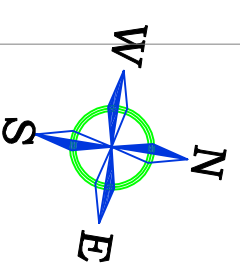
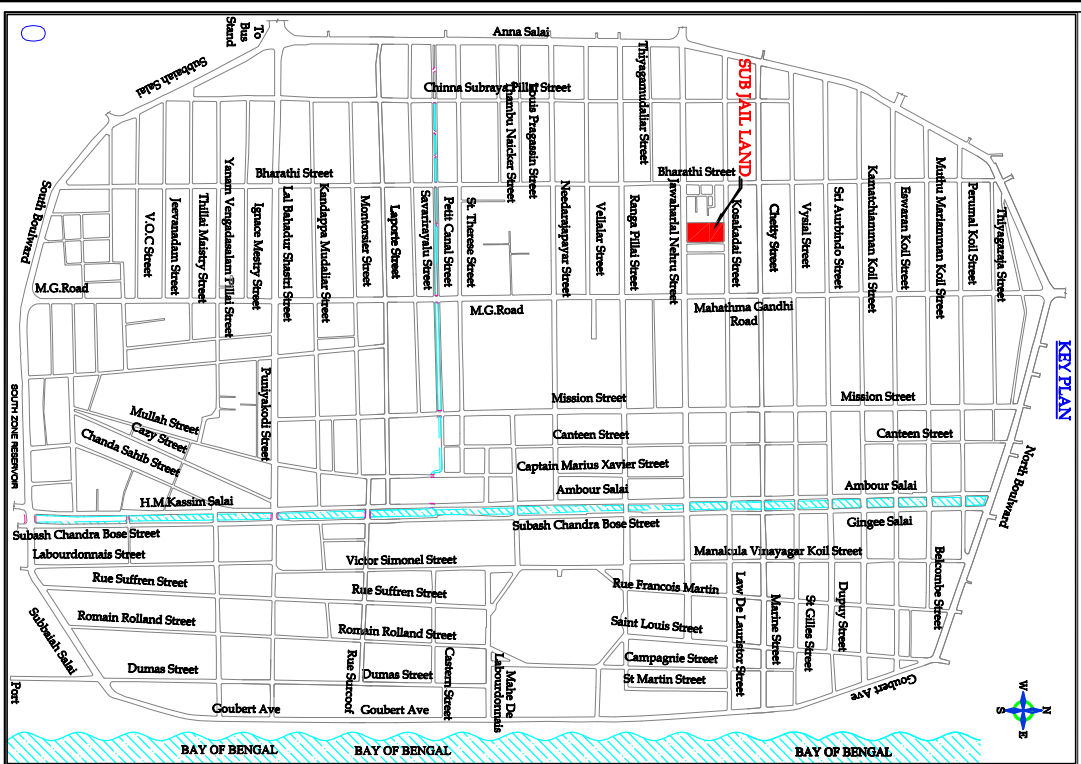
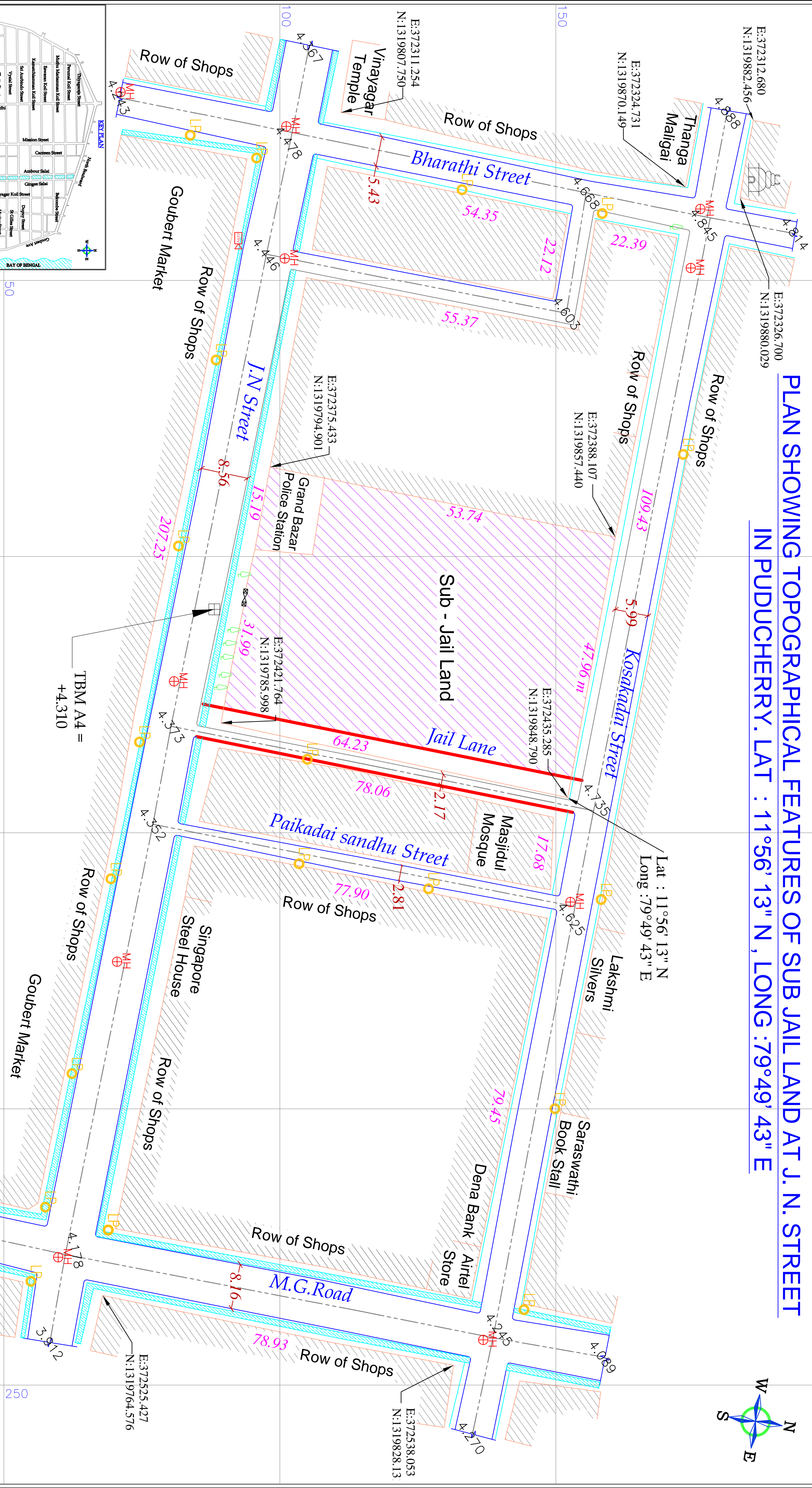


ANNEXURE - I

PLAN SHOWING TOPOGRAPHICAL FEATURES OF SUB JAIL LAND AT J. N. STREET IN PUDUCHERRY. LAT : 11°56' 13" N , LONG :79°49' 43" E



Lat : 11°56' 13" N
Long :79°49' 43" E



TBM A4 = +4.310

— - Proposed ROW at 6m wide

LEGEND:

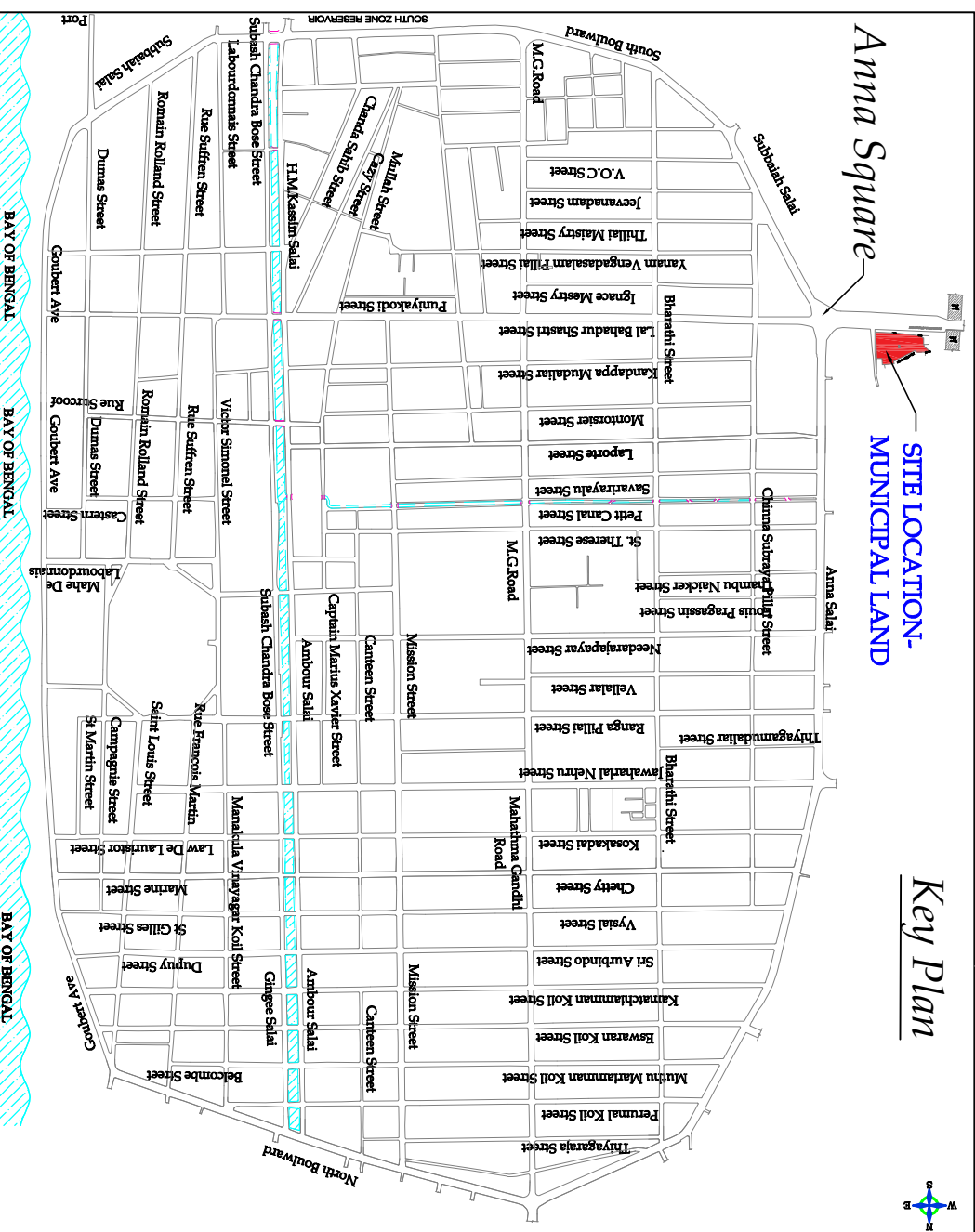
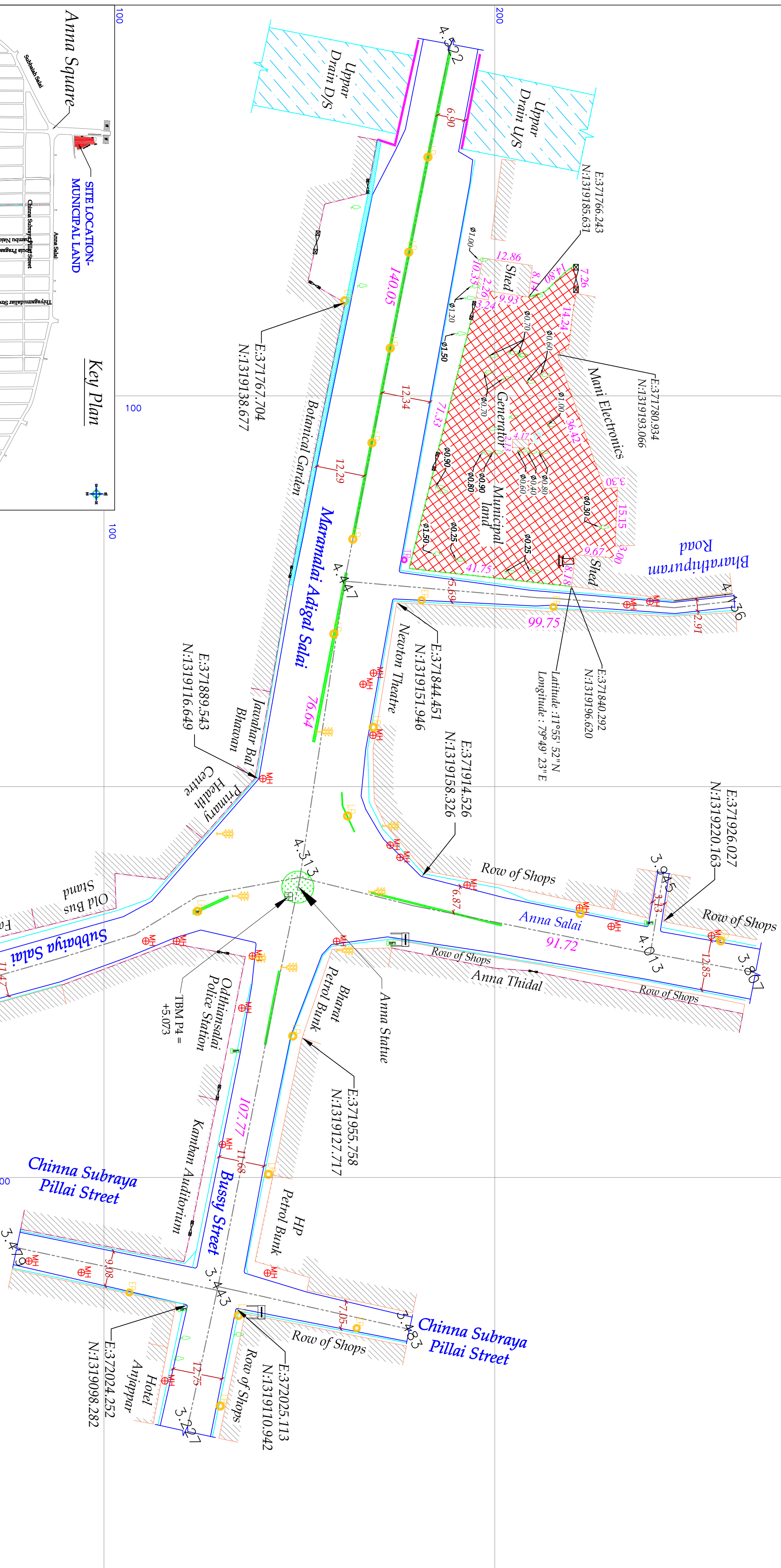
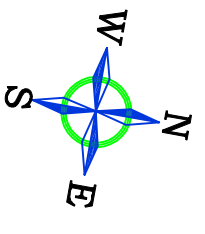
SYMBOL	DESCRIPTION
	ROAD EDGE
	BUILDING
	DRAIN
	SURVEILLANCE CAMERA
	LAMP POST
	MANHOLE
	ORDINARY TREE
	SPOT LEVEL

NOTES :-
1. All dimensions are in metres.
2. Sub Jail Land = 3044.46Sqm

TITLE :-
PLAN SHOWING TOPOGRAPHICAL FEATURES OF SUB JAIL LAND AT J.N. STREET PUDUCHERRY.

