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REPORT ON

SOIL INVESTIGATIONFOR THE CONSTRUCTION OF (S+6 FLOORS) SLUM TENEMENTS FOR TNSCB AT MEENAMBAL SIVARAJ NAGAR PHASE I & II IN CORPORATION Dn.104, ZONE 8, EGMORE CONSTITUENCY, CHENNAI.

CLIENT

THE EXECUTIVE ENGINEER,

DIVISION-IV,

TAMILNADU SLUM CLEARANCE BOARD (TNSCB), CHENNAI.

CONSULTANT

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February 2020

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Report No.:IC1920CE792TSCB002777 dated 11/02/2020

REPORT ON SOIL INVESTIGATIONFOR THE CONSTRUCTION OF (S+6 FLOORS) SLUM TENEMENTS FOR TNSCB AT MEENAMBAL SIVARAJ NAGAR PHASE I & II IN CORPORATION Dn.104, ZONE 8, EGMORE CONSTITUENCY, CHENNAI.

1. INTRODUCTION

On a request from the Executive Engineer, Division- IV, Tamil Nadu Slum Clearance Board, Chennai, the Department of Civil Engineering, Indian Institute of Technology Madras undertook the consultancy for geotechnical Investigation to evaluate the soil properties and to recommend suitable foundations for the construction of (S+6 floors) slum tenements at Meenambal Sivaraj Nagar Phase I & II in corporation Dn.104, Zone 8, Egmore Constituency, Chennai.

The field investigation consisting of drilling of boreholes, carrying out standard Penetration tests in the boreholes, collection of soil samples, and ground water table observation. The complete logging of borehole at the site was carried out from21st December 2019 to 16th December 2019by M/s. Geotechnical Solutions, Chennai under the guidance of undersigned in the presence of Engineers from Tamil Nadu Slum Clearance Board. In addition, advanced Multi channel Analysis of Surface Waves (MASW) tests were carried out at the site on 21stJanuary2020 by IIT Madras technicians. This report presents the details of the field and laboratory investigations carried out at the site, evaluation of design soil parameters, recommendations on capacity of soil strata and type of foundations to be adopted for the proposed buildings.

2. FIELD INVESTIGATIONS

2.1 Drilling of Boreholes and SPT Test

The investigation program comprises of sinking six exploratory boreholes at the locations shown in the Figure 1. These boreholes were advanced up to a maximum

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depth of about 25 m below the ground level.

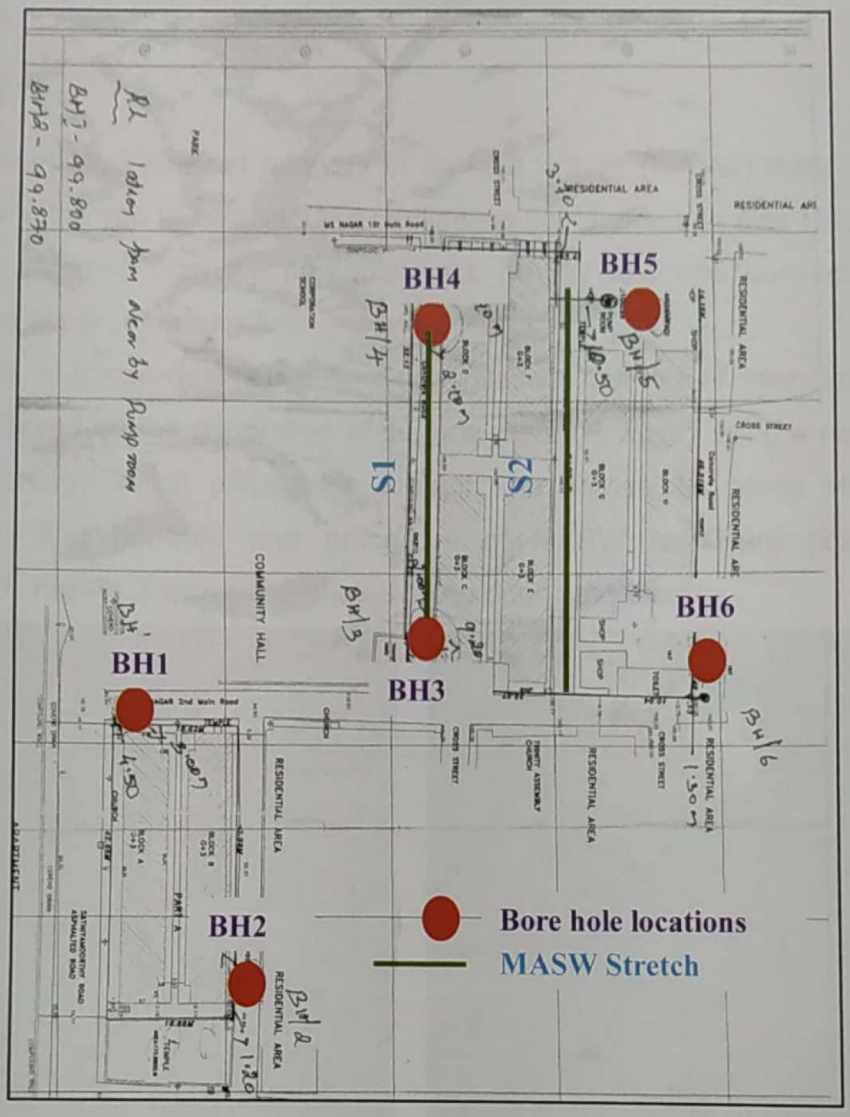


Figure 1: Site plan showing location of boreholes and MASW stretches

Exploratory boreholes were advanced from the existing ground level using rotary drilling technique supplemented by bentonite mud circulation. Mud circulation was used to stabilise the sides and the bottom of the boreholes, and then to bring the soil cuts to the surface. Use of drilling mud will also help in preventing the disturbance to the soil at the borehole bottom during drilling operations. Standard Penetration Tests were conducted at regular depth intervals in the boreholes and N values were recorded. The samples collected through the SPT sampler were packed in two layers of polythene bags to retain the natural moisture content. These samples were subjected to natural moisture content determination on the next day. Different soil layers collected from different levels were identified and classified.

The bore logs of all boreholes are shown in **Annexure 1.** Field N values at different

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depths, the depth and thickness of different soil layers are presented in these bore logs.

2.2 MASW Test

The advanced Multi channel Analysis of Surface Waves (MASW) tests have been carried out at the site to establish the continuous soil profile and also to confirm the soil profile obtained from the borehole data. MASW test was conducted in two stretches as shown in **Figure 1**.

MASW test is a non-destructive and non-invasive method of investigation. The method is based on the generation of surface wave (R-wave) using a near-surface impulsive energy which propagates through the soil media along stratigraphic boundaries. The principle and procedure of MASW tests are presented in **Enclosure1**. **Figure 2** shows the photos taken during the tests.



Figure 2: MASW test in progress images

3. LABORATORY INVESTIGATIONS

Grain size analyses on selected samples were conducted on oven dried samples since accurate dry weights of test specimen prior to washing through 75 micron sieve is necessary in this case. The Liquid limit of the soil is determined with the

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standard Casagrande liquid limit apparatus. Casagrande grooving tool is used for making groove in the soil sample. The water content corresponds to 25 blows in the flow curve is taken as the liquid limit of the soil. Air dried sample passing through IS sieve 425 micron is used for determining the liquid limit and plastic limit of the soil sample. About 15 g of soil sample is taken for plastic limit determination and is mixed with a sufficient quantity of water which would enable the soil mass to become plastic enough to be easily shaped into a ball.

Laboratory test results such as determination of natural moisture content, specific gravity, Atterberg's limits and grain size analysis are presented in **Annexure 2** and **Annexure 3**.

4. SITE CHARACTERIZATION

4.1. Soil Profiling based on Borelogs

In general, the soil profile obtained from the bore logs such as the soil stratification and variation in the layer thickness at the site as follows.

The top layer in the site predominantly consists of filled up layer with stones and brick pieces up to a depth of about 2 m from the ground level. It is followed by medium dense sand/stiff clay layer with SPT N in the range of 11 to 35occurs up to a depth of about 5m. A soft clay/loose sand stratum with SPT N value in the range of 1-5occurs between a depth of 5 to 8m.Alayer of very stiff silty clay/ dense to very dense cemented sand with SPT N value of 23-75occurs up to a depth of 19 m. Below this layer, a weathered rock layer occurs with SPT N value more than 100 and a very weak jointed mudstone rock layer is encountered at a depth of 21 m. The Core Recovery (CR) of this rock layer varies in the range of 20-38% and Rock Quality Designation (RQD) in the range of0-12%.

4.2 Soil Profiling based on MASW tests

The one dimensional and two dimensional shear wave velocity (Vs) profiles obtained from the MASW test results are illustrated in **Figures 2a to 2d**. It can be observed that the shear wave velocity (Vs) varies in the range of 200 to 250 m/s within a depth of about 5 m. Below this, the Vs value decreases to about 150 m/s within a depth of 5 to 8 m. The low Vs in the layer denote the presence of loose/soft material within this depth. The Vs is gradually increased to 250-450 m/s up to a depth of about 19 m which indicates the presence of dense/stiff strata. This can be confirmed from the

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boreholes which show the presence of stiff silty clay/dense sand layer at this depth. Further, the Vs value increases from 450 to 750 m/s which show the presence of hard strata below 19 m depth.

The MASW test serves as a confirmatory test to ascertain the presence of the different layers of varying thickness and strength. In the present scenario, the MASW test confirms the presence of hard layers below 19 m depth and matches well with the results of the exploratory boreholes.

From the results of both the MASW tests and the exploratory boreholes, it can be concluded that the present site comprises of loose sand/soft clay layers at shallow depths up to 8 m followed by medium dense/stiff layer up to a depth of 19 m and hard stratum at deeper depths below 19 m.

4.3. Groundwater Table

During the period of field investigation, the ground water table was encountered between 3 m to 3.3 m from ground level for all the bore holes. The ground water table may be expected to come at shallow depth during the monsoon period. However, for the foundation analysis, the ground water table level is considered at the ground level.

4.4. Shear strength

Standard Penetration Test blow counts N is measured at different levels in the borehole. Shear strength parameters for cohesionless soils were selected based on SPT results and grain size distribution analyses. Conventional method of estimating the angle of shearing resistance ϕ corresponding to the corrected SPT N value is adopted. The N values are corrected for overburden and dilatancy as usual before arriving at the angle of friction.

4.5. Liquefaction Susceptibility

Liquefaction is a phenomenon in which the soil loses its strength and stiffness due to the shaking which takes place during an earthquake. It can occur in saturated cohesionless soils if earthquake characteristics and soil conditions are favorable. The present site falls in zone 3 as per the seismic zonation map provided in IS 1893-2002. According to that, moderate level earthquake may be expected in the site. The site predominantly has medium dense sandy/stiff clayey layers at shallow depths. The loose sand layers encountered at shallow depths also contains clay content and

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hence, the site is not vulnerable to liquefaction for the anticipated seismic loading.

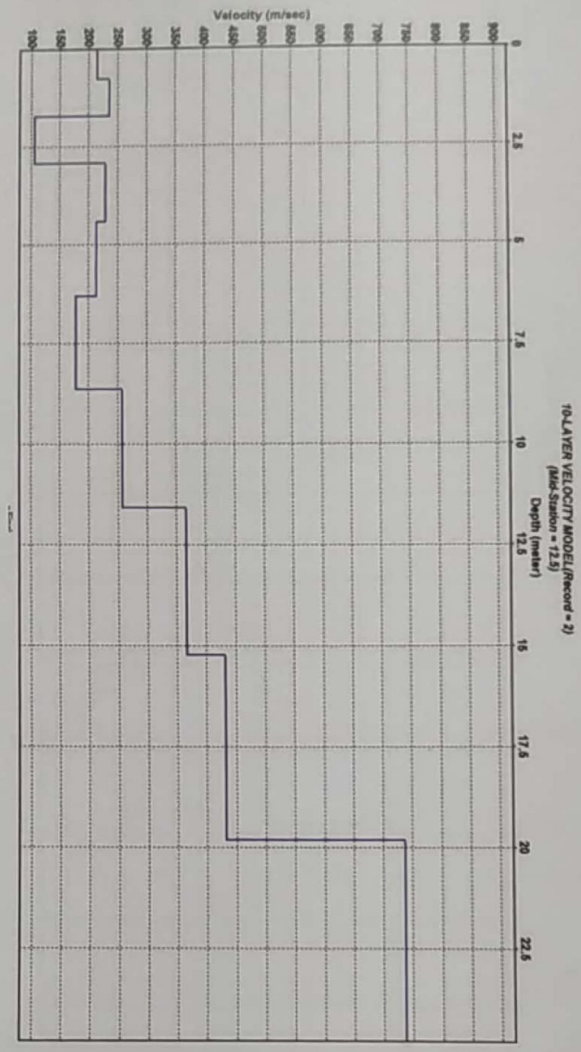


Figure 2a. One dimensional shear wave velocity (Vs) profile for stretch 1

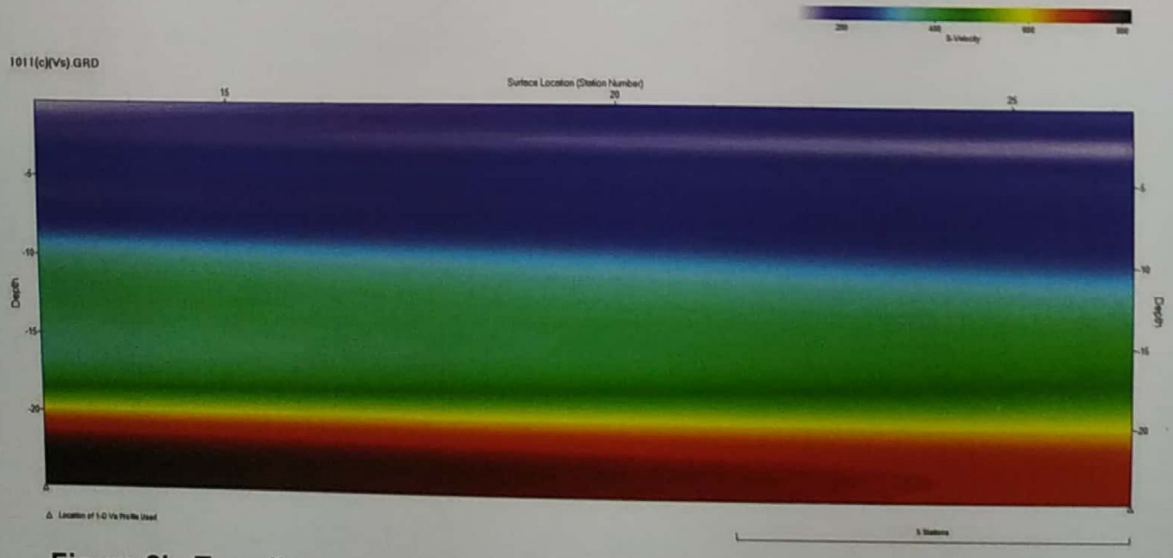


Figure 2b. Two dimensional shear wave velocity (Vs) profile for stretch 1

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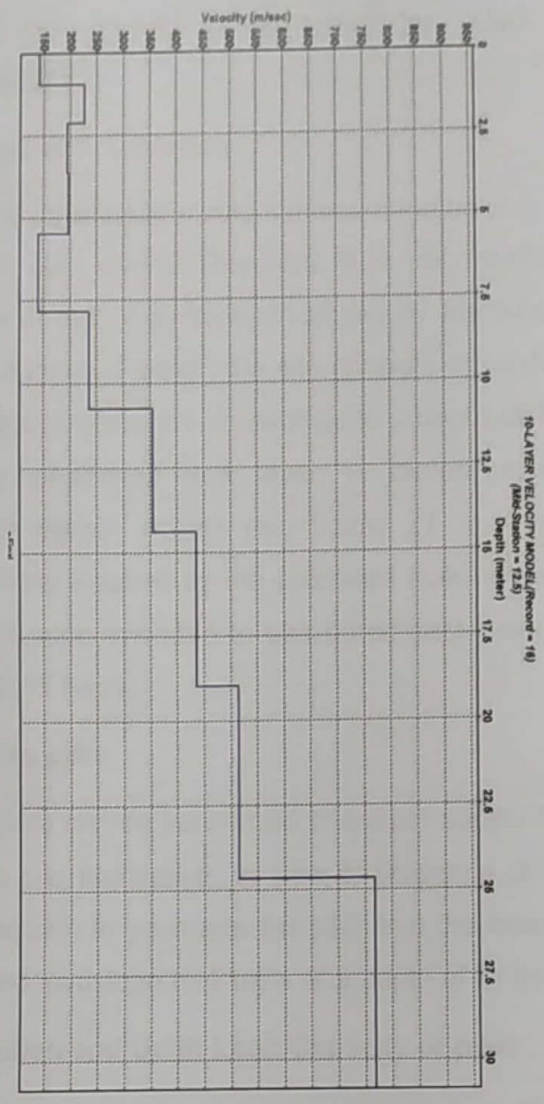


Figure 2c. One dimensional shear wave velocity (Vs) profile for stretch 2

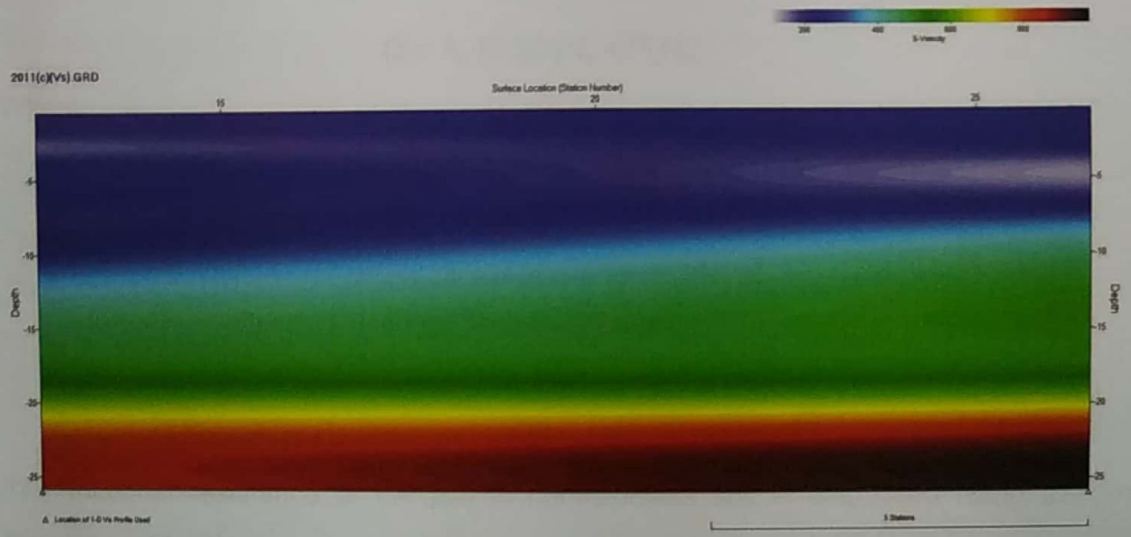


Figure 2d. Two dimensional shear wave velocity (Vs) profile for stretch 2

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5.0. SELECTION OF TYPE OFFOUNDATION AND ESTIMATION OF FOUNDATIONCAPACITY

5.1. Selection of Type of Foundation

The subsoil of the site consists of medium dense sand up to 5 m, followed by a 3 m thick loose sand/soft clay layers. Therefore, it is not feasible to adopt shallow foundations because of higher settlement caused by the loose/soft layers present within the zone of influence. Further, the site consists of predominantly very dense sand/very stiff clay layers which are present up to a depth of 19 m from the ground surface followed by weathered rock layer. A jointed mudstone rock layer is encountered only at deeper depths i.e., below 21 m. Hence considering the anticipated load intensity induced by the proposed buildings and nature of the soil strata at the site, it is recommended to use bored cast-in-situ piles to support the proposed buildings (S+6 floors).

5.2. Bored cast-in-situ piles

The load of the structure can be transferred to deeper depths bypassing the weaker upper layers using a pile foundation. In view of presence of weathered rock layer below 19 m, it is desirable to penetrate the piles into the weathered rock layer and terminate at the jointed mudstone rock layer at a depth of 21 from the ground level.

5.2.1. Safe compression and Uplift Load Capacity of piles

The end bearing capacity of the bored cast in-situ pile is calculated by the formula given in IS: 2911(Part I/ Sec 2) –2010.

$$Q_b = A_p (0.5D\gamma N_\gamma + P_D N_q)$$

Where,

D = Stem diameter in m.

A_p = Cross sectional area of pile toe in m^2

γ = Effective unit weight of soil at pile toe in kN/m^2

N_γ and N_q =Bearing capacity factors depends on the angle of internal friction at toe

P_D =Effective overburden pressure at pile toe in kN/m^2

The frictional resistance of the pile in cohesionless soil is calculated using the formula given below,

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$$Q_{f1} = \sum_{i}^{n} KP_{Di} tan\delta A_{si}$$

Where,

K = Coefficient of earth pressure,

P_{Di} = Effective overburden pressure in kN/m^2 for the ith layer where i varies from 1 to n

δ = Angle of wall friction between pile and soil

A_{si} = Surface area of pile stem in m^2 in the ith layer where i varies from 1 to n.

The frictional resistance of the cohesive soil is calculated using,

$$Q_{f2} = \alpha C A_S$$

Where,

α = Reduction factor

C = Average cohesion throughout the length of pile in kN/m^2

A_S = Surface area of pile stem in m^2

Negative skin friction is considered wherever loose sand/soft clay deposits are present. The parameters used to estimate the bearing capacity of pile were considered based on the corrected SPT N values. Factor of safety of 2.5 is used in the estimation of safe bearing capacity of the piles.

The uplift capacity of the pile is calculated with a factor of safety of 4against the positive skin friction. For compression capacity of pile is also considered from only positive side friction. The safe compression and uplift capacity is estimated for BH3 and the details are presented in **Appendix A**. The bearing stratum for the piles is considered as the weathered rock layer. The calculated safe compression and uplift capacities of piles BH3 is given in **Table 1**.

