Verified RealEstate™

Your trusted partner for buying, selling, and managing property, ensuring hassle-free service with 100% transparency.

3/350/2 Mettukuppam,
OMR Thoraipakkam,
Chennai, India

hello@verified.realestate
+91 9996 12 9996

Official Property Record

Digitally Verified Record - Powered by Verified RealEstate™



Dr. A.Boominathan, Professor (Retired)
Geotechnical Engineering Division
Department of Civil Engineering
Indian Institute of Technology Madras
Chennai – 600 036
boomi@faculty.iitm.ac.in

08-02-2023

To
The Executive Engineer, Division: III (A/C)
Tamil Nadu Urban Habitat Development Board, (TNUHDB) Division: III
T.P.Chatram , Chennai 600010

Sub: TNUHDB-Dn. -III-, Chennai - Reconstruction of Slum Tenements at Vembuliamman Koil Street in Zone - 8 of Chennai Corporation – Revised SBC - Reg.

Ref:
(1) Your letter no: 660/JE(P) /Dn:III/2019 dated 12.01.2023
(2)Soil Investigation Report No. IC1920CE7927SCB002777 dated 24.01.2022
(3) Email dated 6.1.2023 and 10.01.2023 from Centre for Urbanization, Buildings & Environment [CUBE]

With reference to the above the Executive Engineer, Division III (A/C) of TNUHDB and the CUBE requested the undersigned to recommend SBC of the proposed raft S+9 floor building buildings instead of G+5 floors blocks originally proposed at their Project site at Vembuliamman Koil Street in Zone - 8 of Chennai Corporation. Based on the column/ shear wall loading details on the proposed raft provided by the CUBE, the following the type of foundation is recommended to support the S+9 floors building blocks :

- Type of foundation : Full Raft
- Total Raft area : 110 m^2
- Depth of the Foundation : 2m from the existing ground level
- Allowable bearing capacity : 150 kPa

Yours sincerely

(Dr.A.Boominathan)

REPORT ON

SOIL INVESTIGATION FOR THE CONSTRUCTION OF (G+5 FLOORS) SLUM TENEMENTS FOR TNSCB AT VEMBULIAMMAN KOIL STREET IN CORPORATION Dn.107, ZONE 8, EGMORE CONSTITUENCY, CHENNAI.

CLIENT

THE EXECUTIVE ENGINEER,

DIVISION IV,

TAMILNADU SLUM CLEARANCE BOARD (TNSCB), CHENNAI.

CONSULTANT

Prof. A. Boominathan

GEOTECHNICAL ENGINEERING DIVISION
DEPARTMENT OF CIVIL ENGINEERING
INDIAN INSTITUTE OF TECHNOLOGY MADRAS
CHENNAI - 600 036

January 2020

REPORT ON

SOIL INVESTIGATION FOR THE CONSTRUCTION OF (G+5 FLOORS) SLUM TENEMENTS FOR TNSCB AT VEMBULIAMMAN KOIL STREET IN CORPORATION Dn.107, ZONE 8, EGMORE CONSTITUENCY, CHENNAI.

CLIENT

THE EXECUTIVE ENGINEER,

DIVISION IV,

TAMILNADU SLUM CLEARANCE BOARD (TNSCB), CHENNAI.

CONSULTANT

Prof. A. Boominathan

GEOTECHNICAL ENGINEERING DIVISION
DEPARTMENT OF CIVIL ENGINEERING
INDIAN INSTITUTE OF TECHNOLOGY MADRAS
CHENNAI - 600 036

January 2020

Sl. No	CONTENTS	Page No.
1	Introduction	1
2	Field Investigations	1
	2.1 Drilling of Bore Holes and SPT Test	1
	2.2 MASW Test	3
3	Laboratory Investigations	4
4	Site Characterization	4
	4.1 Site Topography andSoil Profile	4
	4.2 Groundwater Table	4
	4.3 Shear Strength	5
	4.4 Analysis of Results	5
	4.5 Liquefaction Susceptibility	7
5	Selection of type of foundation and estimation of capacity	7
	5.1 Bearing capacity calculation	7
	5.2 Settlement calculation	8
6	Summary and Recommendations	9
7	Acknowledgement	10
	References	11
	Annexure 1 - Bore logs	
	Annexure 2 –Laboratory Test Results	
	Annexure 3 - Grain size distribution curves	
	Annexure 4- Lateral soil profile	
	Annexure 5- Bearing capacity calculation	
	Annexure 6- Settlement calculation	
	Enclosure I- MASW Test Results	

Geotechnical Engineering Division, IIT Madras

FAX	COURIER	SPEEDPOST	POST	HAND DELIVERY

GEOTECHNICALENGINEERINGDIVISION
DEPARTMENT OF CIVIL ENGINEERING
INDIAN INSTITUTE OF TECHNOLOGY, MADRAS
CHENNAI - 600 036 INDIA

Dr. A.Boominathan
Professor

Report No.: IC1920CE792TSCB002777 dated 24/01/2020

REPORT ON SOIL INVESTIGATION FOR THE CONSTRUCTION OF (G+5 FLOORS) SLUM TENEMENTS FOR TNSCB AT VEMBULIAMMAN KOIL STREET IN CORPORATION Dn.107, 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 (G+5 floors) slum tenements at Vembuliamman Koil street in corporation Dn.107, 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 from 9th December 2019 to 16th December 2019 by Geo technical 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 20th December 2019by IIT Madras. This report presents the details of the site characterization based on the field and laboratory investigations, 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 three exploratory boreholes at the existing site locations and plan of the proposed buildings are shown in the **Figure 1a & 1b**. The boreholes were advanced up to a maximum depth of 25 m below the GL.

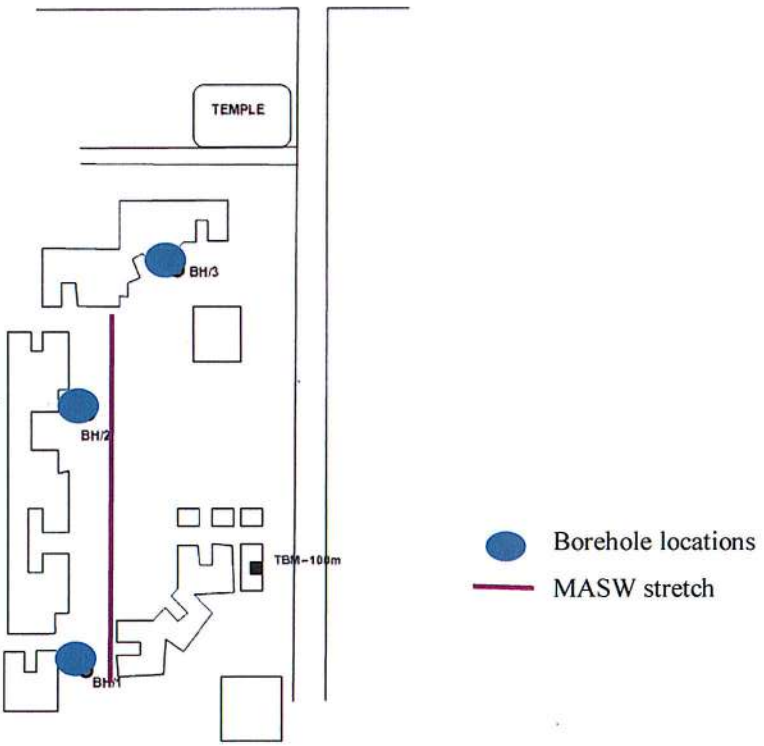


Figure 1a: Site plan showing location of boreholes and MASW stretch (with existing buildings)

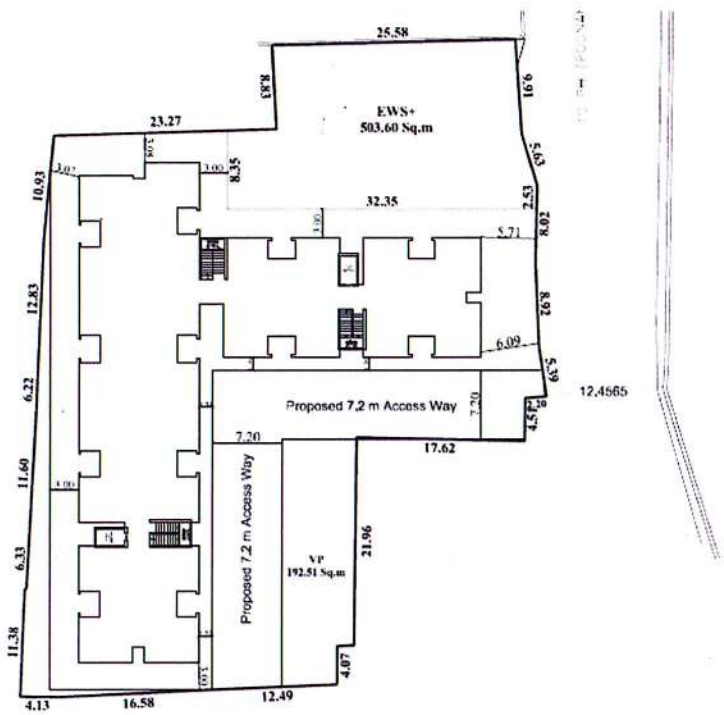


Figure 1b: Site plan of the proposed buildings

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 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 a stretch 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 photo taken during the test.

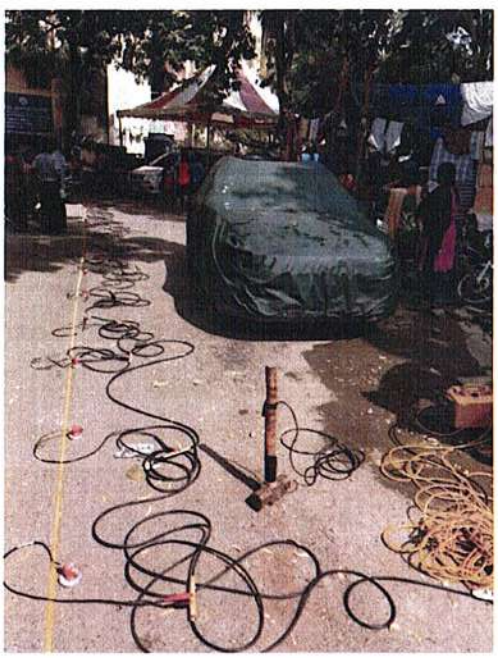


Figure 2: MASW test in progress image

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 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. Site Topography and Soil Profile

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 up to a depth of 1.5m from the ground level. It is followed by medium stiff to stiff sandy clay layer with SPT N in the range of 20 to 30occurs up to a depth of about 4m. Below 4 m depth, a medium dense to dense sand stratum with SPT N value in the range of 17-49is observed up to a depth of about 16m.Alayer of very dense cemented sand/hard sandy clay with stones is encountered in all the boreholes from 16m to 23m depth. Below this layer, occurs a jointed weathered sandstone and mudstone layer up to a depth of borehole termination i.e., 25 m.