CLIENT:	THE CHIEF EXECUTIVE OFFICER PSCDL PUDUCHERRY
SURVEYED BY:	PENTAGON GRAPHICS NO:12, GROUND FLOOR, VTH CROSS(W), KURUNJI NAGAR EXTN PUDUCHERRY-605008
SCALE:	A: 1"=8'
SCALE:	SCALE
DATE:	13.08.2020
MONTH:	AUGUST
YEAR:	2020

PLAN SHOWING TOPOGRAPHICAL FEATURES OF MUNICIPAL LAND OPPOSITE MANI ELECTRONICS IN ANNA SALAI, PUDUCHERRY (LAT :11°55' 52"N ; LONG : 79°49' 23"E)



 -Proposed site location

LEGEND:-	
	DESCRIPTION
	BIT ROAD
	FENCE
	BUILDING
	DRAIN
	COMPOUND WALL
	EB BOX
	SIGN BOARD
	NAME BOARD
	ELECTRIC & LAMP POST
	TAP & SINTEX TANK
	MANHOLE & CULVERT
	ORDINARY TREE
	EB JUNCTION BOX
	SIGNAL POST
	SPOT LEVEL
Δ 1'78	SCALE
1:1000	DATE
19.08.2020	MONTH
AUGUST	

NOTES:-
1. All dimensions are in metres.
2. Municipal land Surveyd area = 2712.3 Sqm

TITLE:-
PLAN SHOWING TOPOGRAPHICAL FEATURES OF MUNICIPAL LAND OPPOSITE MANI ELECTRONICS IN ANNA SALAI, PUDUCHERRY.

CLIENT:
THE CHIEF EXECUTIVE OFFICER PSCDL PUDUCHERRY

SURVEYED BY:
PENTAGON GRAPHICS NO:12, GROUND FLOOR, VTH CROSS(W), KURUNJAI, MAQAR EXTN PUDUCHERRY-605008

ANNEXURE - II

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Ref: AAL/8194/GT-Report/P.No.1627/Nehru street/Pdy/2020-21

Date: 29.08.2020

GEOTECHNICAL INVESTIGATION REPORT

PROJECT : GEOTECHNICAL INVESTIGATION FOR THE PROPOSED CONSTRUCTION OF MULTI LEVEL CAR PARKING AT OLD JAIL COMPLEX, NEHRU STREET, PUDUCHERRY.

PROJECT NO : AAL.1627/NEHRU STREET/PDY/2020-21.

**CLIENT : THE CHIEF EXECUTIVE OFFICER,
PSCDL,
PUDUCHERRY.**

REFERENCE : WORK ORDER NO: 1040/PSCDL/MLCP/2020/513 DATE: 11.08.2020

**EXPLORATION
DATE : 13.08.2020 – 15.08.2020.**

**DATE OF
REPORT : 29.08.2020.**

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Date: 29.08.2020

NAME OF WORK: GEOTECHNICAL INVESTIGATION FOR THE PROPOSED CONSTRUCTION OF MULTI LEVEL CAR PARKING AT OLD JAIL COMPLEX, NEHRU STREET, PUDUCHERRY.

CONTENTS

1. INTRODUCTION

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2. SCOPE OF WORK

3. FIELD INVESTIGATION

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STANDARD PENETRATION TEST (IS: 2131 - 1981)

IS CODE FOR FIELD INVESTIGATION

SITE EXPLORATION

SITE & BORE LOG DETAILS

4. GEOTECHNICAL MODELLING AND OBSERVATION

5. CHEMICAL ANALYSIS

6. RECOMMENDATION

7. APPENDICES

8. SITE PHOTOS

9. SITE LAYOUT WITH BORE LOG LOCATIONS

10. BORE LOG SHEETS

11. DRY SIEVE CHART

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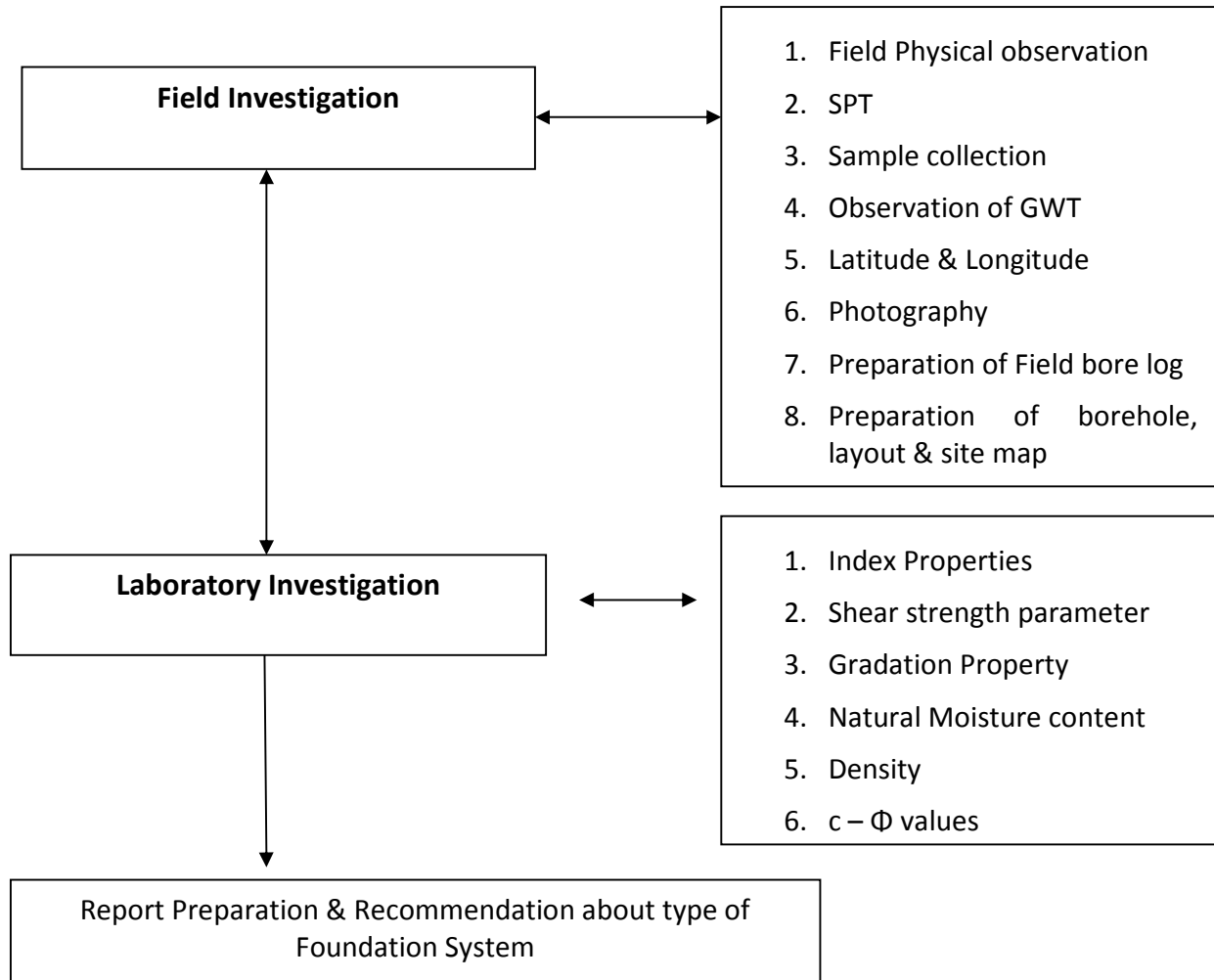
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1. INTRODUCTION

A Geotechnical investigation for the above said work was undertaken as per the authorization given by **THE CHIEF EXECUTIVE OFFICER, PSCDL, Puducherry.**

FLOW CHART



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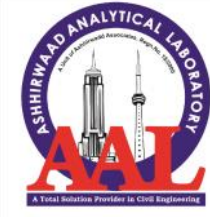
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2. SCOPE OF WORK

2.1 This geotechnical investigation has been carried out to ascertain the safe bearing capacity and to decide upon suitable foundation system for the proposed structure. It was instructed to make two number of bore holes. The BH -1 was driven upto 20.0 m depth BH-2 & BH-3 was driven upto 10.0m depth and terminated as per the clients instruction.

2.2 The allowable safe bearing capacity of the soil is calculated based on the field geotechnical investigation, soil properties, GWT and subsequent laboratory experiments.

3. FIELD INVESTIGATION

3.1 GENERAL

Mobilizations of equipment, skilled and unskilled labours are arranged at site. The various factors for the number and position of boreholes and spacing of boreholes are based on the extent of the site, nature and type of structure. Depth of borehole is concluded based on condition of soil, penetration capacity of soil, shear failure and hard strata condition. Standard Penetration Test (SPT) is conducted at various depths. The disturbed soil sample is collected from the site and transported for examination to Ashhirwaad Analytical Laboratory. The field investigation is being monitored by experienced civil engineers/ Geotechnical/ Structural Engineer.

3.2 STANDARD PENETRATION TEST (IS: 2131 – 1981)

EQUIPMENT PREPARATION

3.2.1 DRILLING EQUIPMENT

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The equipment used shall provide a clean borehole 100 to 150 mm in diameter, for insertion of the sampler ensure that the penetration test is performed on undisturbed soil and shall permit driving of the split spoon sampler to obtain penetration record and sample in accordance with procedure.

3.2.2 DRIVE WEIGHT ASSEMBLY

The drive weight assembly shall consist of driving head and a 63.5 kg weight with 75cm free fall. It is ensured that the energy of the falling weight is not reduced by friction between the drive weight and the guides. The rods to which the sampler is attached for driving should be straight, tightly coupled and straight in alignment. For driving the casting, a hammer heavier than 63.5 kg may be used.

3.2.3 CLEANING THE BOREHOLE

In case wash boring is adopted for cleaning the borehole, side discharge bits are permissible, but in no case a bottom discharge bit be permitted. In cohesive soils, the borehole may be cleaned with bailer with a flap valve.

3.2.4 OBTAINING THE SAMPLES

Test shall be made at every change in stratum or at intervals of not more than 1.5 m whichever is less. Tests may be made at lesser or greater intervals if specified or considered necessary.

The sampler shall be lowered to the bottom of the borehole. The following information shall be noted and recorded.

- (a) Depth of bottom of borehole below ground level.
- (b) Penetration of the sampler into the soil under the combined weight of sampler and rods

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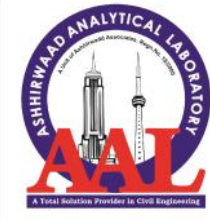
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- (c) Water level in the borehole or casting
- (d) Depth of bottom of casting below ground level.

Labels shall be fixed to the jar or notation shall be written on the covers with the following information:

- a) Origin of sample
- b) Job designation
- c) Boring number
- d) Sample number
- e) Depth of sampling
- f) Penetration record
- g) Length of recovery
- h) Date of sampling

The jars containing samples shall be stored in suitable container for shipment. Samples should not be placed in the sun.