Table 1: Safe compression and uplift capacity of piles

Pile diameter (mm)	500	600	750
Safe bearing capacity, KN	770	935	1340
Safe Uplift capacity, KN	400	450	590

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5.2.2. Lateral Load Capacity of the piles

The safe lateral capacity of piles is governed by the shear strength and modulus of the soil below the pile cut-off level. Generally, soil for a depth of five to seven times the pile diameter influences the resistance to lateral loading. Thus, the safe lateral capacity of piles will depend on the soil present at shallow depth. The safe lateral capacity of pile is estimated restricting the pile head deflection at the cut-off level embedded in soil as 5mm. The equivalent cantilever procedure suggested in IS 2911 (Latest revision) is used for estimating the safe lateral capacity corresponding to 5mm deflection at the pile head.

The safe Lateral Load carrying capacity of piles is calculated using the formula given below (IS 2911 (Part I/ sec 2):2010).

$$H = y * \frac{3EI}{(e + Z_f)^3} \quad for\ Free\ head\ pile$$

$$H = y * \frac{12EI}{(e + Z_f)^3} \quad for\ Fixed\ head\ pile$$

Where, H = Lateral capacity in kN

E = Young's Modulus of the pile material in kN/m^2

I = Moment of Inertia of the pile cross section in m^4

y = Permissible deflection in m

Z_f = Depth to point of fixity in m

e = Cantilever length above ground to the point of load application

Typical estimation of safe lateral capacities corresponding to 5mm allowable deflection at the pile head is presented in **Appendix B.** The lateral load capacity of the pile is calculated and is summarized in **Table 2.**

Table 2: Lateral load capacity of the Pile

Pile diameter in mm	500	600	750
Safe lateral capacity (Fixed head) in kN	44	58	83
Depth to point of fixity in m (Fixed head)	4.7	5.5	6.5
Safe lateral capacity (Free head) in kN	17	22	32
Depth to point of fixity in m (Free head)	4.1	4.7	5.6

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6. SUMMARY AND RECOMMENDATIONS

It is proposed to construct (S+6 floors) slum tenements at Meenambal Sivaraj Nagar Phase I & II in corporation Dn.104, Zone 8, Egmore Constituency, Chennai. A detailed subsoil investigation using six exploratory boreholes was carried out to access the subsoil profile. The soil profile obtained from the bore holes matches with the soil profile obtained from geophysical investigation carried out at the site using advanced MASW apparatus.

The subsoil of the site consists of medium dense sand up to 5 m, followed by a 3 m thick loose sand/soft clay layers. A very dense sand/very stiff clay layer occurs up to a depth of 19 m. A very weathered rock layer occurs below 19 m depth which is followed by a jointed mudstone rock layer that occurs at a depth of about 21 m. In the view of presence of loose/soft layers at shallow depths and hard layers at about 19 m and considering the anticipated load intensity, it is recommended to adopt bored cast-in-situ concrete piles to support the proposed (S+6 floors) buildings.

a) The following type of foundation is recommended to support the proposed buildings:

- Type of foundation – Bored cast in-situ pile
- Pile termination depth –21m below the existing ground level
- Pile cut off level – 2 m bellow the exiting ground level
- Type of soil at pile termination –Jointed mudstone rock layer
- Recommended pile capacities

Pile diameter (mm)	500	600	750
Safe Bearing capacity, KN	770	935	1340
Safe Uplift capacity, KN	400	450	590
Safe lateral capacity (Fixed head) in KN	44	58	83
Depth to point of fixity in m (Fixed head)	4.7	5.5	6.5
Safe lateral capacity (Free head) in KN	17	22	32
Depth to point of fixity in m (Free head)	4.1	4.7	5.6

b) Pile capacities are calculated by using the static formula as per IS 2911-Part 1/Sec 2 (2010).

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c) The recommended safe load carrying capacities of the piles shall be confirmed by carrying out initial load tests (compression and lateral) on piles before the construction of piles and routine load test as per IS 2911-Part 4 (1985).

d) It is recommended to carry out pile integrity tests on working piles minimum 25 percent of the total number of piles in each block.

e) It is recommended to provide at least a two or more piles per pile group using suitable pile diameter instead of single pile–single column by selecting appropriate pile diameter to provide better resistance to bending forces from the column loads. All the pile caps must be rigidly inter-connected with each other in both the directions.

f) Good quality of bentonite with a liquid limit of approx. 350 is recommended to be used as the drilling mud in boring operations. Proper cleaning of borehole bottom after lowering the reinforcement cage shall be strictly employed as quality control measures.

7. ACKNOWLEDGEMENT

The support and assistance provided by Er. K. Krishna Kumar, Executive Engineer, Er. J. Geeta, Assistant Executive Engineer and Er. Saranya, Assistant Engineer, TNSCB, Chennai for planning and execution of the above investigation are greatly acknowledged.

11/02/20

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FIELD BORE LOG

ANNEXURE 1

SHEET 1 OF 2

GEOTECHNICAL Solutions[A1]

PROJECT NO:	TNSCB/MSNGR/G-1308
BORE HOLE NO:	BH/1

Project : Construction of Tenements for TNSCB
Site : MS Nagar, Chetpet, Chennai
Location : As shown in Figure 1
Dia and type of boring : 150mm Rotary boring with drilling mud circulation

Date of start : 4-Jan-2020
Date of finish : 4-Jan-2020
GWL from GL : 3.00m
Ground level RL : 99.80m

Depth from GL(m)	Soil Profile	Field Description	Depth of samples collected		SPT / VST						RD / Consistency
					Test depth	Blow Counts					
			UDS	DS	m	15	30	45	60	N**	
		Greyish dirty sand with stones and sandy clay lumps (fill) + 100mm PCC		0.50							Fill
1.0	0.7	Greenish grey and brown sandy silty clay with black patches		0.75	0.75	4	5	6	10	11	Stiff
2.0	1.4	Brownish grey silty clay with black patches		1.50	1.50	5	9	14	17	23	Very stiff
3.0	2.2	Greyish brown dirty fine to medium sand		2.25	2.25	9	10	10	14	20	Medium dense to dense
				3.00	3.00	10	11	12	16	23	
4.0				3.75	3.75	9	11	14	16	25	
5.0				4.50	4.50	10	16	19	21	35	
6.0	5.4	Greyish sandy silty clay with clayey sand pockets		5.50	5.50	2	2	2	3	4	Medium stiff
7.0	6.5	Greyish clayey fine to medium sand with shells		6.50	6.50	1	0	1	2	1	Loose
8.0				7.50	7.50	2	1	1	2	2	
9.0				8.50	8.50	2	2	3	2	5	
10.0	9.6	Greenish grey sandy silty clay		10.00	10.00	7	10	11	15	21	Stiff to very stiff
11.0											
12.0				11.50	11.50	6	11	12	14	23	
13.0											
14.0	13.7			13.00	13.00	6	12	20	23	32	
15.0		Greenish grey silty fine sand with clay and weathered stones		14.50	14.50	10	13	23	25	36	Dense
16.0	15.7										
17.0		Yellowish brown and greenish grey clayey sandy silt		16.00	16.00	14	18	25		43	Hard
18.0	17.2	Greenish grey and yellowish brown dirty fine to medium sand		17.50	17.50	50/12cm				>100	Very dense
19.0	19.0				19.00	Rebound				RB	
20.0	20.0	Greenish grey weathered fractured rock	19.00-19.80		TC core drilling 19.80	Rebound				RB	Very weak

Continued in the next sheet

Borehole terminated at 21.80m

**Note: SPT Conducted using winch cat-head device, N values reported are close to N_{60}

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FIELD BORE LOG

GEOTECHNICAL Solutions[A1]

PROJECT NO:	TNSCB/MSNGR/G-1308
BORE HOLE NO:	BH/1

Project : Construction of Tenements for TNSCB
Site : MS Nagar, Chetpet, Chennai
Location : As shown in Figure 1
Dia and type of boring : 150mm Rotary boring with drilling mud circulation

Date of start : 4-Jan-2020
Date of finish : 4-Jan-2020
GWL from GL : 3.00m
Ground level RL : 99.80m

Depth from GL(m)		Soil Profile	Field Description	Depth of samples collected		SPT / VST						RD / Consistency
				UDS	DS	Test depth m	Blow Counts 15	30	45	60	N**	
21.0			Light greenish grey and brown jointed weathered mudstone	19.80-20.80		DC core drilling NX size					R24% Qnil	Weak
22.0	21.8			20.80-21.80		DC core drilling NX size					R47% Q10%	
23.0												
24.0												
25.0												
26.0												
27.0												
28.0												
29.0												
30.0												
31.0												
32.0												
33.0												
34.0												
35.0												
36.0												
37.0												
38.0												
39.0			TC core drilling from 19.00m to 19.80m DC core drilling from 19.80m to 21.80m									
40.0												
			Continued from sheet 1	**Borehole terminated at 21.80m**								

**Note: SPT Conducted using winch cat-head device, N values reported are close to N_{60}

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FIELD BORE LOG

GEOTECHNICAL Solutions[A1]

PROJECT NO:	TNSCB/MSNGR/G-1308
BORE HOLE NO:	BH/2

Project : Construction of Tenements for TNSCB
Site : MS Nagar, Chetpet, Chennai
Location : As shown in Figure 1
Dia and type of boring : 150mm Rotary boring with drilling mud circulation

Date of start : 2-Jan-2020
Date of finish : 3-Jan-2020
GWL from GL : 3.20m
Ground level RL : 99.87m

Depth from GL(m)	Soil Profile	Field Description	Depth of samples collected UDS	Depth of samples collected DS	SPT / VST Test depth m	Blow Counts 15	30	45	60	N**	RD / Consistency
		Brownish grey dirty sand with stones (fill)+PCC									Fill
1.0	0.6	Brownish grey silty clay with fine sand		0.75	0.75	4	7	8	8	15	Stiff
2.0	1.4	Greyish brown clayey / dirty fine to medium sand		1.50	1.50	12	14	15	15	29	Medium dense
3.0	2.9			2.25	2.25	9	10	10	10	20	
4.0	3.8	Brownish silty fine to medium sand		3.00	3.00	9	11	10	11	21	Medium dense
5.0		Greyish brown fine to medium sand		3.75	3.75	10	11	13	15	24	Medium dense
6.0	5.4	Greyish sandy silty clay with clayey sand pockets		4.50	4.50	6	10	13	17	23	
7.0	6.4	Greyish clayey silty fine to medium sand with dirty sand pockets and shells		5.50	5.50	2	2	3	4	5	Medium stiff
8.0				6.50	6.50	2	1	2	3	3	Loose
9.0			7.50	Collected	8.00	8.00	2	1	2	2	3
10.0					9.00	9.00	1	1	1	2	2
11.0	11.0				10.00	10.00	2	1	1	1	2
12.0		Greenish grey clayey cemented sand with white patches			11.50	11.50	11	10	12	11	22	Medium dense
13.0	12.7	Greenish grey silty fine sand with clay			13.00	13.00	12	12	17	19	29	Very stiff to hard
14.0											
15.0					14.50	14.50	24	30	37		67	
16.0	15.7	Greenish grey dirty fine sand with weathered sandstone pieces (weathered disintegrated sandstone)			16.00	16.00	50/15cm				>100	Very dense
17.0											
18.0					17.50	17.50	50/5cm				>100	
19.0	19.0					19.00	Rebound				RB	
20.0	20.0	Greenish grey weathered fractured rock	19.00-19.60			19.60	Rebound				RB	Very weak
			19.60-20.60			DC core drilling						
		Continued in the next sheet	Borehole terminated at 21.60m									

**Note: SPT Conducted using winch cat-head device, N values reported are close to N_{60}

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FIELD BORE LOG

GEOTECHNICAL Solutions[A1]

PROJECT NO:	TNSCB/MSNGR/G-1308
BORE HOLE NO:	BH/2

Project : Construction of Tenements for TNSCB
Site : MS Nagar, Chetpet, Chennai
Location : As shown in Figure 1
Dia and type of boring : 150mm Rotary boring with drilling mud circulation

Date of start : 2-Jan-2020
Date of finish : 3-Jan-2020
GWL from GL : 3.20m
Ground level RL : 99.87m

Depth from GL(m)	Soil Profile	Field Description	Depth of samples collected UDS	Depth of samples collected DS	SPT / VST Test depth m	Blow Counts 15	30	45	60	N**	RD / Consistency
21.0		Yellowish brown and greenish grey jointed weathered mudstone	19.60-20.60		DC core drilling NX size					R25%	Weak
21.6			20.60-21.60		DC core drilling NX size					R42% Q12%	
22.0		TC core drilling from 19.00m to 19.60m DC core drilling from 19.60m to 21.60m									
23.0											
24.0											
25.0											
26.0											
27.0											
28.0											
29.0											
30.0											
31.0											
32.0											
33.0											
34.0											
35.0											
36.0											
37.0											
38.0											
39.0											
40.0											

Continued from sheet 1

Borehole terminated at 21.60m

**Note: SPT Conducted using winch cat-head device, N values reported are close to N_{60}

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FIELD BORE LOG

GEOTECHNICAL Solutions[A1]

PROJECT NO:	TNSCB/MSNGR/G-1308
BORE HOLE NO:	BH/3

Project : Construction of Tenements for TNSCB
Site : MS Nagar, Chetpet, Chennai
Location : As shown in Figure 1
Dia and type of boring : 150mm Rotary boring with drilling mud circulation

Date of start : 30-Dec-2020
Date of finish : 31-Dec-2020
GWL from GL : 3.20m
Ground level RL : 99.95m

Depth from GL(m)	Soil Profile	Field Description	Depth of samples collected		SPT / VST						RD / Consistency
			UDS	DS	Test depth m	Blow Counts 15	30	45	60	N**	
1.0		Greyish clayey sand with brick pieces (fill)		0.75							Fill
1.3				1.50	1.50	7	9	11	15	20	Stiff
2.0		Greyish and brownish fine sandy silty clay with stones		2.25	2.25	3	5	15	13	20	
3.0	2.9			3.00	3.00	8	7	8	8	15	Med dense/ med stiff
4.0		Brownish and grey clayey silty fine sand / sandy silty clay		3.75	3.75	3	4	4	5	8	
4.4		Greyish fine to medium sand		4.50	4.50	7	8	5	3	13	Med dense
5.0	4.9	Greyish sandy silty clay									Med stiff
5.5				5.50	5.50	1	1	1	1	2	Loose
6.0				6.50	6.50	1	2	1	1	3	
7.0		Greyish clayey fine to medium sand with shells with occasional sandy clay lumps		7.50	7.50	1	1	1	1	2	
8.0				8.50	8.50	1	0	1	0	1	
9.0											
9.6				10.00	10.00	5	7	10	11	17	Stiff
10.0		Greenish grey sandy silty clay									
11.0				11.50	11.50	10	11	12	15	23	Very stiff
11.2											
12.0				13.00	13.00	10	12	15	16	27	
13.0		Greenish grey sandy silty clay / clayey cemented sand with brown patches									
14.0				14.50	14.50	10	35	40		75	Very dense
14.2											
15.0											
16.0				16.00	16.00	23	33	40		73	
17.0		Yell grey & gr grey clayey silty fine to medium sand with weathered sandstone									
18.0				17.50	17.50	17	31	45		76	
18.4											
19.0				19.00	19.00	50/10cm				>100	Very dense
20.0	20.0	Yellowish grey dirty fine to medium sand with weathered sandstone									

Continued in the next sheet

Borehole terminated at 24.70m

**Note: SPT Conducted using winch cat-head device, N values reported are close to N_{60}

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FIELD BORE LOG

GEOTECHNICAL Solutions[A1]

PROJECT NO:	TNSCB/MSNGR/G-1308
BORE HOLE NO:	BH/3

Project : Construction of Tenements for TNSCB
Site : MS Nagar, Chetpet, Chennai
Location : As shown in Figure 1
Dia and type of boring : 150mm Rotary boring with drilling mud circulation

Date of start : 30-Dec-2020
Date of finish : 31-Dec-2020
GWL from GL : 3.20m
Ground level RL : 99.95m

Depth from GL(m)	Soil Profile	Field Description	Depth of samples collected UDS	Depth of samples collected DS	SPT / VST Test depth m	SPT / VST Blow Counts 15 30 45 60	SPT / VST N**	RD / Consistency
21.0		Greenish grey and yellowish brown hard clay with weathered mudstone		20.50	20.50	50/15cm	>100	Hard
22.0	22.0				22.00	Rebound	RB	
23.0	22.7	Greenish grey weathered fractured rock	22.00-22.70		TC core drilling 22.70	Rebound	RB	Very weak
24.0		Brownish and grey weathered sandstone and mudstone	22.70-23.70		DC core drilling NX size		R25% Q0%	Weak
25.0	24.7		23.70-24.70		DC core drilling NX size		R36% Q0%	
26.0								
27.0								
28.0								
29.0								
30.0								
31.0								
32.0								
33.0								
34.0								
35.0								
36.0								
37.0								
38.0								
39.0		TC core drilling from 22.00m to 22.70m DC core drilling from 22.70m to 24.70m						
40.0								
		Continued from sheet 1	Borehole terminated at 24.70m					

**Note: SPT Conducted using winch cat-head device, N values reported are close to N_{60}

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FIELD BORE LOG

GEOTECHNICAL Solutions[A1]

PROJECT NO:	TNSCB/MSNGR/G-1308
BORE HOLE NO:	BH/4

Project : Construction of Tenements for TNSCB
Site : MS Nagar, Chetpet, Chennai
Location : As shown in Figure 1
Dia and type of boring : 150mm Rotary boring with drilling mud circulation

Date of start : 25-Dec-2020
Date of finish : 26-Dec-2020
GWL from GL : 3.00m
Ground level RL : 99.90m

Depth from GL(m)	Soil Profile	Field Description	Depth of samples collected		SPT / VST						RD / Consistency
					Test depth	Blow Counts					
			UDS	DS	m	15	30	45	60	N**	
1.0		Brownish grey dirty sand with stones (fill) + 100mm PCC		0.75							Fill
2.0	1.1	Brownish grey sandy silty clay with brick pieces		1.50	1.50	4	4	3	5	7	Med stiff
3.0	2.2 / 2.9	Light brownish grey silty clay		2.25	2.25	6	7	7	10	14	Stiff
4.0	3.7	Brownish and grey fine sandy silty clay with fine sand patches		3.00	3.00	6	9	12	12	21	Stiff
		Light brownish grey dirty fine sand		3.75	3.75	8	10	12	14	22	Med dense
5.0				4.50	4.50	8	12	11	16	23	
6.0	5.4	Greyish fine sandy silty clay with sand pockets		5.50	5.50	1	1	1	1	2	Soft
7.0				6.50	6.50	1	2	1	2	3	
8.0	7.4	Greyish clayey silty fine sand / fine sandy silty clay		7.50	7.50	1	0	1	0	1	Loose / soft
9.0				8.50	8.50	1	0	1	1	1	
10.0	9.8	Greenish grey and brownish sandy silty clay		10.00	10.00	10	17	20	25	37	Very stiff to hard
11.0											
12.0				11.50	11.50	11	16	18	16	34	
13.0	12.7	Yellowish grey / greenish grey clayey silty fine sand with medium sand particles		13.00	13.00	14	20	24	26	44	Dense
14.0											
15.0	14.2	Light greenish grey dirty fine sand		14.50	14.50	15	32	39		71	Very dense
16.0											
17.0	17.0			16.00	16.00	23	35	40		75	
18.0		Light greenish grey dirty fine to medium sand with weathered sandstone		17.50	17.50	50/10cm				>100	Very dense
19.0	18.8										
20.0	20.0	Yellowish brown and light grey hard clay with sand pockets (weathered sandstone)		19.00	19.00	26	50/10cm			>100	Hard

Continued in the next sheet

Borehole terminated at 23.70m

**Note: SPT Conducted using winch cat-head device, N values reported are close to N_{60}

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FIELD BORE LOG

GEOTECHNICAL Solutions[A1]

PROJECT NO:	TNSCB/MSNGR/G-1308
BORE HOLE NO:	BH/4

Project : Construction of Tenements for TNSCB
Site : MS Nagar, Chetpet, Chennai
Location : As shown in Figure 1
Dia and type of boring : 150mm Rotary boring with drilling mud circulation

Date of start : 25-Dec-2020
Date of finish : 26-Dec-2020
GWL from GL : 3.00m
Ground level RL : 99.90m

Depth from GL(m)	Soil Profile	Field Description	Depth of samples collected		SPT / VST						RD / Consistency
					Test depth	Blow Counts					
			UDS	DS	m	15	30	45	60	N**	
21.0		Greenish grey and yellowish grey hard clay (weathered mudstone)		20.50	20.50	50/10cm				>100	Hard
					21.20	Rebound				RB	
21.2 / 21.7		Greenish grey weathered fractured rock	21.20-21.70		21.70	Rebound				RB	Very weak
22.0		Yell brown & gr. grey severely jointed weathered mudstone with black interface	21.70-22.70		DC core drilling NX size					R38% Q0%	Very weak
23.0			22.70-23.70		DC core drilling NX size					R30% Q0%	Weak
23.2 / 23.7		Yell brown weathered sandstone									
24.0											
25.0											
26.0											
27.0											
28.0											
29.0											
30.0											
31.0											
32.0											
33.0											
34.0											
35.0											
36.0											
37.0											
38.0											
39.0		TC core drilling from 21.20m to 21.70m DC core drilling from 21.70m to 23.70m									
40.0											
		Continued from sheet 1	**Borehole terminated at 23.70m**								

**Note: SPT Conducted using winch cat-head device, N values reported are close to N_{60}

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FIELD BORE LOG

GEOTECHNICAL Solutions[A1]

PROJECT NO:	TNSCB/MSNGR/G-1308
BORE HOLE NO:	BH/5

Project : Construction of Tenements for TNSCB
Site : MS Nagar, Chetpet, Chennai
Location : As shown in Figure 1
Dia and type of boring : 150mm Rotary boring with drilling mud circulation