4.2. Groundwater Table

During the period of field investigation, the ground water table was encountered between 6.1 m to 7.0 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.

4.3. 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.

4.4 Analysis of Results

The 1D & 2D profiles of the MASW stretch is illustrated in **Figures 2a & 2b**. It can be observed that the shear wave velocity (Vs) of about 150-200 m/s within a depth of 5 m. The Vs indicates the presence of medium dense sand or soft clay soil at shallow depth. Below 5 m, the Vs is gradually increased to 300-500 m/s up to a depth of about 16 m which indicates the presence of dense/stiff strata. This can be confirmed from the boreholes which show the presence of medium dense to dense layer at this depth. Further, the Vs value increases from 500 to 800 m/s which shows the presence of hard strata below 16 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 medium dense/stiff layers at shallow depths and hard layers below 16 m depth and matches well with the results of the exploratory boreholes.

From the results of the MASW test and the exploratory boreholes, it can be concluded that the present site comprises of medium dense /stiff layers at shallow depths and hard layers below 16 m depth.

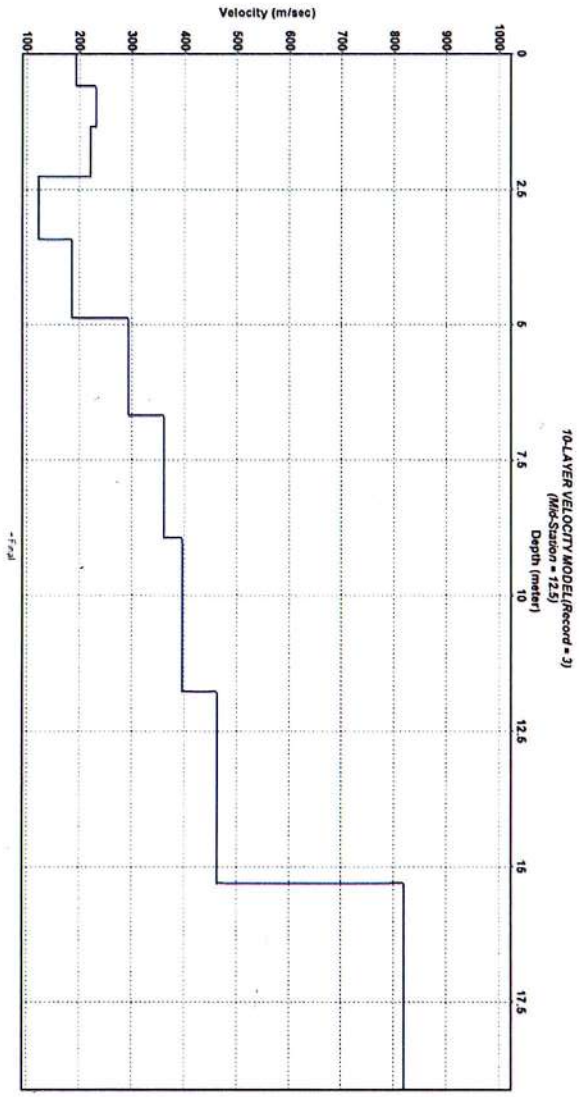


Figure 2a. One dimensional shear wave velocity (Vs) profile

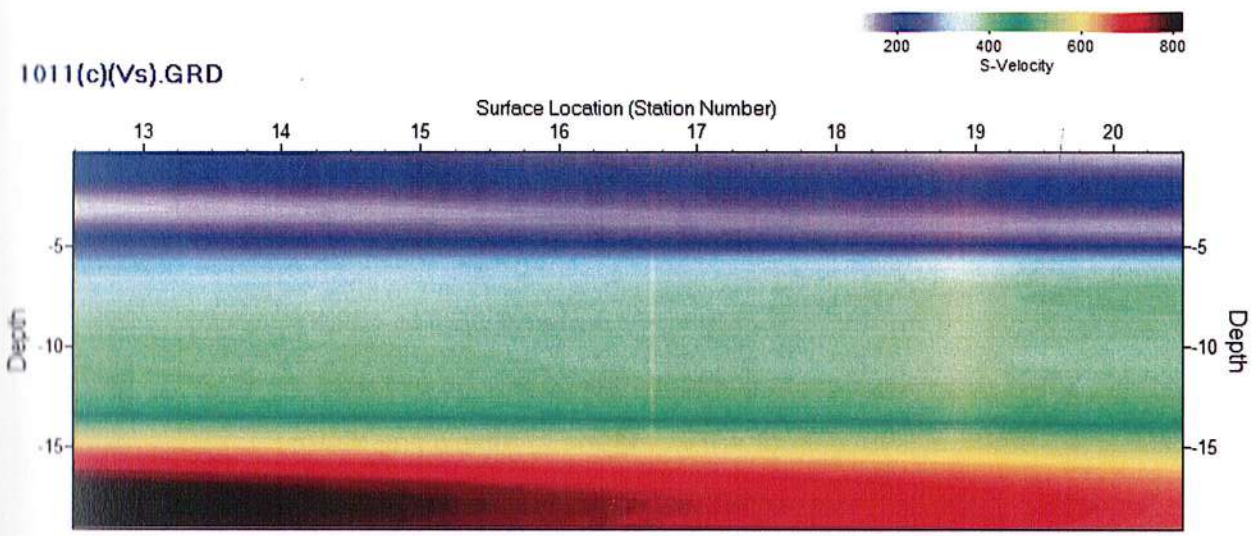


Figure 2b. Two dimensional shear wave velocity (Vs) profile

4.6. 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 dense sandy/stiff clayey layers at shallow depths and hence, the site is not vulnerable to liquefaction for the anticipated seismic loading.

5.0. SELECTION OF TYPE OF FOUNDATION AND ESTIMATION OF FOUNDATION CAPACITY

5.1. Selection of Type of Foundation

The subsoil of the site consists of relatively dense sandy and stiff clay layers from 2 m onwards from the existing ground surface. It is proposed to construct G + 5 storeyed buildings, therefore, considering the anticipated load intensity induced by the proposed buildings and nature of the soil strata at the site, it is preferable to adopt raft foundations to support the proposed buildings.

5.1. Bearing Capacity Calculation

The size of the proposed building is about 33 m x 9 m and hence the size of the raft for estimation of bearing capacity is considered as 34 m x 10 m. The depth of the foundation is assumed as 2.0 m from the existing ground surface. The ultimate capacity for the raft foundation is calculated using the following formula (IS 6403-1981):

$$U.B.C = cN_c s_c d_c i_c + 1/2 B_\gamma N_\gamma s_\gamma d_\gamma i_\gamma W' + q(Nq-1) s_q d_q i_q$$

Where,

c = cohesion in kN/m^2.

B = width of footing in m

q = Effective surcharge weight of soil at footing level in kN/m^2,

γ = Bulk unit weight of soil below the footing level in kN/m^2

N_c, N_γ & N_q = Bearing capacity factors depending upon the angle of internal friction at footing level

W' = Water table correction which is 0.5 for the condition considered

S_c =Shape factor as defined in code

d_c =Depth factor as define in code

i_c =inclination factor as defined in code

The ultimate bearing capacity is estimated based on average soil profile at the site and the details of calculations are presented in **Annexure 5.** A factor of safety 2.5 is adopted to arrive at the net safe bearing capacity. The net safe bearing capacity of the raft is found to be about 279 kN/m^2.

5.2. Settlement calculation

The settlement analysis is carried out for the representative soil profile (BH-1). The permissible settlement is limited to 50 mm. The safe bearing capacity for 50 mm settlement is obtained from the using the following formula:

Total settlement (ΔH), is calculated as the sum of elastic and consolidation settlement.

$$\Delta H = \Delta H_1 + \Delta H_2$$

The elastic settlement is calculated based on theory of Elasticity for sandy soils by using the following formula (Bowles, 2012):

$$\Delta H_1 = \frac{qB'(1-\mu^2)mI_sI_F}{E_s}$$

where

q= Intensity of pressure(SBC)

B= Width of footing.

μ= Poisson's ratio

Es= Modulus of elasticity of soil,

m = Number of corners contributing to settlement

I_S =Steinbrenner influence factors,

I_F= Fox's influence factors

Young's modulus is adopted based on the following equations:

Es = 250(N+15), for sand layer

Es = (100 to 500)s_u, for clay layer

where

N = SPT value

s_u= cohesion

The consolidation settlement of the raft is calculated based on consolidation theory for clayey soils using the following formula (Bowles, 1997):

$$\Delta H_2 = m_v \Delta\sigma_i H_i$$

where

mv = Coefficient of volume compressibility in m^2/kN

mv is calculated from the SPT 'N' value using Stroud and Butler (1975).

The settlement calculations are presented in **Annexure 6**. The allowable bearing capacity for a total settlement of 50 mm is found to be about 135 kPa, which is less than the net safe bearing capacity of 279 kPa.

6. SUMMARY AND RECOMMENDATIONS

It is proposed to constructG+5 floors slum tenements at Vembuliamman Koil street in corporation Dn.107, Zone 8, Egmore Constituency, Chennai. The soil profile obtained from the bore holes matches with the geophysical investigation carried out at the site using advanced MASW apparatus.

The site consists of predominantly medium dense to dense sand/stiff clay layers up to a depth of 16 m and very dense cemented sand/hard sandy clay layers from 16 to a depth of borehole termination. In view of the presence of medium dense to dense sandy/stiff clay layers at shallow depth sand considering the anticipated load, it is recommended to adopt raft foundation.

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

- Type of foundation – Full Raft
- Size of the Raft – 34 m x 10 m
- Depth of foundation – 2.0 m from the existing ground level
- Allowable bearing capacity – 135 kPa

(b) The recommended safe capacities for shallow foundations can be realized only if the foundation excavations are made without disturbing the soil below the founding level. During monsoon periods water table may rise to ground surface. Hence excavation work has to be done carefully considering the above factor. Pumping from the sump in the excavation is unacceptable because of the danger of collapse of bottom of the excavation as a result of the lowered effective stress due to rising of the water. Hence, it is

recommended to use well points with good controls during dewatering in the excavation.

Furthermore, care must be taken that a nearby building is not affected by lowering the water table beneath the building. It is also recommended to re-roll the excavation bottom using 20- tons capacity vibro compactor with a minimum of three passes.

(c) In order to avoid future flooding at the site and good drainage, it is recommended to raise the overall site level by at least 0.75 m above the existing road level and the building ground floor level about 0.5 m above the finished site level. This will prevent rainwater flooding into the site.