3.3 IS CODE FOR FIELD INVESTIGATION

SL.NO	IS CODE NUMBER	IS CODE NAME
1	IS : 1498 – 1970 (Reaffirmed 2007)	Classification & Identification of soil for general engineering purpose (First Revision)
2	IS : 1892 – 1979 (Reaffirmed 2002)	Code of practice for sub surface investigation for foundation (First Revision)
3	IS : 2131 – 1981 (Reaffirmed 2002)	Method of Standard Penetration Test for soil (First Revision)
4	IS : 2132 – 1986 (Reaffirmed 2002)	Code of practice for thin walled tube sampling of soil (Second Revision)
5	IS : 4968 – 1976 (Reaffirmed 2007)	Method of sub surface sounding of soil : Static cone penetration (First Revision)

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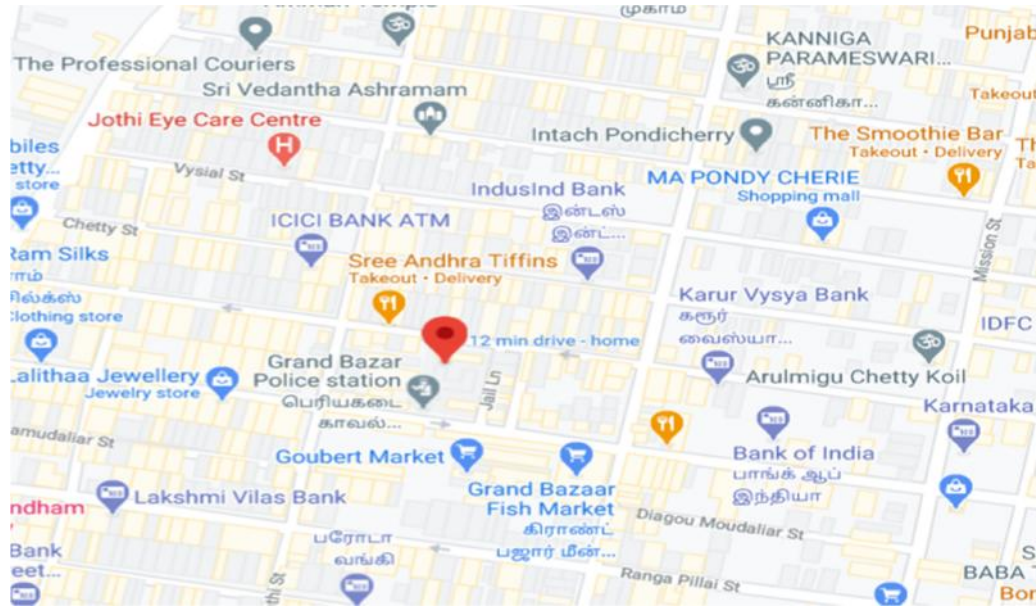
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3.4 SITE EXPLORATION

Subsurface exploration should be carried out in preliminary and detailed exploration. Shear strength and compressibility of the soil is determined in the detailed exploration. The method of boring for soil exploration is rotary boring. Rotary boring is effected by cutting action of the soil. The bit is carried at the end of hollow, jointed drill rods which is rotated by the chuck. A mud laden fluid is pumped continuously and fluid returns to surface in angular space. Undisturbed samples are collected at suitable intervals.

3.5 SITE MAP



Bore Hole No	LATITUDE	LONGITUDE
BH-1	11°56'11.24"N	79°49'42.18"E
BH-2	11°56'11.24"N	79°49'42.18"E
BH-3	11°56'12.33"N	79°49'41.79"E

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3.6 BOREHOLE DETAILS

Three number of bore holes are driven in the field at various location of the site. As per IS: 1892 - 1979 (Reaffirmed 2002), the various driven depth of the borehole, Ground Water Table and their corresponding identifications are tabulated below

SL.NO	BOREHOLE IDENTIFICATION NUMBER	DRIVEN BOREHOLE DEPTH (m)
1.	BH-1	20.0
2.	BH-2	10.0
3.	BH-3	10.0

BOREHOLE IDENTIFICATION NUMBER	GROUND WATER TABLE (m)
BH-1	1.20
BH-2	1.20
BH-3	1.20

4. GEOTECHNICAL MODELLING AND OBSERVATION:

4.1 GENERAL

Various laboratory test are carried out to assess the soil as per IS code standard and calculations are done. The results of the test are tabulated and interpretation is given.

4.2 LIST OF IS CODE

4.2.1 LABORATORY IS CODE

SL.NO	IS CODE NUMBER	IS CODE NAME
1	IS : 2720 – 1983 (Part – 1) (Reaffirmed 2006)	Methods of test for soil :Preparation of dry soil sample for various test (Second Revision)

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2	IS 2720 – 1980 (Part – 2) (Reaffirmed 2010)	Methods of test for soil : Determination of water content (Second Revision)
3	IS 2720 – 1980 (Part – 3) (SECTION – 1) (Reaffirmed 2002)	Methods of test for soil : Determination of specific gravity : Fine grained soil (First Revision)
4	IS 2720 – 1980 (Part – 3) (SECTION – 2) (Reaffirmed 2002)	Methods of test for soil : Determination of specific gravity : Fine, Medium, Coarse grained soil (First Revision)
5	IS 2720 – 1985 (Part – 4) (Reaffirmed 2006)	Methods of test for soil : Grain size analysis(Second Revision)
6	IS 2720 – 1985 (Part – 5) (Reaffirmed 2006)	Methods of test for soil : Determination of liquid and plastic limit (Second Revision)
7	IS 2720 – 1985 (Part – 15) (Reaffirmed 2006)	Methods of test for soil : Determination of consolidation properties (First Revision)
8	IS 1809 – 1972 (Reaffirmed 2006)	Methods of test for soil : Glossary of terms & symbols relating to soil engineering (Third Revision)

4.2.2 FOUNDATION IS CODE

SL.NO	IS CODE NUMBER	IS CODE NAME
1	IS : 1080 – 1986 (Reaffirmed 2002)	Code of practice for design and construction of shallow foundation on soil (other than raft, ring and shell) (Second Revision)
2	IS 1904 : 1968 (Reaffirmed 2006)	Code of practice for design and construction of foundation on soil :General requirement (Third Revision)
3	IS 6403 – 1981 (Reaffirmed 2002)	Code of practice for determination of bearing capacity of shallow foundation (First Revision)

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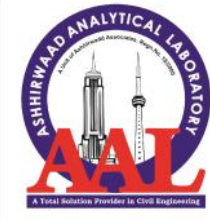
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4.2.3 SEISMIC IS CODE

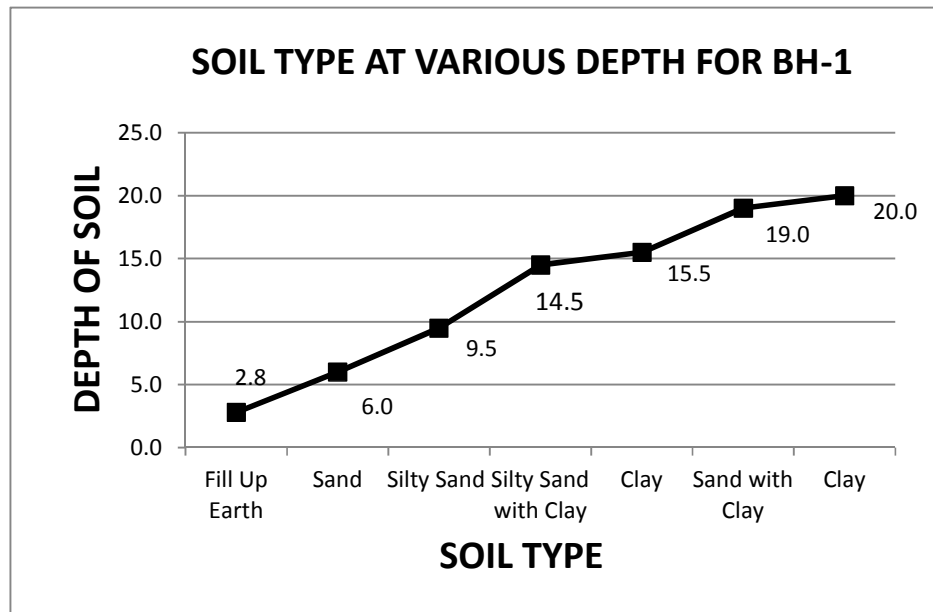
SL.NO	IS CODE NUMBER	IS CODE NAME
1	IS 1893 – 2002 (Reaffirmed 2007)	Criteria for Earthquake Resistant design of Structures(Fifth Revision)

4.3 RESULT:

Laboratory tests the following soil profiles for the boreholes as observed is detailed below:

BH -1

The details of soil stratification are presented in the bore - log and their interpretation is shown below



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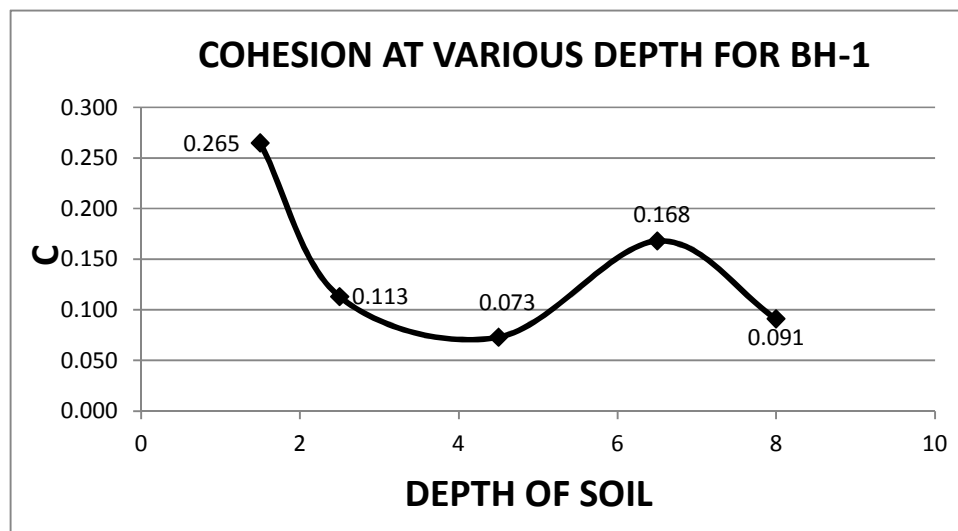
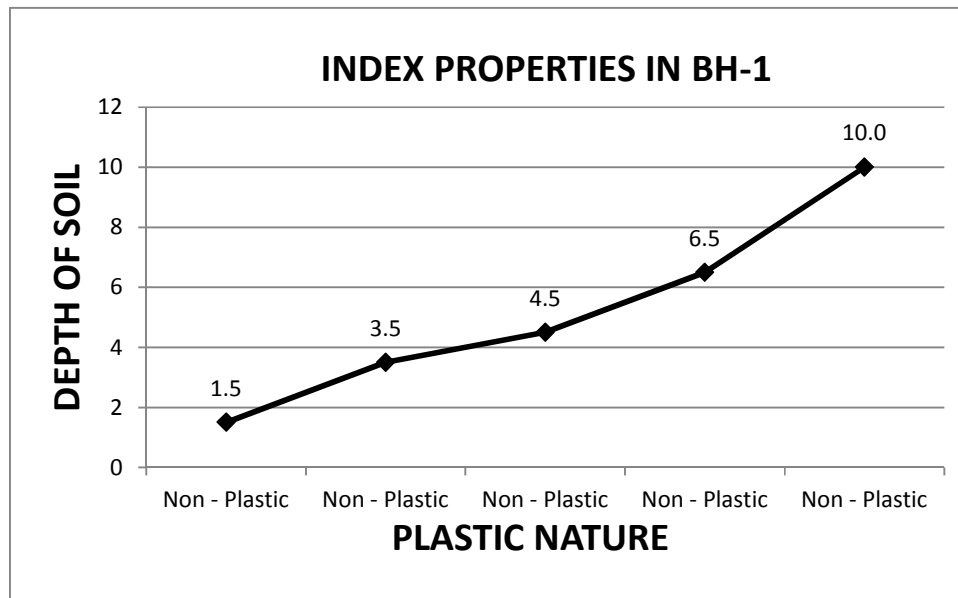
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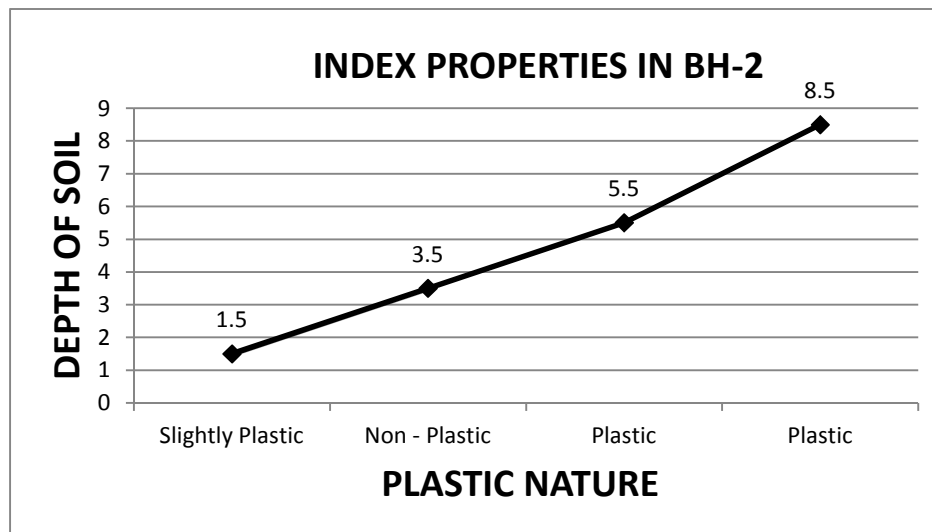
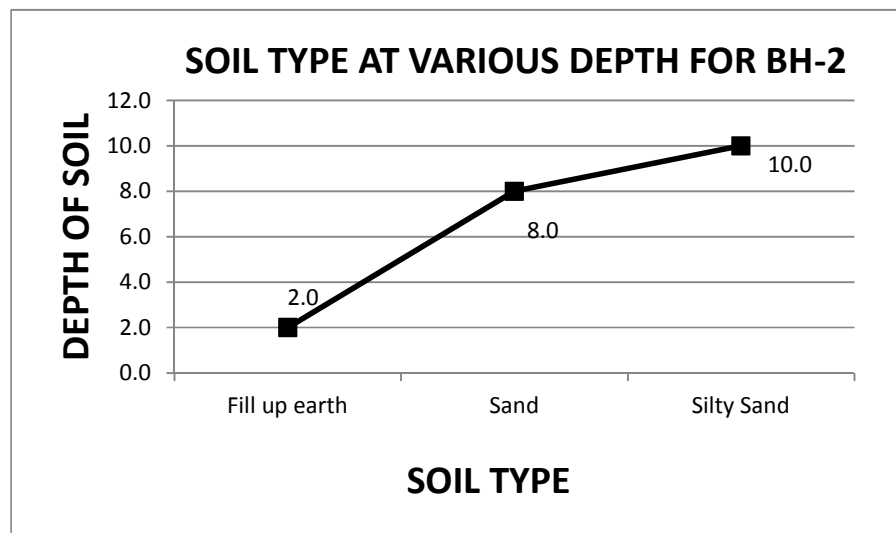


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BH -2

The details of soil stratification are presented in the bore - log and their interpretation is shown below



