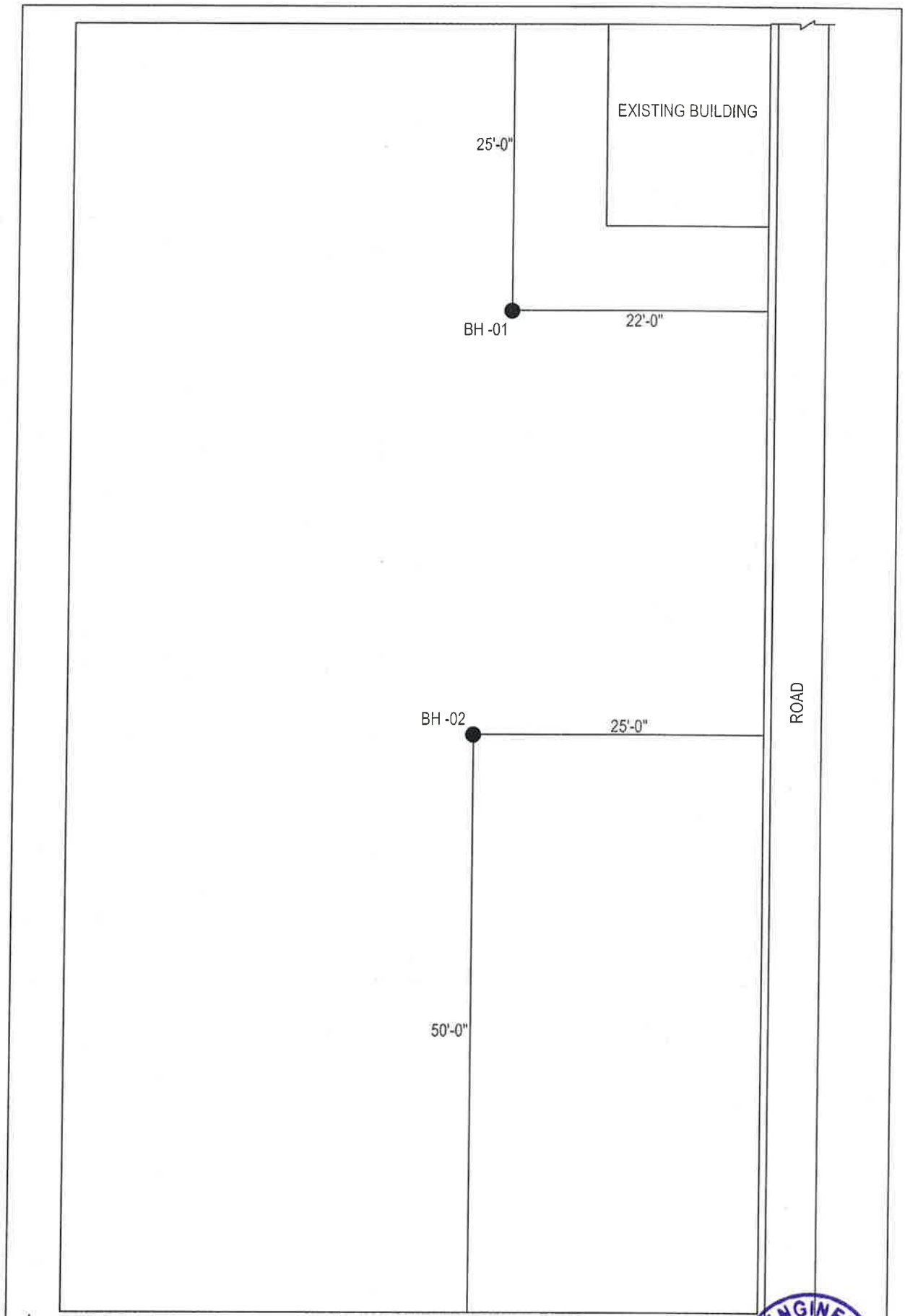
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For T.J. Engineers