(d) Proximity of the site to the coastal region requires considerations for reinforced concrete design for saline environments. IS 456:2000 suggests the nominal cover for reinforcement as per the exposure conditions given in clause 8.2.2.45mm is suggested for structures immersed in sea water or exposed to coastal environment (Clause 26.4.2). It is also recommended to use a corrosion resistant steel (CRS) or regular steel with anticorrosive epoxy coat or Cement Polymer Composite Coating, and slag or pozzolana cement instead of OPC, and other recommendations specified in Clause 8.2.8 of IS 456:2000 for the construction of substructures up to plinth level.

(e) Portland Pozzolona cement or super slag cement shall be preferred in the construction of footing.

(f) The recommended safe capacity of the foundation can be ensured only by adopting a quality construction procedure with good quality control.

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, Division IV, TNSCB, Chennai for planning and execution of the above investigation are greatly acknowledged.

24/01/2020

(Prof. A. Boominathan)

Prof. A. Boominathan, Ph.D.,
Geotechnical Engg. Division
Department of Civil Engineering
Indian Institute of Technology Madras
Chennai - 600 036. INDIA.
boomi@iitm.ac.in

Prof. A. Boominathan, Ph.D.,
Geotechnical Engg. Division
Department of Civil Engineering
Indian Institute of Technology Madras
Chennai - 600 036. INDIA.
boomi@iitm.ac.in

REFERENCES

1. Bowles J.E (1997), Foundation Analysis and Design, McGraw-Hill Companies Ltd.
2. Briaud J.L, (2013), Geotechnical engineering: saturated and unsaturated soils, Wiley, New York.
3. Compendium of Indian Standards on Soil Engineering SP 36 (Part 1 and Part 2)
4. Gopal Ranjan and Rao A.S.R.(1991), Basic and Applied Soil Mechanics, New Age International Limited Publishers, New Delhi
5. IS 6403:1981 (reaffirmed in 1997), Code of Practice for Determination of Bearing Capacity of Shallow Foundations.
6. IS 2911-1-2 (2010): Design and construction of pile foundations- code of practice, Part 1: concrete piles, Section 2: Bored cast in-situ piles.
7. IS 2911(Part 4)-1985 (reaffirmed in 2010), Code of Practice for Design and Construction of Pile Foundation; Part 4: Load Test on Piles.
8. Look B.G, (2007), Handbook of Geotechnical Investigation and Design Tables, Taylor & Francis, UK.
9. Park,C.B.(2000), Surfseis 2000: For MASW, Users Manual, Kansas Geological Survey, USA.

FIELD BORE LOG

ANNEXURE 1

SHEET 1 OF 2

GEOTECHNICAL Solutions[A1]

PROJECT NO:	TNSCK/VAKS/1306
BORE HOLE NO:	BH/1

Project : New Tenements for TNSCB
Site : Vempuli Amman Koil Street
Location : As shown in Figure 1
Dia and type of boring : 150mm Rotary boring with drilling mud circulation

Date of start : 9-Dec-2019
Date of finish : 10-Dec-2019
GWL from GL : 6.10m
Ground level RL : 99.680m

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			Dark grey dirty sand with stones (fill) with top road section		0.50							Random fill
	1.4											
2.0			Greyish brown sandy clay with black patches		1.50	1.50	3	3	4	4	7	Medium stiff
	2.2											
3.0	2.9		Greyish brown fine sandy clay with sand patches		2.25	2.25	6	8	12	19	20	Stiff
					3.00	3.00	7	10	12	12	22	
4.0												
					3.75	3.75	7	8	9	11	17	
5.0			Brownish grey / light grey clayey fine to medium sand		4.50	4.50	8	8	11	13	19	Medium dense
6.0					5.50	5.50	9	10	11	12	21	
	6.2											
7.0			Reddish brown clayey fine to medium sand with light grey patches		6.50	6.50	10	11	13	13	24	Medium dense
	7.4											
8.0					7.50	7.50	9	8	10	13	18	
			Light yellowish grey dirty fine to medium sand with light grey patches									Medium dense
9.0					8.50	8.50	10	10	10	17	20	
10.0	9.8											
			Light grey dirty fine to medium sand		10.00	10.00	10	9	10	11	19	Medium dense
11.0												
	11.3											
12.0			Light yellowish grey dirty fine sand with medium sand particles		11.50	11.50	14	21	27		48	Dense
	12.5											
13.0					13.00	13.00	11	15	15	20	30	
			Light grey and brownish dirty fine sand with medium sand particles									Dense
14.0												
15.0					14.50	14.50	12	14	20	25	34	
	15.5											
16.0					16.00	16.00	30	50/15cm			>100	
			Greyish brown clayey silty fine to medium sand with stones									Very dense
17.0	17.0											
18.0			Brownish and light grey clayey cemented sand / sandy clay		17.50	17.50	24	30	38		68	Hard
	18.3											
19.0			Reddish brown, yellowish brown and light grey sandy clay with stones		19.00	19.00	50/11cm				>100	Hard
20.0	20.0											
			Continued in the next sheet		Borehole terminated at 22.40m							

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

FIELD BORE LOG

GEOTECHNICAL Solutions[A1]

PROJECT NO:	TNSCK/VAKS/1306
BORE HOLE NO:	BH/1

Project : New Tenements for TNSCB
Site : Vempuli Amman Koil Street
Location : As shown in Figure 1
Dia and type of boring : 150mm Rotary boring with drilling mud circulation

Date of start : 9-Dec-2019
Date of finish : 10-Dec-2019
GWL from GL : 6.10m
Ground level RL : 99.680m

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 grey hard clay (weathered mudstone)		20.50	20.50	50/12cm				>100	Hard
22.0	22.0				22.00	Rebound				RB	
	22.3	Yellowish brown weathered fractured rock			22.40	Rebound				RB	Very weak
23.0		Yellowish grey, yellowish brown and brown jointed weathered sandstone and mudstone	22.40-23.40		DC core drilling NX size					R24% Q0%	Weak
24.0			23.40-24.40		DC core drilling NX size					R28% Q0%	
	24.4										
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		TC core drilling from 22.00m to 22.40m DC core drilling from 22.40m to 24.40m									

Continued from sheet 1

Borehole terminated at 22.40m

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

FIELD BORE LOG

GEOTECHNICAL Solutions[A1]

PROJECT NO:	TNSCK/VAKS/1306
BORE HOLE NO:	BH/2

Project : New Tenements for TNSCB
Site : Vempuli Amman Koil Street
Location : As shown in Figure 1
Dia and type of boring : 150mm Rotary boring with drilling mud circulation

Date of start : 11-Dec-2019
Date of finish : 12-Dec-2019
GWL from GL : 7.00m
Ground level RL : 99.450m

Depth from (G.L.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	0.9		Greyish dirty sand with stones (fill) with top road section		0.50							Random fill
2.0			Brownish grey silty clay with fine sand		1.50	1.50	6	9	10	11	19	Stiff
3.0	2.2		Brownish grey silty clay with grey patches		2.25	2.25	6	11	11	13	22	Very stiff
4.0	3.7				3.00	3.00	7	10	13	18	23	
5.0			Brownish and grey clayey fine to medium sand (cemented)		3.75	3.75	9	10	9	13	19	Medium dense
6.0					4.50	4.50	8	9	9	11	18	
7.0	6.2		Reddish brown and light grey dirty fine to medium sand		5.50	5.50	6	8	9	11	17	
8.0					6.50	6.50	9	9	10	9	19	Medium dense
9.0	8.4		Light grey / whitish grey dirty fine to medium sand		7.50	7.50	10	10	11	12	21	
10.0	9.7				8.50	8.50	10	13	14	16	27	Medium dense
11.0			Light yellowish brown and light grey dirty fine to medium sand		10.00	10.00	9	13	13	15	26	Medium dense
12.0					11.50	11.50	10	11	15	15	26	
13.0	12.8		Yellowish grey silty fine sand with some clay		13.00	13.00	14	19	25		44	Dense
14.0					14.50	14.50	13	20	29		49	
15.0												
16.0	15.5		Yellowish grey clayey fine sand with medium sand particles		16.00	16.00	50/13cm				>100	Very dense
17.0	16.8		Yellowish brown and light grey fine to coarse sand with silt and gravel		17.50	17.50	50/10cm				>100	Very dense
18.0												
19.0	18.6		Yellowish fine sandy silty clay with light grey patches		19.00	19.00	20	28	34		62	Hard
20.0	20.0											

Continued in the next sheet

Borehole terminated at 22.70m

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

FIELD BORE LOG

GEOTECHNICAL Solutions[A1]

PROJECT NO:	TNSCK/VAKS/1306
BORE HOLE NO:	BH/2

Project : New Tenements for TNSCB
Site : Vempalli Amman Koil Street
Location : As shown in Figure 1
Title and type of boring : 150mm Rotary boring with drilling mud circulation

Date of start : 11-Dec-2019
Date of finish : 12-Dec-2019
GWL from GL : 7.00m
Ground level RL : 99.450m

Soil Profile	Field Description	Depth of samples collected		SPT / VST						RD / Consistency
		UDS	DS	Test depth m	Blow Counts 15	30	45	60	N**	
	Greyish dirty sand with stones (fill) with top road section		0.50							Random fill
	Brownish grey silty clay with fine sand		1.50	1.50	6	9	10	11	19	Stiff
	Brownish grey silty clay with grey patches		2.25	2.25	6	11	11	13	22	Very stiff
			3.00	3.00	7	10	13	18	23	
	Brownish and grey clayey fine to medium sand (cemented)		3.75	3.75	9	10	9	13	19	Medium dense
			4.50	4.50	8	9	9	11	18	
			5.50	5.50	6	8	9	11	17	
	Reddish brown and light grey dirty fine to medium sand		6.50	6.50	9	9	10	9	19	Medium dense
			7.50	7.50	10	10	11	12	21	
	Light grey / whitish grey dirty fine to medium sand		8.50	8.50	10	13	14	16	27	Medium dense
	Light yellowish brown and light grey dirty fine to medium sand		10.00	10.00	9	13	13	15	26	Medium dense
			11.50	11.50	10	11	15	15	26	
	Yellowish grey silty fine sand with some clay		13.00	13.00	14	19	25		44	Dense
			14.50	14.50	13	20	29		49	
	Yellowish grey clayey fine sand with medium sand particles		16.00	16.00	50/13cm				>100	Very dense
	Yellowish brown and light grey fine to coarse sand with silt and gravel		17.50	17.50	50/10cm				>100	Very dense
	Yellowish fine sandy silty clay with light grey patches		19.00	19.00	20	28	34		62	Hard

Continued in the next sheet

Borehole terminated at 22.70m

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

FIELD BORE LOG

GEOTECHNICAL Solutions[A1]

PROJECT NO:	TNSCK/VAKS/1306
BORE HOLE NO:	BH/2

Project : New Tenements for TNSCB
Site : Vempuli Amman Koil Street
Location : As shown in Figure 1
Dia and type of boring : 150mm Rotary boring with drilling mud circulation