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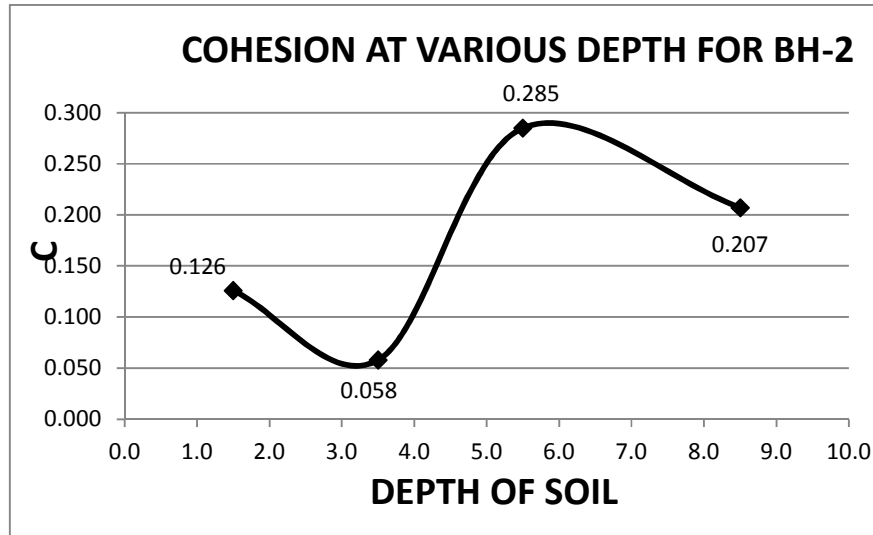
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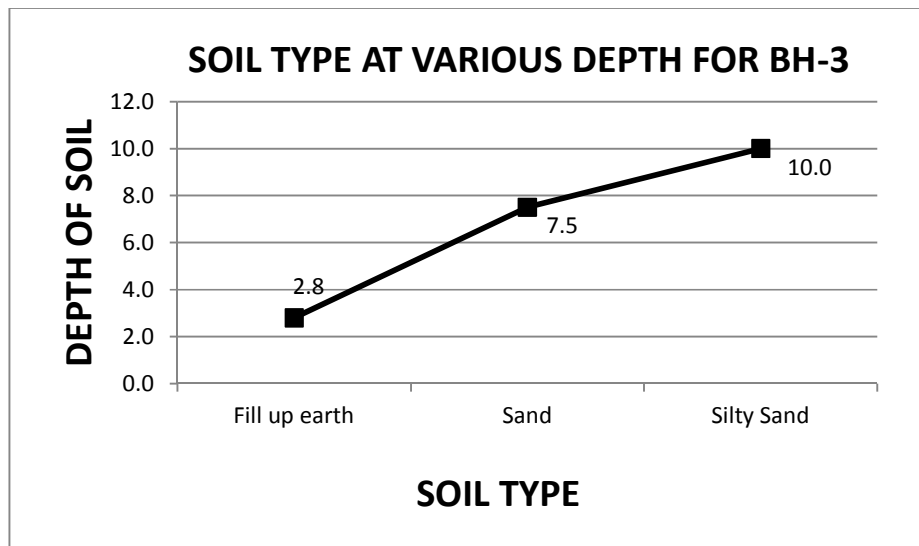
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Date: 29.08.2020



BH -3

The details of soil stratification are presented in the bore - log and their interpretation is shown below



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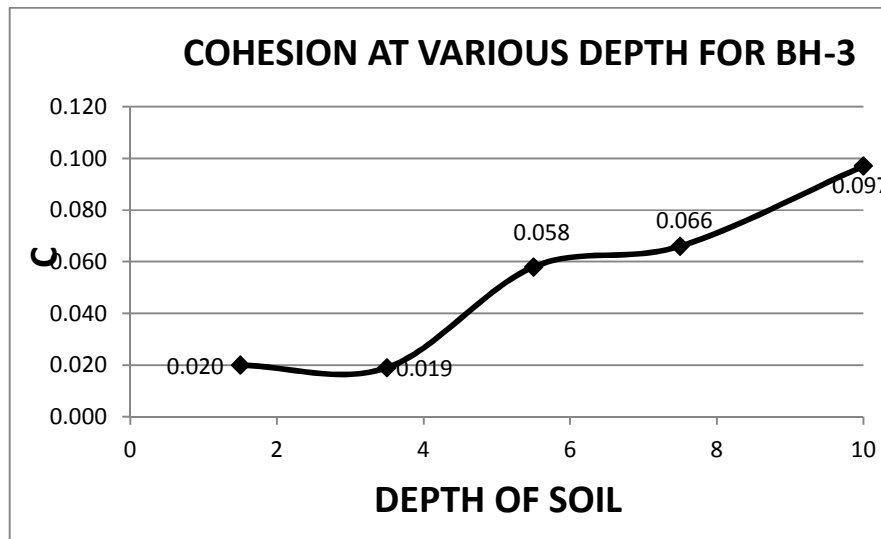
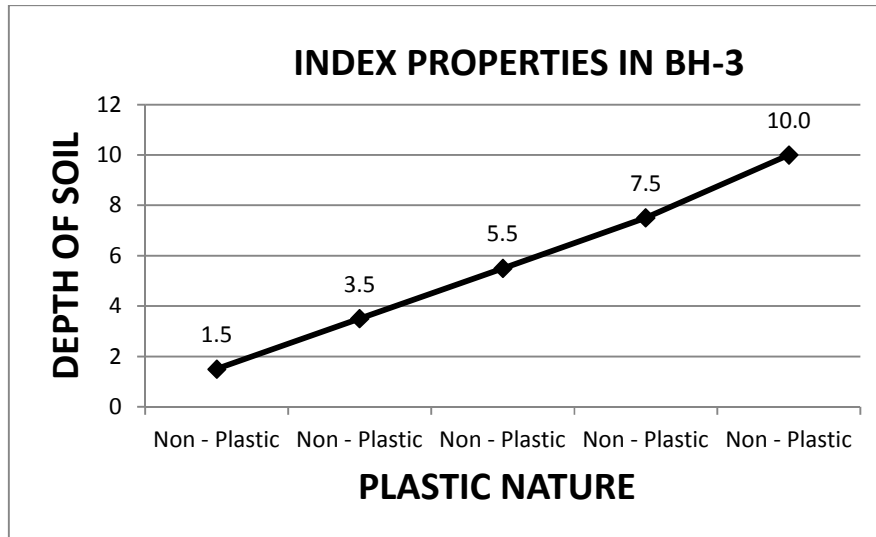
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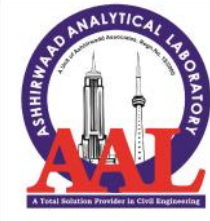
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Date: 29.08.2020

5. CHEMICAL TEST:

Chemical tests were performed on water samples collected from bore holes for determining pH value and chloride. The results are given in a tabular form below:

Table 5.1
As per IS 3025 (Part 11 & 32), IS 456-2000.

SL.NO	Particulars	Results	Stipulations of IS 456-2000, IS 3025(Part 32) (Water for Construction Purpose)
1.	pH value	7.9	6.5 – 8.5
2.	Chloride	201.17mg/l	500 - 2000 mg/l

It is seen that the values are within the permissible limit (As per IS 456-2000). So no special cement will be required for foundation concrete.

6. RECOMMENDATIONS:

The following recommendations are made based on the field investigations SPT values, GWT and subsequent Laboratory Experiments.

6.1 Considering in situ condition of the soil Strata, two types of foundations are suggested for the **Proposed Construction Of Multi Level Car Parking at Old jail Complex, Nehru Street, Pondicherry.**

a) Isolated/Combined Footing

or

b) Strip Raft Foundation

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Note: Filled up Earth Formation was seen in the Bore Hole Locations upto a maximum Depth of 2.80m from the NGL. Hence Footing have to be founded over/Medium to Dense Layer available beyond 2.80m.

6.2 If "ISOLATED/COMBINED FOOTING" is considered, the allowable safe bearing capacities are calculated and tabulated below along with the allowable settlement.

Table 6.2.1
Safe Bearing Capacity Calculation As per IS 6403:1981

Sl. No.	Bore Hole No	Depth in meter from NGL	SBC in T/m ²	As per IS:1904-1986 (Reaffirmed 2006)	
				Total Arrived Settlement (mm)	Total Arrived Settlement (mm)
1.	BH-1	3.0	13	3.34	50
2.	BH-2 &	3.25	15	4.00	50
3.	BH-3	3.5	17	4.66	50

6.3. If "STRIP RAFT FOUNDATION" is considered, the allowable safe bearing capacities are calculated and tabulated below along with the allowable settlement.

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Table 6.3.1
Safe Bearing Capacity Calculation As per IS 6403:1981

Sl. No.	Bore Hole No	Depth in meter from NGL	SBC in T/m ²	As per IS:1904-1986 (Reaffirmed 2006)	
				Total Allowable Settlement (mm)	Total Allowable Settlement (mm)
1.	BH-1	3.0	15	4.11	75
2.	BH-2 & BH-3	3.25	17	4.73	75
3.		3.50	19	5.12	75

***NGL – Natural Ground Level**

- 6.3.2 The Decision of selecting the suitable type and depth of foundation rests with the Structural Engineer Concerned.
- 6.3.3 The width of footing should not be less than 1.5m in order to satisfy the stability requirements.
- 6.4 **SAFETY PRECAUTIONS:** Since the **GWT** is located at 1.20m depth, during construction, adequate safety measures should be taken for the safety of adjacent structures by controlled and constant dewatering with sufficient support measures for prevention of the sliding soil mass. The safety of the men, machineries and structure should be ensured.
- 6.5 For the sub structure [RCC] the environmental exposure condition may be considered as '**Severe**' and all the precautions as laid by the relevant code of practice for the design of structures may be adopted.

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6.6 The entire recommendations as above are based on three bore holes executed as per the Clients directions at the location shown by the client's representative as per terms of reference. The uniformity or otherwise of the soil delineation and strength profile over the entire site shall be verified during execution. If there are any variations the same shall be reported to us for review and further advice.

S\d-

Er. N.J.L. RAMESH

CHIEF CONSULTANT (Geotech& Structures)

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Place : Puducherry

Date : 29.08.2020

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7.APPENDICES

7.1 SAFE BEARING CAPACITY CALCULATIONS:

7.1.1 For Shallow foundation it is as per **IS: 1904 – 1995**, *Code of practice for design and construction of foundations*: General requirements (third revision). The recommended safe bearing Capacity of soil for shallow foundation was calculated as per **IS: 6403-1981**, Code of practice for Determination of Bearing Capacity of Shallow Foundation. The settlement calculations are as per **IS: 8009 (Part-I) - 1976**, *Code of practice for calculation of settlements in foundations, part I Shallow foundation subjected to symmetrical static vertical Loads*. All the calculations are carried out based on the SPT value observed from the field.

7.2. SAFE BEARING CAPACITY CALCULATION FORMULAE:

7.2.1 FOR SHALLOW FOUNDATION:

IN CASE OF GENERAL SHEARE FAILURE AS PER IS: 6403: 1981

$$\text{The Ultimate Net Bearing Capacity } q_d = c N_c s_c d_c i_c + q (N_q -) s_q d_q i_q + 0.5 B \gamma N_\gamma s_\gamma d_\gamma i_\gamma W'$$

$$\text{Safe Load Carrying Capacity} = q_d / F.S$$

DEPTH FACTOR

$$d_c = 1 + (0.2 D_f / B \sqrt{N \phi})$$

$$d_q = d_\gamma = 1 \text{ for } \phi < 10^\circ$$

$$d_q = d_\gamma = 1 + 0.1 D_f / B \sqrt{N \phi} \text{ for } \phi > 10^\circ$$

INCLINATION FACTOR

$$i_c = i_q = (1 - \alpha / 90) ^2$$

$$i_\gamma = (1 - \alpha / \phi) ^2$$

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SHAPE FACTOR

Sl. No.	Shape of Base	$\frac{c}{sc}$	$\frac{q}{sq}$	$\frac{\gamma}{s\gamma}$
i)	Continuous strip	1.00	1.00	1.00
ii)	Rectangle	$1 + 0.2 B/L$	$1 + 0.2 B/L$	$1 - 0.4 B/L$
iii)	Square	1.3	1.2	0.8
iv)	Circle	1.3	1.2	0.6

Where,

c	= Cohesion in Kg/cm
D_f	= Depth of foundation in cm
d_c, d_q, d_γ	= Depth factors
i_c, i_q, i_γ	= Inclination factors
L	= Length of footing in cm
L'	= Effective length of footing in cm
N	= Corrected standard penetration value
N_c, N_q, N_γ	= Bearing capacity factors
N_ϕ	= $\tan^2 (\pi/4 + \phi/2)$
q	= Effective surcharge at the base level of Foundation
qd	= Net ultimate bearing capacity based on general shear failure
W'	= Correction factor for location of water table
α	= Inclination of the load to the vertical in degrees
ϕ	= Angle of shearing resistance of soil in degrees
γ	= Bulk unit weight of foundation soil
F.S	= Factor of safety.

