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Dial: 98304 83074, 98307 37826, Mail Id: rajusubhankar@yahoo.co.in

JOB NO.

SOIL REPORT FOR

(MULTI STORIED BUILDING)

(BS / SOIL / 4257/ 2022)

AT

PREMISES NO. - 933, RAJA RAMMOHAN ROY ROAD, WARD NO.- 121,
BOROUGH NO.- XIV, P. S.- BEHALA, DIST- SOUTH 24 PGS., KOLKATA -
700008, UNDER K.M.C.(S.S.UNIT), STATE - WEST BENGAL.

NAME OF C.A.- SRI PANKAJ BERA (PROPRIETOR PDC ASSOCIATES) AS
CONSTITUTED ATTORNEY OF {1} NETAI CHARAN ROY, {2} SRI AMAL
KISHORE ROY, {3} SMT. SOBHA ROY & {4} SMT. GARGI CHAKRABORTY.

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(Formerly known as FOUNDATION-X)

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237, KABI NABIN SEN ROAD, NAGER BZAR, KOLKATA-700028.

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<u>SI NO</u>	<u>NOMENCLATURE</u>	<u>PAGE NO</u>
1	SUMMARY	2-3
2	INTRODUCTION	4
3	SCOPE OF WORK	5
4	FIELD OPERATION	5-6
5	LABORATORY TEST METHODS	6-9
6	SUB SOIL PROFILE	10-13
7	HYDROLOGY	13
8	FOUNDATION SIZE & BEARING CAPACITY	14-16
	a) STRIP FOOTING	
	b) ISOLATED SQUARE FOOTING	
9	RECOMMENDATION AND CONCLUSION	17
<u>ANNEXTURE</u>		
1.0	GENERALILSED SOIL PROFILE	18
2.0	BORE HOLE LOCATION	19
3.0	BORE LOG DATA SHEET BH- 1, BH-2 & BH - 3	20-23
4.0	SUMMARY OF LABORATORY TEST RESULTS	24
5.0	GRAPH	
	a) DEPTH VS N VALUE CURVE	25



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1.0 SUMMARY

RECONNAISSANCE

- a) Description of site (level or sloping) : Same Level
- b) General geology of site (in-situ soil, alluvial soil): soft to medium brownish gray silty clay/clayey silt.
- c) Details of existing or demolished building and trees :
- d) Level of site with respect to road level : As same as E.R.L.
- e) Local inquiry on GW conditions & soil stratification: 1.2 m
- f) Comment on fill (Thickness, soil type and age) : 1.5 m
- g) Distance of site from coast : NA
- h) Is any water body (river /nalah/ etc) exist near site : NA

If yes - Type of water body:

Distance form site:



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FOUNDATION SIZE & BEARING CAPACITY

Type	Size M*M	Depth of Foundation (M)	Q allowable t/m ²	Permissible Settlement (mm)
Thickness of Compacted Sand Cushion= 0.3 m				
SQUARE	1.5	1.4	9.1	75
	2.0		8.8	
	2.5		8.5	
STRIP	1.5	1.4	8.2	75
	2.0		7.8	
Thickness of Compacted Sand Cushion= 0.6m				
SQUARE	1.5	1.4	9.5	75
	2.0		9.2	
	2.5		8.8	
STRIP	1.5	1.4	8.5	75
	2.0		8.1	

NB: To achieve the SBC value mentioned in the table, we have to provide compacted sand cushion of fine to medium coarse sand of different thickness mentioned above just below the foundation in such a way as the dry density of the sand become 97% and above of the value of maximum dry density of the sand at its' optimum moisture content. Again sand layer should be free from clayey lump. Presence of the clayey lump may be the reason of future development of the higher differential settlement.

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3



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2.0 INTRODUCTION

It has been proposed to construct a MULTI STORIED BUILDING at PREMISES NO. - 933, RAJA RAMMOHAN ROY ROAD, WARD NO.- 121, BOROUGH NO.- XIV, P. S.- BEHALA, DIST- SOUTH 24 PGS., KOLKATA - 700008, UNDER K.M.C.(S.S.UNIT), STATE - WEST BENGAL. Soil exploration work including laboratory testing was carried out.

The object of this investigation was to study the sub-soil characteristics of the underlying deposit of soil and to recommend the safe bearing capacity of the soil for design of appropriate foundation for the said project. BS PROJECTS & ENGINEERS PVT. LTD. (237, KABI NABIN SEN ROAD, NAGERBAZAR, KOLKATA. - 700 028) was requested to do so.