Date of start : 11-Dec-2019
Date of finish : 12-Dec-2019
GWL from GL : 7.00m
Ground level RL : 99.450m

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		Yellowish brown dirty fine to medium sand with weathered stones		20.50	20.50	50/14cm	>100	Very dense
22.0	22.0				22.00	Rebound	RB	
23.0	22.7	Yellowish brown fractured rock			22.70	Rebound	RB	Very weak
24.0		Yellowish brown and light grey weathered sandstone and mudstone	22.70-23.70		DC core drilling NX size		R43% Q29%	Weak
25.0	24.7		23.70-24.70		DC core drilling NX size		R39% Q23%	
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		TC core drilling from 22.00m to 22.70m DC core drilling from 22.70m to 24.70m						

Continued from sheet 1

Borehole terminated at 22.70m

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

FIELD BORE LOG

GEOTECHNICAL Solutions[A1]

PROJECT NO:	TNSCK/VAKS/1306
BORE HOLE NO:	BH/3

Project : New Tenements for TNSCB
Site : Vempuli Amman Koil Street
Location : As shown in Figure 1
Dia and type of boring : 150mm Rotary boring with drilling mud circulation

Date of start : 13-Dec-2019
Date of finish : 16-Dec-2019
GWL from GL : 7.00m
Ground level RL : 99.500m

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		Brownish sandy gravel with clay (fill) with top PCC		0.50							Fill
1.1		Greyish brown fine sandy silty clay		1.50	1.50	7	10	13	16	23	Very stiff
2.0											
2.2		Brownish grey silty clay with fine sand		2.25	2.25	9	14	16	17	30	Very stiff
2.9		Brownish grey sandy clay / clayey cemented sand		3.00	3.00	10	11	16	17	27	Very stiff
3.0											
3.8		Greyish brown / brownish clayey / dirty fine to medium sand		3.75	3.75	9	10	11	11	21	Medium dense
4.0											
5.0				4.50	4.50	10	11	11	12	22	
6.0				5.50	5.50	10	12	14	16	26	
7.0				6.50	6.50	9	10	13	15	23	
7.3		Light grey and brownish silty / dirty fine to medium sand		7.50	7.50	11	13	13	15	26	Medium dense
8.0											
9.0				8.50	8.50	9	10	13	15	23	
10.0				10.00	10.00	10	11	12	14	23	
11.0											
11.2		Yellowish dirty fine to medium sand		11.50	11.50	10	12	14	17	26	Medium dense
12.0											
12.7		Yellowish grey and greenish grey silty fine sand		13.00	13.00	14	21	28		49	Dense
13.0											
14.0				14.50	14.50	16	6	30		36	
15.0											
15.7		Yellowish grey silty fine sand with medium sand particles		16.00	16.00	50/12cm				>100	Very dense
16.0											
17.0											
17.3		Yellowish brown and light grey clayey cemented sand with sandy clay		17.50	17.50	21	30	38		68	Hard
18.0											
18.7		Yellowish brown dirty fine to medium sand with weathered stones		19.00	19.00	50/15cm				>100	Very dense
19.0											
20.0	20.0										

Continued in the next sheet

Borehole terminated at 22.90m

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

FIELD BORE LOG

GEOTECHNICAL Solutions[A1]

PROJECT NO:	TNSCK/VAKS/1306
BORE HOLE NO:	BH/3

Project : New Tenements for TNSCB
Site : Vempuli Amman Koil Street
Location : As shown in Figure 1
Dia and type of boring : 150mm Rotary boring with drilling mud circulation

Date of start : 13-Dec-2019
Date of finish : 16-Dec-2019
GWL from GL : 7.00m
Ground level RL : 99.500m

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 yellowish brown and light grey clayey sandy silt with light grey patches		20.50	20.50	50/11cm				>100	Hard
22.0	22.0					22.00	Rebound				RB	
23.0	22.9		Yellowish brown weathered fractured rock	22.00-22.90		TC core drilling 22.90	Rebound				RB	Very weak
24.0			Yellowish brown and light grey weathered sandstone and mudstone	22.90-23.90		DC core drilling NX size					R45% Q23%	Weak
25.0	24.9			23.90-24.90		DC core drilling NX size					R32% 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												
40.0			TC core drilling from 22.00m to 22.90m DC core drilling from 22.90m to 24.90m									

Continued from sheet 1

Borehole terminated at 22.90m

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

GEOTECHNICAL SOLUTIONS[A1]

SUMMARY OF LABORATORY TEST RESULTS

Project: **TNSCB Vembuliamman Koil Street** **Annexure-2**

Borehole Nos: **BH/1, BH/2** and **BH/3** SHEET 1 OF 4

Type of Boring and dia of bore hole: 150mm diameter rotary boring with mud circulation Ground Water Table: 6.10m in boreholes, December 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															
GL-0.75	DS	Dark grey dirty sand with stones (fill) with top road section			20.7												
1.50	SPT	Greyish brown sandy clay with black patches	7		20.3												
2.25	SPT	Greyish brown fine sandy clay with sand patches	20	SC-CH	30.5	61.7	24.4	37.3	0.164	63.6							
3.00	SPT	Brownish grey clayey cemented fine to medium sand	22	SC-SP	14.2							0.8	0.7	24.7	48.2	25.6	
3.75	SPT	Light brownish grey clayey fine to medium sand	17		14.2												
4.50	SPT	Lt brownish grey clayey fine to medium sand with yell brown patches	19	SC-SP	14.3							0.5	0.3	40.8	35.2	23.2	
5.50	SPT	Light grey and brownish clayey fine to medium sand	21		14.0												
6.50	SPT	Reddish brown clayey fine to medium sand with light grey patches	24	SC-SP	12.9								0.1	47.5	33.2	19.2	
7.50	SPT	Light yellowish grey dirty fine to medium sand	18	SP	12.0							0.8	3.3	47.3	33.5	15.1	
8.50	SPT	Light yellowish grey dirty fine to medium sand with light grey patches	20		11.5												
10.00	SPT	Light grey dirty fine to medium sand	19	SM-SP	11.7							0.7	3.5	40.5	39.5	15.8	
11.50	SPT	Light yellowish grey dirty fine sand with medium sand particles	28		14.4												
13.00	SPT	Light grey and brownish dirty fine sand with medium sand particles	30	SM-SP	16.0								1.5	23.6	56.3	18.6	
14.50	SPT	Light greenish grey and brown dirty fine sand with medium sand particles	34		14.3												
16.00	SPT	Greyish brown clayey silty fine to medium sand with stones	>100	SC-SP	14.1							1.3	1.5	28.7	42.6	25.9	

SUMMARY OF LABORATORY TEST RESULTS

Project: **TNSCB Vembuliamman Koil Street**

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)
17.50	SPT	Brownish and light grey clayey cemented sand / sandy clay	68	SC-SM	12.5							0.2	6.7	31.4	25.0	36.7	
19.00	SPT	Reddish brown, yellowish brown and light grey sandy clay with stones	>100		18.2												
20.50	SPT	Greenish grey and yellowish grey hard clay (weathered mudstone)	>100		17.9												
22.40-23.40		Yellowish grey and brown weathered sandstone and mudstone															
23.40-24.40		Light yellowish brown and grey weathered sandstone and mudstone															

SUMMARY OF LABORATORY TEST RESULTS

Project: **TNSCB Vembuliamman Koil Street**

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															
GL-0.75	DS	Greyish dirty sand with stones (fill) with top road section			10.9												
1.50	SPT	Brownish grey silty clay with fine sand	19	CI	22.3	40.3	17.7	22.6	0.204	36.4							
2.25	SPT	Brownish grey silty clay with grey patches	22		24.1												
3.00	SPT	Brownish grey silty clay with grey patches	23	CH	26.5	53.6	22.1	31.5	0.140	45.5							
3.75	SPT	Brownish and grey clayey fine to medium sand (cemented)	19	SC-SP	15.0									32.5	44.1	23.4	
4.50	SPT	Brownish and dark grey clayey fine to medium sand	18		15.5												
5.50	SPT	Brownish and light grey clayey fine to medium sand	17	SC-SP	13.7									44.3	34.1	21.6	
6.50	SPT	Reddish brown and light grey dirty fine to medium sand	19		12.0												
7.50	SPT	Reddish brown dirty fine to medium sand with light grey patches	21	SC-SP	13.2								0.2	45.4	33.8	20.6	
8.50	SPT	Light grey / whitish grey dirty fine to medium sand	27	SC-SP	10.8							1.1	3.4	41.2	38.9	15.4	
10.00	SPT	Light yellowish brown and light grey dirty fine to medium sand	26		12.5												
11.50	SPT	Yellowish brown dirty fine to medium sand	26	SM-SP	12.5							0.4	2.5	30.0	53.4	13.7	
13.00	SPT	Yellowish grey silty fine sand	44	SM-SP	15.1							1.2	1.4	13.7	56.0	27.7	
14.50	SPT	Yellowish brown and grey silty fine sand with clay	49		14.4												
16.00	SPT	Yellowish grey clayey fine sand with medium sand particles	>100	SC-SP	14.1							0.4	2.0	17.2	50.6	29.8	
17.50	SPT	Yellowish brown and light grey fine to coarse sand with silt and gravel	>100	GM-SW	14.3							20.3	27.7	17.3	10.6	24.1	
19.00	SPT	Yellowish fine sandy silty clay with light grey patches	62	SC-CI	16.9	38.6	17.3	21.3	<0.00								
20.50	SPT	Yellowish brown dirty fine to medium sand with weathered stones	>100	SC-SP	12.8								0.9	14.1	60.1	24.9	
22.70-23.70		Yellowish brown weathered sandstone															
23.70-24.70		Yellowish brown and light grey weathered sandstone and mudstone															

SUMMARY OF LABORATORY TEST RESULTS

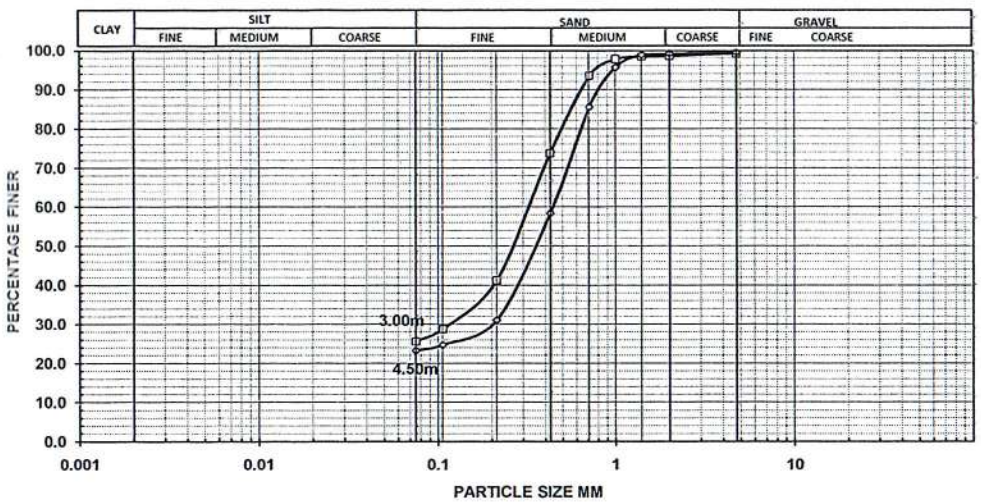
Project: **TNSCB Vembuliamman Koil Street**