17– 10 – 2023

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NOT TO SCALE

CLIENT:-	PROJECT:-		
M/S RPN CONSTRUCTIONS PRIVATE LIMITED CHENNAI	PROPOSED BUILDING AT NO. 8,HANUMANTHA ROAD, ROYAPETTAH, CHENNAI-14	SITE PLAN FIG:1	T.J. ENGINEERS soil investigation and foundation design division

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BORE LOG

PROJECT	Proposed Building at No. 8, Hanumantha Road, Royapettah, Chennai-600 014.	DATE OF COMMENCEMENT	10 - 10 - 2023
BORE HOLE NO	B.H:01	DATE OF COMPLETION	11 - 10 - 2023
TYPE OF BORING	Rotary Drilling	G.W.L	3.00m

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		Filled Up Soil	1.00						
1.00		Silty Clayey Sand-SLCS1 (Brown)	0.40	1.00					
				1.40		1.50	16	Medium Dense	
2.00									
3.00		Silty Sand-SLS1 (Yellowish Brown)	4.00			3.00	25	Medium Dense	
4.00						4.50	24	Medium Dense	
5.00				5.40					
6.00		Sandy Silty Clay-SSLC1 (Gray)	1.10	6.50		6.00	9	Stiff	
7.00						7.50	21	Medium Dense	
8.00									
9.00						9.00	20	Medium Dense	
10.00									
						10.50	17	Medium Dense	
11.00		Silty Sand-SLS2 (Gray Whitish Brown)	9.40						
12.00						12.00	30	Dense	
13.00									
						13.50	35	Dense	
14.00									
15.00						15.00	36	Dense	
				15.90					
16.00									
						16.50	27	Medium Dense	

Graphical representation of penetration resistance: 10 20 30 40 50

Remark: All Dimensions in meters

End of Boring

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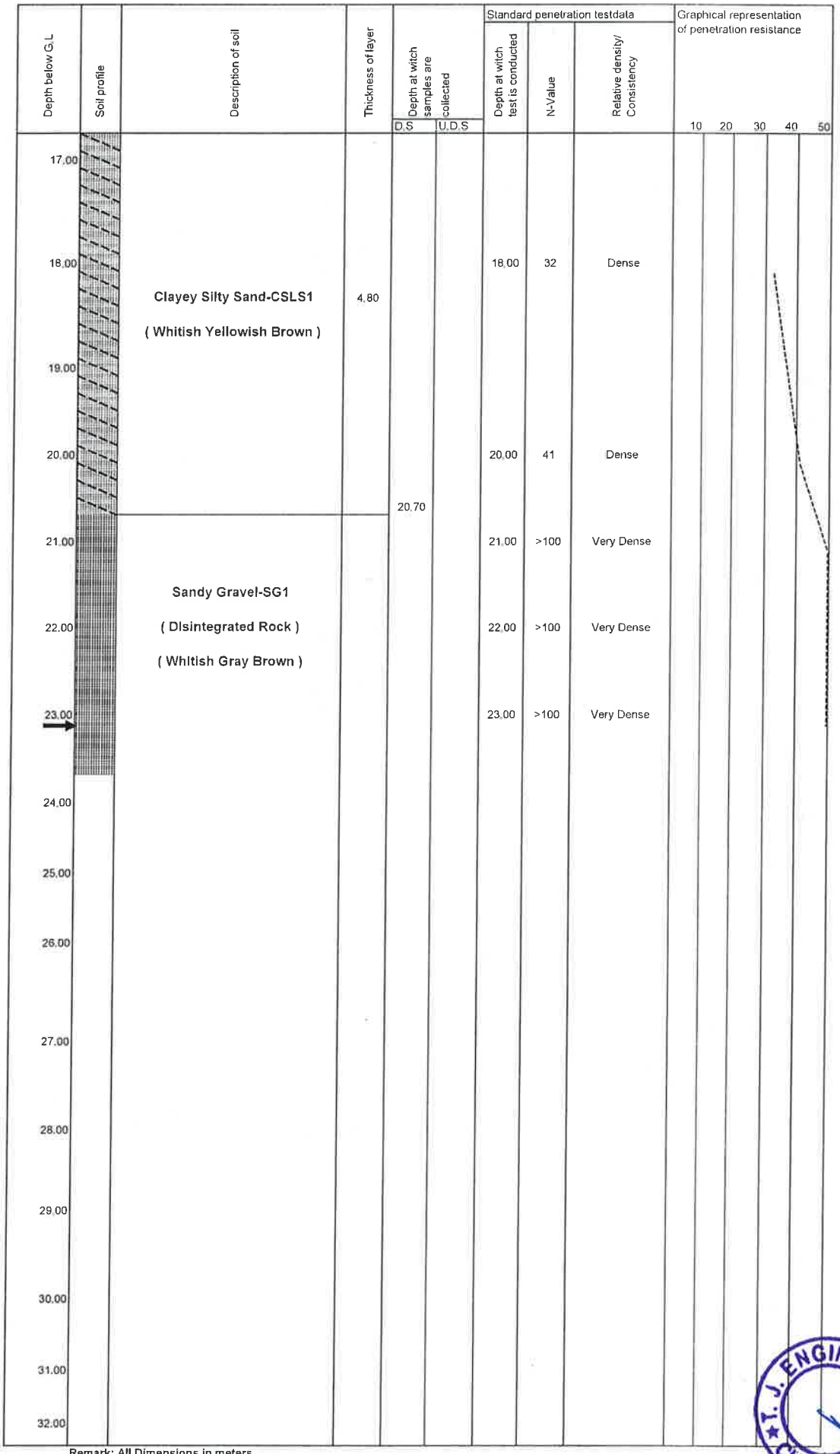
FIG: 2