The scope of this comprised of sinking of three nos boreholes of 20 m, 11 m & 11 m depth respectively. Collecting disturbed and undisturbed soil samples from those boreholes at suitable intervals and testing of the undisturbed samples in laboratory for reporting purpose.

The report has been prepared after a careful study of all the data collected during the field operation and the results of deferent laboratory test. Detailed discussions regarding the type of foundation are also furnished in this report.

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4



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3.0 SCOPE OF WORK

The scope of investigation consists of three nos boreholes of 20 m, 11 m & 11 m depth respectively. The boreholes were scheduled to determine the depth of full sub-soil stratification and to conduct field i.e. standard penetration test and laboratory test. Disturbed and undisturbed soil samples were also collected from those boreholes.

Normal schedule of field and laboratory test schedule of field and laboratory testing were adopted and all these testing have been done as per relevant IS specification for multi-storied building.

4.0 FIELD EXPLORATIONS

4.1 Boring:

The boreholes were advanced into the soil by wash boring method and auger equipment. Flush-jointed seam less casings were used to stabilize the boreholes. The standing water level of each boreholes was determined at the end of boring.

4.2 Sampling:

Undisturbed and disturbed soil samples were collected at regular intervals of depth or at changes of strata. Disturbed samples including Penetrometer samples were collected and stored in polythene bags after proper labeling. Undisturbed samples were collected in 100 mm diameter

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5



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sample tubes. The area ratio of each tube was kept within 14 %. The tubes were sealed with paraffin wax at both ends labeled depth wise and dispatched to the laboratory for testing. The depth wise locations of all the undisturbed and disturbed samples are given in the bore log data sheets.

4.3 In situ test:

Standard penetration test:

Standard penetration tests were conducted within each borehole at suitable intervals of depth as levels shown in the bore log data sheets. The tests were done with the standard split-spoon sampler as per I.S.2131.

The N values were obtained by counting the number of blows required to drive the spoon from 15cm to 45cm.

5.0 LABORATORY TESTS METHODS:

The soil samples from the 10cm diameter sampling tubes were extracted in the laboratory by pushing out the soil core with the help of a jack and a frame. The core was jacked out in a direction that corresponded to the soil movement within the tube during sampling.

The following tests were done on representative samples of the cohesive strata.

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- a) Natural water content.
- b) Atterberg limits.
- c) Bulk density.
- d) Specific gravity
- e) Grain size distribution.
- f) Undrained triaxial test.
- g) Consolidation test.
- h) Direct Shear test.

For triaxial tests 38 mm diameter \times 76 mm long specimens were obtained by jacking out the soil core into thin-walled brass tubes each having a wall thickness of 0.8 mm. The inside of the tube was coated with a thin layer of silicon oil

To obtain specimens for consolidation test, the odometer ring was placed on the trimmed horizontal face of the soil within 10 cm sampling tube and the soil around the cutting edge was gradually removed with a spatula as the ring was gently pushed into the soil. The ring with the soil was then removed by cutting across the soil core with the help of a piano wire saw.

The laboratory tests as detailed below were run to ascertain the engineering properties of the soil and to obtain the necessary data required for design of the foundations.

A summary of all test results is given with this report.

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7



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5.a Natural water content:

These were determined by measuring the weights before and after oven drying of triaxial test samples.

5.b Atterberg limits and natural water content:

Liquid limit, plastic limit, and natural water content of the silty clay/clayey silt samples were determined.

(a) To classify the soil by the M.I.T classification system and

(b) To qualitatively assess there consistency and compressibility of the soil samples.

5.c Bulk density:

These were determined by measuring the weights and dimensions of triaxial test samples.

5.d Specific Gravity:

It is defined as the ratio of the mass of a given volume of solid grains to the mass of an equal volume of water, measured at the same temperature,

$$G = \frac{M_s(\text{Mass of any volume } V \text{ of solid grains})}{M_w(\text{Mass of water of volume } V)}$$

5.e Grain size analysis:

The grain size distributions of some representative samples were determined from sieve analysis / combined sieve analysis and hydrometer analysis.