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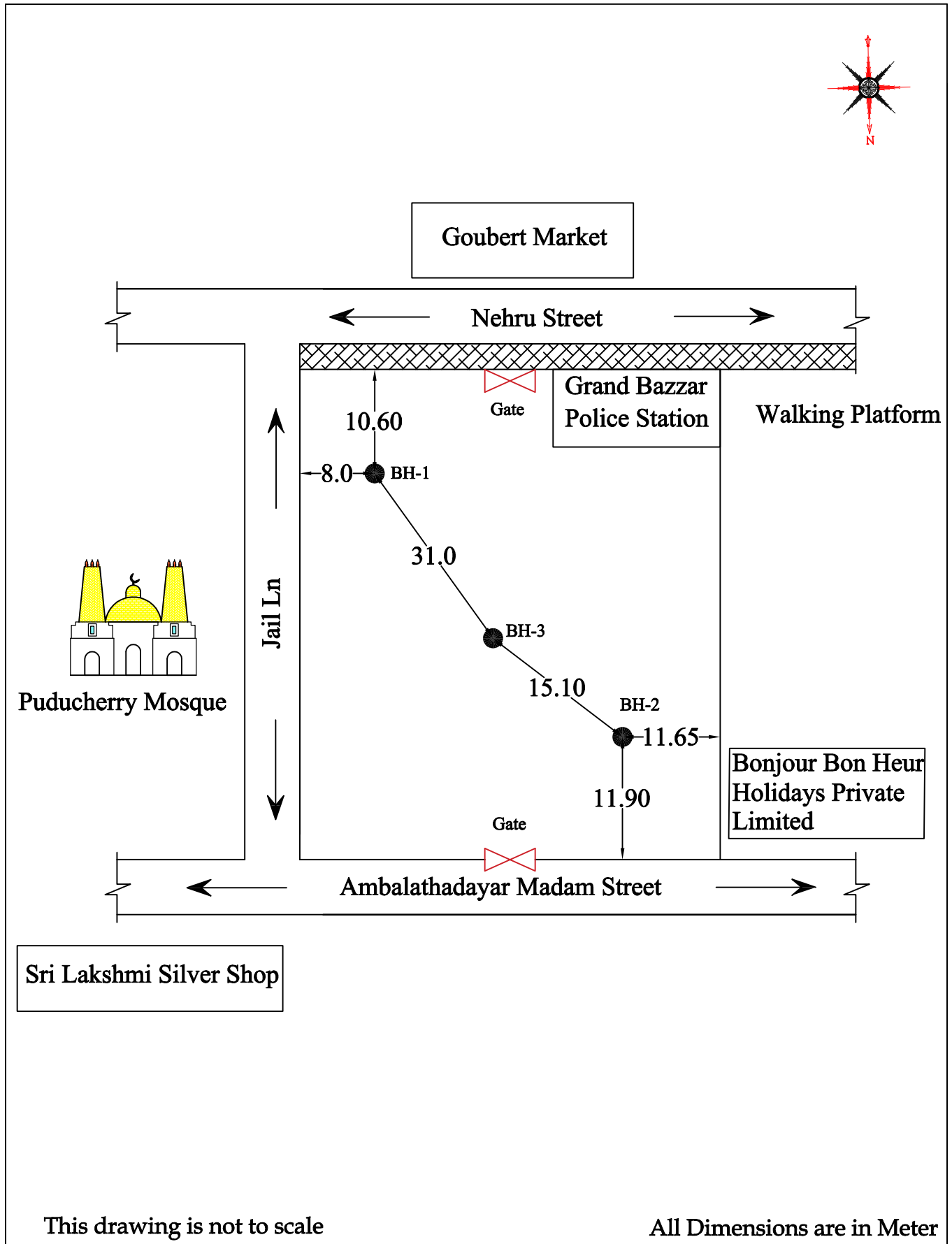


Fig. 1 – Site Photo Showing the Soil Exploration Work.

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Borehole Layout



Name Of The Work : Geotechnical Investigation For The Proposed Construction Of Multi Level Car Parking at Old jail Complex, Nehru Street, Puducherry.



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BORE LOG - 2/3

Project No:		Date:		Location:		Index properties (%)					Shear strength parameters		Gradation properties (%)																														
BH. No :		GWT (m):		Graphical Representation of Standard Penetration Test Data (N)					Description /consistency	Natural moisture content (%)	Density (γ) t/m ³	Liquid limit (W _L)	Plastic limit (W _p)	Plasticity index(I _p)	Consistency index (I _c)	Free swell index(C _s)	Direct shear test		Sieve analysis																								
Depth of boring (m) :																	20.00		N Value	10	20	30	40	50	C (kg/cm ²)	Φ (degrees)	Gravel	Coarse sand	Medium sand	Fine sand	silt & clay												
Depth Below GL	Soil stratum	Classification of soil	Thickness of Layer (m)														Depth of Sampling(m)	UDS														DS											
1.0	Fill Up Earth Red sand	2.00	0.5	5	5	5	5	5	5	5	5	23	1.71	Non - Plastic	Nil	0.030	28°25'	0.00	1.29	11.59	84.98	2.15																					
2.0			1.0																				1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	9.5	10.0			
3.0	Light Brown Sand (SP)	6.00	2.5	11	11	11	11	11	11	11	11	15	1.66	Non - Plastic	Nil	0.042	30°45'	0.00	1.37	64.73	32.53	1.37																					
4.0			3.0																				3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	9.5	10.0							
5.0			4.0																				4.5	5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	9.5	10.0	11	11	11	11	11	11	11	11	
6.0			5.0																				5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	9.5	10.0	11	11	11	11	11	11	11	11	11	11	
7.0			6.0																				6.5	7.0	7.5	8.0	8.5	9.0	9.5	10.0	11	11	11	11	11	11	11	11	11	11	11	11	
8.0			7.0																				7.5	8.0	8.5	9.0	9.5	10.0	11	11	11	11	11	11	11	11	11	11	11	11	11	11	
9.0			8.0																				8.5	9.0	9.5	10.0	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	
10.0			9.0																				9.5	10.0	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	
9.0			Black Silty Sand (SM-SW)																				2.00	8.5	19	19	19	19	19	19	19	19	19	1.84	Non - Plastic	Nil	0.036	31°10'	0.00	0.00	40.80	58.28	0.92
10.0																								8.0																			
10.0	10.0	12	12	12	12	12	12	12	12	12	12	14	1.9	Non - Plastic	Nil	0.018	31°32'	0.00	0.00	27.82	70.56	1.61																					

Name Of The Work : Geotechnical Investigation For The Proposed Construction Of Multi Level Car Parking at Old jail Complex, Nehru Street, Puducherry.



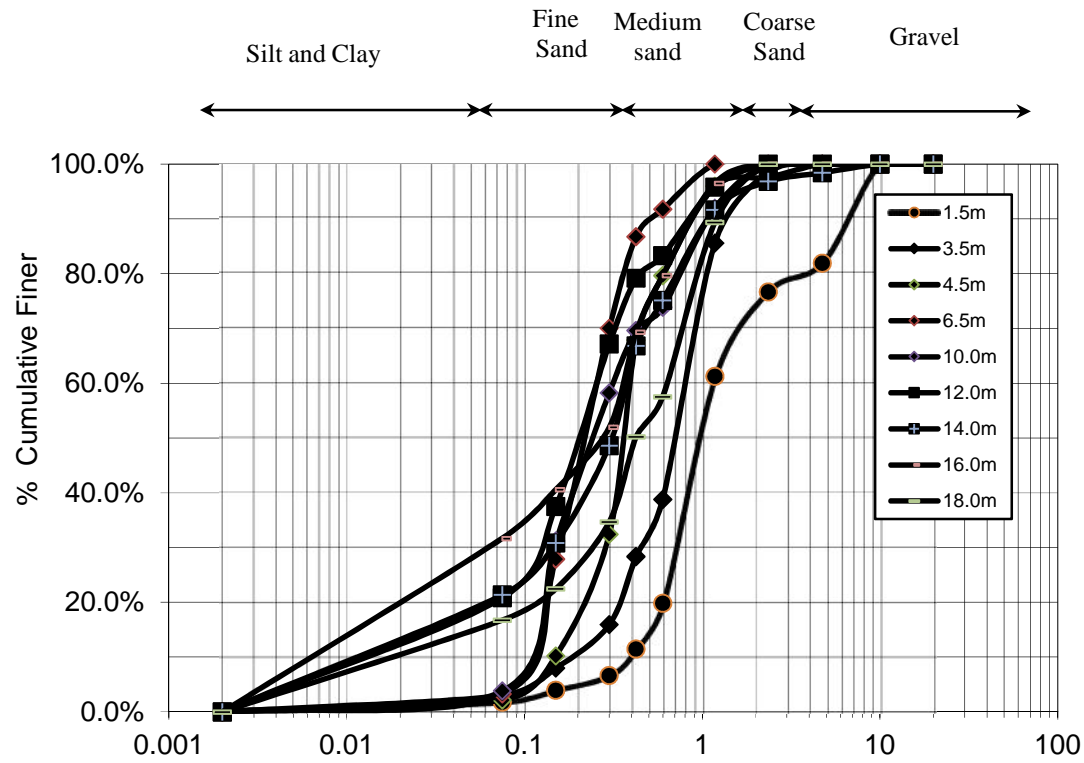
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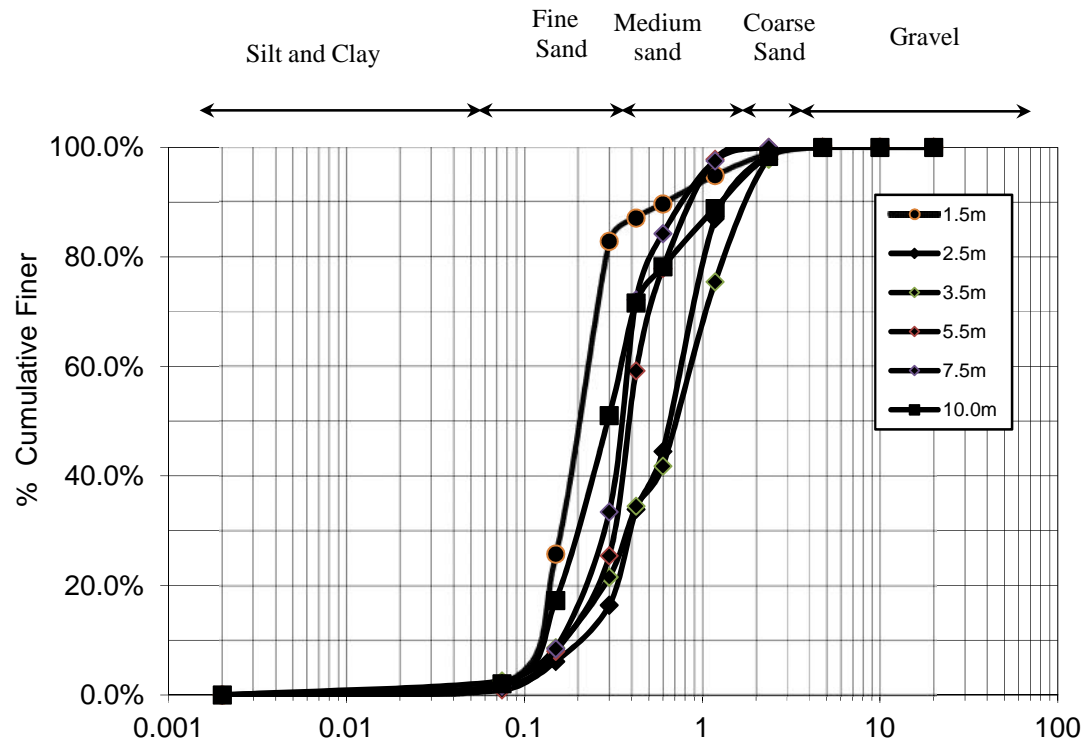
BORE LOG - 3/3

Project No:	AAL.1627/2020	Date:	16.08.2020	Location:	Old Jail Complex, Puducherry					Index properties (%)					Shear strength parameters		Gradation properties (%)														
BH. No :	3	GWT (m):	1.20	Graphical Representation of Standard Penetration Test Data (N)																											
Depth of boring (m) :				10.00												Description/consistency		Natural moisture content (%)	Density (γ) t/m ³	Liquid limit (W _L)	Plastic limit (W _p)	Plasticity index(I _p)	Consistency index (I _c)	Free swell index(C _s)	Direct shear test		Sieve analysis				
Depth Below GL	Soil stratum	Classification of soil	Thickness of Layer (m)	Depth of Sampling(m)		N Value	10	20	30	40	50									C (kg/cm ²)	Φ (degrees)	Gravel	Coarse sand	Medium sand	Fine sand	silt & clay					
1.0	Fill Up Earth Sand (SW) with gravel	2.80	2.80	UDS	0.5																										
				DS	1.0																										
2.0						6										Loose	19	1.59			Non - Plastic	Nil	0.020	30°32'	4.56	1.65	26.75	69.55	2.06		
3.0						8										Medium															
4.0				Light Brown Sand (SP)	4.70		16									Medium	22	1.73			Non - Plastic	Nil	0.019	31°10'	0.00	0.00	64.06	34.88	1.07		
5.0		26												Medium																	
6.0		21												Very Dense	21	1.73			Non - Plastic	Nil	0.058	30°32'	0.00	1.09	43.48	52.90	2.54				
7.0		18												Very Dense																	
8.0		6												Dense	20	1.66			Non - Plastic	Nil	0.066	31°32'	0.00	32.67	42.20	50.46	3.67				
9.0	Black Silty Sand (SM-SW)	2.50				16									Medium																
10.0						13										Medium	9	1.56			Non - Plastic	Nil	0.097	30°45'	0.00	0.00	33.61	64.75	1.64		