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															
GL-0.75	DS	Brownish sandy gravel with clay (fill) with top PCC			6.8												
1.50	SPT	Greyish brown fine sandy silty clay	23	SC-CI	20.1	36.0	17.5	18.5	0.141	27.3							
2.25	SPT	Brownish grey silty clay with fine sand	30	CH	28.1	57.6	24.4	33.2	0.111	50.0							
3.00	SPT	Brownish grey sandy clay / clayey cemented sand	27	SC-SP	13.8								0.6	21.8	50.1	27.5	
3.75	SPT	Greyish brown dirty fine to medium sand	21	SC-SP	11.7									21.9	55.7	22.4	
4.50	SPT	Brownish and grey clayey silty fine to medium sand with sandy clay lumps	22		11.9												
5.50	SPT	Brownish and light grey clayey fine to medium sand	26	SC-SP	11.9								0.3	41.0	37.3	21.4	
6.50	SPT	Brownish clayey fine to medium sand with light grey patches	20		11.6												
7.50	SPT	Light grey and brownish silty fine to medium sand	26	SM-SP	10.7									40.1	39.1	20.8	
8.50	SPT	Light grey dirty fine to medium sand	23	SM-SP	11.0							0.6	3.9	54.1	28.0	13.4	
10.00	SPT	Light grey and yellowish dirty fine to medium sand	23	SM-SP	12.7								3.6	37.7	41.5	17.2	
11.50	SPT	Yellowish dirty fine to medium sand	26		10.6												
13.00	SPT	Yellowish grey silty fine sand	49	SM-SP	14.6								0.9	13.9	56.8	28.4	
14.50	SPT	Light yellowish grey and greenish grey silty fine sand	56		14.7												
16.00	SPT	Yellowish grey silty fine sand with medium sand particles	>100	SM-SP	16.1							2.1	1.6	17.1	48.5	30.7	
17.50	SPT	Yellowish brown and light grey clayey cemented sand with sandy clay	68	SC-SM	12.5	35.2	LSL = 7.8%					1.4	6.5	33.7	24.2	34.2	
19.00	SPT	Yellowish brown dirty fine to medium sand with weathered stones	>100	SC-SP	12.4								2.5	14.8	58.2	24.5	
20.50	SPT	Light yellowish brown and light grey clayey sandy silt with light grey patches	>100		15.6												
22.90-23.90		Yellowish brown weathered sandstone and mudstone															
23.90-24.90		Yellowish brown and light grey weathered sandstone and mudstone															

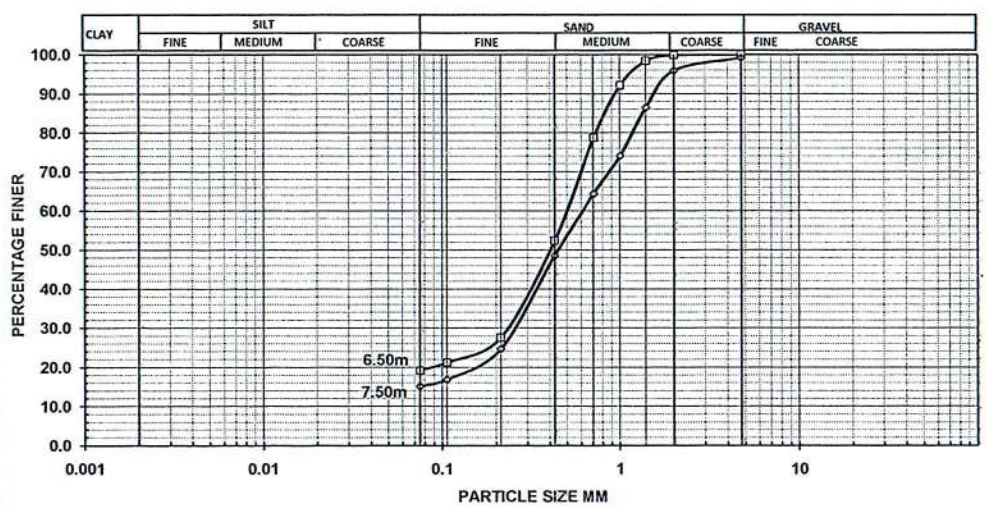
ANNEXURE 3

GRAIN SIZE DISTRIBUTION CURVES

PROJECT: **Construction of Tenements for TNSCBVembuli Amman Koil Street, Off Harrington Road, Chennai**



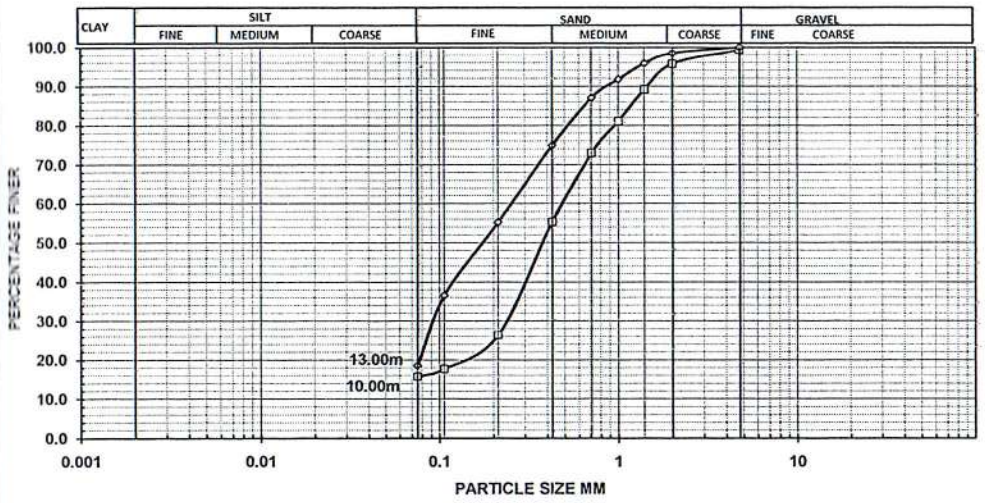
BH NO	DEPTH	PERCENTAGE FINER (Sieve size in mm)							Fine Gravel	Coarse Sand	Medium Sand	Fine Sand	Silt	Clay	Classification	D50 mm	cu (sand)	cc (sand)
	M	80.0	20.0	4.75	2.00	0.425	0.075	0.002	G	CS	MS	FS	Si	C	CLASS			
BH/1	3.00m		100.0	99.2	98.5	73.8	25.6		0.8	0.7	24.7	48.2	25.6		SC-SP	0.255	2.937	1.130
BH/1	4.50m		100.0	99.5	99.2	58.4	23.2		0.5	0.3	40.8	35.2	23.2		SC-SP	0.343	2.521	0.900



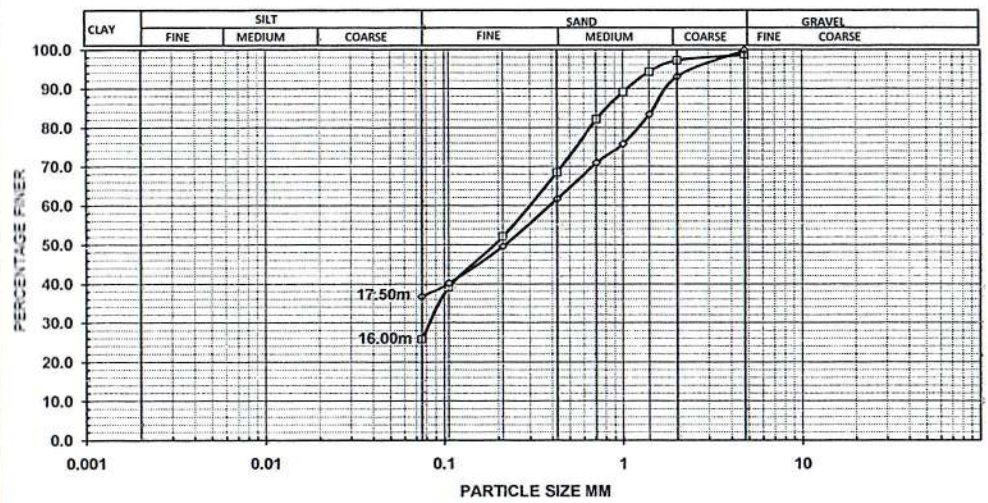
BH NO	DEPTH	PERCENTAGE FINER (Sieve size in mm)							Fine Gravel	Coarse Sand	Medium Sand	Fine Sand	Silt	Clay	Classification	D50 mm	cu (sand)	cc (sand)
	M	80.0	20.0	4.75	2.00	0.425	0.075	0.002	G	CS	MS	FS	Si	C	CLASS			
BH/1	6.50m		100.0	100.0	99.9	52.4	19.2		0.0	0.1	47.5	33.2	19.2		SC-SP	0.397	2.794	0.933
BH/1	7.50m		100.0	99.2	95.9	48.6	15.1		0.8	3.3	47.3	33.5	15.1		SC-SP	0.445	3.916	0.783

GRAIN SIZE DISTRIBUTION CURVES

PROJECT: **Construction of Tenements for TNSCBVembuli Amman Koil Street, Off Harrington Road, Chennai**