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5.f Undrained triaxial test/Unconfined compression test:

Tests were run on the silty clay/clayey silt samples to determine their undrained shear strength. The cell pressures employed in the triaxial tests were 1.0, 2.0, and 3.0 kg/cm². The samples were tested under undrained condition at a rate of 1.25 mm/min and were loaded up to a maximum of 20% axial strain.

In case of unconfined compression test all are same as UU triaxial test but all in absence of cell pressure.

5.g Consolidation test:

Consolidation tests were run in floating ring type odometers in an eight unit consolidation frame under standard load increment ratio of one, starting from 1/4 kg/cm² and going up to 8 kg/cm² in general. Two such samples were tested to represent the relevant clay/clayey silt strata encountered. The *e* vs. *log p* curves as given with this report.

5.h Direct shear tests:

This test help to determine the share strength parameters, unit cohesion and angle of shearing resistance, by direct shear of soil in a small shear box. It is suitable for the soil having maximum particle size 4.75 mm.

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9



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6.0 SUB SOIL PROFILE:

The Soil profile as revealed by borings is shown the depth wise variations of N values along the borehole are shown in separate page. The subsoil profile indicates almost similar subsoil stratification throughout the site with some minor variation in the thickness of the individual strata. In general the subsoil resembles successive layers of soft to medium brownish gray silty clay/clayey silt, followed by medium grayish silty clay/clayey silt, followed by very soft to soft blackish gray silty clay with D. O and O.R.G matter, followed by medium grayish silty clay/clayey silt, followed by medium to firm bluish gray silty clay/clayey silt, followed by medium to firm yellowish gray silty clay/clayey silt, followed by medium yellowish gray silty sandy clay/ sandy clayey silt with mica traces, which extent to a depth of 20.1 m or more below G.L.

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10



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The soil stratification may in general be summarized as shown in Table 1

Table 1: sub soil profile

	Stratum Description	Average Depth (m)	N-value
	Filled up soil.	1.5	
I	Soft to medium brownish gray silty clay/clayey silt.	3.0	5-7
II	Medium grayish silty clay/clayey silt.	1.8	5-7
III	Very soft to soft blackish gray silty clay with D. O and O.R.G matter.	5.6	2-5
IV	Medium grayish silty clay/clayey silt.	0.9	5-7
V	Medium to firm bluish gray silty clay/clayey silt.	3.9	7-11
VI	Medium to firm yellowish gray silty clay/clayey silt.	2.5	11-18
VII	Medium yellowish gray silty sandy clay/ sandy clayey silt with mica traces.	0.9 or more	18-22 or more

The ground water table at the time of investigation was located 1.2 m below G.L in the month of October. There would however be seasonal fluctuation of the G.W.T and so the design of foundation.

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6.1 Soil properties

6.1. A. Standard penetration resistance:

A summary of the stratum wise variation of N values throughout the site is given in bore log data sheet. The subsoil of stratum I is soft to medium brownish gray silty clay/clayey silt. The N value increase appreciably from stratum 7 which consist of Medium yellowish gray silty sandy clay sandy clayey silt with mica traces.

6.1. B. Laboratory test data

A summary of all laboratory test results is given an appendix D. From study of these test result the engineering properties of different strata can be summarized as follows.

Filled up soil

Thickness of this layer is more or less 1.5 m. Characteristics of this layer are uncertain.

Stratum I

The topmost stratum is a deposit of Soft to medium brownish gray silty clay/clayey silt. This layer is found to exist up to a maximum depth 4.5 m below existing G.L. The N value recorded in this stratum various from 5 to 7. This deposit shows more or less fair engineering properties and may be considered for shallow footings.

Stratum II

This stratum is a deposit of Medium grayish silty clay/clayey silt. This layer is found to exist up to a maximum depth of 6.3 m below from existing G.L. The N value recorded in this stratum varies from 5 to 7.

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12



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Stratum III

This stratum is a deposit of Very soft to soft blackish gray silty clay with D. O and O.R.G matter. This layer is found to exist up to a maximum depth of 11.9 m below from existing G.L. The N value recorded in this stratum varies from 2 to 5.

Stratum IV

This stratum is a deposit of Medium grayish silty clay/clayey silt. This layer is found to exist up to a maximum depth of 12.8 m below from existing G.L. The N value recorded in this stratum varies from 5 to 7.

Stratum V

This stratum is a deposit of Medium to firm bluish gray silty clay/clayey silt. This layer is found to exist up to a maximum depth of 16.7 m below from existing G.L. The N value recorded in this stratum varies from 7 to 11.