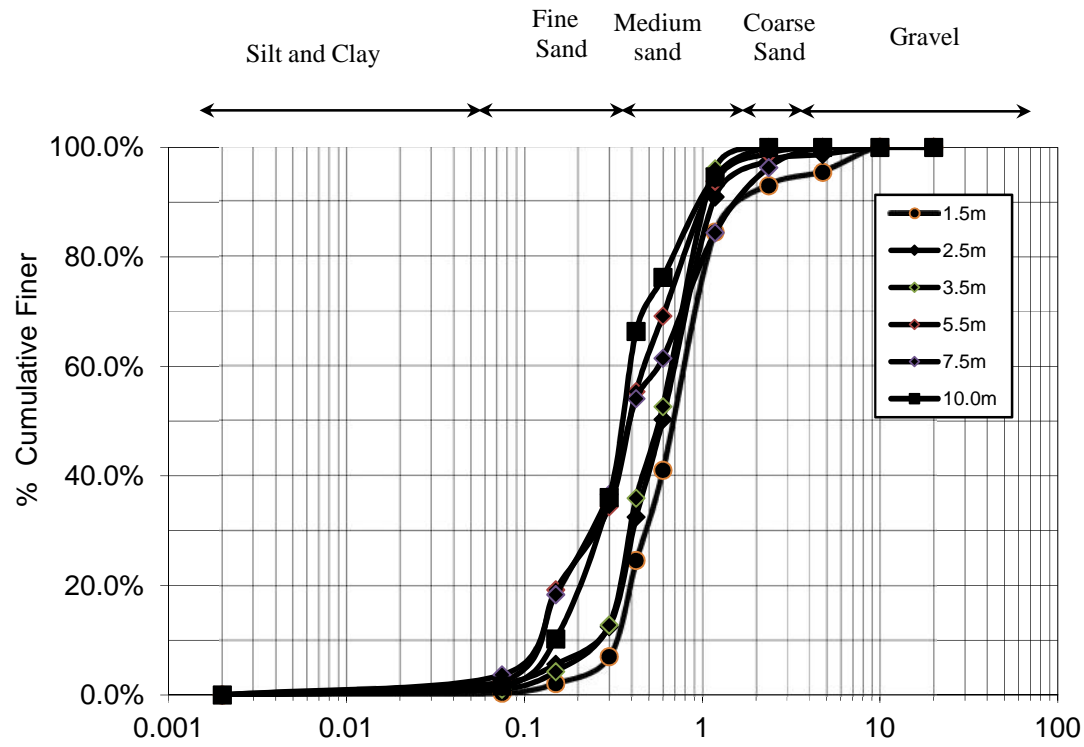
BH - 1
GRAIN SIZE DISTRIBUTION CURVE



BH - 2
GRAIN SIZE DISTRIBUTION CURVE



BH - 3
GRAIN SIZE DISTRIBUTION CURVE



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GEOTECHNICAL INVESTIGATION REPORT

PROJECT : GEOTECHNICAL INVESTIGATION FOR THE PROPOSED CONSTRUCTION OF MULTI LEVEL CAR PARKING AT MARAIMALAI ADIGAL SALAI, PUDUCHERRY

PROJECT NO : AAL.1638/MARAIMALAI ADIGAL SALAI /PDY/2020-21.

**CLIENT : THE CHIEF EXECUTIVE OFFICER,
PSCDL,
PUDUCHERRY.**

REFERENCE : WORK ORDER NO: 1040/PSCDL/MLCP/2020/513 DATE: 11.08.2020

EXPLORATION

DATE : 29.08.2020 – 01.09.2020.

DATE OF REPORT

: 10.09.2020

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**NAME OF WORK: GEOTECHNICAL INVESTIGATION FOR THE PROPOSED CONSTRUCTION OF
MULTI LEVEL CAR PARKING AT MARAIMALAI ADIGAL SALAI,
PUDUCHERRY_**

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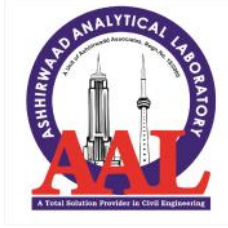
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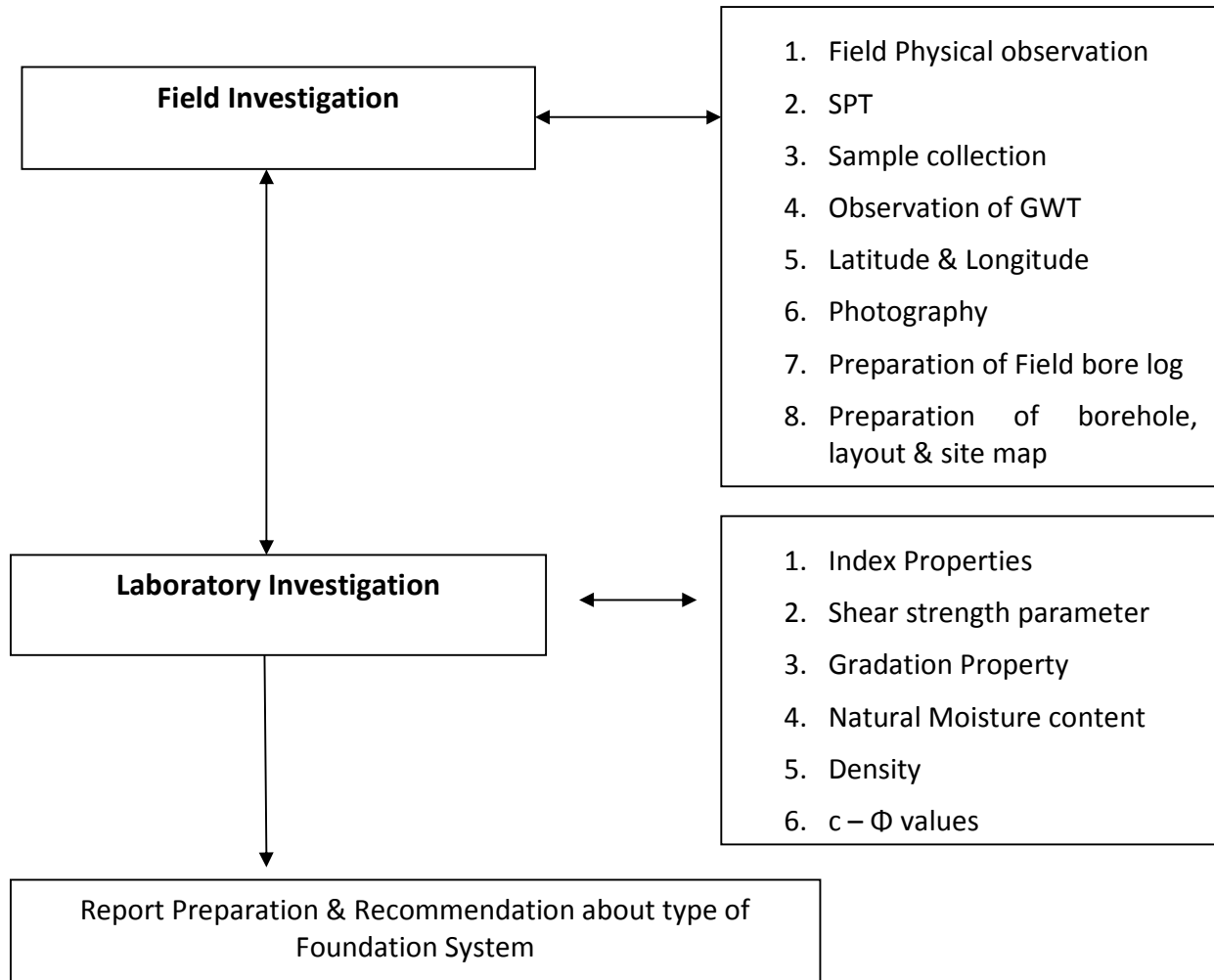
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1. INTRODUCTION

A Geotechnical investigation for the above said work was undertaken as per the authorization given by **THE CHIEF EXECUTIVE OFFICER, PSCDL, Puducherry.**

FLOW CHART



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2. SCOPE OF WORK

2.1 This geotechnical investigation has been carried out to ascertain the safe bearing capacity and to decide upon suitable foundation system for the proposed structure. It was instructed to make two number of bore holes. The BH -1 was driven upto 22.0m & BH-2 was driven upto 10.0m depth and terminated as per the clients instruction.

2.2 The allowable safe bearing capacity of the soil is calculated based on the field geotechnical investigation, soil properties, GWT and subsequent laboratory experiments.

3. FIELD INVESTIGATION

3.1 GENERAL

Mobilizations of equipment, skilled and unskilled labours are arranged at site. The various factors for the number and position of boreholes and spacing of boreholes are based on the extent of the site, nature and type of structure. Depth of borehole is concluded based on condition of soil, penetration capacity of soil, shear failure and hard strata condition. Standard Penetration Test (SPT) is conducted at various depths. The disturbed soil sample is collected from the site and transported for examination to Ashhirwaad Analytical Laboratory. The field investigation is being monitored by experienced civil engineers/ Geotechnical/ Structural Engineer.

3.2 STANDARD PENETRATION TEST (IS: 2131 – 1981)

EQUIPMENT PREPARATION

3.2.1 DRILLING EQUIPMENT

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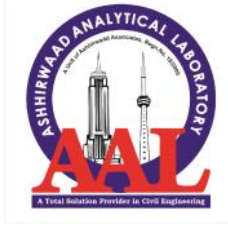
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The equipment used shall provide a clean borehole 100 to 150 mm in diameter, for insertion of the sampler ensure that the penetration test is performed on undisturbed soil and shall permit driving of the split spoon sampler to obtain penetration record and sample in accordance with procedure.

3.2.2 DRIVE WEIGHT ASSEMBLY

The drive weight assembly shall consist of driving head and a 63.5 kg weight with 75cm free fall. It is ensured that the energy of the falling weight is not reduced by friction between the drive weight and the guides. The rods to which the sampler is attached for driving should be straight, tightly coupled and straight in alignment. For driving the casting, a hammer heavier than 63.5 kg may be used.

3.2.3 CLEANING THE BOREHOLE

In case wash boring is adopted for cleaning the borehole, side discharge bits are permissible, but in no case a bottom discharge bit be permitted. In cohesive soils, the borehole may be cleaned with bailer with a flap valve.

3.2.4 OBTAINING THE SAMPLES

Test shall be made at every change in stratum or at intervals of not more than 1.5 m whichever is less. Tests may be made at lesser or greater intervals if specified or considered necessary.

The sampler shall be lowered to the bottom of the borehole. The following information shall be noted and recorded.

- (a) Depth of bottom of borehole below ground level.
- (b) Penetration of the sampler into the soil under the combined weight of sampler and rods

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- (c) Water level in the borehole or casting
- (d) Depth of bottom of casting below ground level.

Labels shall be fixed to the jar or notation shall be written on the covers with the following information:

- a) Origin of sample
- b) Job designation
- c) Boring number
- d) Sample number
- e) Depth of sampling
- f) Penetration record
- g) Length of recovery
- h) Date of sampling

The jars containing samples shall be stored in suitable container for shipment. Samples should not be placed in the sun.

3.3 IS CODE FOR FIELD INVESTIGATION

SL.NO	IS CODE NUMBER	IS CODE NAME
1	IS : 1498 – 1970 (Reaffirmed 2007)	Classification & Identification of soil for general engineering purpose (First Revision)
2	IS : 1892 – 1979 (Reaffirmed 2002)	Code of practice for sub surface investigation for foundation (First Revision)
3	IS : 2131 – 1981 (Reaffirmed 2002)	Method of Standard Penetration Test for soil (First Revision)
4	IS : 2132 – 1986 (Reaffirmed 2002)	Code of practice for thin walled tube sampling of soil (Second Revision)
5	IS : 4968 – 1976 (Reaffirmed 2007)	Method of sub surface sounding of soil : Static cone penetration (First Revision)

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3.4 SITE EXPLORATION

Subsurface exploration should be carried out in preliminary and detailed exploration. Shear strength and compressibility of the soil is determined in the detailed exploration. The method of boring for soil exploration is rotary boring. Rotary boring is effected by cutting action of the soil. The bit is carried at the end of hollow, jointed drill rods which is rotated by the chuck. A mud laden fluid is pumped continuously and fluid returns to surface in angular space. Undisturbed samples are collected at suitable intervals.

3.5 SITE MAP



Bore Hole No	LATITUDE	LONGITUDE
BH-1	11°55'50.84"N	79°49'21.52"E
BH-2	11°55'51.17"N	79°49'22.79"E

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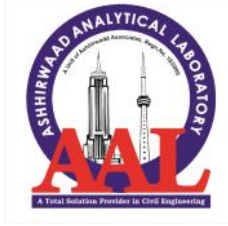
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3.6 BOREHOLE DETAILS

Two number of bore holes are driven in the field at various location of the site. As per IS: 1892 - 1979 (Reaffirmed 2002), the various driven depth of the borehole, Ground Water Table and their corresponding identifications are tabulated below

SL.NO	BOREHOLE IDENTIFICATION NUMBER	DRIVEN BOREHOLE DEPTH (m)
1.	BH-1	22.0
2.	BH-2	10.0

BOREHOLE IDENTIFICATION NUMBER	GROUND WATER TABLE (m)
BH-1	2.80
BH-2	2.80

4. GEOTECHNICAL MODELLING AND OBSERVATION:

4.1 GENERAL

Various laboratory test are carried out to assess the soil as per IS code standard and calculations are done. The results of the test are tabulated and interpretation is given.