Date of start : 21-Dec-2020
Date of finish : 22-Dec-2020
GWL from GL : 3.00m
Ground level RL : 100.10m

Depth from GL(m)	Soil Profile	Field Description	Depth of samples collected		SPT / VST						RD / Consistency
					Test depth	Blow Counts					
			UDS	DS	m	15	30	45	60	N**	
1.0		Greyish brown fine to medium sand with brick pieces and stones (fill)		0.75							Fill
1.4											
2.0		Brownish grey silty clay with fine sand patches		1.50	1.50	4	6	6	7	12	Med stiff
3.0	2.9			2.25	2.25	4	6	5	6	11	
4.0		Brownish grey sandy clay with white and brown clayey sand pockets / silty clay with fine sand		3.00	3.00	5	8	8	10	16	Stiff
				3.75	3.75	5	8	10	10	18	
4.4											
5.0		Light brownish grey fine to medium sand		4.50	4.50	15	15	11	11	26	Med dense
5.3											
6.0		Greyish sandy silty clay with sand patches		5.50	5.50	1	1	1	1	2	Soft
7.0				6.50	6.50	1	2	1	1	3	
7.3											
8.0		Dark grey sandy silty clay with sand patches	7.50	Collected							
				8.00	8.00	1	1	1	2	2	Soft
9.0				9.00	9.00	1	1	1	2	2	
9.8											
10.0		Greenish grey sandy silty clay with brown patches		10.00	10.00	7	10	12	15	22	Stiff
11.0											
12.0				11.50	11.50	11	13	16	15	29	
12.7											
13.0		Yellowish grey dirty fine to medium sand with weathered sandstone		13.00	13.00	13	15	16	17	31	Med dense to dense
14.0											
15.0				14.50	14.50	6	11	18	20	29	
15.4											
16.0		Yellowish grey dirty fine to medium sand with weathered sandstone		16.00	16.00	18	35	40		75	Very dense
17.0											
18.0				17.50	17.50	50/15cm				>100	
19.0				19.00	19.00	50/10cm				>100	
20.0	20.0										

Continued in the next sheet

Borehole terminated at 24.30m

**Note: SPT Conducted using winch cat-head device, N values reported are close to N_{60}

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FIELD BORE LOG

GEOTECHNICAL Solutions[A1]

PROJECT NO:	TNSCB/MSNGR/G-1308
BORE HOLE NO:	BH/5

Project : Construction of Tenements for TNSCB
Site : MS Nagar, Chetpet, Chennai
Location : As shown in Figure 1
Dia and type of boring : 150mm Rotary boring with drilling mud circulation

Date of start : 21-Dec-2020
Date of finish : 22-Dec-2020
GWL from GL : 3.00m
Ground level RL : 100.10m

Depth from GL(m)		Soil Profile	Field Description	Depth of samples collected		SPT / VST						RD / Consistency
				UDS	DS	Test depth m	Blow Counts 15	30	45	60	N**	
21.0			Yell brown and greenish grey hard clay with coarse particles (mudstone)		20.50	20.50	50/10cm				>100	Hard
						21.70	Rebound				RB	
22.0	21.7		Yellowish grey weathered fractured rock	21.70-22.30		22.30	Rebound				RB	Very weak
	22.3											
23.0			Greenish grey jointed mudstone with black interface	22.30-23.30		DC core drilling NX size					R20% Q0%	Weak
24.0				23.30-24.30		DC core drilling NX size					R35% Q15%	
	24.3											
25.0												
26.0												
27.0												
28.0												
29.0												
30.0												
31.0												
32.0												
33.0												
34.0												
35.0												
36.0												
37.0												
38.0												
39.0			TC core drilling from 21.70m to 22.30m DC core drilling from 22.30m to 24.30m									
40.0												
			Continued from sheet 1	**Borehole terminated at 24.30m**								

**Note: SPT Conducted using winch cat-head device, N values reported are close to N_{60}

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FIELD BORE LOG

GEOTECHNICAL Solutions[A1]

SHEET 1 OF 2

PROJECT NO:	TNSCB/MSNGR/G-1308
BORE HOLE NO:	BH/6

Project : Construction of Tenements for TNSCB
Site : MS Nagar, Chetpet, Chennai
Location : As shown in Figure 1
Dia and type of boring : 150mm Rotary boring with drilling mud circulation

Date of start : 23-Dec-2020
Date of finish : 24-Dec-2020
GWL from GL : 3.30m
Ground level RL : 100.02m

Depth from GL(m)	Soil Profile	Field Description	Depth of samples collected UDS	Depth of samples collected DS	SPT / VST Test depth m	Blow Counts 15	30	45	60	N**	RD / Consistency
1.0		Greyish dirty sand and stones (fill)									Fill
	1.1			0.75							
2.0		Brownish grey fine sandy silty clay with brown and black patches		1.50	1.50	5	8	10	12	18	Stiff
	2.2										
3.0	3.0	Greyish brown clayey fine to medium sand		2.25	2.25	6	9	14	17	23	Med dense
				3.00	3.00	4	6	7	9	13	
4.0		Greyish brown clayey silty fine sand with silty fine sand pockets									Med dense
				3.75	3.75	7	10	12	14	22	
	4.4										
5.0				4.50	4.50	10	8	7	10	15	
		Brownish and grey fine to medium sand									Med dense
6.0				5.50	5.50	8	10	8	11	18	
	6.2										
7.0			6.50	Not Collected							
				7.00	7.00	1	0	1	1	1	
8.0		Greyish sandy silty clay with clayey sand pockets									Soft
				8.00	8.00	1	1	1	2	2	
9.0	8.8										
				9.00	9.00	2	2	2	3	4	
10.0		Dark grey clayey fine to medium sand									Loose
				10.00	10.00	2	2	3	4	5	
11.0	11.0										
12.0		Greenish grey and yellowish brown sandy silty clay / clayey cemented sand		11.50	11.50	13	15	22	26	37	Hard
	12.6										
13.0				13.00	13.00	10	12	12	17	24	
		Greenish grey clayey silty fine to medium sand									Med dense
14.0											
	14.3										
15.0				14.50	14.50	23	27	30		57	
16.0											
				16.00	16.00	24	27	32		59	
17.0		Light greenish grey dirty fine to medium sand with weathered sandstone									Very dense
18.0				17.50	17.50	22	26	35		61	
	18.6										
19.0				19.00	19.00	50/15cm				>100	
		Yell brown clayey sandy silt / fine sandy silty clay (weathered mudstone)									Hard
20.0	20.0										

Continued in the next sheet | **Borehole terminated at 24.0m**

**Note: SPT Conducted using winch cat-head device, N values reported are close to N_{60}

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FIELD BORE LOG

GEOTECHNICAL Solutions[A1]

PROJECT NO:	TNSCB/MSNGR/G-1308
BORE HOLE NO:	BH/6

Project : Construction of Tenements for TNSCB
Site : MS Nagar, Chetpet, Chennai
Location : As shown in Figure 1
Dia and type of boring : 150mm Rotary boring with drilling mud circulation

Date of start : 23-Dec-2020
Date of finish : 24-Dec-2020
GWL from GL : 3.30m
Ground level RL : 100.02m

Depth from GL(m)	Soil Profile	Field Description	Depth of samples collected		SPT / VST					RD / Consistency
			UDS	DS	Test depth m	Blow Counts 15	30	45	60	N**	
21.0		Greenish grey and yellowish brown hard clay (weathered mudstone)		20.50	20.50	50/8cm				>100	Hard
					21.50	Rebound				RB	
22.0	21.5 / 22.0	Yellowish grey weathered fractured rock	21.50-22.00		22.00	Rebound				RB	Very weak
23.0	22.7	Greenish grey & brownish weathered mudstone	22.00-23.00		DC core drilling NX size					R20% Q0%	
24.0	24.0	Yellowish brown weathered sandstone	23.00-24.00		DC core drilling NX size					R35% Q12%	Weak
25.0											
26.0											
27.0											
28.0											
29.0											
30.0											
31.0											
32.0											
33.0											
34.0											
35.0											
36.0											
37.0											
38.0											
39.0		TC core drilling from 21.50m to 22.00m DC core drilling from 22.00m to 24.00m									
40.0											
		Continued from sheet 1	Borehole terminated at 24.0m								

**Note: SPT Conducted using winch cat-head device. N values reported are close to N_{60}

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GEOTECHNICAL SOLUTIONS[A1]

SUMMARY OF LABORATORY TEST RESULTS

Project: **Construction of Tenements for TNSCB, MS Nagar**
Borehole Nos: **BH/1, BH/2, BH/3, BH/4, BH/5 and BH/6**
Type of Boring and dia of bore hole: 150mm diameter rotary boring with mud circulation

ANNEXURE-2

Ground Water Table: 3.30m in borehole (Dec 2019)

Sample Depth m	Sample Type	Visual Identification of Soil	SPT "N"	Classification	Natural Moisture content %	Liquid Limit %	Plastic Limit %	Plasticity Index %	Liquidity Index	Differential Free Swell Index %	Specific Gravity	Gravel %	Coarse Sand %	Medium Sand %	Fine Sand %	Silt %	Clay %
Depth (1)	Type (2)	Description (3)	(4)	CLASS (5)	NMC (6)	LL (7)	PL (8)	PI (9)	LI (10)	DFSI (11)	SG (12)	G (13)	CS (14)	MS (15)	FS (16)	Silt (17)	Clay (18)
		BOREHOLE BH/1															
0.50	DS	Greyish dirty sand with stones and sandy clay lumps (fill)			5.9												
0.75	SPT	Greenish grey and brown sandy silty clay with black patches	11	SC-CI	23.2	38.8	13.8	25.0	0.376	27.3							
1.50	SPT	Brownish grey silty clay with black patches	23	CH	27.0	60.9	21.7	39.2	0.135	54.5							
2.25	SPT	Greyish brown dirty fine to medium sand	20	SC-SP	13.6									22.8	60.6	16.6	
3.00	SPT	Yellowish brown dirty fine to medium sand	23	SM-SP	10.4									25.0	60.5	14.5	
3.75	SPT	Light brownish grey fine to medium sand	25	SP	18.4								2.1	44.2	46.1	7.6	
4.50	SPT	Light greyish brown fine to medium sand	35		15.1												
5.50	SPT	Greyish sandy silty clay with clayey sand pockets	4	SC-CL	36.8	30.0	LSL-4.28%			9.1							
6.50	SPT	Greyish clayey fine to medium sand	1	SC-SP	22.5								2.6	20.9	57.9	18.6	
7.50	SPT	Greyish clayey fine to medium sand with shells	2	SC-SP	21.3								2.5	24.0	53.5	20.0	
8.50	SPT	Greyish clayey fine to medium sand with shells	5		23.3												
10.00	SPT	Greenish grey sandy silty clay	21	SC-CL	15.7	32.1	LSL-7.85%										
11.50	SPT	Greenish grey clayey silty cemented sand	23	SC-SP	16.7								3.6	31.8	40.2	24.4	
13.00	SPT	TOP: Light greenish grey clayey silty cemented sand	32		15.2												
		BOT: Greenish grey silty fine sand with clay and weathered stones		SC-SM	11.3							1.5	4.6	13.0	50.1	30.8	

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SUMMARY OF LABORATORY TEST RESULTS

Project: **Construction of Tenements for TNSCB, MS Nagar**

Depth (1)	Type (2)	Description (3)	"N" (4)	CLASS (5)	NMC (6)	LL (7)	PL (8)	PI (9)	LI (10)	DFSI (11)	SG (12)	G (13)	CS (14)	MS (15)	FS (16)	Silt (17)	Clay (18)
14.50	SPT	Greenish grey silty fine sand with clay and weathered stones	36	SC-SM	12.7							5.7	4.5	14.2	49.4	26.2	
16.00	SPT	Yellowish brown and greenish grey clayey sandy silt	43	SC-ML	19.8	32.7	LSL-7.14%										
17.50	SPT	Greenish grey and yellowish brown dirty fine to medium sand	>100	SC-SP	12.3							1.7	3.2	18.8	52.1	24.2	
19.80-20.80		Light greenish grey and brown jointed weathered mudstone															
20.80-21.80		Light greenish grey and brown jointed weathered mudstone with sandstone															

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SUMMARY OF LABORATORY TEST RESULTS

Project: **Construction of Tenements for TNSCB, MS Nagar**

Depth (1)	Type (2)	Description (3)	"N" (4)	CLASS (5)	NMC (6)	LL (7)	PL (8)	PI (9)	LI (10)	DFSI (11)	SG (12)	G (13)	CS (14)	MS (15)	FS (16)	Silt (17)	Clay (18)
		BOREHOLE BH/2															
0.75	SPT	Brownish grey silty clay with fine sand	15	SC-CI	17.1	40.6	14.5	26.1	0.100	36.4							
1.50	SPT	Greyish brown clayey fine to medium sand	29	SC-SP	12.8							0.3	1.0	30.9	44.0	23.8	
2.25	SPT	Greyish brown dirty fine to medium sand	20	SM-SP	12.9								1.3	21.5	64.9	12.3	
3.00	SPT	Brownish silty fine to medium sand	21	SM-SP	10.5									20.1	66.5	13.4	
3.75	SPT	Greyish brown medium sand	24	SP	15.2								4.0	56.5	31.6	7.9	
4.50	SPT	Greyish brown fine to medium sand	23		16.8												
5.50	SPT	Greyish sandy silty clay with clayey sand pockets	5	SC-CI	35.2	38.8	LSL-8.57%			27.3							
6.50	SPT	Greyish clayey silty fine to medium sand with dirty sand pockets	3		22.2												
7.50	UDS	Greyish clayey silty fine to medium sand with shells		SC-SP	20.4							0.2	3.7	33.2	46.8	16.1	
8.00	SPT	Greyish clayey silty fine to medium sand with shells	3		22.6												
9.00	SPT	Greyish clayey silty fine to medium sand with shells	2	SC-SP	24.2								1.6	26.6	54.0	17.8	
10.00	SPT	Greyish clayey silty fine to medium sand with shells	2	SC-SP	20.8							0.3	2.0	31.6	49.2	16.9	
11.50	SPT	Greenish grey clayey cemented sand with white patches	22		14.1												
13.00	SPT	Greenish grey silty fine sand with clay	29	SC-SM	14.5							3.9	5.1	15.2	50.2	25.6	
14.50	SPT	Greenish grey silty fine sand with clay	67		13.9												
16.00	SPT	Greenish grey dirty fine sand with weathered sandstone pieces	>100	SC-SM	13.0							3.0	5.8	14.5	50.6	26.1	
17.50	SPT	Light greenish grey weathered sandstone (w.d.r)	>100		18.3												
19.60-20.60		Yellowish brown and greenish grey jointed weathered mudstone															
20.60-21.60		Yellowish brown and greenish grey jointed weathered mudstone															

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SUMMARY OF LABORATORY TEST RESULTS

Project: **Construction of Tenements for TNSCB, MS Nagar**

Depth (1)	Type (2)	Description (3)	"N" (4)	CLASS (5)	NMC (6)	LL (7)	PL (8)	PI (9)	LI (10)	DFSI (11)	SG (12)	G (13)	CS (14)	MS (15)	FS (16)	Silt (17)	Clay (18)
		BOREHOLE BH/3															
0.50-0.75	DS	Greyish clayey sand with brick pieces (fill)			20.2												
1.50	SPT	Greyish and brownish fine sandy silty clay	20	SC-Cl	17.7	39.3	15.9	23.4	0.077	27.3							
2.25	SPT	TOP: Greyish and brownish fine sandy silty clay	20	SC-Cl	20.7	42.6	14.8	27.8	0.212	36.4							
		TIP: Stone															
3.00	SPT	Brownish grey clayey silty fine sand	15		26.3												
3.75	SPT	Brownish and grey clayey silty fine sand / sandy silty clay	8	SC-Cl	23.9	39.6	13.5	26.1	0.398	18.2			0.3	3.7	61.7		34.3
4.50	SPT	TOP: Greyish fine to medium sand	13	SP	19.3									16.6	75.1	8.3	
		BOT: Greyish sandy silty clay		SC-Cl	34.8	49.8	19.7	30.1	0.502	45.5							
5.50	SPT	Greyish clayey fine to medium sand with sandy clay lumps	2		29.1												
6.50	SPT	Greyish clayey fine to medium sand	3	SC-SP	23.2								0.8	26.6	53.3		19.3
7.50	SPT	Greyish clayey fine to medium sand with shells	2	SC-SP	22.1								2.8	40.9	40.3		16.0
8.50	SPT	Greyish clayey fine to medium sand with shells	1		19.8												
10.00	SPT	Greenish grey sandy silty clay	17	SC	15.1									30.9	38.5		30.6
11.50	SPT	Greenish grey sandy silty clay / clayey cemented sand with brown patches	23	SC	14.4								4.2	49.8	22.6		23.4
13.00	SPT	Greenish grey sandy silty clay / clayey cemented sand with brown patches	27		13.9												
14.50	SPT	Greyish yellow clayey silty fine to medium sand with weathered sandstone	75	SC-SP	13.1								3.6	5.2	14.1	50.6	26.5
16.00	SPT	Yell grey & gr grey clayey silty fine to medium sand with weathered sandstor	73		16.7												
17.50	SPT	Yell grey & gr grey clayey silty fine to medium sand with weathered sandstor	76	SC-SP	17.7								1.5	3.8	17.2	50.3	27.2
19.00	SPT	Greenish grey and white clayey silty sand / clayey sandy silt with stones	>100	SC-Sl	16.8	36.0	17.1	18.9	<0.00								
20.50	SPT	Greenish grey and yellowish brown hard clay with weathered mudstone	>100		15.5												
22.70-23.70		Brownish and grey weathered sandstone and mudstone															
23.70-24.70		Brownish and grey weathered sandstone and mudstone															

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SUMMARY OF LABORATORY TEST RESULTS

Project: **Construction of Tenements for TNSCB, MS Nagar**

Depth (1)	Type (2)	Description (3)	"N" (4)	CLASS (5)	NMC (6)	LL (7)	PL (8)	PI (9)	LI (10)	DFSI (11)	SG (12)	G (13)	CS (14)	MS (15)	FS (16)	Silt (17)	Clay (18)
		BOREHOLE BH/4															
0.50-0.75	DS	Brownish grey dirty sand with stones (fill)			10.6												
1.50	SPT	Brownish grey sandy silty clay with brick pieces	7		17.4												
2.25	SPT	Light brownish grey silty clay	14	CH	27.9	67.1	23.0	44.1	0.111	58.3							
3.00	SPT	Brownish and grey fine sandy silty clay with fine sand patches	21	SC-CI	23.4	38.0	17.8	20.2	0.277	27.3							
3.75	SPT	Light brownish grey dirty fine sand	22		22.2												
4.50	SPT	Light brownish grey dirty fine sand	23	SC-SP	21.1									6.3	77.8		15.9
5.50	SPT	Greyish fine sandy silty clay	2	SC-CH	37.0	52.2	20.9	31.3	0.514	36.4							
6.50	SPT	Greyish fine sandy silty clay with sand pockets	3	SC-CI	30.5	39.1	15.6	23.5	0.634	27.3							
7.50	SPT	Greyish clayey silty fine sand / fine sandy silty clay	1		22.4												
8.50	SPT	Greyish clayey silty fine sand / fine sandy silty clay	1	SC-CL	25.5	28.9	LSL-4.28%										
10.00	SPT	Greenish grey and brownish sandy silty clay	37	SC	13.1							2.4	5.3	22.8	44.2		25.3
11.50	SPT	Greenish grey sandy silty clay	34	SC	15.0								0.7	29.8	38.9		30.6
13.00	SPT	Yellowish grey / greenish grey clayey silty fine sand with medium sand partic	44	SC-SP	12.9								0.3	19.6	62.2		17.9
14.50	SPT	Light greenish grey dirty fine sand	71	SM-SP	11.2							3.7	4.0	14.4	49.9		28.0
16.00	SPT	Light greenish grey dirty fine sand with weathered sandstone pieces	75		12.7												
17.50	SPT	Light greenish grey dirty fine to medium sand with weathered sandstone	>100	SC-SP	12.0							8.2	6.7	21.1	42.7		21.3
19.00	SPT	Yellowish brown and light grey hard clay with sand pockets (weathered sand	>100		16.3												
20.50	SPT	Greenish grey and yellowish grey hard clay (weathered mudstone)	>100		20.2												
21.70-22.70		Yell brown & gr. grey severely jointed weathered mudstone with black interface															
22.70-23.70		TOP: Yell brown & gr grey severely jointed weathered mudstone with black interface															
		BOT: Yell brown weathered sandstone															

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SUMMARY OF LABORATORY TEST RESULTS

Project: **Construction of Tenements for TNSCB, MS Nagar**

Depth (1)	Type (2)	Description (3)	"N" (4)	CLASS (5)	NMC (6)	LL (7)	PL (8)	PI (9)	LI (10)	DFSI (11)	SG (12)	G (13)	CS (14)	MS (15)	FS (16)	Silt (17)	Clay (18)
		BOREHOLE BH/5															
0.50-0.75	DS	Greyish brown fine to medium sand with brick pieces and stones (fill)			9.4												
1.50	SPT	Brownish grey silty clay	12	CH	28.6	65.0	24.5	40.5	0.101	50.0							
2.25	SPT	Brownish grey silty clay with fine sand patches	11		28.3												
3.00	SPT	Brownish grey sandy clay with white and brown clayey sand pockets	16	CH	34.8	64.6	24.3	40.3	0.261	58.3							
3.75	SPT	Brownish grey silty clay with fine sand	18		29.6												
4.50	SPT	Light brownish grey fine to medium sand	26	SP	18.6								0.1	25.9	63.1	10.9	
5.50	SPT	Greyish sandy clay with dirty sand patches	2		25.9												
6.50	SPT	Greyish sandy silty clay with sand patches	3	SC-CL	26.6	32.2	LSL-7.14%			18.2							
7.50	UDS	Dark grey sandy silty clay with sand patches		CI	43.5	60.2	24.3	35.9	0.535								
8.00	SPT	Dark grey sandy silty clay with sand patches	2		26.0												
9.00	SPT	Greyish fine sandy silty clay with clayey fine to medium sand patches	2	SC-CI	28.5	36.8	14.2	22.6	0.633								
10.00	SPT	Greenish grey sandy silty clay	22	SC-CL	15.9	29.9	LSL-5.71%										
11.50	SPT	Greenish grey sandy silty clay with brown patches	29		15.3												
13.00	SPT	Yellowish grey dirty fine to medium sand	31	SM-SP	16.2								0.8	15.9	65.3		18.0
14.50	SPT	Yellowish grey dirty fine to medium sand with weathered sandstone	29		12.2												
16.00	SPT	Yellowish grey dirty fine to medium sand	75	SM-SP	13.3							7.1	4.5	20.8	46.8		20.8
17.50	SPT	Yellowish grey dirty fine to medium sand with weathered sandstone	>100		12.1												
19.00	SPT	Yellowish grey dirty fine to medium sand with weathered sandstone	>100	SM-SP	13.0							11.3	5.8	39.4	28.3		15.2
20.50	SPT	Yell brown and greenish grey hard clay with coarse particles (mudstone)	>100		15.6												
22.30-23.30		Greenish grey jointed mudstone with black interface															
23.30-24.30		Greenish grey jointed mudstone with black interface															