cont....

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BORE LOG

PROJECT	Proposed Building at No. 8, Hanumantha Road, Royapettah, Chennai-600 014.	DATE OF COMMENCEMENT	10 - 10 - 2023
BORE HOLE NO	B.H:01	DATE OF COMPLETION	11 - 10 - 2023
TYPE OF BORING	Rotary Drilling	G.W.L	3.00m



Remark: All Dimensions in meters

End of Boring

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FIG: 2

BORE LOG

PROJECT	Proposed Building at No. 8, Hanumantha Road, Royapettah, Chennai-600 014.	DATE OF COMMENCEMENT	10 - 10 - 2023
BORE HOLE NO	B.H:02	DATE OF COMPLETION	11 - 10 - 2023
TYPE OF BORING	Rotary Drilling	G.W.L	3.00m

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	Standard penetration testdata: N-Value	Standard penetration testdata: Relative density/ Consistency	Graphical representation of penetration resistance
0.00		Filled Up Soil	0.70	0.70					
1.00		Silty Clay-SLC1 (Brown)	1.70			1.50	9	Stiff	
2.00				2.40					
3.00		Silty Sand-SLS1 (Yellowish Brown)	3.30			3.00	26	Medium Dense	
4.00						4.50	24	Medium Dense	
5.00				5.70					
6.00		Sandy Silty Clay-SSLC2 (Gray)	1.30			6.00	16	Very Stiff	
7.00				7.00					
8.00		Silty Sand-SLS2 (Yellowish Whitish Brown)	1.70	8.70		7.50	22	Medium Dense	
9.00		Silty Sand-SLS3 (Gray Whitish Brown)				9.00	17	Medium Dense	
10.00									
10.50						10.50	22	Medium Dense	
11.00									
12.00									
13.00									
14.00									
15.00									
16.00									

Graphical representation of penetration resistance: 10 20 30 40 50

Remark: All Dimensions in meters

End of Boring

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FIG: 3

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soil exploration & foundation design division