4.2 LIST OF IS CODE

4.2.1 LABORATORY IS CODE

SL.NO	IS CODE NUMBER	IS CODE NAME
1	IS : 2720 – 1983 (Part – 1) (Reaffirmed 2006)	Methods of test for soil :Preparation of dry soil sample for various test (Second Revision)

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2	IS 2720 – 1980 (Part – 2) (Reaffirmed 2010)	Methods of test for soil : Determination of water content (Second Revision)
3	IS 2720 – 1980 (Part – 3) (SECTION – 1) (Reaffirmed 2002)	Methods of test for soil : Determination of specific gravity : Fine grained soil (First Revision)
4	IS 2720 – 1980 (Part – 3) (SECTION – 2) (Reaffirmed 2002)	Methods of test for soil : Determination of specific gravity : Fine, Medium, Coarse grained soil (First Revision)
5	IS 2720 – 1985 (Part – 4) (Reaffirmed 2006)	Methods of test for soil : Grain size analysis(Second Revision)
6	IS 2720 – 1985 (Part – 5) (Reaffirmed 2006)	Methods of test for soil : Determination of liquid and plastic limit (Second Revision)
7	IS 2720 – 1985 (Part – 15) (Reaffirmed 2006)	Methods of test for soil : Determination of consolidation properties (First Revision)
8	IS 1809 – 1972 (Reaffirmed 2006)	Methods of test for soil : Glossary of terms & symbols relating to soil engineering (Third Revision)

4.2.2 FOUNDATION IS CODE

SL.NO	IS CODE NUMBER	IS CODE NAME
1	IS : 1080 – 1986 (Reaffirmed 2002)	Code of practice for design and construction of shallow foundation on soil (other than raft, ring and shell) (Second Revision)
2	IS 1904 : 1968 (Reaffirmed 2006)	Code of practice for design and construction of foundation on soil :General requirement (Third Revision)
3	IS 6403 – 1981 (Reaffirmed 2002)	Code of practice for determination of bearing capacity of shallow foundation (First Revision)

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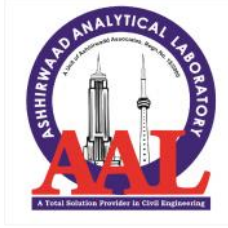
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4.2.3 SEISMIC IS CODE

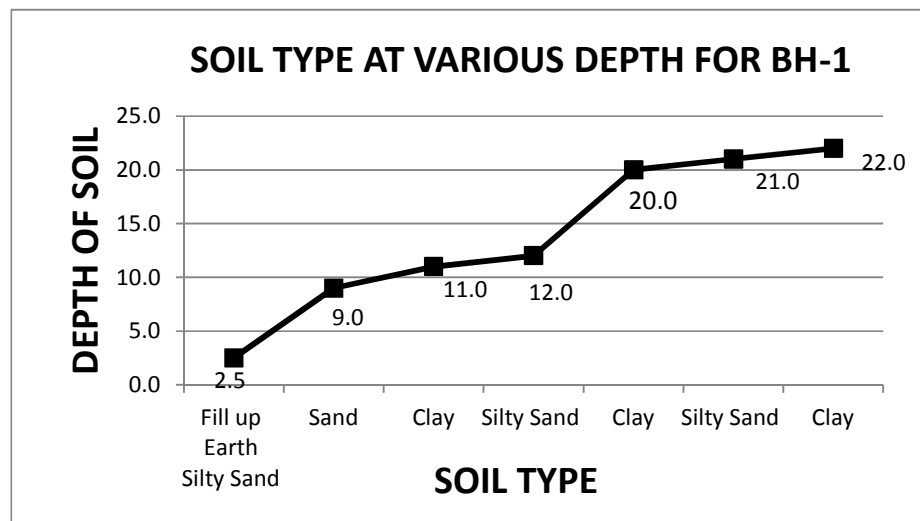
SL.NO	IS CODE NUMBER	IS CODE NAME
1	IS 1893 – 2002 (Reaffirmed 2007)	Criteria for Earthquake Resistant design of Structures(Fifth Revision)

4.3 RESULT:

Laboratory tests the following soil profiles for the boreholes as observed is detailed below:

BH -1

The details of soil stratification are presented in the bore - log and their interpretation is shown below



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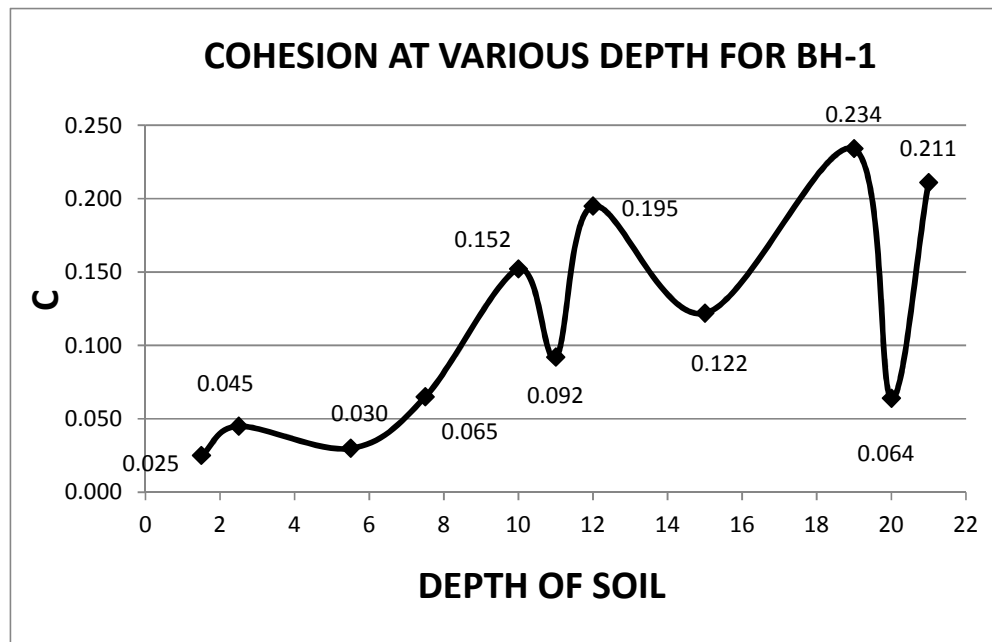
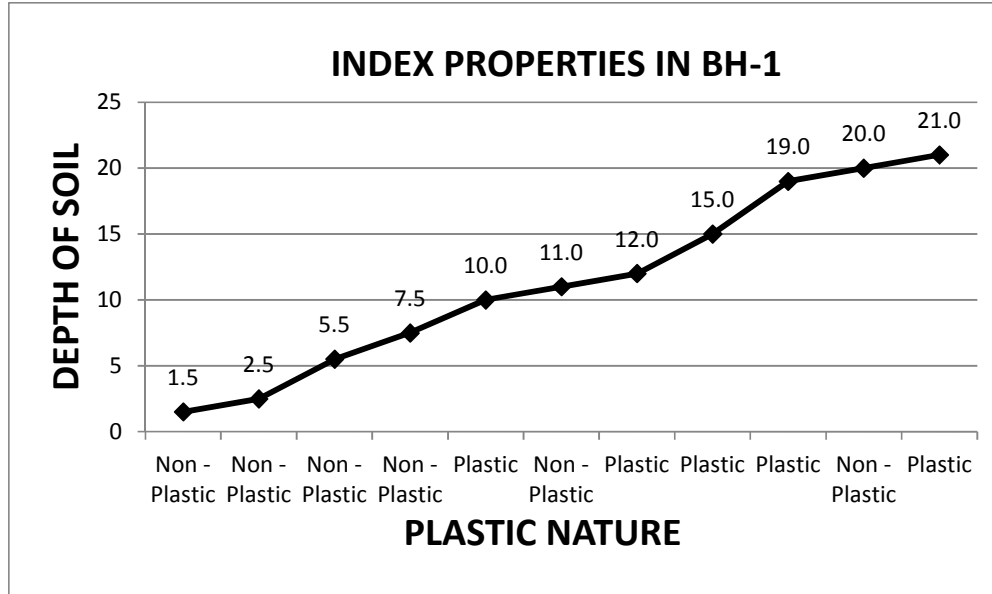


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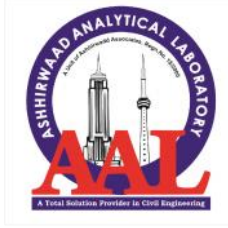
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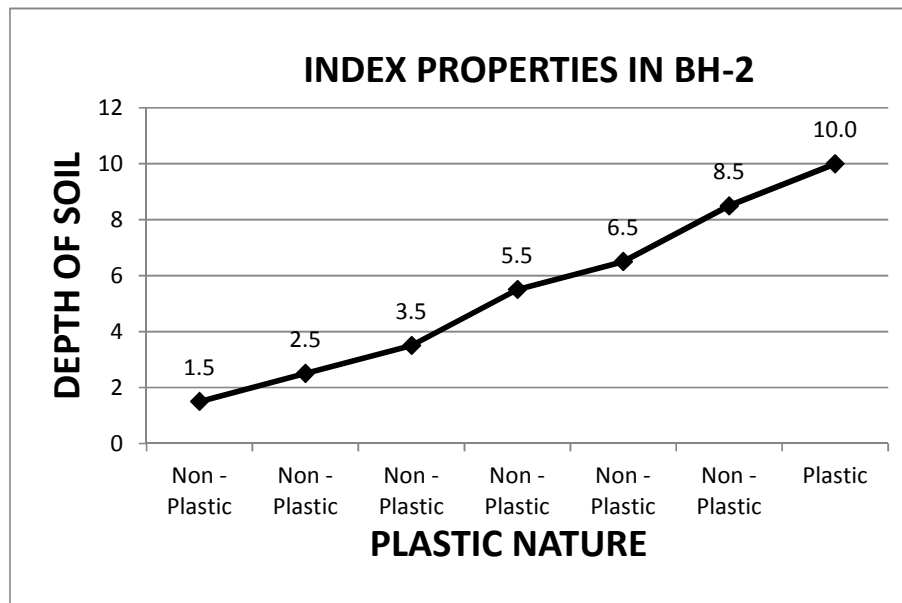
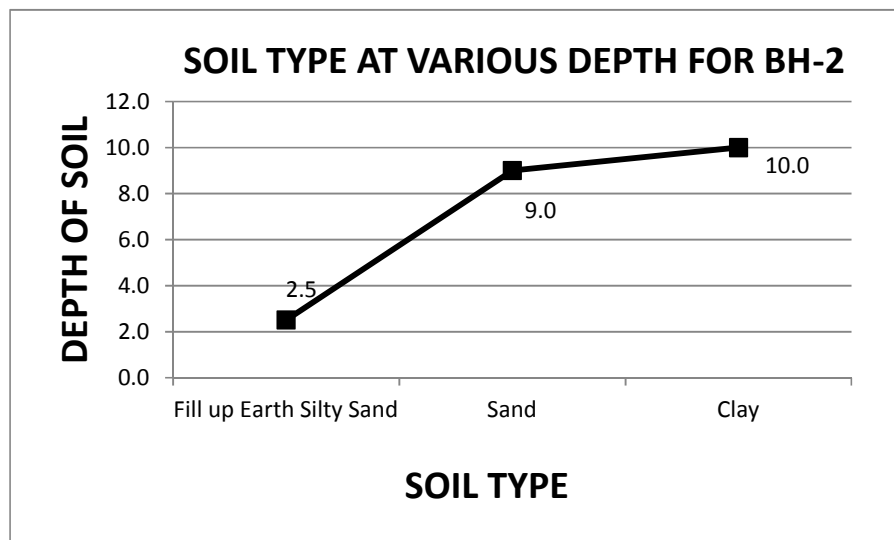


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BH -2

The details of soil stratification are presented in the bore - log and their interpretation is shown below



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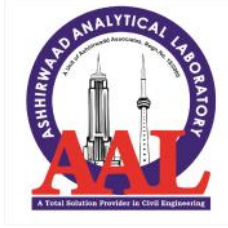
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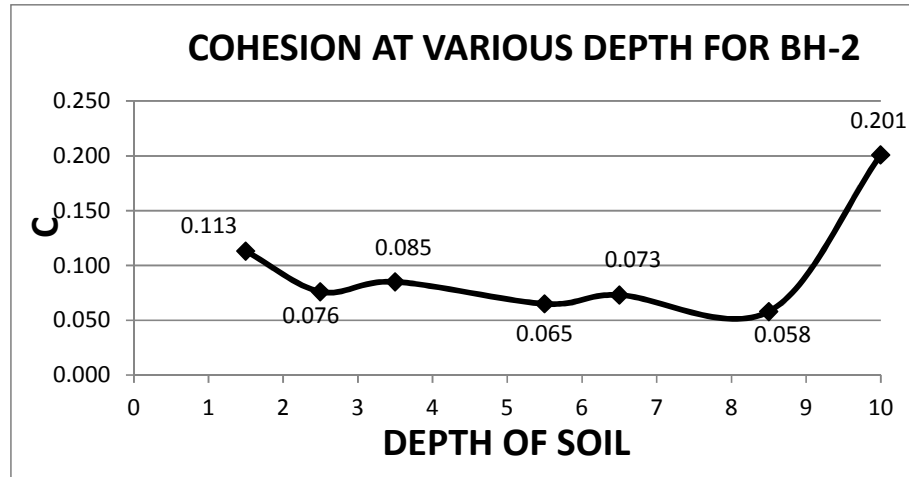
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5. CHEMICAL TEST:

Chemical tests were performed on water samples collected from bore holes for determining pH value and chloride. The results are given in a tabular form below:

Table 5.1
As per IS 3025 (Part 11 & 32), IS 456-2000.

SL.NO	Particulars	Results	Stipulations of IS 456-2000, IS 3025(Part 32) (Water for Construction Purpose)
1.	pH value	7.2	6.5 – 8.5
2.	Chloride (Cl)	136.48 mg/l	500 (for RCC) - 2000 mg/l (for PCC)

It is seen that the values are within the permissible limit (As per IS 456-2000). So no special cement will be required for foundation concrete.

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6. RECOMMENDATIONS:

The following recommendations are made based on the field investigations SPT values, GWT and subsequent Laboratory Experiments.

5.1 Considering in situ condition of the soil Strata, two types of foundations are suggested for the **Proposed Construction Of Multi Level Car Parking at Maraimalai Adigal Salai, Puducherry.**

- a) Isolated/Combined Footing
or
- b) Strip Raft Foundation

6.2 If "ISOLATED/COMBINED FOOTING" is considered, the allowable safe bearing capacities are calculated and tabulated below along with the allowable settlement.

Table 6.2.1.1

Safe Bearing Capacity Calculation As per IS 6403:1981

Sl. No.	Bore Hole No	Depth in meter from NGL	SBC in T/m ²	As per IS:1904-1986 (Reaffirmed 2006)	
				Total Arrived Settlement (mm)	Total Arrived Settlement (mm)
1.	BH-1 &	2.75	12	9.84	50
2.	BH-2	3.0	14	12.24	50

6.2 B

6.2.1 If "STRIP RAFT FOUNDATION" is considered, the allowable safe bearing capacities are calculated and tabulated below along with the allowable settlement.