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SUMMARY OF LABORATORY TEST RESULTS

Project: **Construction of Tenements for TNSCB, MS Nagar**

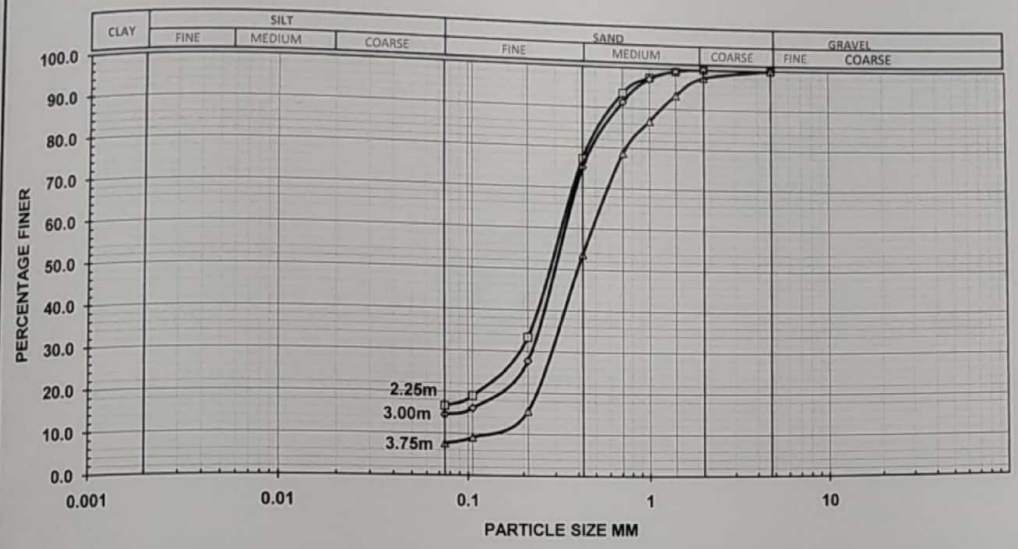
Depth (1)	Type (2)	Description (3)	"N" (4)	CLASS (5)	NMC (6)	LL (7)	PL (8)	PI (9)	LI (10)	DFSI (11)	SG (12)	G (13)	CS (14)	MS (15)	FS (16)	Silt (17)	Clay (18)
		BOREHOLE BH/6															
0.50-0.75	DS	Greyish dirty sand and stones (fill)			7.5												
1.50	SPT	Brownish grey fine sandy silty clay with brown and black patches	18	SC-CI	16.4	32.9	LSL-7.85%										
2.25	SPT	Greyish brown clayey fine to medium sand	23	SC-SP	13.7							0.3	2.7	23.6	49.0		24.4
3.00	SPT	Greyish brown clayey silty fine sand with silty fine sand pockets	13		25.4												
3.75	SPT	Greyish brown silty fine sand with clay	22	SC-SP	19.4								0.2	9.7	67.1		23.0
4.50	SPT	Brownish and grey fine to medium sand	15	SP	20.3							1.5	0.7	34.8	56.7	6.3	
5.50	SPT	Light brownish fine to medium sand	18		21.4												
7.00	SPT	Greyish sandy silty clay	1	SC-CH	42.5	50.2	18.3	31.9	0.759								
9.00	SPT	Dark grey clayey fine to medium sand	4	SC-SP	18.9							1.0	3.1	39.4	41.5		15.0
10.00	SPT	Greyish clayey silty fine to medium sand with sandy clay pockets	5		21.9												
11.50	SPT	Greenish grey and yellowish brown sandy silty clay / clayey cemented sand	37	SC	13.4								0.1	37.0	35.4		27.5
13.00	SPT	Greenish grey clayey silty fine to medium sand	24	SC-SP	16.8							1.8	2.9	32.0	46.4		16.9
14.50	SPT	Light greenish grey dirty fine to medium sand with weathered sandstone	57	SC-SP	11.7							6.0	4.8	15.9	43.3		30.0
16.00	SPT	Light greenish grey dirty fine to medium sand with weathered sandstone	59		13.6												
17.50	SPT	Light greenish grey dirty fine to medium sand with weathered sandstone	61	SC-SP	12.0							13.3	5.1	15.3	34.9		31.4
19.00	SPT	Yell brown clayey sandy silt / fine sandy silty clay (weathered mudstone)	>100	SC-CI	17.5	39.7	18.7	21.0	<0.00								
20.50	SPT	Greenish grey and yellowish brown hard clay (weathered mudstone)	>100		17.1												
22.00-23.00		TOP: Greenish grey and brownish weathered mudstone															
		BOT: Yellowish brown weathered sandstone															
23.00-24.00		Yellowish brown weathered sandstone															

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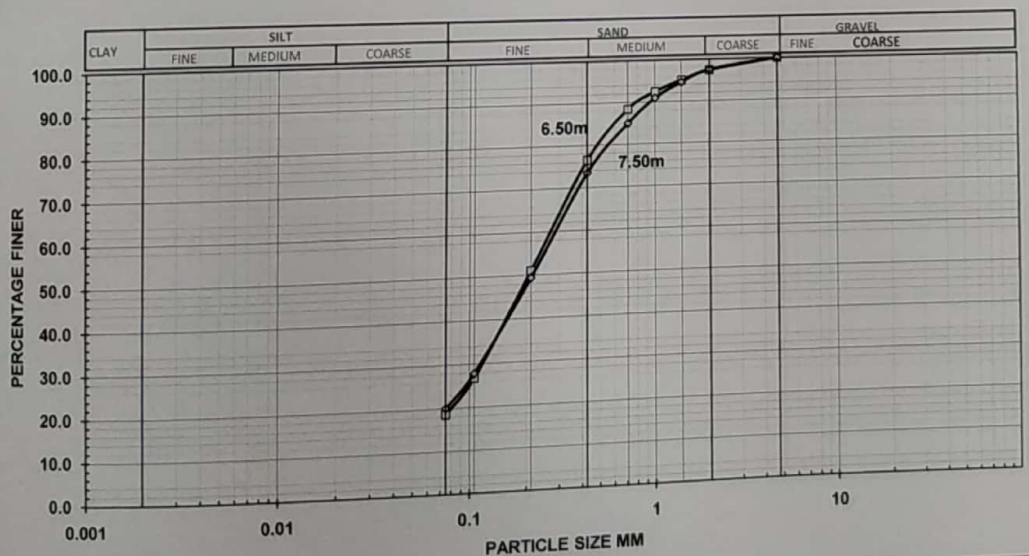
GRAIN SIZE DISTRIBUTION CURVES

ANNEXURE 3

PROJECT: Construction of Tenements for TNSCBMS Nagar, Chetpet, Chennai



BH NO	DEPTH	PERCENTAGE FINER (Sieve size in mm)							Fine Gravel	Coarse Sand	Medium Sand	Fine Sand	Silt	Clay	Classification	D50 mm	cu (sand)	cc (sand)
	M	80.0	20.0	4.75	2.00	0.425	0.075	0.002	G	CS	MS	FS	Si	C	CLASS			
BH/1	2.25m		100.0	100.0	100.0	77.2	16.6		0.0	0.0	22.8	60.6	16.6		SC-SP	0.276	2.554	1.154
BH/1	3.00m		100.0	100.0	100.0	75.0	14.5		0.0	0.0	25.0	60.5	14.5		SM-SP	0.294	2.311	1.087
BH/1	3.75m		100.0	100.0	97.9	53.7	7.6		0.0	2.1	44.2	46.1	7.6		SP	0.397	2.373	0.827



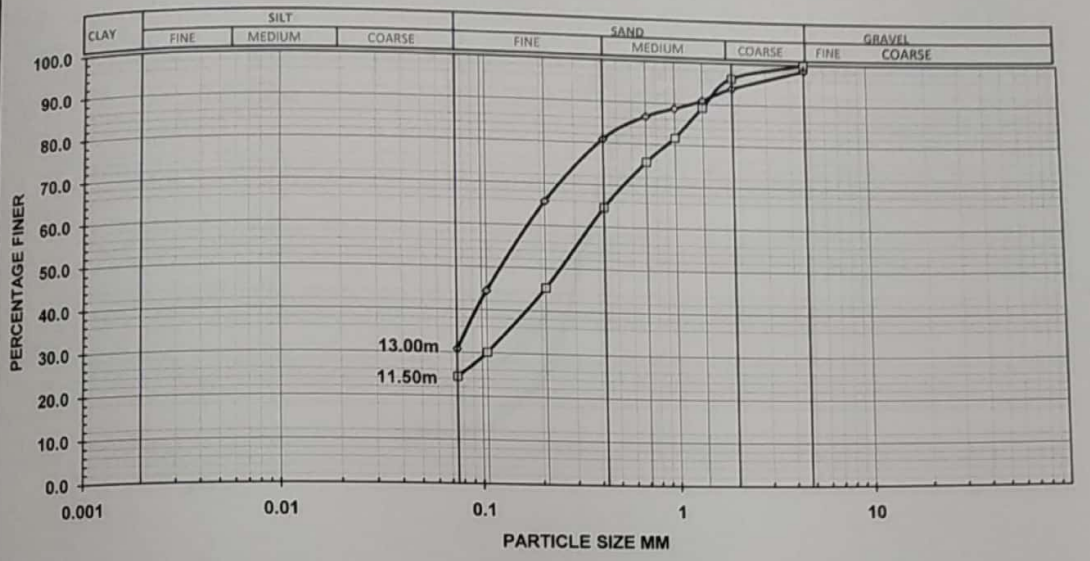
BH NO	DEPTH	PERCENTAGE FINER (Sieve size in mm)							Fine Gravel	Coarse Sand	Medium Sand	Fine Sand	Silt	Clay	Classification	D50 mm	cu (sand)	cc (sand)
	M	80.0	20.0	4.75	2.00	0.425	0.075	0.002	G	CS	MS	FS	Si	C	CLASS			
BH/1	6.50m		100.0	100.0	97.4	76.5	18.6		0.0	2.6	20.9	57.9	18.6		SC-SP	0.206	3.140	0.811
BH/1	7.50m		100.0	100.0	97.5	73.5	20.0		0.0	2.5	24.0	53.5	20.0		SC-SP	0.216	3.398	0.822

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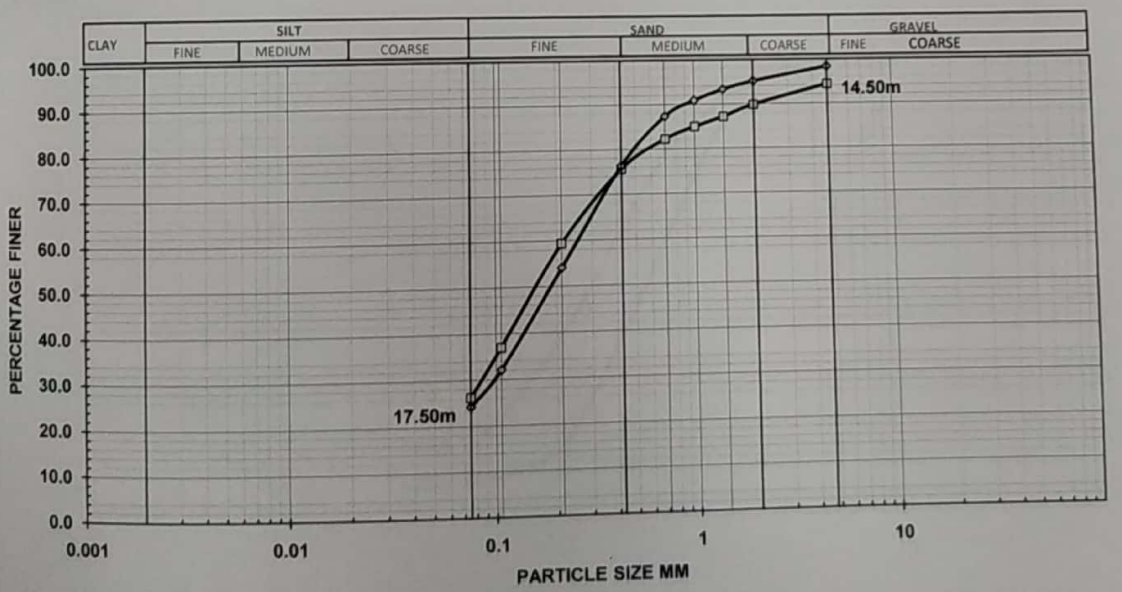
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PROJECT: Construction of Tenements for TNSCBMS Nagar, Chetpet, Chennai



BH NO	DEPTH	PERCENTAGE FINER (Sieve size in mm)							Fine Gravel	Coarse Sand	Medium Sand	Fine Sand	Silt	Clay	Classification	D50 mm	cu (sand)	cc (sand)
	M	80.0	20.0	4.75	2.00	0.425	0.075	0.002	G	CS	MS	FS	Si	C	CLASS			
BH/1	11.50m		100.0	100.0	96.4	64.6	24.4		0.0	3.6	31.8	40.2	24.4		SC-SP	0.250	4.695	0.819
BH/1	13.00m		100.0	98.5	93.9	80.9	30.8		1.5	4.6	13.0	50.1	30.8		SC-SM	0.127	3.210	0.698



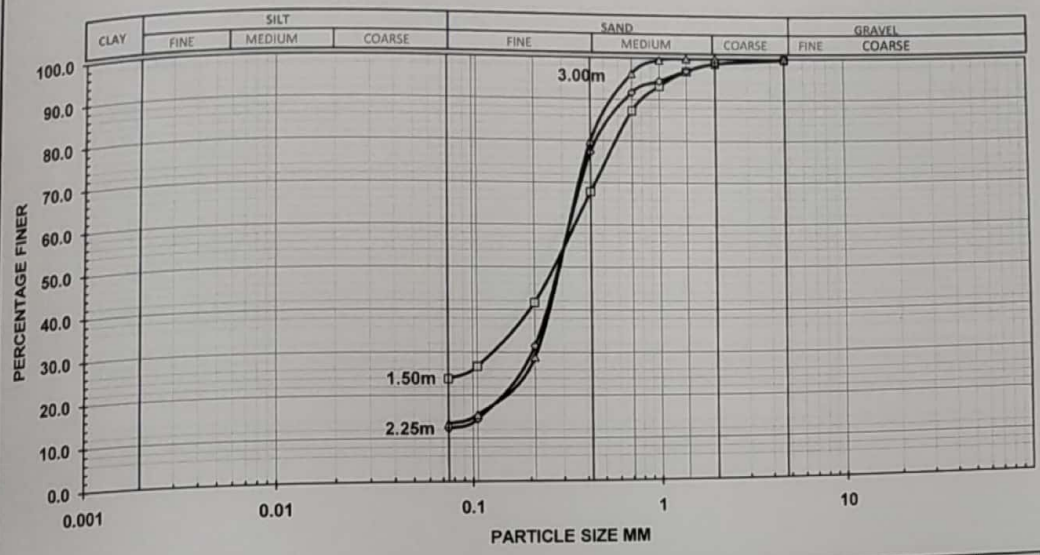
BH NO	DEPTH	PERCENTAGE FINER (Sieve size in mm)							Fine Gravel	Coarse Sand	Medium Sand	Fine Sand	Silt	Clay	Classification	D50 mm	cu (sand)	cc (sand)
	M	80.0	20.0	4.75	2.00	0.425	0.075	0.002	G	CS	MS	FS	Si	C	CLASS			
BH/1	14.50m		100.0	94.3	89.8	75.6	26.2		5.7	4.5	14.2	49.4	26.2		SC-SM	0.159	3.591	0.700
BH/1	17.50m		100.0	98.3	95.1	76.3	24.2		1.7	3.2	18.8	52.1	24.2		SC-SP	0.187	3.308	0.795

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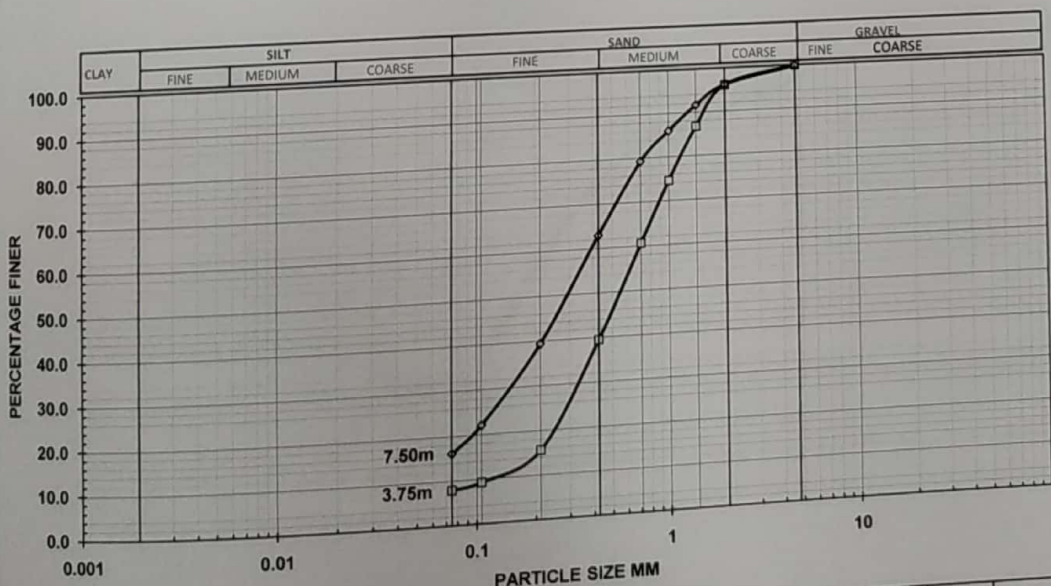
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GRAIN SIZE DISTRIBUTION CURVES

PROJECT: Construction of Tenements for TNSCBMS Nagar, Chetpet, Chennai



BH NO	DEPTH	PERCENTAGE FINER (Sieve size in mm)							Fine Gravel	Coarse Sand	Medium Sand	Fine Sand	Silt	Clay	Classification	D50 mm	cu (sand)	cc (sand)
	M	80.0	20.0	4.75	2.00	0.425	0.075	0.002	G	CS	MS	FS	Si	C	CLASS			
BH/2	1.50m		100.0	99.7	98.7	67.8	23.8		0.3	1.0	30.9	44.0	23.8		SC-SP	0.265	3.375	0.999
BH/2	2.25m		100.0	100.0	98.7	77.2	12.3		0.0	1.3	21.5	64.9	12.3		SM-SP	0.281	2.544	1.142
BH/2	3.00m		100.0	100.0	100.0	79.9	13.4		0.0	0.0	20.1	66.5	13.4		SM-SP	0.283	2.343	1.153



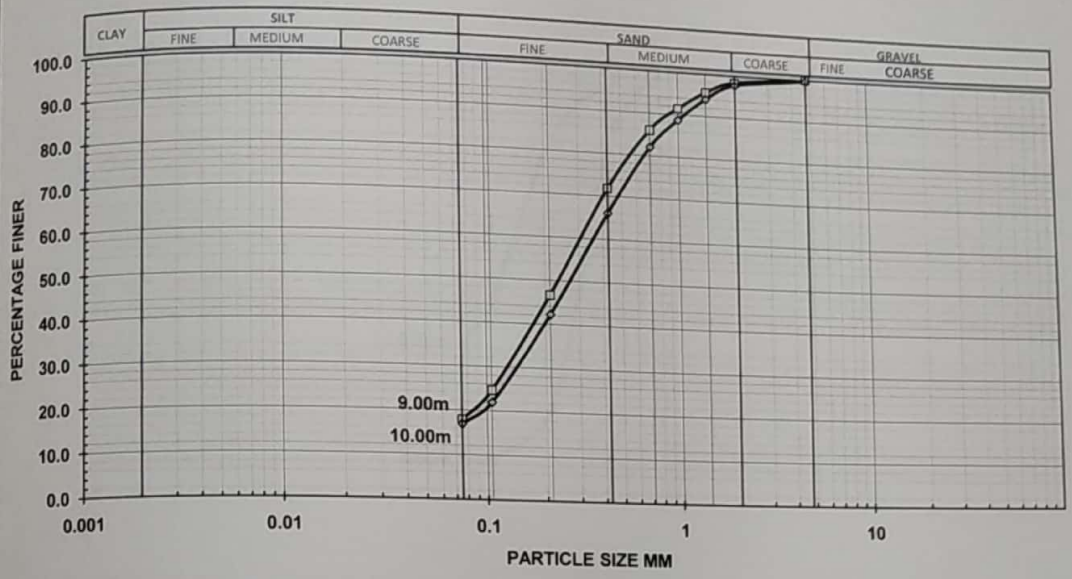
BH NO	DEPTH	PERCENTAGE FINER (Sieve size in mm)							Fine Gravel	Coarse Sand	Medium Sand	Fine Sand	Silt	Clay	Classification	D50 mm	cu (sand)	cc (sand)
	M	80.0	20.0	4.75	2.00	0.425	0.075	0.002	G	CS	MS	FS	Si	C	CLASS			
BH/2	3.75m		100.0	100.0	96.0	39.5	7.9		0.0	4.0	56.5	31.6	7.9		SP	0.548	3.406	0.858
BH/2	7.50m		100.0	99.8	96.1	62.9	16.1		0.2	3.7	33.2	46.8	16.1		SC-SP	0.290	4.071	0.906