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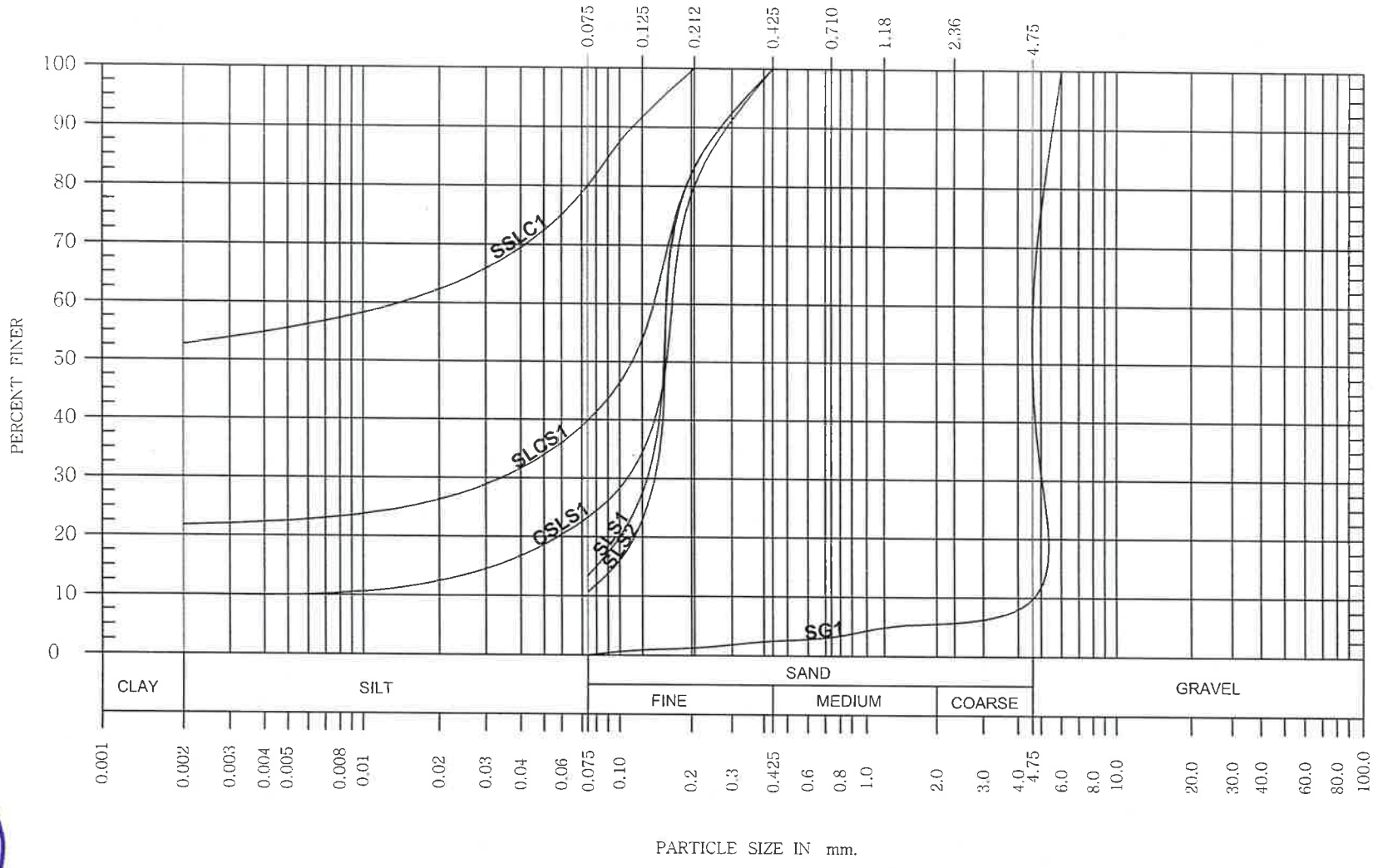


FIG. 4 GRAIN SIZE DISTRIBUTION CURVE-BH-01

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Project: Proposed Building at No. 8, Hanumantha Road, Royapettah, Chennai-600 014.