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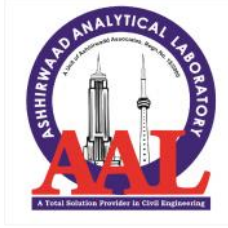
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Table 6.2.1.1

Safe Bearing Capacity Calculation As per IS 6403:1981

Sl. No.	Bore Hole No	Depth in meter from NGL	SBC in T/m ²	As per IS:1904-1986 (Reaffirmed 2006)	
				Total Allowable Settlement (mm)	Total Allowable Settlement (mm)
1.	BH-1 &	2.75	14	9.66	75
2.	BH-2	3.0	16	11.52	75

**NGL – Natural Ground Level*

6.2.2 The Decision of selecting the suitable type and depth of foundation rests with the Structural Engineer Concerned.

6.2.3 The width of footing should not be less than 1.5m in order to satisfy the stability requirements.

6.3 SAFETY PRECAUTIONS: Since the **GWT** is located at 2.8m depth, during construction, adequate safety measures should be taken for the safety of adjacent structures by controlled and constant dewatering with sufficient support measures for prevention of the sliding soil mass. The safety of the men, machineries and structure should be ensured.

6.4 For the sub structure [RCC] the environmental exposure condition may be considered as '**Severe**' and all the precautions as laid by the relevant code of practice for the design of structures may be adopted.

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6.5 The entire recommendations as above are based on two bore holes executed as per the Clients directions at the location shown by the client's representative as per terms of reference. The uniformity or otherwise of the soil delineation and strength profile over the entire site shall be verified during execution. If there are any variations the same shall be reported to us for review and further advice.

sd/-

Er. N.J.L. RAMESH

CHIEF CONSULTANT (Geotech& Structures)

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Date : 10.09.2020

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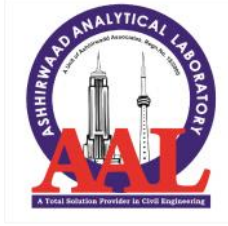
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7.APPENDICES

7.1 SAFE BEARING CAPACITY CALCULATIONS:

7.1.1 For Shallow foundation it is as per **IS: 1904 – 1995**, *Code of practice for design and construction of foundations: General requirements (third revision)*. The recommended safe bearing Capacity of soil for shallow foundation was calculated as per **IS: 6403-1981**, *Code of practice for Determination of Bearing Capacity of Shallow Foundation*. The settlement calculations are as per **IS: 8009 (Part-I) - 1976**, *Code of practice for calculation of settlements in foundations, part I Shallow foundation subjected to symmetrical static vertical Loads*. All the calculations are carried out based on the SPT value observed from the field.

7.2. SAFE BEARING CAPACITY CALCULATION FORMULAE:

7.2.1 FOR SHALLOW FOUNDATION:

IN CASE OF GENERAL SHEARE FAILURE AS PER IS: 6403: 1981

$$\text{The Ultimate Net Bearing Capacity } q_d = cN_c s_c d_c i_c + q(N_q -)s_q d_q i_q + 0.5 B \gamma N_\gamma s_\gamma d_\gamma i_\gamma W'$$

$$\text{Safe Load Carrying Capacity} = q_d / F.S$$

DEPTH FACTOR

$$d_c = 1 + (0.2 D_f / B \sqrt{N_\phi})$$

$$d_q = d_\gamma = 1 \text{ for } \phi < 10^\circ$$

$$d_q = d_\gamma = 1 + 0.1 D_f / B \sqrt{N_\phi} \text{ for } \phi > 10^\circ$$

INCLINATION FACTOR

$$i_c = i_q = (1 - \alpha / 90)^\circ$$

$$i_\gamma = (1 - \alpha / \phi)^\circ$$

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SHAPE FACTOR

Sl. No.	Shape of Base	\bar{s}_c	\bar{s}_q	\bar{s}_γ
i)	Continuous strip	1.00	1.00	1.00
ii)	Rectangle	$1 + 0.2 B/L$	$1 + 0.2 B/L$	$1 - 0.4 B/L$
iii)	Square	1.3	1.2	0.8
iv)	Circle	1.3	1.2	0.6

Where,

- c** = Cohesion in Kg/cm
- D_f** = Depth of foundation in cm
- d_c, d_q, d_γ** = Depth factors
- i_c, i_q, i_γ** = Inclination factors
- L** = Length of footing in cm
- L'** = Effective length of footing in cm
- N** = Corrected standard penetration value
- N_c, N_q, N_γ** = Bearing capacity factors
- N_ϕ** = $\tan^2 (\pi/4 + \phi/2)$
- q** = Effective surcharge at the base level of Foundation
- qd** = Net ultimate bearing capacity based on general shear failure
- W'** = Correction factor for location of water table
- α** = Inclination of the load to the vertical in degrees
- ϕ** = Angle of shearing resistance of soil in degrees
- γ** = Bulk unit weight of foundation soil
- F.S** = Factor of safety.

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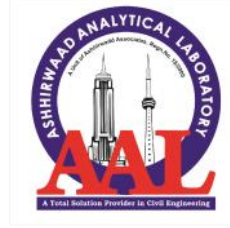
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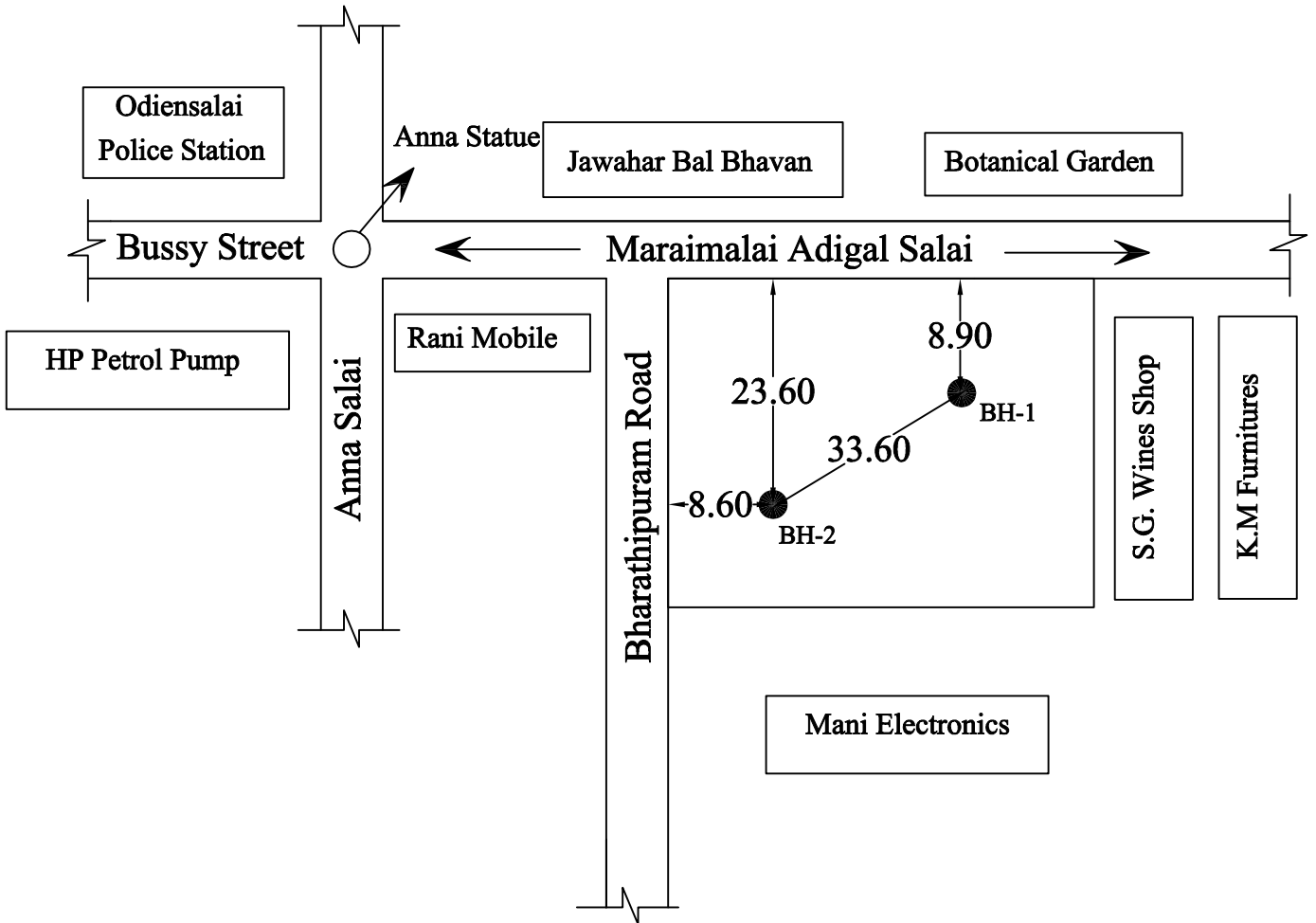


Fig. 1 – Site Photo Showing the Soil Exploration Work.

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Borehole Layout



This drawing is not to scale

All Dimensions are in Meter

Name Of The Work : Geotechnical Investigation For The Proposed Construction Of Multi Level Car Parking at Maraimalai Adaigal Salai, Puducherry.



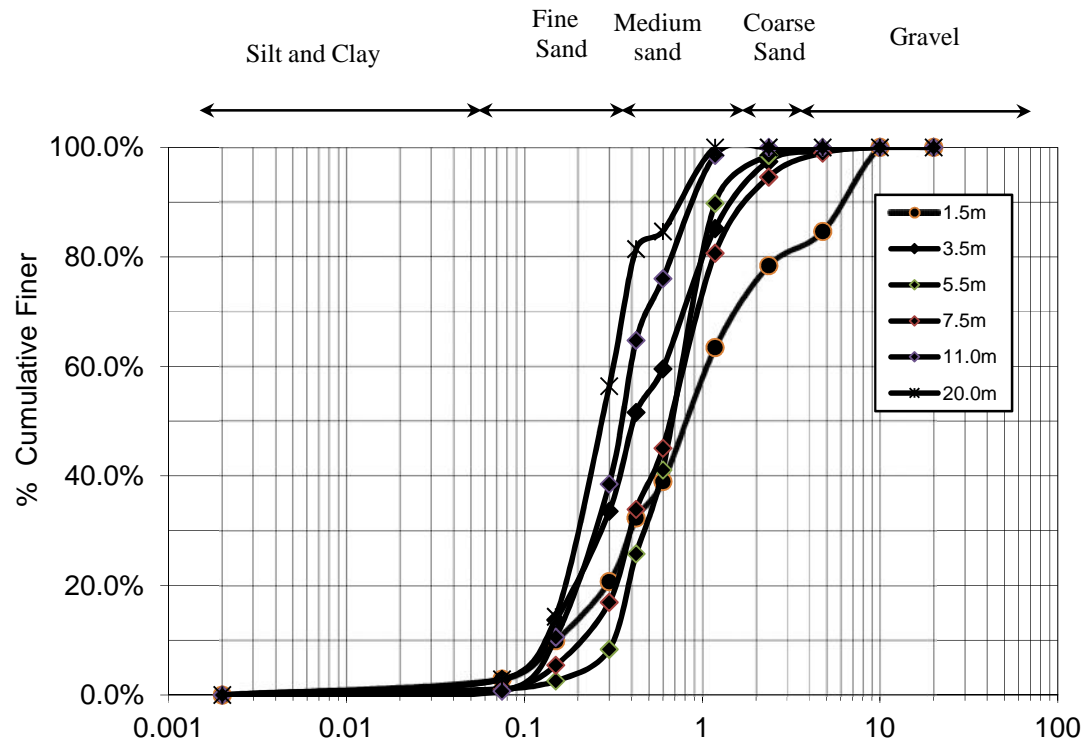
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BORE LOG - 1/2

Project No:	AAL.1638/Pdy/2020	Date:	31.08.2020	Location:	Maraimalai Adigal Salai, Puducherry					Index properties (%)					Shear strength parameters		Gradation properties (%)								
BH. No :	1	GWT (m):	2.80	Graphical Representation of Standard Penetration Test Data (N)					Description /consistency	Natural moisture content (%)	Density () t/m ³	Liquid limit (W _L)	Plastic limit (W _p)	Plasticity index(I _p)	Consistency index (I _c)	Free swell index(C _s)	Direct shear test		Sieve analysis						
Depth of boring (m) :		22.00															C (kg/cm ²)		(degrees)		Gravel	Coarse sand	Medium sand	Fine sand	silt & clay
Depth Below GL	Soil stratum	Classification of soil	Thickness of Layer (m)	Depth of Sampling(m)		N Value	10	20	30	40	50	C (kg/cm ²)	(degrees)	Gravel	Coarse sand	Medium sand	Fine sand	silt & clay							
			UDS	DS																					
11.0		Black Clay (CH)	1.00		10.5																				
					11.0	13						23	1.56	Non-Plastic		Nil	0.092	29°55'	0.00	0.00	35.27	64.00	0.73		
12.0		Black Silty sand (SM-SW)	1.00		11.5																				
					12.0	2						42	1.05	72	31	41	0.73	100	0.195	4°41'	0.00	0.00	0.00	0.0	100.00
13.0		Black Clay (CH)	7.50	*	12.5																				
							13.0	1 (30cm)																	
14.0							13.5																		
							14.0	3																	
15.0							14.5																		
							15.0	5						48	1.21	78	35	37	0.73	80	0.122	5°11'	0.00	0.00	0.00
16.0					15.5																				
					16.0	4																			
17.0					16.5																				
					17.0	4																			
18.0					17.5																				
					18.0	5																			
19.0					18.5																				
					19.0	4						51	1.11	75	32	43	0.56	100	0.234	6°16'	0.00	0.00	0.00	2.24	97.76
20.0		Silty sand (SM-SW)	0.50		19.5																				
					20.0	41						20	1.65	Non-Plastic		Nil	0.064	31°10'	0.00	0.00	18.57	78.57	2.86		

BH - 1
GRAIN SIZE DISTRIBUTION CURVE



BH - 2
GRAIN SIZE DISTRIBUTION CURVE