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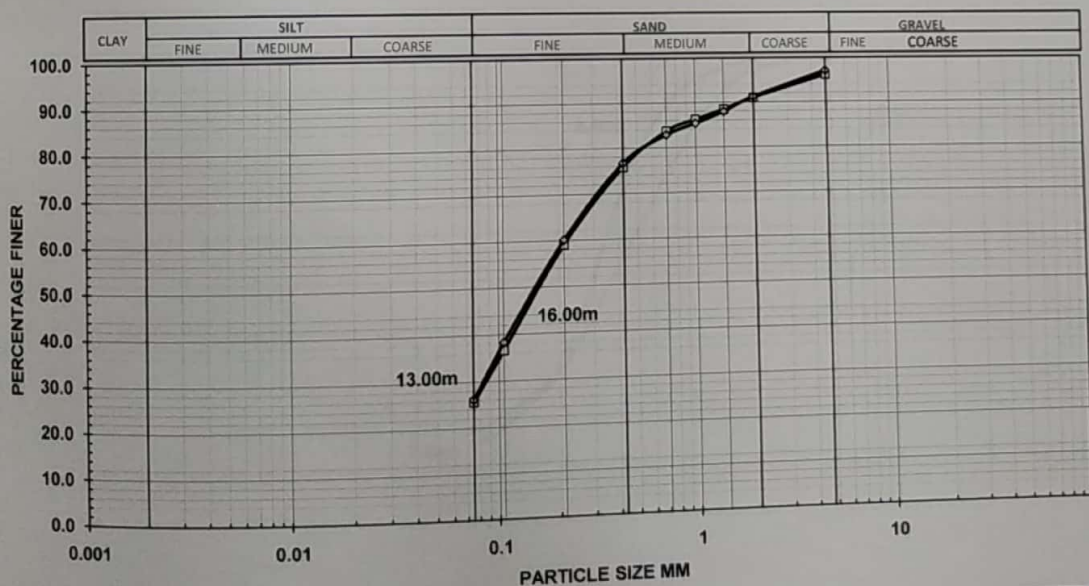
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GRAIN SIZE DISTRIBUTION CURVES

PROJECT: Construction of Tenements for TNSCBMS Nagar, Chetpet, Chennai



BH NO	DEPTH	PERCENTAGE FINER (Sieve size in mm)							Fine Gravel	Coarse Sand	Medium Sand	Fine Sand	Silt	Clay	Classification	D50 mm	cu (sand)	cc (sand)
	M	80.0	20.0	4.75	2.00	0.425	0.075	0.002	G	CS	MS	FS	Si	C	CLASS			
BH/2	9.00m		100.0	100.0	98.4	71.8	17.8		0.0	1.6	26.6	54.0	17.8		SC-SP	0.232	3.369	0.833
BH/2	10.00m		100.0	99.7	97.7	66.1	16.9		0.3	2.0	31.6	49.2	16.9		SC-SP	0.266	3.658	0.850



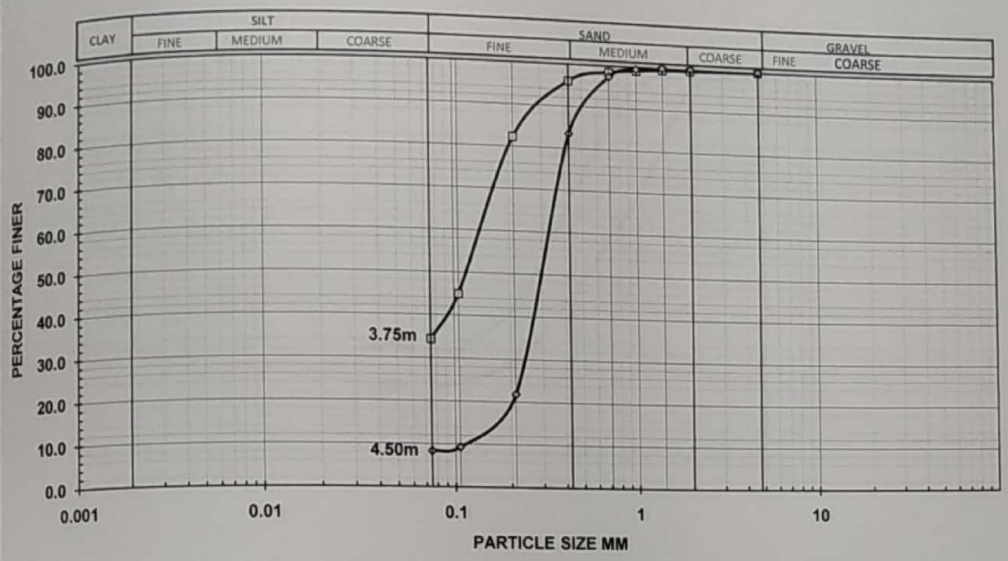
BH NO	DEPTH	PERCENTAGE FINER (Sieve size in mm)							Fine Gravel	Coarse Sand	Medium Sand	Fine Sand	Silt	Clay	Classification	D50 mm	cu (sand)	cc (sand)
	M	80.0	20.0	4.75	2.00	0.425	0.075	0.002	G	CS	MS	FS	Si	C	CLASS			
BH/2	13.00m		100.0	96.1	91.0	75.8	25.6		3.9	5.1	15.2	50.2	25.6		SC-SM	0.160	3.557	0.706
BH/2	16.00m		100.0	97.0	91.2	76.7	26.1		3.0	5.8	14.5	50.6	26.1		SC-SM	0.154	3.535	0.700

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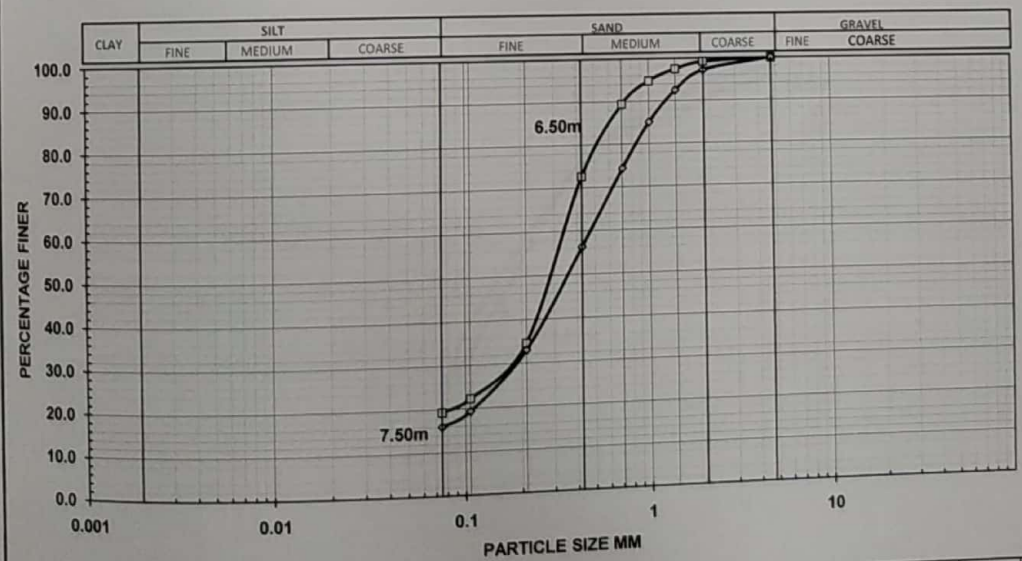
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GRAIN SIZE DISTRIBUTION CURVES

PROJECT: **Construction of Tenements for TNSCBMS Nagar, Chetpet, Chennai**



BH NO	DEPTH	PERCENTAGE FINER (Sieve size in mm)							Fine Gravel	Coarse Sand	Medium Sand	Fine Sand	Silt	Clay	Classification	D50 mm	cu (sand)	cc (sand)
	M	80.0	20.0	4.75	2.00	0.425	0.075	0.002	G	CS	MS	FS	Si	C	CLASS			
BH/3	3.75m		100.0	100.0	99.7	96.0	34.3		0.0	0.3	3.7	61.7	34.3		SC-Cl	0.116	1.950	0.936
BH/3	4.50m		100.0	100.0	100.0	83.4	8.3		0.0	0.0	16.6	75.1	8.3		SP	0.292	2.032	1.092



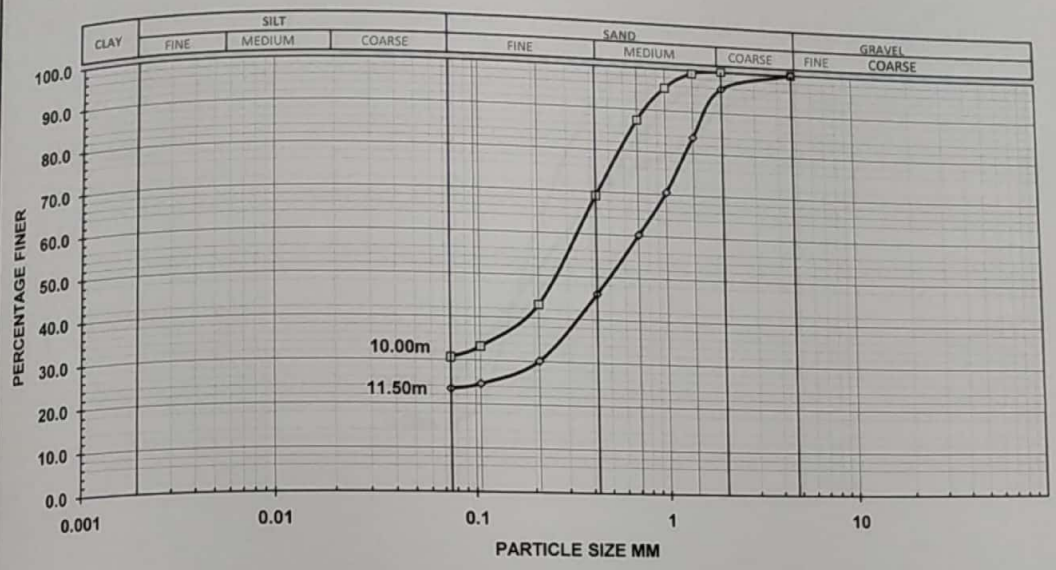
BH NO	DEPTH	PERCENTAGE FINER (Sieve size in mm)							Fine Gravel	Coarse Sand	Medium Sand	Fine Sand	Silt	Clay	Classification	D50 mm	cu (sand)	cc (sand)
	M	80.0	20.0	4.75	2.00	0.425	0.075	0.002	G	CS	MS	FS	Si	C	CLASS			
BH/3	6.50m		100.0	100.0	99.2	72.6	19.3		0.0	0.8	26.6	53.3	19.3		SC-SP	0.281	2.755	1.136
BH/3	7.50m		100.0	100.0	97.2	56.3	16.0		0.0	2.8	40.9	40.3	16.0		SC-SP	0.352	4.143	0.946

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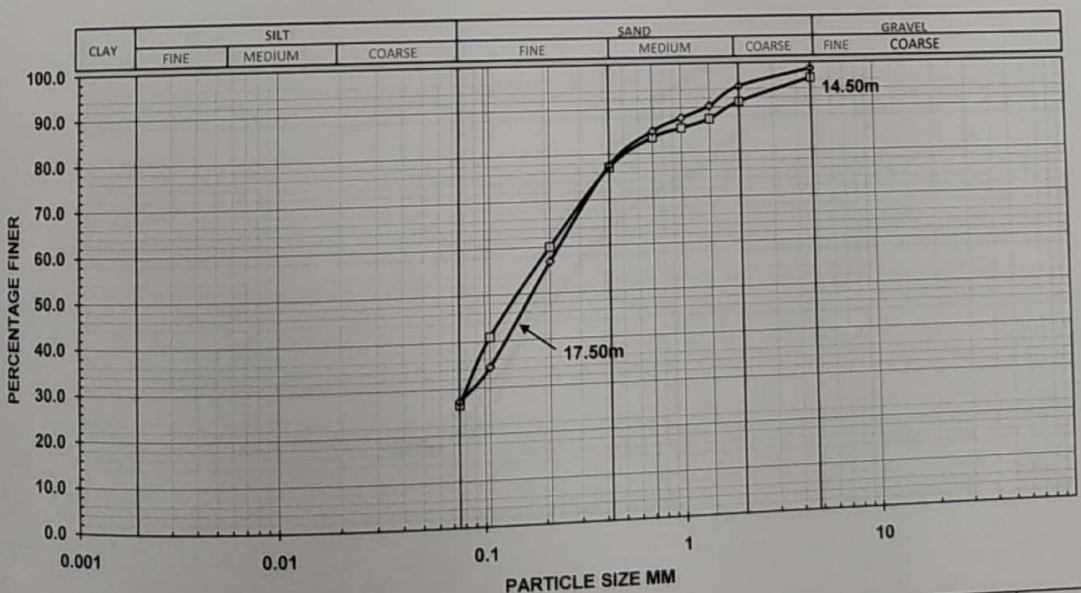
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GRAIN SIZE DISTRIBUTION CURVES

PROJECT: Construction of Tenements for TNSCBMS Nagar, Chetpet, Chennai



BH NO	DEPTH	PERCENTAGE FINER (Sieve size in mm)							Fine Gravel	Coarse Sand	Medium Sand	Fine Sand	Silt	Clay	Classification	D50 mm	cu (sand)	cc (sand)
	M	80.0	20.0	4.75	2.00	0.425	0.075	0.002	G	CS	MS	FS	Si	C	CLASS			
BH/3	10.00m		100.0	100.0	100.0	69.1	30.6		0.0	0.0	30.9	38.5	30.6		SC	0.255	3.241	1.052
BH/3	11.50m		100.0	100.0	95.8	46.0	23.4		0.0	4.2	49.8	22.6	23.4		SC	0.491	4.355	0.872



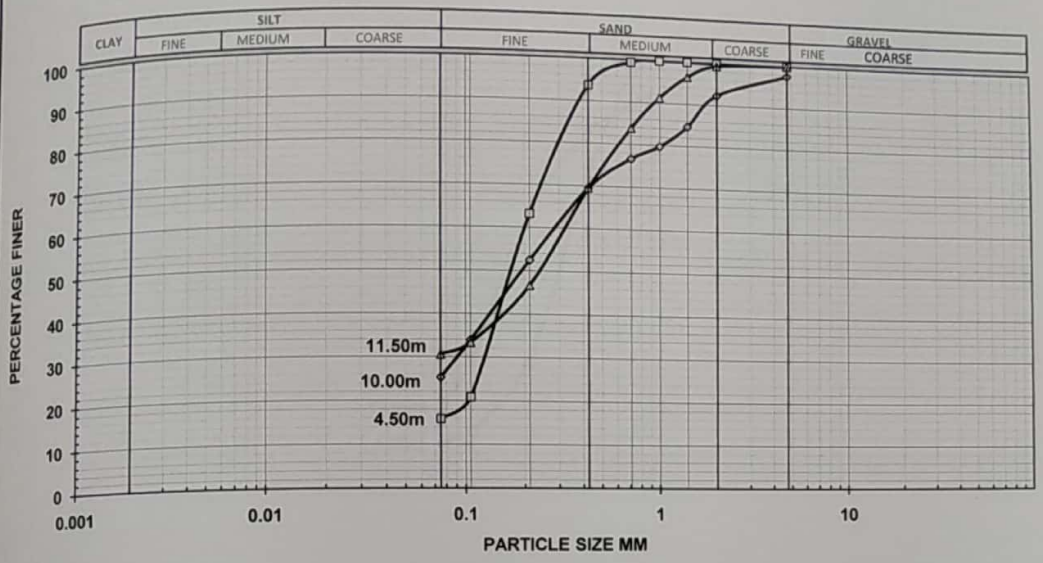
BH NO	DEPTH	PERCENTAGE FINER (Sieve size in mm)							Fine Gravel	Coarse Sand	Medium Sand	Fine Sand	Silt	Clay	Classification	D50 mm	cu (sand)	cc (sand)
	M	80.0	20.0	4.75	2.00	0.425	0.075	0.002	G	CS	MS	FS	Si	C	CLASS			
BH/3	14.50m		100.0	96.4	91.2	77.1	26.5		3.6	5.2	14.1	50.6	26.5		SC-SP	0.148	3.646	0.670
BH/3	17.50m		100.0	98.5	94.7	77.5	27.2		1.5	3.8	17.2	50.3	27.2		SC-SP	0.172	3.200	0.768

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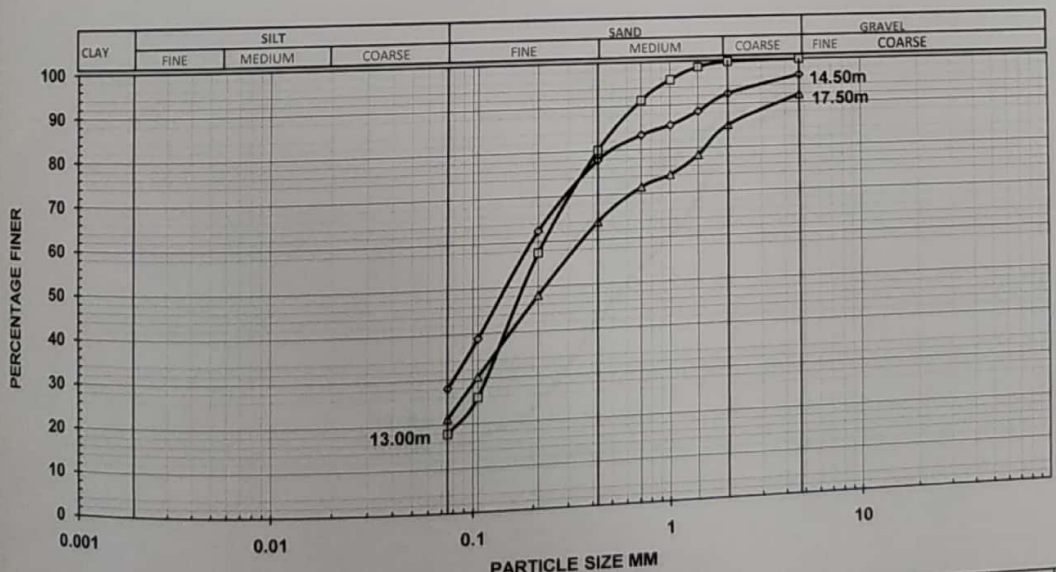
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GRAIN SIZE DISTRIBUTION CURVES

PROJECT: Construction of Tenements for TNSCB
MS Nagar, Chetpet, Chennai



BH NO	DEPTH	PERCENTAGE FINER (Sieve size in mm)							Fine Gravel	Coarse Sand	Medium Sand	Fine Sand	Silt	Clay	Classification	D50 mm	cu (sand)	cc (sand)
	M	80.0	20.0	4.75	2.00	0.425	0.075	0.002	G	CS	MS	FS	Si	C	CLASS			
BH/4	4.50m		100.0	100.0	100.0	93.7	15.9		0.0	0.0	6.3	77.8	15.9		SC-SP	0.171	2.032	0.854
BH/4	10.00m		100.0	97.6	92.3	69.5	25.3		2.4	5.3	22.8	44.2	25.3		SC	0.194	4.388	0.702
BH/4	11.50m		100.0	100.0	99.3	69.5	30.6		0.0	0.7	29.8	38.9	30.6		SC	0.235	3.547	0.971



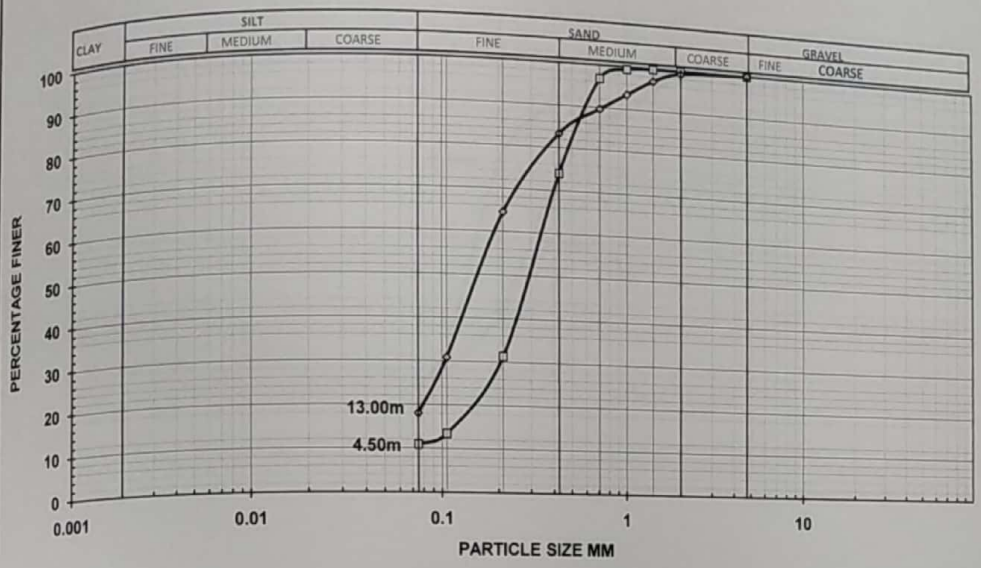
BH NO	DEPTH	PERCENTAGE FINER (Sieve size in mm)							Fine Gravel	Coarse Sand	Medium Sand	Fine Sand	Silt	Clay	Classification	D50 mm	cu (sand)	cc (sand)
	M	80.0	20.0	4.75	2.00	0.425	0.075	0.002	G	CS	MS	FS	Si	C	CLASS			
BH/4	13.00m		100.0	100.0	99.7	80.1	17.9		0.0	0.3	19.6	62.2	17.9		SC-SP	0.180	2.675	0.767
BH/4	14.50m		100.0	96.3	92.3	77.9	28.0		3.7	4.0	14.4	49.9	28.0		SM-SP	0.147	3.336	0.712
BH/4	17.50m		100.0	91.8	85.1	64.0	21.3		8.2	6.7	21.1	42.7	21.3		SC-SP	0.231	5.721	0.601