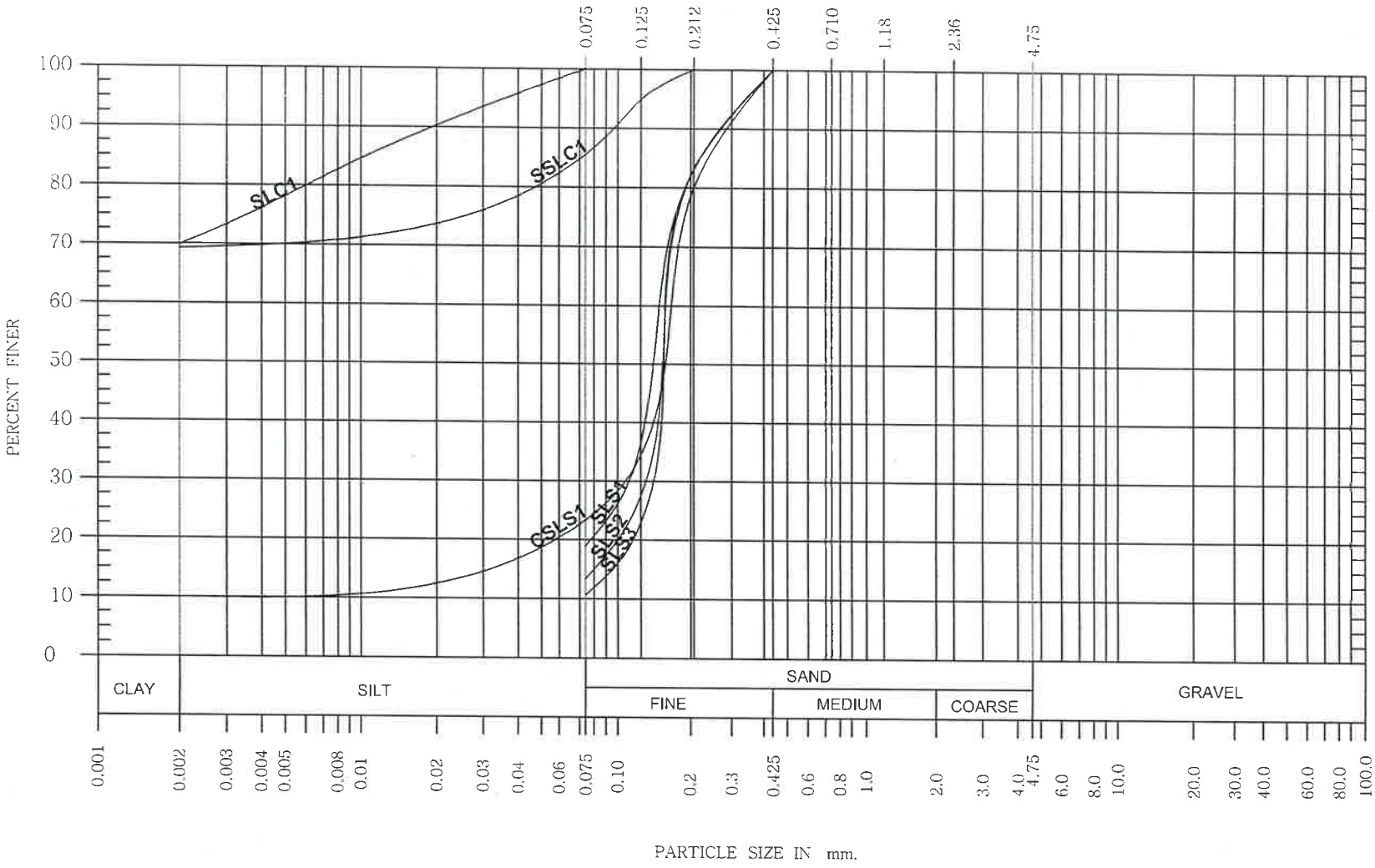


FIG. 5 GRAIN SIZE DISTRIBUTION CURVE-BH-02

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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 - 1.00	Filled Up Soil	–	–	–	–	–	–	–	–	–
	1.00 - 1.40	Silty Clayey Sand-SLCS1	1.00	–	2.65	–	23	16	61	0	–
	1.40 - 5.40	Silty Sand-SLS1	1.50	–	2.63	–	0	14	86	0	–
	5.40 - 6.50	Sandy Silty Clay-SSLC1	6.00	–	2.65	29	53	28	19	0	–
	6.50 - 15.90	Silty Sand-SLS2	7.50	–	2.63	–	0	12	88	0	–
	15.90 - 20.70	Clayey Silty Sand-CSLS1	16.50	–	2.64	–	10	14	76	0	–
	20.70 - 23.00	Sandy Gravel-SG1	23.00	–	2.63	–	0	0	9	91	–
2	0.00 - 0.70	Filled Up Soil	–	–	–	–	–	–	–	–	–
	0.70 - 2.40	Silty Clay-SLC1	1.50	–	2.66	32	69	31	0	0	–
	2.40 - 5.70	Silty Sand-SLS1	3.00	–	2.63	–	0	18	82	0	–
	5.70 - 7.00	Sandy Silty Clay-SSLC1	6.00	–	2.65	29	68	18	14	0	–
	7.00 - 8.70	Silty Sand-SLS2	7.50	–	2.63	–	0	14	86	0	–
	8.70 - 10.50	Silty Sand-SLS3	10.50	–	2.64	–	0	12	88	0	–

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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
			DS / SPT	UDS				e_o	Cc	Cu	φ	
	m		m	m	%	%	t/m^3			t/m^2	degree	
1	0.00 - 1.00	Filled Up Soil	–	–	–	–	–	–	–	–	–	–
	1.00 - 1.40	Silty Clayey Sand-SLCS1	1.00	–	–	–	–	–	–	–	–	–
	1.40 - 5.40	Silty Sand-SLS1	1.50	–	–	–	1.54	–	–	–	34	–
	5.40 - 6.50	Sandy Silty Clay-SSLC1	6.00	–	51	19	1.50	1.62	0.32	5.12	–	–
	6.50 - 15.90	Silty Sand-SLS2	7.50	–	–	–	1.55	–	–	–	34	–
	15.90 - 20.70	Clayey Silty Sand-CSLS1	16.50	–	–	–	1.57	–	–	–	36	–
	20.70 - 23.00	Sandy Gravel-SG1	23.00	–	–	–	1.60	–	–	–	41	–