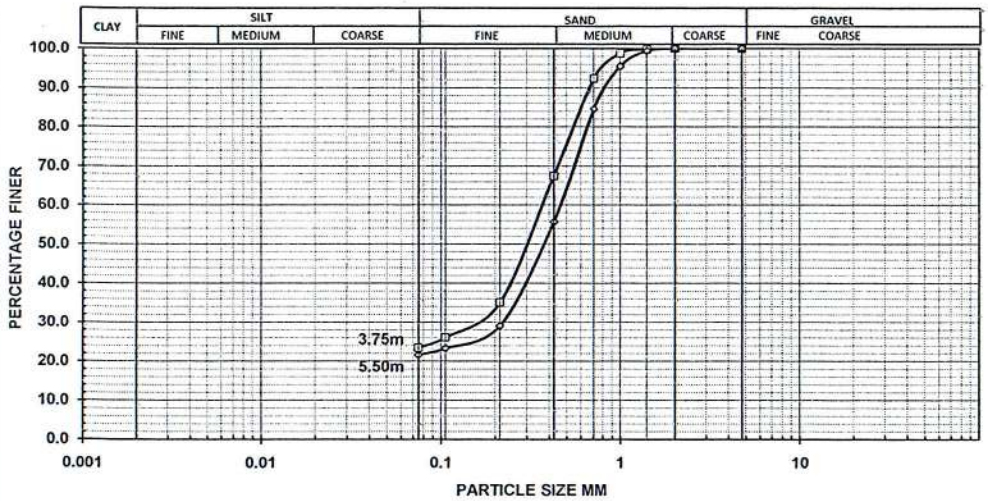
BH NO	DEPTH	PERCENTAGE FINER (Sieve size in mm)							Fine Gravel	Coarse Sand	Medium Sand	Fine Sand	Silt	Clay	Classification	D50 mm	cu (sand)	cc (sand)
	M	80.0	20.0	4.75	2.00	0.425	0.075	0.002	G	CS	MS	FS	Si	C	CLASS			
BH/1	10.00m		100.0	99.3	95.8	55.3	15.8		0.7	3.5	40.5	39.5	15.8		SM-SP	0.374	3.283	0.873
BH/1	13.00m		100.0	100.0	98.5	74.9	18.6		0.0	1.5	23.6	56.3	18.6		SM-SP	0.175	3.724	0.633



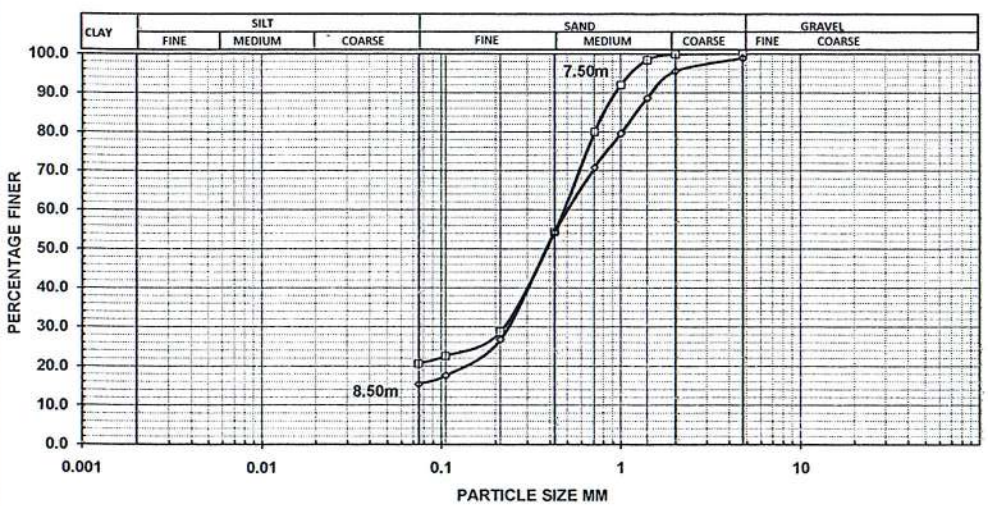
BH NO	DEPTH	PERCENTAGE FINER (Sieve size in mm)							Fine Gravel	Coarse Sand	Medium Sand	Fine Sand	Silt	Clay	Classification	D50 mm	cu (sand)	cc (sand)
	M	80.0	20.0	4.75	2.00	0.425	0.075	0.002	G	CS	MS	FS	Si	C	CLASS			
BH/1	16.00m		100.0	98.7	97.2	68.5	25.9		1.3	1.5	28.7	42.6	25.9		SC-SP	0.190	5.002	0.709
BH/1	17.50m		100.0	99.8	93.1	61.7	36.7		0.2	6.7	31.4	25.0	36.7		SC-SM	0.217	7.043	0.754

GRAIN SIZE DISTRIBUTION CURVES

PROJECT: **Construction of Tenements for TNSCBVembuli Amman Koil Street, Off Harrington Road, 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	3.75m		100.0	100.0	100.0	67.5	23.4		0.0	0.0	32.5	44.1	23.4		SC-SP	0.292	2.844	1.064
BH/2	5.50m		100.0	100.0	100.0	55.7	21.6		0.0	0.0	44.3	34.1	21.6		SC-SP	0.366	2.500	0.908

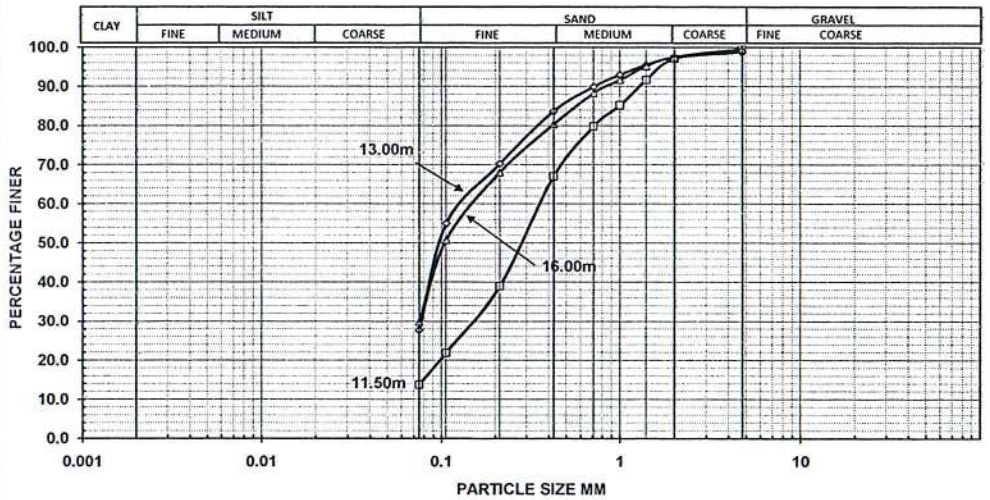


BH NO	DEPTH	PERCENTAGE FINER (Sieve size in mm)							Fine Gravel	Coarse Sand	Medium Sand	Fine Sand	Silt	Clay	Classification	D50 mm	cu (sand)	cc (sand)
	M	80.0	20.0	4.75	2.00	0.425	0.075	0.002	G	CS	MS	FS	Si	C	CLASS			
BH/2	7.50m		100.0	100.0	99.8	54.4	20.6		0.0	0.2	45.4	33.8	20.6		SC-SP	0.377	2.724	0.910
BH/2	8.50m		100.0	98.9	95.5	54.3	15.4		1.1	3.4	41.2	38.9	15.4		SC-SP	0.381	3.617	0.873

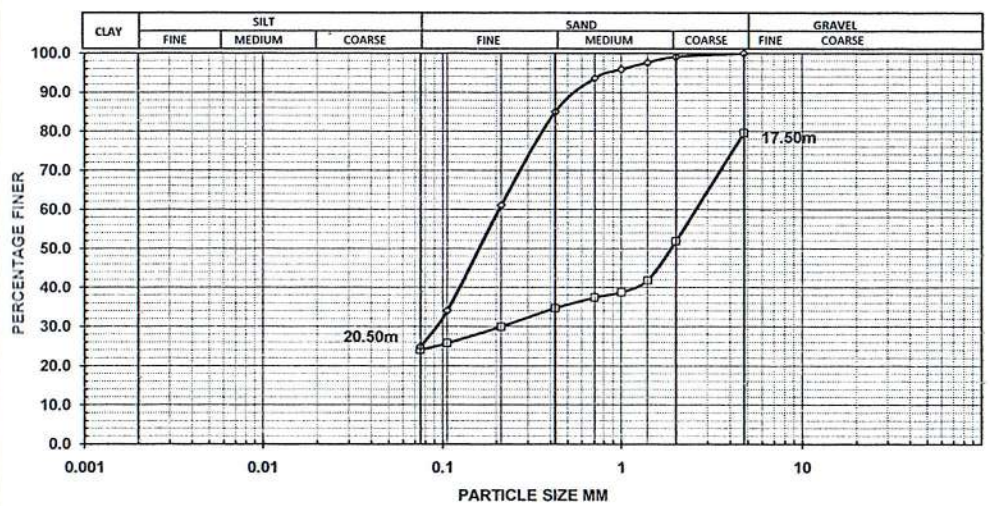
GEOTECHNICAL Solutions, Chennai

GRAIN SIZE DISTRIBUTION CURVES

PROJECT: **Construction of Tenements for TNSCBVembuli Amman Koil Street, Off Harrington Road, Chennai**



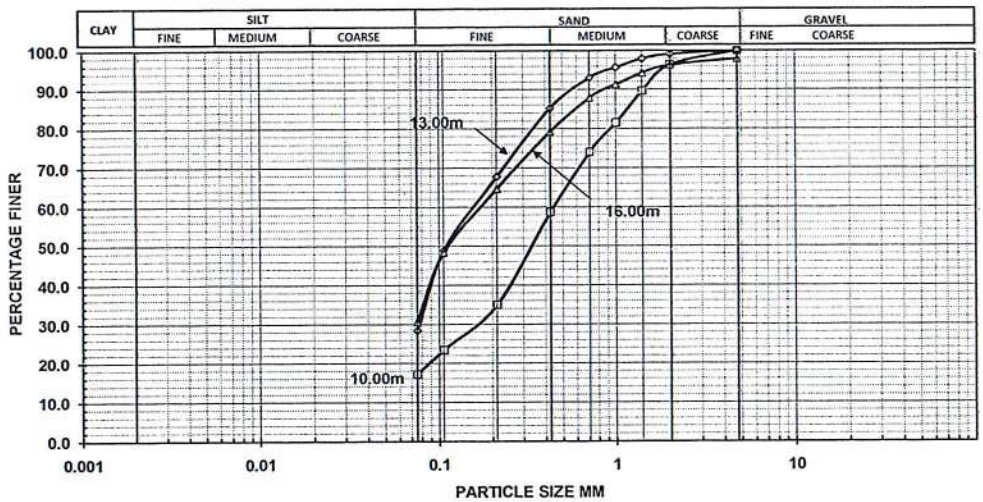
BH NO	DEPTH	PERCENTAGE FINER (Sieve size in mm)							Fine Gravel	Coarse Sand	Medium Sand	Fine Sand	Silt	Clay	Classification	D50 mm	cu (sand)	cc (sand)
	M	80.0	20.0	4.75	2.00	0.425	0.075	0.002	G	CS	MS	FS	Si	C	CLASS			
BH/2	11.50m		100.0	99.6	97.1	67.1	13.7		0.4	2.5	30.0	53.4	13.7		SM-SP	0.278	3.784	1.050
BH/2	13.00m		100.0	98.8	97.4	83.7	27.7		1.2	1.4	13.7	56.0	27.7		SM-SP	0.100	2.686	0.537
BH/2	16.00m		100.0	99.6	97.6	80.4	29.8		0.4	2.0	17.2	50.6	29.8		SC-SP	0.105	3.125	0.510