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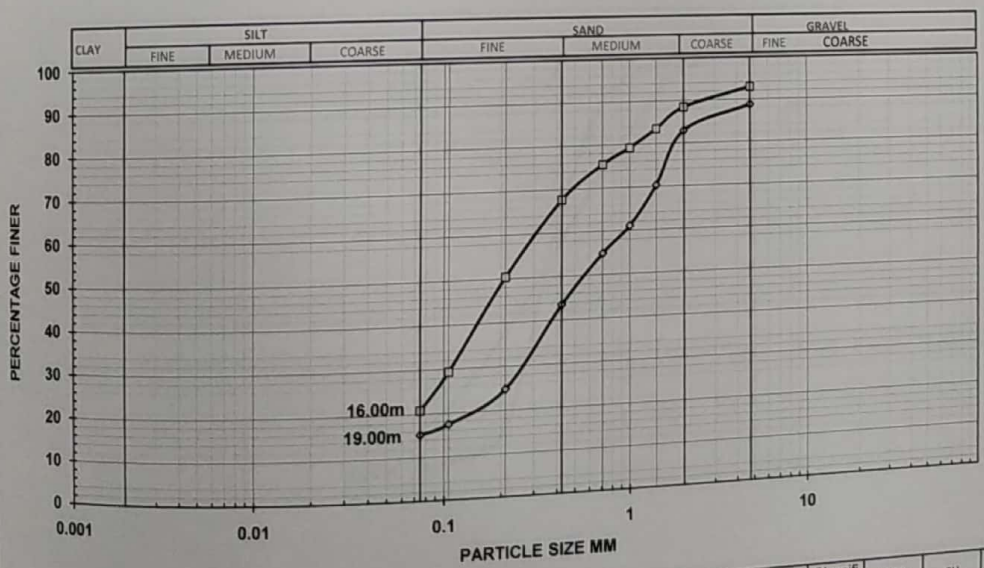
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GRAIN SIZE DISTRIBUTION CURVES

PROJECT: Construction of Tenements for TNSCB
MS Nagar, Chetpet, Chennai



BH NO	DEPTH	PERCENTAGE FINER (Sieve size in mm)							Fine Gravel	Coarse Sand	Medium Sand	Fine Sand	Silt	Clay	Classification	D50 mm	cu (sand)	cc (sand)
	M	80.0	20.0	4.75	2.00	0.425	0.075	0.002	G	CS	MS	FS	Si	C	CLASS			
BH/5	4.50m		100.0	100.0	99.9	74.0	10.9		0.0	0.1	25.9	63.1	10.9		SP	0.288	2.673	1.119
BH/5	13.00m		100.0	100.0	99.2	83.3	18.0		0.0	0.8	15.9	65.3	18.0		SM-SP	0.157	2.503	0.832



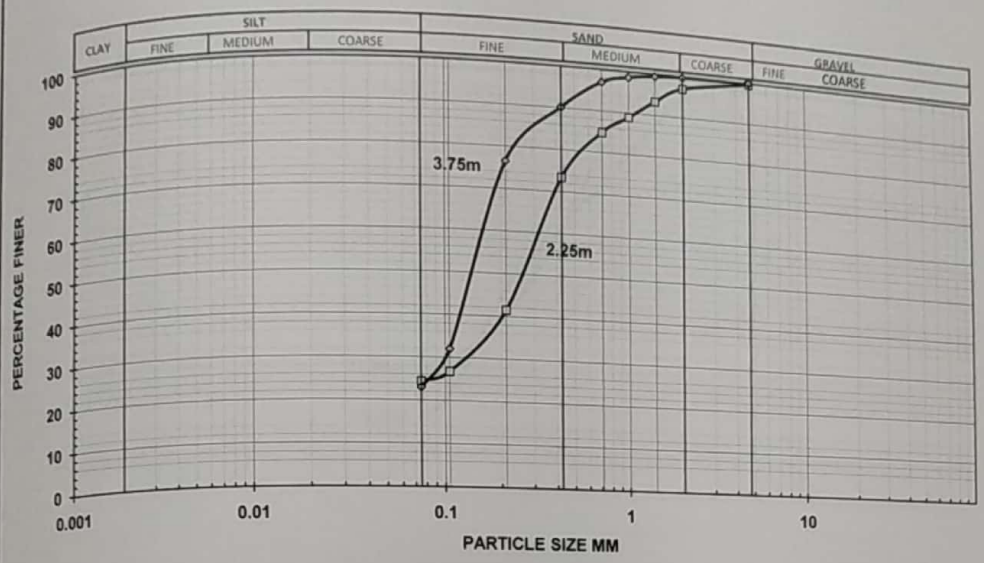
BH NO	DEPTH	PERCENTAGE FINER (Sieve size in mm)							Fine Gravel	Coarse Sand	Medium Sand	Fine Sand	Silt	Clay	Classification	D50 mm	cu (sand)	cc (sand)
	M	80.0	20.0	4.75	2.00	0.425	0.075	0.002	G	CS	MS	FS	Si	C	CLASS			
BH/5	16.00m		100.0	92.9	88.4	67.6	20.8		7.1	4.5	20.8	46.8	20.8		SM-SP	0.209	4.319	0.666
BH/5	19.00m		100.0	88.7	82.9	43.5	15.2		11.3	5.8	39.4	28.3	15.2		SM-SP	0.570	6.285	0.637

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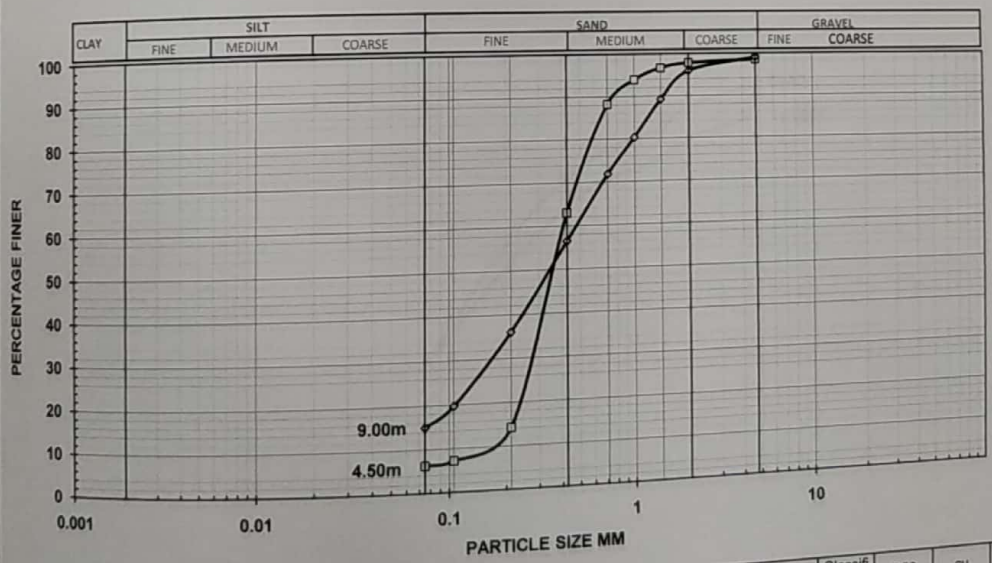
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GRAIN SIZE DISTRIBUTION CURVES

PROJECT: Construction of Tenements for TNSCB
MS Nagar, Chetpet, Chennai



BH NO	DEPTH	PERCENTAGE FINER (Sieve size in mm)							Fine Gravel	Coarse Sand	Medium Sand	Fine Sand	Silt	Clay	Classification	D50 mm	cu (sand)	cc (sand)
	M	80.0	20.0	4.75	2.00	0.425	0.075	0.002	G	CS	MS	FS	Si	C	CLASS			
BH/6	2.25m		100.0	99.7	97.0	73.4	24.4		0.3	2.7	23.6	49.0	24.4		SC-SP	0.256	2.892	1.079
BH/6	3.75m		100.0	100.0	99.8	90.1	23.0		0.0	0.2	9.7	67.1	23.0		SC-SP	0.140	1.877	0.914



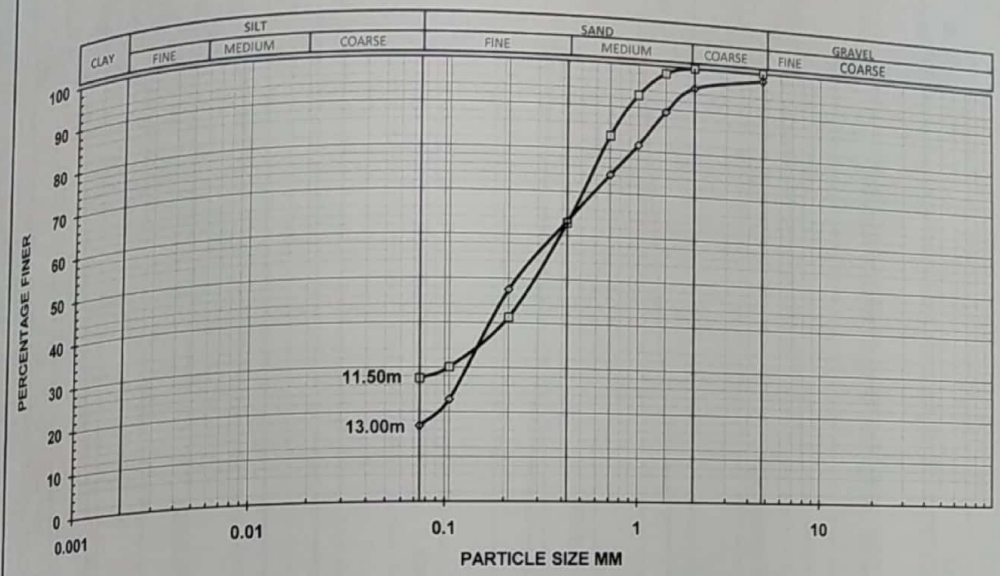
BH NO	DEPTH	PERCENTAGE FINER (Sieve size in mm)							Fine Gravel	Coarse Sand	Medium Sand	Fine Sand	Silt	Clay	Classification	D50 mm	cu (sand)	cc (sand)
	M	80.0	20.0	4.75	2.00	0.425	0.075	0.002	G	CS	MS	FS	Si	C	CLASS			
BH/6	4.50m		100.0	98.5	97.8	63.0	6.3		1.5	0.7	34.8	56.7	6.3		SP	0.353	1.950	0.875
BH/6	9.00m		100.0	99.0	95.9	56.5	15.0		1.0	3.1	39.4	41.5	15.0		SC-SP	0.341	4.691	0.838

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GRAIN SIZE DISTRIBUTION CURVES

PROJECT: Construction of Tenements for TNSCB
MS Nagar, Chetpet, Chennai



BH NO	DEPTH	PERCENTAGE FINER (Sieve size in mm)							Fine Gravel	Coarse Sand	Medium Sand	Fine Sand	Silt	Clay	Classification	D50 mm	cu (sand)	cc (sand)
	M	80.0	20.0	4.75	2.00	0.425	0.075	0.002	G	CS	MS	FS	Si	C	CLASS			
BH/6	11.50m		100.0	100.0	99.9	62.9	27.5		0.0	0.1	37.0	35.4	27.5		SC	0.281	3.676	1.013
BH/6	13.00m		100.0	98.2	95.3	63.3	16.9		1.8	2.9	32.0	46.4	16.9		SC-SP	0.237	4.411	0.576

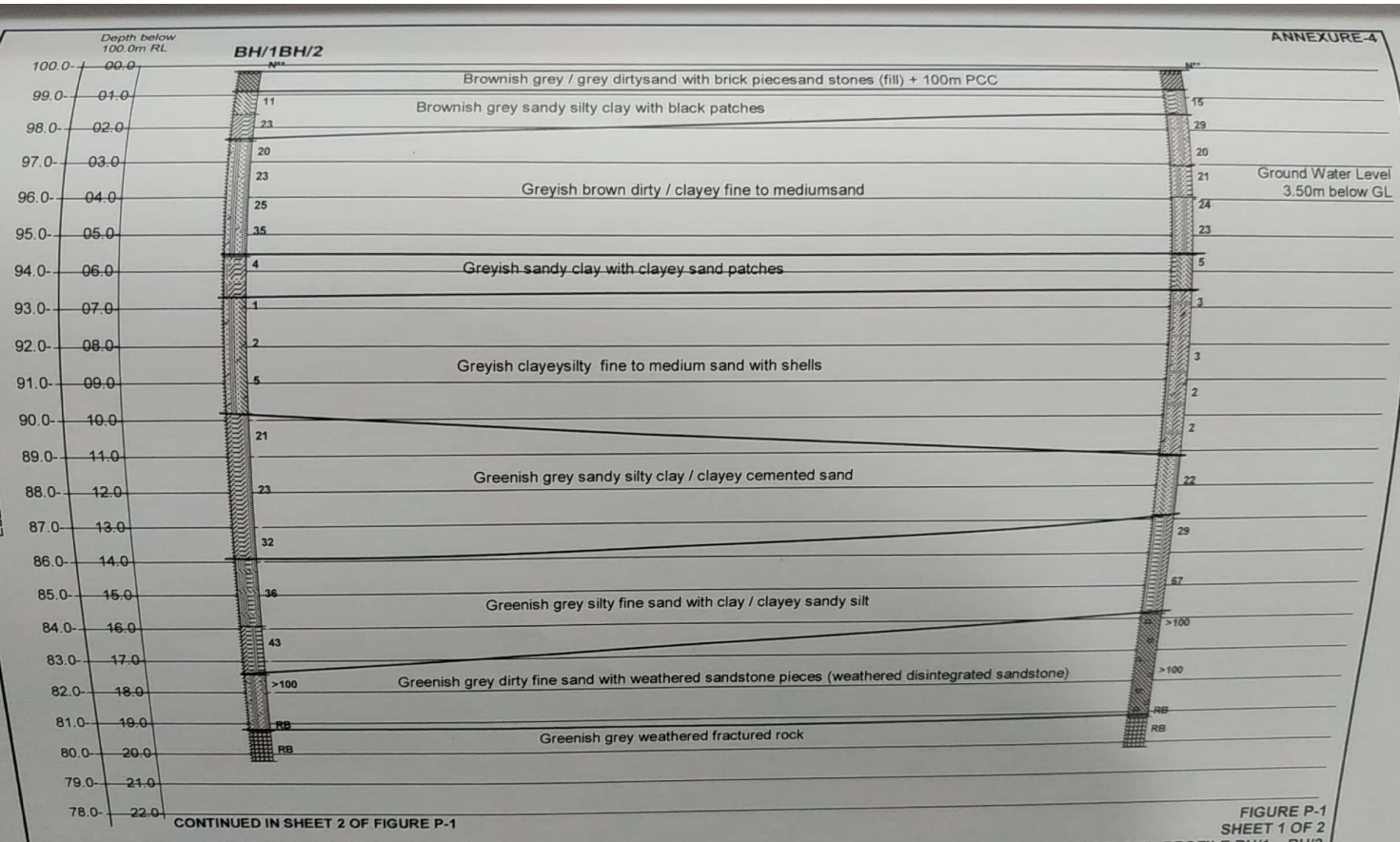


BH NO	DEPTH	PERCENTAGE FINER (Sieve size in mm)							Fine Gravel	Coarse Sand	Medium Sand	Fine Sand	Silt	Clay	Classification	D50 mm	cu (sand)	cc (sand)
	M	80.0	20.0	4.75	2.00	0.425	0.075	0.002	G	CS	MS	FS	Si	C	CLASS			
BH/6	14.50m		100.0	94.0	89.2	73.3	30.0		6.0	4.8	15.9	43.3	30.0		SC-SP	0.149	4.239	0.640
BH/6	17.50m		100.0	86.7	81.6	66.3	31.4		13.3	5.1	15.3	34.9	31.4		SC-SP	0.178	6.844	0.503

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ANNEXURE-4

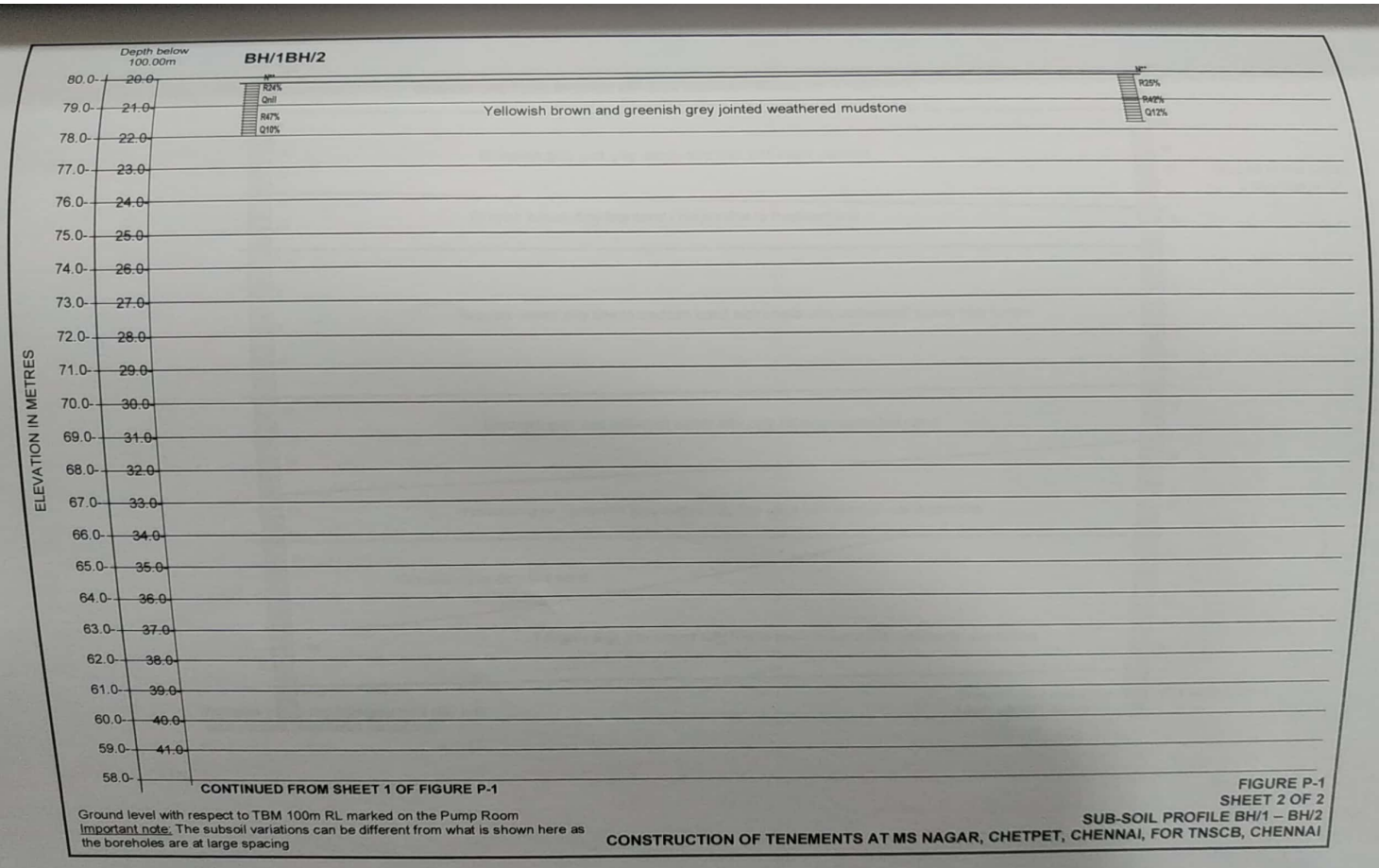


CONTINUED IN SHEET 2 OF FIGURE P-1

Ground level with respect to TBM 100m RL marked on the Pump Room
Important note: The subsoil variations can be different from what is shown here as the boreholes are at large spacing

FIGURE P-1
SHEET 1 OF 2
SUB-SOIL PROFILE BH/1 – BH/2
CONSTRUCTION OF TENEMENTS AT MS NAGAR, CHETPET, CHENNAI, FOR TNSCB, CHENNAI