2	0.00 - 0.70	Filled Up Soil	–	–	–	–	–	–	–	–	–	–
	0.70 - 2.40	Silty Clay-SLC1	1.50	–	67	24	1.50	1.62	0.32	5.12	–	–
	2.40 - 5.70	Silty Sand-SLS1	3.00	–	–	–	1.54	–	–	–	33	–
	5.70 - 7.00	Sandy Silty Clay-SSLC1	6.00	–	66	23	1.52	1.30	0.25	9.11	–	–
	7.00 - 8.70	Silty Sand-SLS2	7.50	–	–	–	1.55	–	–	–	34	–
	8.70 - 10.50	Silty Sand-SLS3	10.50	–	–	–	1.56	–	–	–	33	–

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our services doesn't just end there

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Property Buying Assistance, Property Selling Support, Market Price Analysis, Owner Outreach and Negotiation.

Legal & Documentation Services

Certified EC, Patta, legal opinions, property verification, due diligence, litigation solutions, and legal heir certificates.

Property Development & Approvals

Building plan approvals, construction, layout and sub-division approvals, zone conversion, and occupancy certification.

NRI & Investment Services

Escrow Services, Rentals, Litigation Solutions, Property Valuation and Property Management

Compliance & Special Services

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



empowering your real estate decisions with smart tools

Property Valuation & Cost Estimation

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

Property Documentation & Workflow Tools

Forms & Templates, Document Generator, Document Translation, Dictionary

Vastu & Property Management Tools

Home Vastu Shastra, Plot Vastu Shastra, Property Management

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