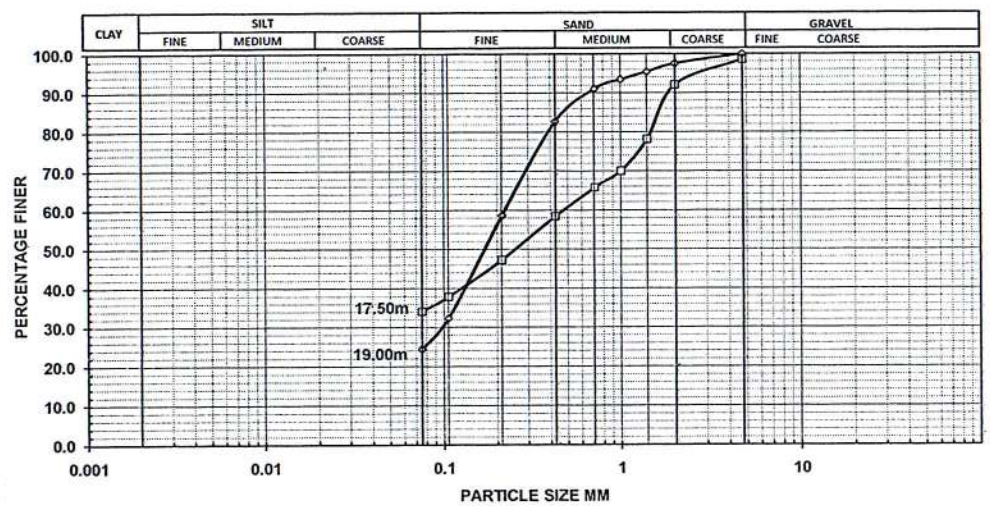
BH NO	DEPTH	PERCENTAGE FINER (Sieve size in mm)							Fine Gravel	Coarse Sand	Medium Sand	Fine Sand	Silt	Clay	Classification	D50 mm	cu (sand)	cc (sand)
	M	80.0	20.0	4.75	2.00	0.425	0.075	0.002	G	CS	MS	FS	Si	C	CLASS			
BH/2	17.50m		100.0	79.7	52.0	34.7	24.1		20.3	27.7	17.3	10.6	24.1		GM-SW	1.864	10.097	3.722
BH/2	20.50m		100.0	100.0	99.1	85.0	24.9		0.0	0.9	14.1	60.1	24.9		SC-SP	0.159	2.758	0.816

GRAIN SIZE DISTRIBUTION CURVES

PROJECT: Construction of Tenements for TNSCBVembuli Amman Koil Street, Off Harrington Road, Chennai

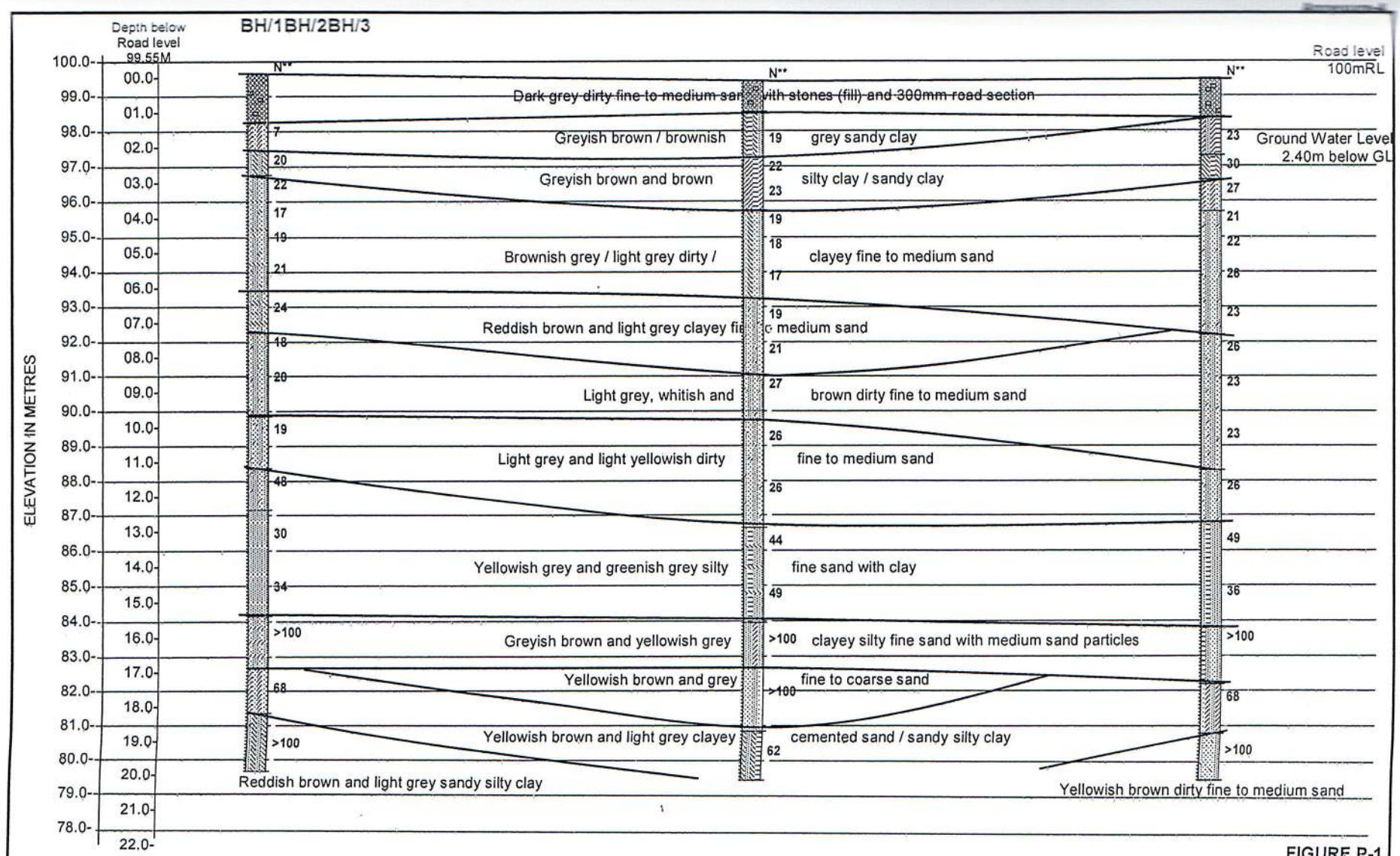


BH NO	DEPTH	PERCENTAGE FINER (Sieve size in mm)							Fine Gravel	Coarse Sand	Medium Sand	Fine Sand	Silt	Clay	Classification	D50 mm	cu (sand)	cc (sand)
	M	80.0	20.0	4.75	2.00	0.425	0.075	0.002	G	CS	MS	FS	Si	C	CLASS			
BH/3	10.00m		100.0	100.0	96.4	58.7	17.2		0.0	3.6	37.7	41.5	17.2		SM-SP	0.329	4.683	1.018
BH/3	13.00m		100.0	100.0	99.1	85.2	28.4		0.0	0.9	13.9	56.8	28.4		SM-SP	0.110	2.889	0.584
BH/3	16.00m		100.0	97.9	96.3	79.2	30.7		2.1	1.6	17.1	48.5	30.7		SM-SP	0.114	3.551	0.558



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	17.50m		100.0	98.6	92.1	58.4	34.2		1.4	6.5	33.7	24.2	34.2		SC-SM	0.251	8.850	0.679
BH/3	19.00m		100.0	100.0	97.5	82.7	24.5		0.0	2.5	14.8	58.2	24.5		SC-SP	0.169	2.806	0.802

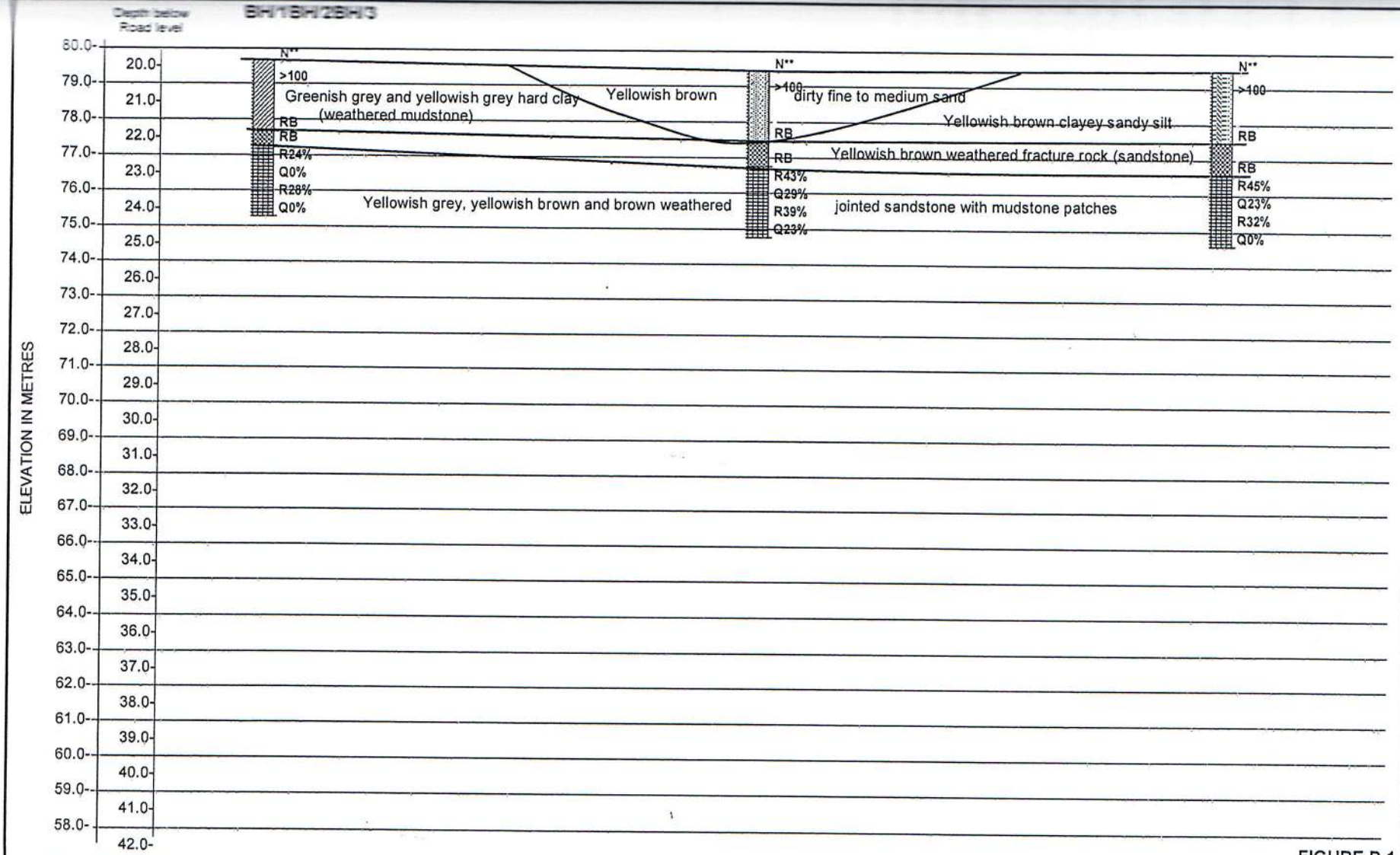
GEOTECHNICAL Solutions, Chennai



CONTINUED IN SHEET 2 OF FIGURE P-1

Ground level with respect to TBM 100m RL marked on theCorporation Toilet Floor
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 – BH/3
CONSTRUCTION OF TENEMENTS FOR TNSCB
VEMBULI AMMAN KOIL ST, HARRINGTON ROAD, CHENNAI