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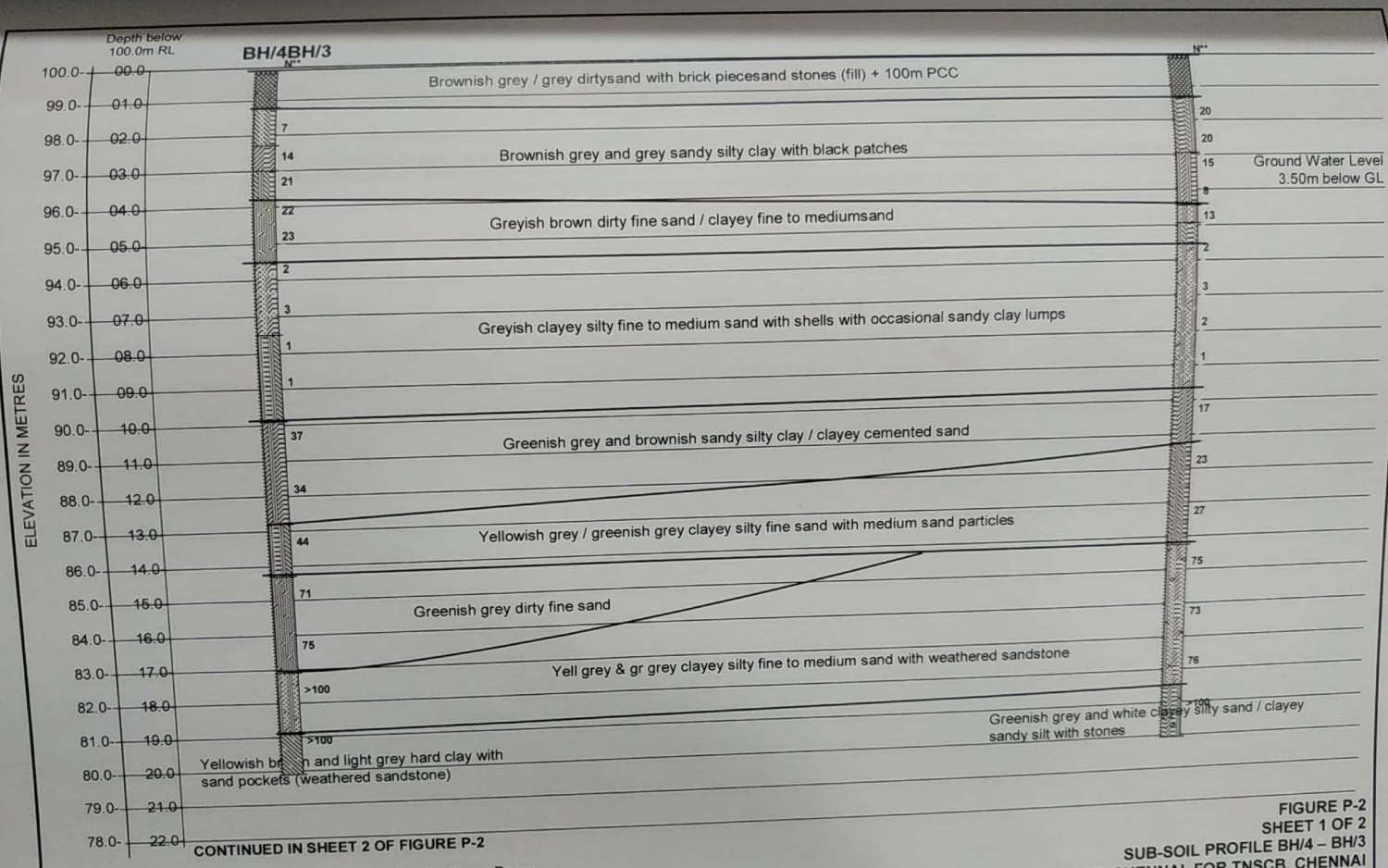


CONTINUED FROM SHEET 1 OF FIGURE P-1

Ground level with respect to TBM 100m RL marked on the Pump Room
Important note: The subsoil variations can be different from what is shown here as the boreholes are at large spacing

FIGURE P-1
SHEET 2 OF 2
SUB-SOIL PROFILE BH/1 – BH/2
CONSTRUCTION OF TENEMENTS AT MS NAGAR, CHETPET, CHENNAI, FOR TNSCB, CHENNAI

Scanned with CamScanner

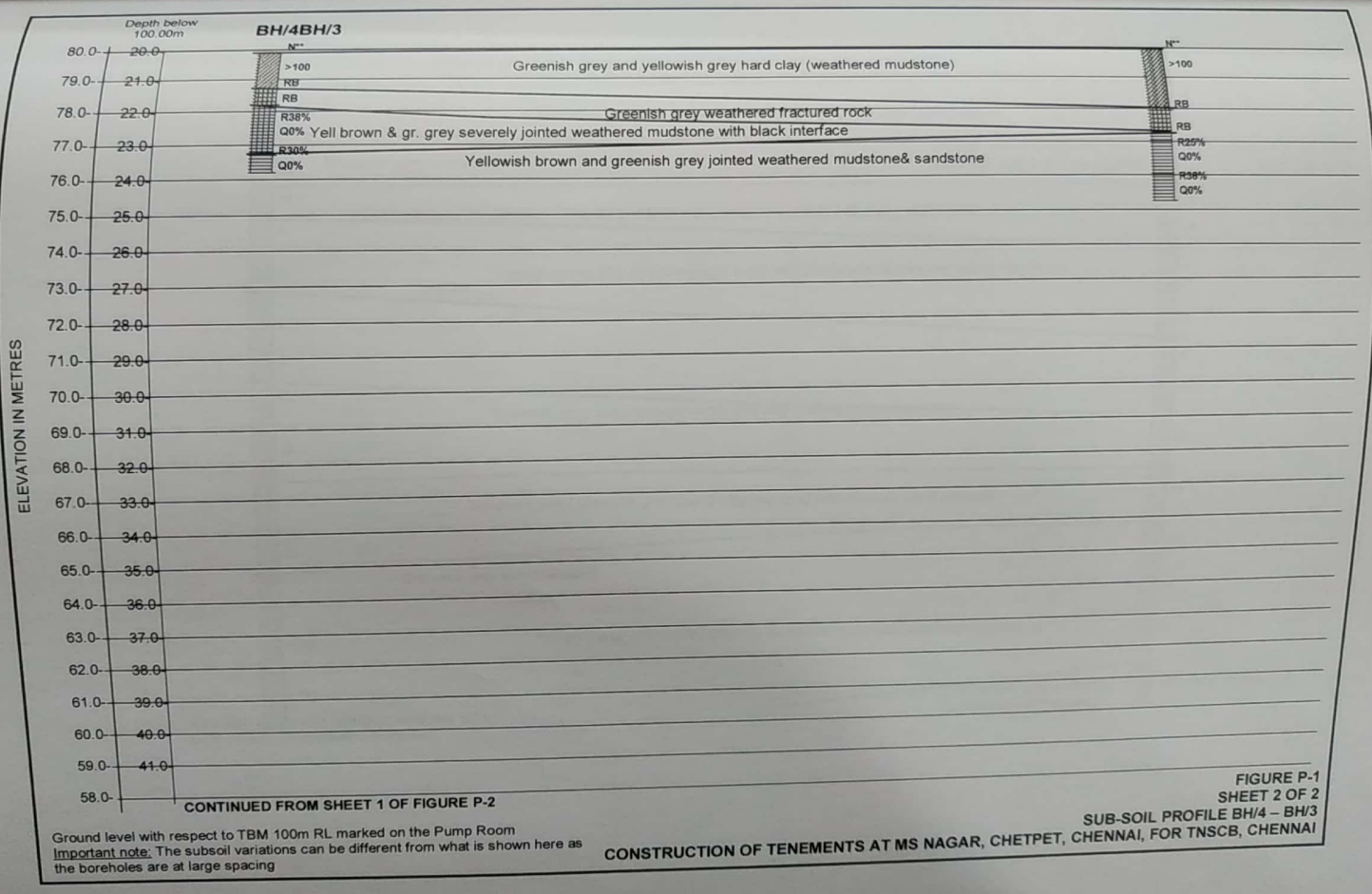


Ground level with respect to TBM 100m RL marked on the Pump Room

Important note: The subsoil variations can be different from what is shown here as the boreholes are at large spacing

FIGURE P-2
SHEET 1 OF 2
SUB-SOIL PROFILE BH/4 – BH/3
CONSTRUCTION OF TENEMENTS AT MS NAGAR, CHETPET, CHENNAI, FOR TNSCB, CHENNAI

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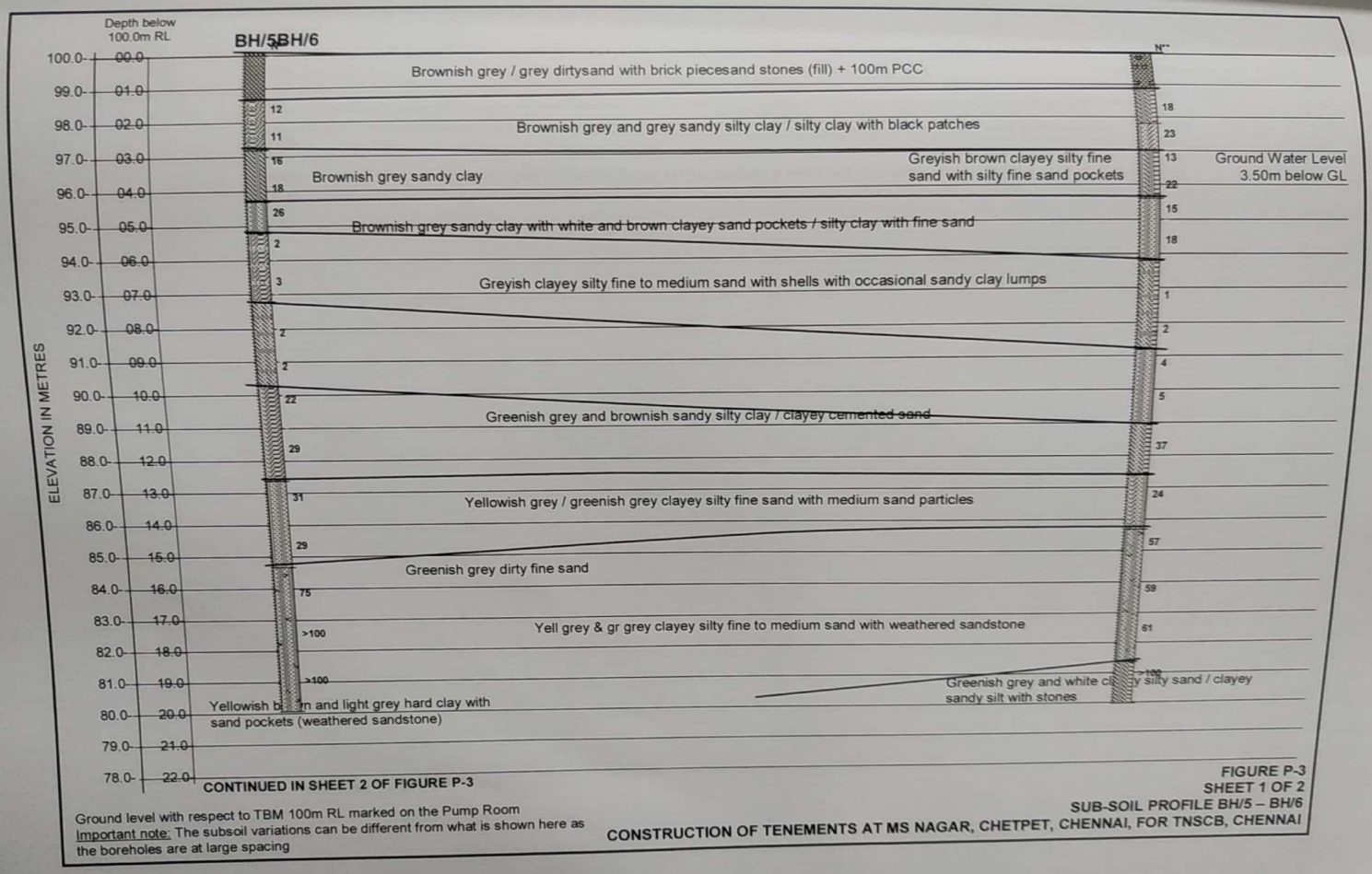
CONTINUED FROM SHEET 1 OF FIGURE P-2

Ground level with respect to TBM 100m RL marked on the Pump Room
Important note: The subsoil variations can be different from what is shown here as the boreholes are at large spacing

CONSTRUCTION OF TENEMENTS AT MS NAGAR, CHETPET, CHENNAI, FOR TNSCB, CHENNAI

FIGURE P-1
SHEET 2 OF 2
SUB-SOIL PROFILE BH/4 – BH/3

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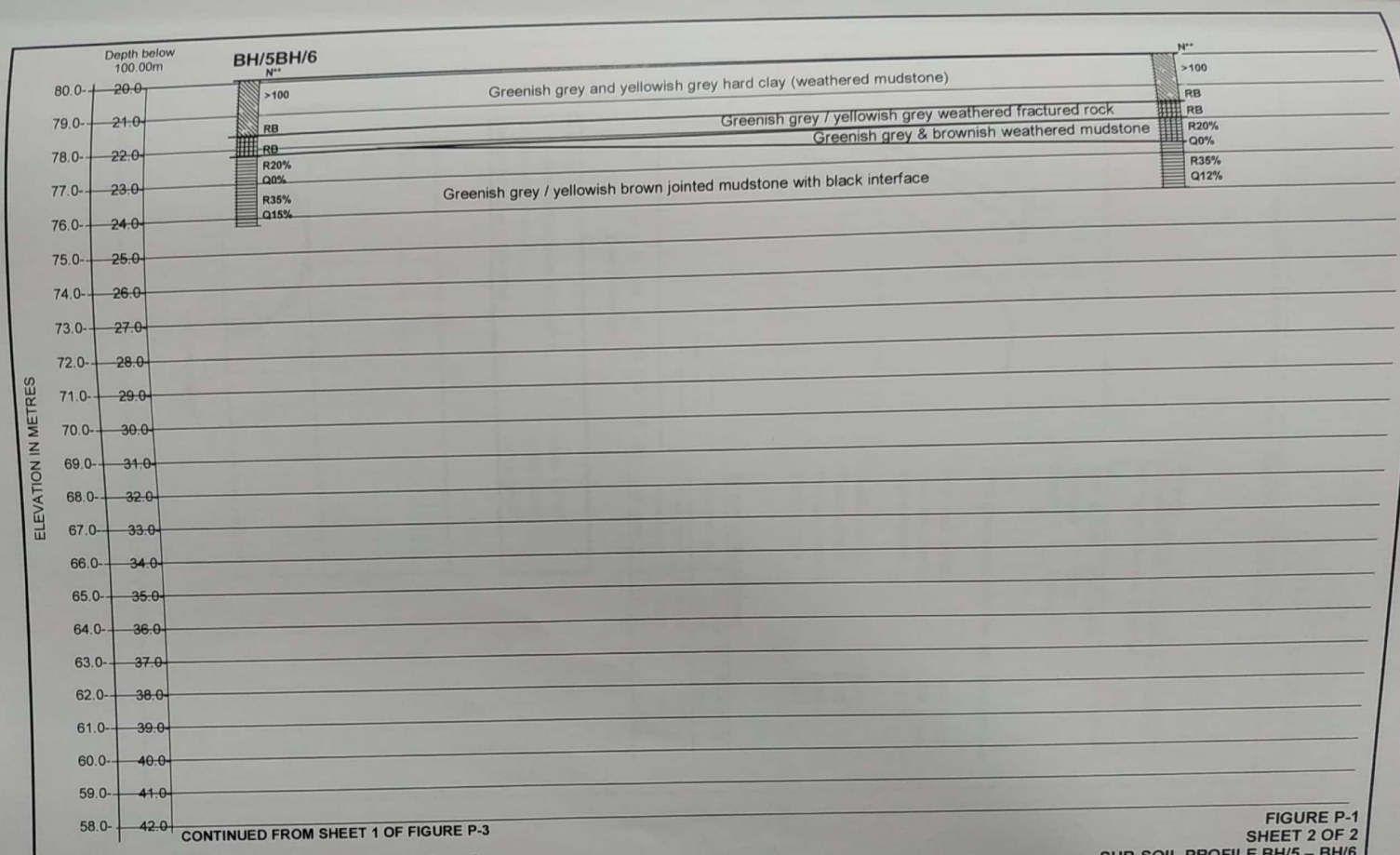
Ground level with respect to TBM 100m RL marked on the Pump Room

Important note: The subsoil variations can be different from what is shown here as the boreholes are at large spacing

FIGURE P-3
SHEET 1 OF 2
SUB-SOIL PROFILE BH/5 – BH/6

CONSTRUCTION OF TENEMENTS AT MS NAGAR, CHETPET, CHENNAI, FOR TNSCB, CHENNAI

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CONTINUED FROM SHEET 1 OF FIGURE P-3

Ground level with respect to TBM 100m RL marked on the Pump Room

Important note: The subsoil variations can be different from what is shown here as the boreholes are at large spacing

FIGURE P-1
SHEET 2 OF 2
SUB-SOIL PROFILE BH/5 – BH/6
CONSTRUCTION OF TENEMENTS AT MS NAGAR, CHETPET, CHENNAI, FOR TNSCB, CHENNAI

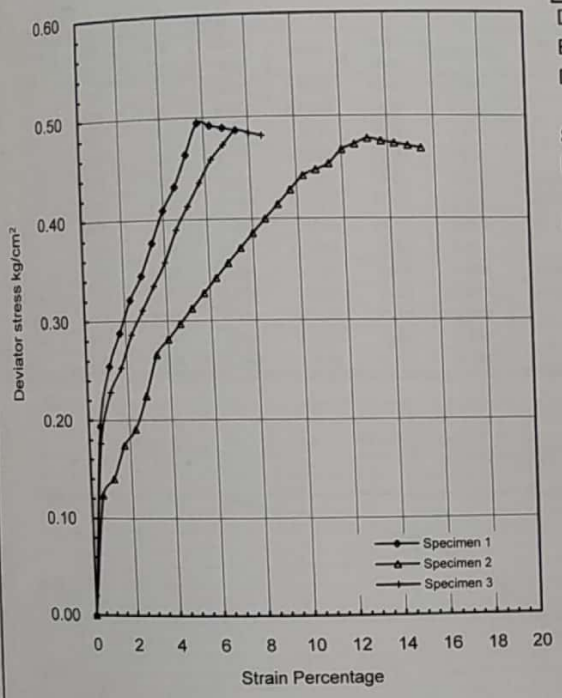
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ANNEXURE 5

Unconfined Compression Strength Test UCC on soil sample

Project:

Construction of Tenements for TNSCB at MS Nagar, Chetpet, Chennai



Date of Test	**23/12/2019**
Borehole	**BH/5**
Depth	**7.50m**

Soil

Dark grey sandy silty clay with sand patches

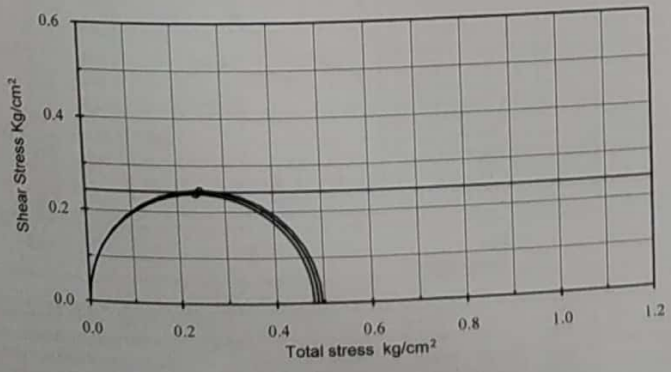
Insitu bulk density	1.810 gm/cc
Insitu Dry Density	1.298 gm/cc
Water Content	39.41 %
Liquid Limit %	60.20
Plastic Limit %	24.30
Plasticity Index %	35.90
Liquidity Index	0.42

Maximum Shear Stress

Specimen No:	Deviator stress	Shear stress kg/cm²
Specimen 1	0.495	0.247
Specimen 2	0.478	0.239
Specimen 3	0.487	0.243

Results

Unconfined compression strength q_u	0.486 kg/cm²
Undrained Cohesion c_u	0.243 kg/cm²
Secant Modulus (undrained)	14.13 kg/cm²



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ONE DIMENSIONAL CONSOLIDATION TEST RESULTS

strain - log p curve

ANNEXURE-6
SHEET 1 of 2

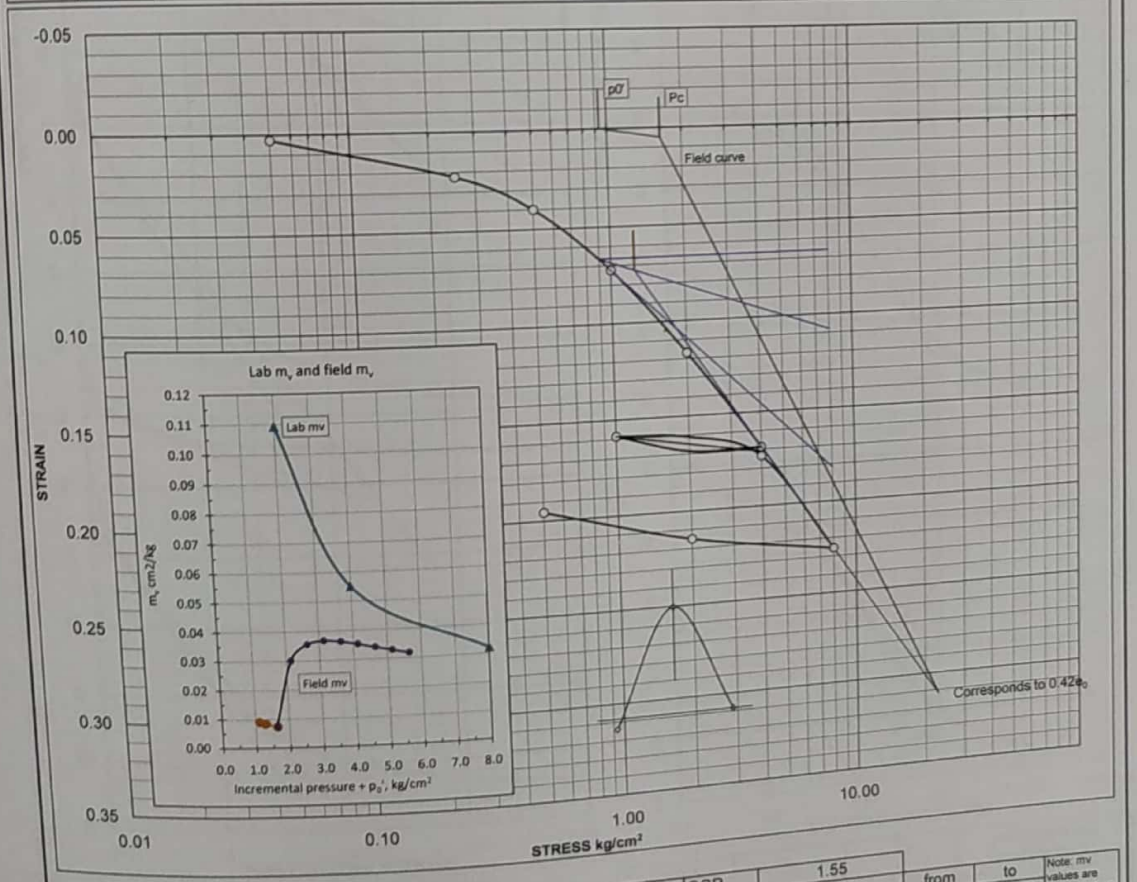
Test Data			
Wt of Consolidation Ring gm :	189.17	Diameter of ring mm :	59.85
Wt of Ring + wet Soil gm :	284.75	Height of ring mm :	19.40
Wt of Wet Soil gm :	95.58	Volume of Ring :	54.60
Wt of Wet Soil after test gm :	87.05	Specific Gravity :	2.644
Wt of ring + Dry Soil gm :	255.97	Initial Void Ratio :	1.16
Wt of Dry soil gm :	66.80	Moisture Content % :	43.08
Wet Density gm/cc :	1.751	Moisture after Test %:	30.31
Dry Density gm/cc :	1.223	Height of Solids mm :	8.977
Liquid Limit %	69.60	Saturated Moisture %:	43.92
Plastic Limit %	20.80	Per cent Saturation :	98.11
Plasticity Index	48.80		
Liquidity Index	0.457		