CONTINUED FROM SHEET 1 OF FIGURE P-1

Ground level with respect to TBM 100m RL marked on thecorporation toilet floor
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 – BH/3
CONSTRUCTION OF TENEMENTS FOR TNSCB
VEMBULI AMMAN KOIL ST, HARRINGTON ROAD, CHENNAI

Annexure 5

Bearing Capacity — **Raft at at 2.0 m below GL**

Project: Foundation Recommendation for Vempuliamman

Ultimate Bearing Capacity: $cN_cs_cd_ci_c + 1/2\gamma BN_\gamma s_\gamma d_\gamma i_\gamma + \gamma D(N_q-1)s_qd_qi_q$ — IS Code 6403 -1981

Reference Borehole	Average BH1	**Failure case**
Type of Soil	Sandy clay	*General shear failure when SPT N1 $_{60}$ value is >20*
		Cohesion is taken as the original value
Cohesion (average)	120 kN/sq.m	*Local shear failure whenSPT N1 $_{60}$ is between 5-20*
Bulk Density	18 kN/cu.m	*Cohesion is reduced to 0.67c*
Ground Water Table	0 m	
Factor of Safety	2.5	

						Navg	24
Depth of Foundation		2 m				Angle of Friction ϕ	30
Shape of Footing	Raft					Failure case	General
Width of Foundation		10 m					
Length of Foundation		34 m					
General shear failure							
		N_i	s_i	d_i	ic	N	
	N_c	5.14	1.06	1.07	1.00	698.3292	
	N_q	1.00	1.06	1.03	1.00	0	
	N_r	0.00	0.88	1.03	1.00	0	
				Ultimate Bearing Capacity		698	kN/sq.m
				Net Safe Bearing Capacity		279	kN/sq.m

Annexure 6

Calculation of total settlement based on Theory of Elasticity and Consolidation theory

Project	Vempuliamman																		
Reference Borehole		BH1																	
L	34	m		Area (LxB)		340	m^2			μ	0.35								
B	10	m		Load intensity		135	kPa			B'	5	m				4			
D	2	m		M		3.4				N	0.4			Rigidity factor		1			

Layer	Layer no	From	To	Thickness (m)	Field SPT - N value	Corrected SPT - N value	E (kPa)	Z_i (m)	Unit weight	Overburden pressure (kPa)	Stress (kPa)	N	I1	I2	Is	If	Immediate Settlement (mm)	mv (kPa^{-1})	Consolidation Settlement (mm)	Total settlement (mm)
Sandy clay	1	2	3	1	20	25	36000	0.50	17.5	3.85	126.7	0.20	0.007	0.043	0.027	1.0	1.64	0.00005	6.34	7.98
Sand	2	3	3.75	0.75	22	22	9500	1.38	18	10.76	114.1	0.15	0.004	0.034	0.019	1.0	4.07	-	-	4.07
	3	3.75	4.5	0.75	17	17	8000	2.13	18	16.90	104.8	0.15	0.004	0.034	0.019	1.0	4.44	-	-	4.44
	4	4.5	5.5	1	19	19	8500	3.00	18	24.07	95.4	0.20	0.007	0.043	0.027	1.0	5.24	-	-	5.24
	5	5.5	6.5	1	21	21	9000	4.00	18	32.26	86.3	0.20	0.007	0.043	0.027	1.0	4.47	-	-	4.47
	6	6.5	7.5	1	24	24	10000	5.00	18	40.45	78.5	0.20	0.007	0.043	0.027	1.0	3.66	-	-	3.66
	7	7.5	8.5	1	18	18	8500	6.00	18	48.64	71.7	0.20	0.007	0.043	0.027	1.0	3.94	-	-	3.94
	8	8.5	10	1.5	20	18	8500	7.25	18	58.88	64.5	0.30	0.014	0.061	0.042	1.0	5.63	-	-	5.63
	9	10	11.5	1.5	19	17	8000	8.75	18.5	71.54	57.3	0.30	0.014	0.061	0.042	1.0	5.31	-	-	5.31
	10	11.5	13	1.5	48	31	11500	10.25	18.5	84.57	51.2	0.30	0.014	0.061	0.042	1.0	3.30	-	-	3.30
	11	13	14	1	30	22	9500	11.50	18.5	95.44	46.9	0.20	0.007	0.043	0.027	1.0	2.30	-	-	2.30
																Total	43.99	-	6.34	50.33

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

(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.

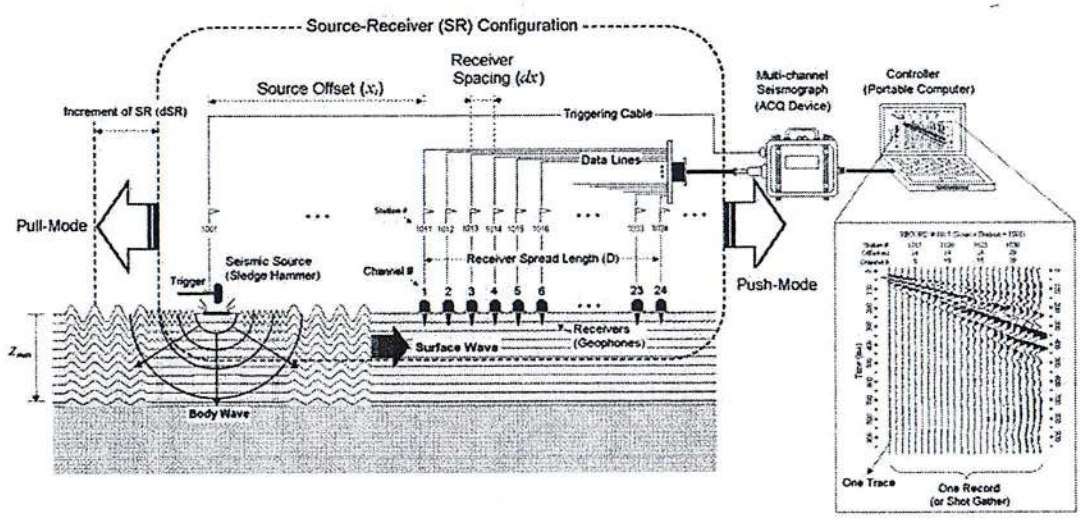


Figure 4.1. MASW Test Setup

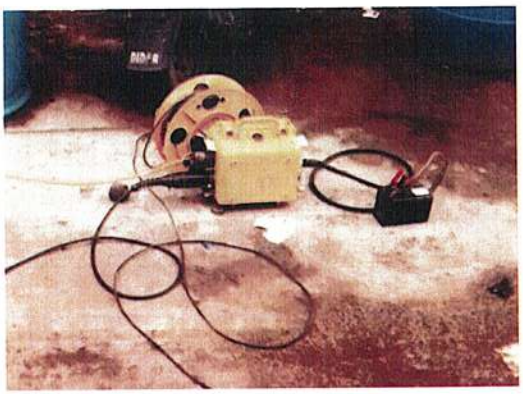


Figure 4.2. Geode Seismic Recorder

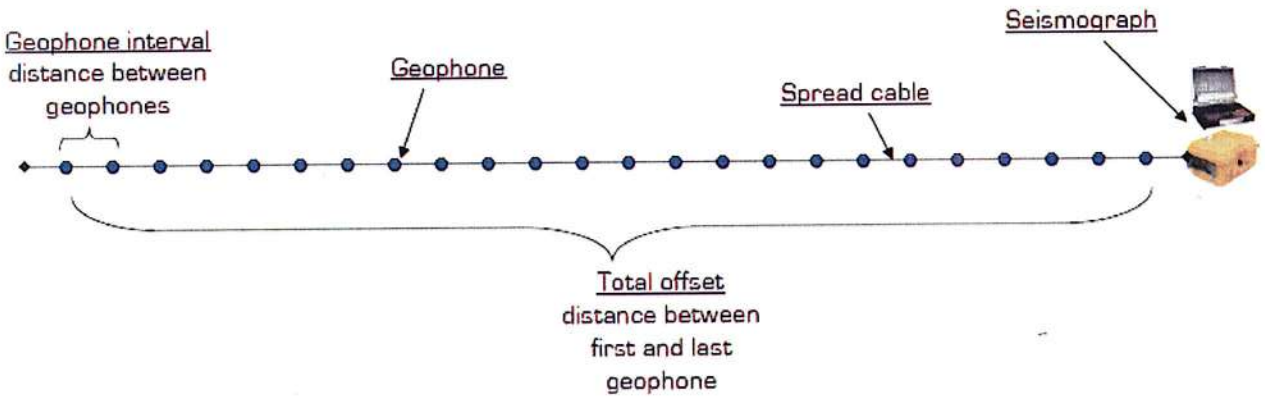


Figure 4.3. MASW Test Arrangement

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.

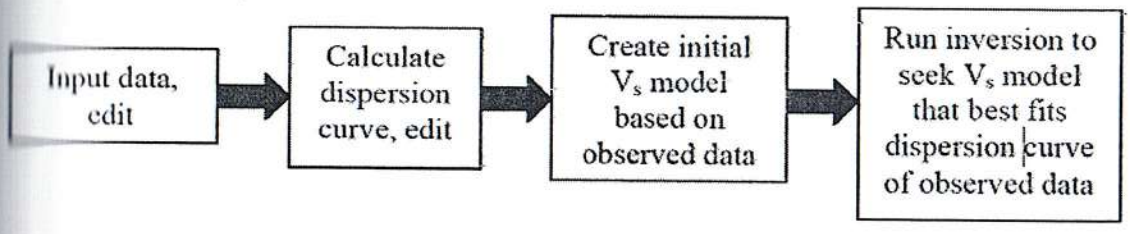


Figure 4.4. Flow Chart of MASW Analysis

- 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.



our services doesn't just end there

Buying & Selling Services

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

Verified RealEstate™

We're honored to be part of your real estate journey

3/350/2 Mettukuppam,
OMR Thoraipakkam,
Chennai, India

hello@verified.realestate
+91 9996 12 9996
www.verified.realestate