PROJECT: TNSCB MS NAGAR

BH NO: BH/5 DEPTH 7.50m

SOIL: Dark grey sandy silty clay with sand patches

Stress kg/cm²	Dial div	Incr div	Comp mm	Strain	Height mm	Void ratio	T_{90} min	$C_{v(t90)}$ m²/yr	T_{50} min	$C_{v(t50)}$ m²/yr	Δ_p kg/cm²	m_v cm²/kg	E_c kg/cm²
0.00	5715	0	0.000	0.0000	19.40	1.161	–	–	–	–	–		
0.05	5688	27	0.054	0.0028	19.35	1.155	–	–	–	–	–		
0.25	5497	218	0.436	0.0225	18.96	1.113	–	–	–	–	–		
0.50	5327	388	0.776	0.0400	18.62	1.075	–	–	–	–	–	–	–
1.00	5013	702	1.404	0.0724	18.00	1.005	44.6	0.84	11.1	0.78	0.07	1.0339	1.0
2.00	4582	1133	2.266	0.1168	17.13	0.909	45.6	0.75	13.8	0.58	1.07	0.1092	9.2
4.00	4078	1637	3.274	0.1688	16.13	0.796	46.1	0.67	12.2	0.58	3.07	0.0550	18.2
1.00	4177	1538	3.076	0.1586	16.32	0.818	–	–	–	–	–	–	–
4.00	4033	1682	3.364	0.1734	16.04	0.786	16.4	1.78	–	–	3.00	0.0049	202.1
8.00	3526	2189	4.378	0.2257	15.02	0.673	46.4	0.58	14.6	0.43	7.07	0.0319	31.3
2.00	3631	2084	4.168	0.2148	15.23	0.697	–	–	–	–	–		
0.50	3818	1897	3.794	0.1956	15.61	0.738	–	–	–	–	–		
0.00	4086	1629	3.258	0.1679	16.14	0.798	–	–	–	–	–		



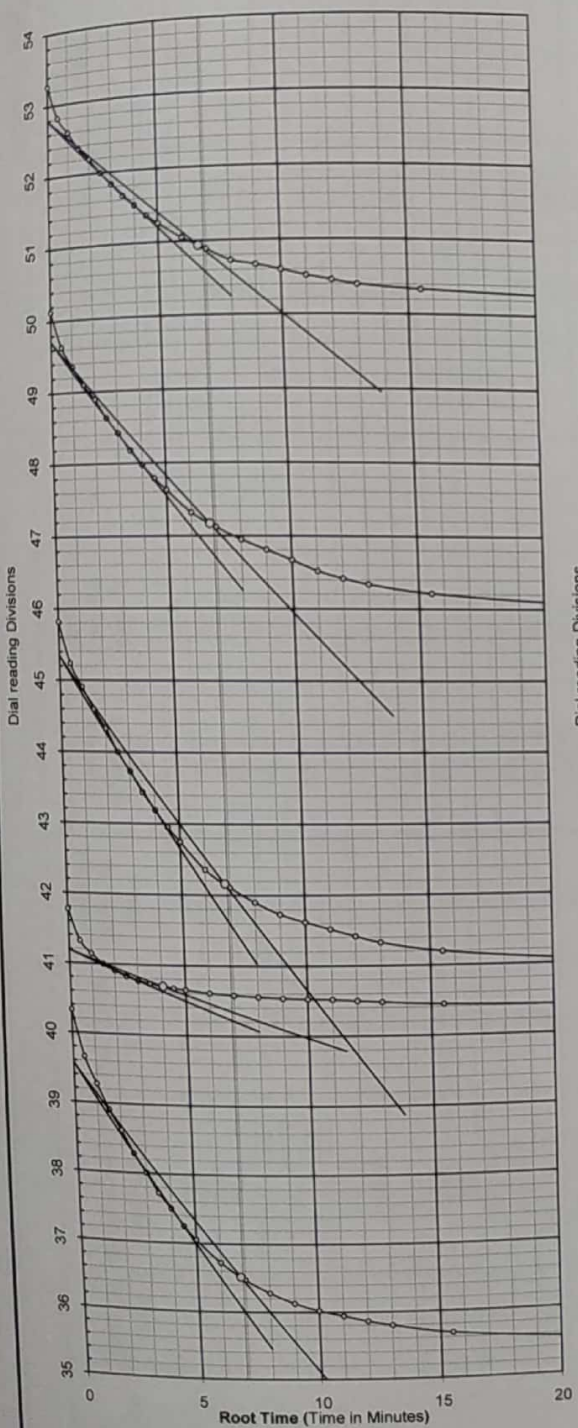
Compression Ratio CR [= cc/(1+e0)]	0.2678		OCR	1.55			Note: mv values are from effective overburden pressure only
Re-compression ratio RR [= cr/(1+e0)]	0.0208		CR/RR	12.88	from	to	
Effective overburden presure	0.930	kg/cm²	Lab m_v	(cm^2 /kg)	0.0319	1.0339	
Pre-consolidation Pressure P_c (Schmertmann)	1.634	kg/cm²	Field m_v	(cm^2 /kg)	0.0072	0.0367	
Pre-consolidation Pressure P_c (Casagrande)	1.244	kg/cm²	Note: for settlement estimations, use field m_v				
Coefficient of secondary consolidation $C_{\alpha\varepsilon}$	4.29E-03 up to 200 kN/m²		6.50E-03 up to 800 kN/m²				

Date December 23, 2019
GEOTECHNICAL Solutions, Chennai

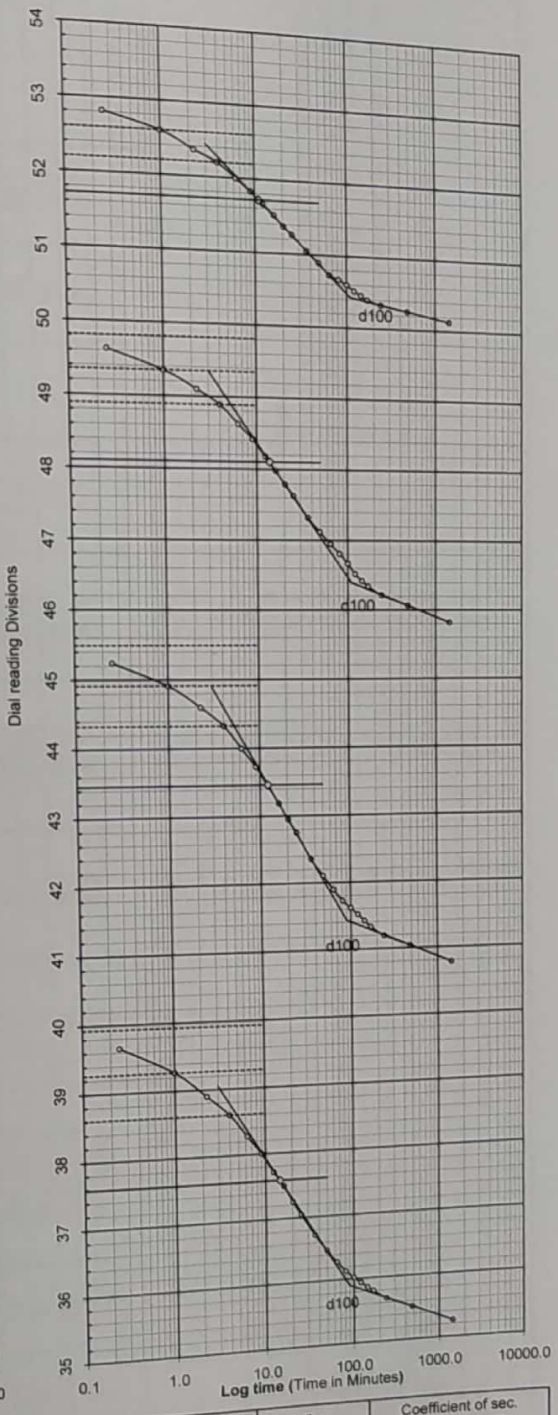
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ONE DIMENSIONAL CONSOLIDATION TEST RESULTS

Project: TNSCB MS NAGAR
Bore hole: BH/5 Depth 7.50m
Soil: Dark grey sandy silty clay with sand patches



Range kg/cm²	t_{90} min	Coefficient of cons C_{v1} m²/year
0.50 to 1.00	44.60	0.838
1.00 to 2.00	45.60	0.754
2.00 to 4.00	46.10	0.668
1.00 to 4.00	16.40	1.779
4.00 to 8.00	46.40	0.579



Range kg/cm²	t_{50} min	C_{v2} m²/year	Coefficient of sec. consolidation $C_{\alpha\varepsilon}$
0.50 to 1.00	11.07	0.784	2.87E-03
1.00 to 2.00	13.79	0.579	5.71E-03
2.00 to 4.00	12.24	0.585	6.34E-03
	-	-	-
4.00 to 8.00	14.58	0.428	6.65E-03

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Appendix- A

Calculation of Load Carrying Capacity of Piles

Project : MS Nagar

Reference BH3

Layer	From	To	SPT - N value	Relative density/ Consistency	Thickness (m)	Corrected SPT - N value	Effective Over burden pressure (kPa)	Sub. Density (kN/m^3)	k	α	φ	δ	c (kPa)	Ultimate unit skin Friction (kPa)
	2	2.25	20	Stiff	0.25	20	1.92	7.69	-	0.38	-	-	120	45.60
Silty clay	2.25	3	20	Stiff	0.75	20	7.69	7.69	-	0.38	-	-	120	45.60
	3	3.75	15	Medium dense	0.75	15	13.46	7.69	1	-	30	27	-	6.86
Clayey silty sand	3.75	4.5	8	Medium dense	0.75	8	18.85	7.19	1	-	29	26.1	-	9.23
Silty clay	4.5	5.5	13	Medium Stiff	1	13	26.54	7.69	-	0.58	-	-	78	45.24
	5.5	6.5	2	Loose	1	2	33.73	7.19	1	-	28	25.2	-	15.87
Sand with clay lumps	6.5	7.5	3	Loose	1	3	40.92	7.19	1	-	28	25.2	-	19.26
	7.5	8.5	2	Loose	1	2	48.11	7.19	1	-	28	25.2	-	22.64
	8.5	10	1	Loose	1.5	1	58.90	7.19	1	-	28	25.2	-	27.71
	10	11.5	17	Stiff	1.5	16	70.43	7.69	-	0.45	-	-	96	43.20
Sandy silty clay	11.5	13	23	Very stiff	1.5	19	81.97	7.69	-	0.42	-	-	114	47.88
	13	14.5	27	Very stiff	1.5	21	93.50	7.69	-	0.37	-	-	126	46.62
	14.5	16	75	Very dense	1.5	43	105.79	8.19	1.15	-	33	29.7	-	69.39
	16	17.5	73	Very dense	1.5	41	118.07	8.19	1.15	-	33	29.7	-	77.45
Sand with weathered sandstone	17.5	19	76	Very dense	1.5	42	130.36	8.19	1.15	-	33	29.7	-	85.51
	19	20.5	100	Very dense	1.5	100	144.14	9.19	1.3	-	36	32.4	-	118.92
	20.5	21	100	Very dense	0.5	100	148.74	9.19	1.3	-	36	32.4	-	122.71

Length of the pile is 19 m

Pile Diameter (m)	0.5	0.6	0.75
C/S Area (sq.m)	0.196	0.283	0.442
Nq	48	48	48
Nq	50	50	50
End bearing capacity of the pile (kN)	904	1308	2059
Safe End bearing capacity of the pile (kN)	362	523	824
Total Positive skin friction (kN)	1410	1498	1873
Positive skin friction with FOS (kN)	564	599	749
Negative skin friction (kN)	156	187	234
Safe Bearing Capacity of the pile (kN)	**770**	**935**	**1339**
Safe Bearing Capacity of the pile (T)	77	94	134
Weight of pile, (kN)	52	75	117
Uplift Capacity of pile (kN)	405	450	586
Uplift Capacity of pile (T)	40	45	59

Note:

1) Pile capacities are estimated based on the procedure suggested in IS:2911 (Part1/Sec 2)-2010. Effective overburden pressure at pile toe is limited to depth equal to 20 times pile diameter.

2) the φ value is restricted to 36 degree in the case of bored piles as per FHWA.

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Appendix-B

Calculation of Lateral capacity of piles (IS 2911)

Project : MS Nagar

Loading Type = Normal
Type of pile = Bored cast-in-situ concrete piles
Length of pile (below cut-off level) = 19 m
Grade of Concrete = M25
f_{ck} = 25 N/mm2
Elastic modulus of concrete, E_c = 5000 √fck MPa
Pile cut off level = 2 m below ground level
Allowable deflection at pile head = 5 mm

	Fixed head	Free head
Diameter of the pile (m)	0.50	0.50
Characteristic strength of concrete (MPa)	25	25
E (MPa)	25000	25000
I (m^4)	3.07E-03	3.07E-03
ηh (kN/m^3) *	1680	1680
Stiffness factor T in m	2.15	2.15
L1/T	0	0
e (m)	0	0
Lf/T **	2.2	1.9
Lf (m) or Z_f	4.72	4.08
Y (permissible deflection) mm	5.0	5.0
H in kN	**43.64**	**16.94**
H in Tonnes	**4.36**	**1.69**

Pile Dia (m)	Lateral Load Capacity of the piles		Lateral Load Capacity of the piles (tons)	
	Fixed Head	Free Head	Fixed Head	Free Head
0.50	43.64	16.94	4.36	1.69
0.60	58.42	22.67	5.84	2.27
0.75	83.49	32.40	8.35	3.24

**Lf/T, ratio between depth of fixity and T read from IS 2911 corresponding to the ratio L1/T, L1 being the free standing length

*ηh , modulus of subgrade reaction as per IS 2911

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Enclosure 1

Multi-channel Analysis of Spectral Waves

Principle

Seismic methods make use of the variation in elastic properties of the strata which affect the velocity of shock/seismic waves travelling through them, thus providing dynamic elastic moduli determinations in addition to mapping of the subsurface horizons. The required shock waves are generated within the subsurface materials, at the ground surface or at a certain depth below it, by striking a plate on the soil/rock with a hammer by detonating a small charge of explosives in the soil/rock.

A series of receivers, usually geophones, are placed in a linear array. An impulse energy source, which can be mechanical or explosive, is located at or near the ground surface at some offset from the end geophone. The output of all of the receivers is recorded when the impulse load is triggered. This shot record is then processed using a Fast Fourier Transform after which, dispersion curves can be picked representing the fundamental Rayleigh waves. These dispersion curves are used in inversion analysis which provides 1D velocity profiles. Multiple 1D velocity profiles can be used to produce a 2D velocity profile of the survey line. A typical test setup is shown in **Figure 4.1**.

The common procedure for MASW surveys usually consists of three steps.

1. Data Acquisition: acquiring multichannel field records (commonly called shot gathers in conventional seismic exploration)

2. Dispersion Analysis: extracting dispersion curves (one from each record)

3. Inversion: back-calculating shear-wave velocity (Vs) variation with depth (called1D Vs profile) that gives theoretical dispersion curves closest to the extracted curves (one 1-D Vs profile from each curve).

The MASW tests at the site were carried out using a 24 channel Geode seismic recorder (Make: Geometrics, USA) as shown in **Figure 4.2**. The data acquisition was done by Seismodule Controller Software (SCS). The vertical geophones of 4.5 Hz

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(24Nos.) are used to receive the wave fields generated by the active source of 10 kg sledgehammer.

Field Survey Procedure

- Vertical geophones of 4.5 Hz were installed in straight line connected to 24 channel seismograph through spread cable. **Figure 4.3** shows the MASW test arrangement. Geophone spacing of 1 to 1.5mwas adopted depending on the length of the survey.
- Wave fields are generated by striking a sledge hammer of 10 kg on a base plate located at some offset from the 1st geophone.
- The data is acquired through seismodule controller software installed in a laptop.
- After one set of records is obtained from one shot the SR (source receiver) configuration is moved by a distance of nd (d is the distance between successive geophones) as shown in **Figure 4.4** and the test is repeated for the required length of survey.

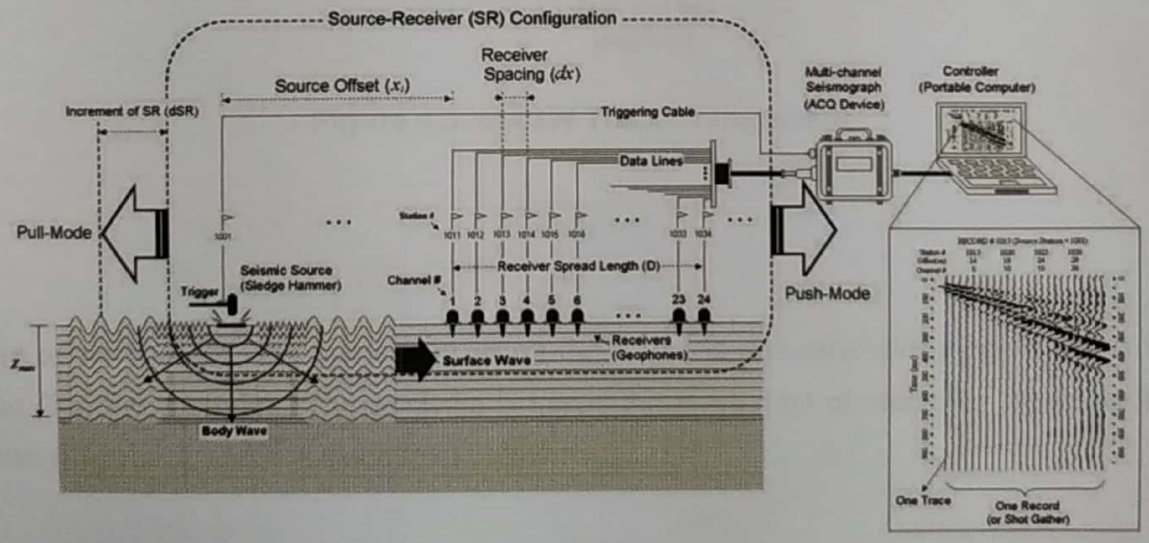


Figure 4.1. MASW Test Setup

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Figure 4.2. Geode Seismic Recorder

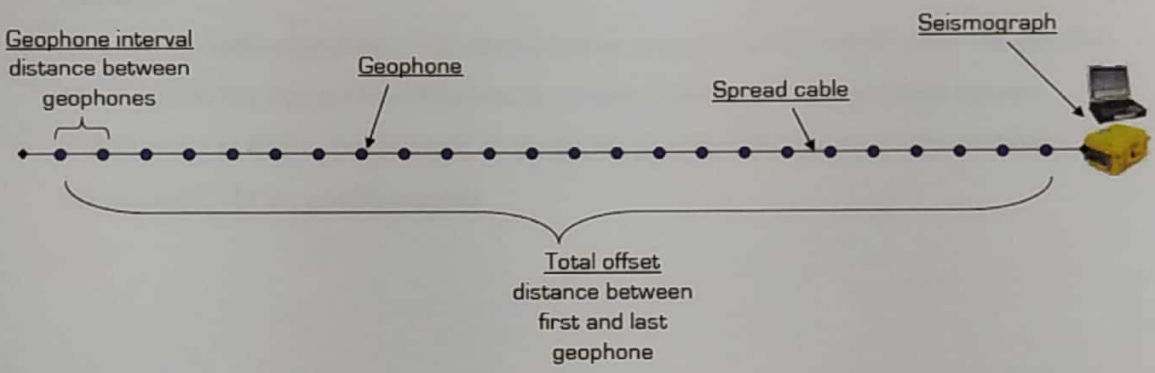


Figure 4.3. MASW Test Arrangement

The acquired data was processed using the Surfseis software with pickwin Wave Eq, and GeoPlot modules. The analysis involves the sequence of steps as shown in flow chart **(Figure 5)** and it is discussed below.

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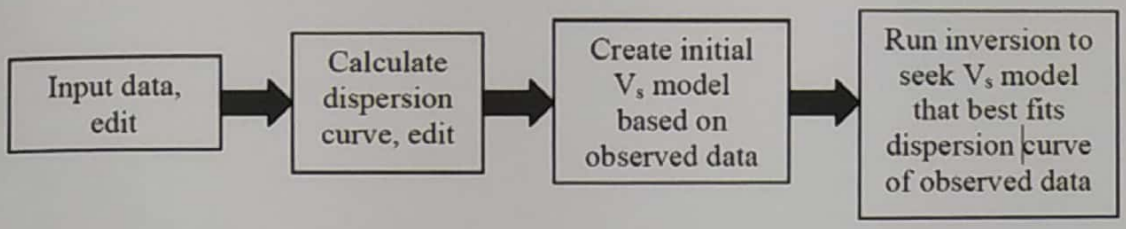


Figure 4.4. Flow Chart of MASW Analysis

- Importing multichannel field record collected during data acquisition in Surfseis.
- Dispersion Analysis: Extracting dispersion curves from each record for getting frequency Vs phase velocity plot. Initial shear wave velocity model is created in this step.
- Inversion: Back-calculation of shear-wave velocity (Vs) depth (1D Vs profile) which gives the theoretical dispersion curves closest to the extracted curves.
- A 2-D map is then constructed through an appropriate interpolation scheme by using each 1-D Vs profile curves.

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