Stratum VI

This stratum is a deposit of Medium to firm yellowish gray silty clay/clayey silt. This layer is found to exist up to a maximum depth of 19.2 m below from existing G.L. The N value recorded in this stratum varies from 11 to 18.

Stratum VII

This stratum is a deposit of Medium yellowish gray silty sandy clay/ sandy clayey silt with mica traces. This layer is found to exist up to a maximum depth of 20.1 m below or more from existing G.L. The N value recorded in this stratum varies from 18 to 22 or more.

7.0 HYDROLOGY

The water table in the month of October was located at 1.2 m below ground Level.


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8.0 FOUNDATION SIZE, BEARING CAPACITY RECOMMENDATION:

Foundation of each structure is to be designed from consideration of superstructure loading as well as subsoil condition at the location. Suitable foundation for this structure should satisfy the basic design criteria:

- There must be adequate factor of safety of the foundations against any possible bearing capacity or uplift failure and
- The settlement of the foundations must be within permissible limits.
- The suitability of the foundation types for each structure has been discussed in this chapter with due consideration to the above requirements.

The net safe bearing capacity ($q_{net(safe)}$) of a square footing is given by.

$$Q_n(safe) = (c' N_c' + \gamma D N_q' + 0.5 \gamma B N_\gamma') / f$$

$$c = 2/3c$$

& N_c' , N_q' & N_γ' are the bearing capacity factor obtained from ϕ'

Where, $\phi' = \tan^{-1} (2/3 \tan \phi)$

C = Undrained shear strength.

B = Breadth of footing.

L = Length of footing.

D = Depth of foundation below G.L.

F = Factor of safety.

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$$\text{The immediate settlement } (S_i) = \frac{q_n B}{E} (1 - \nu^2) I_c$$

where q_n = net foundation pressure

ν = poisson's ratio

I_c = influence factor

E = modulus of elasticity

A rigidity correction of 0.8 may be applied to the raft foundation. The consolidation settlement (S_c) is given below.

$$S_c = \frac{C_c}{1 + e_0} H \log_{10} \left(\frac{p + \Delta p}{p} \right)$$

A rigidity correction of 0.8 and a pre pressure correction of 0.8 may be applied.

The total settlement $S = S_i + S_c$

The total settlement should not exceed the limit value of 75 mm as per provisions of relevant IS code of practice.

Based of the above principal shallow foundation in the form of individual / strip footing have been investigated. The net safe bearing capacity of shallow individual and strip footings with their estimated settlements has been worked out and presented in table 1

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FOUNDATION SIZE & BEARING CAPACITY

Type	Size M*M	Depth of Foundation (M)	Q allowable t/m ²	Permissible Settlement (mm)
Thickness of Compacted Sand Cushion= 0.3 m				
SQUARE	1.5	1.4	9.1	75
	2.0		8.8	
	2.5		8.5	
STRIP	1.5	1.4	8.2	75
	2.0		7.8	
Thickness of Compacted Sand Cushion= 0.6m				
SQUARE	1.5	1.4	9.5	75
	2.0		9.2	
	2.5		8.8	
STRIP	1.5	1.4	8.5	75
	2.0		8.1	

NB: To achieve the SBC value mentioned in the table, we have to provide compacted sand cushion of fine to medium coarse sand of different thickness mentioned above just below the foundation in such a way as the dry density of the sand become 97% and above of the value of maximum dry density of the sand at its' optimum moisture content. Again sand layer should be free from clayey lump. Presence of the clayey lump may be the reason of future development of the higher differential settlement.

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RECOMMENDATION AND CONCLUSION

Based on the field data laboratory test result, bearing capacity and foundation size has been considered. And following precautions should be taken.

- 1) The sub soils are soft to medium in quality. Depth of WL exists at a depth of 1.2 m from EGL in the month of October. Depth of filled up soil is 1.5 m.
- 2) SBC values of different size of foundations are given for easy reference. To achieve the SBC value mentioned in the table, we have to provide different thickness of compacted sand cushion of fine to medium coarse sand just below the foundation in such a way as the dry density of the sand become 97% and above of the value of maximum dry density of the sand at its optimum moisture content. Again sand layer should be free from clayey lump. Presence of the clayey lump may be the reason of future development of the higher differential settlement.
- 3) Tie beam should be provided to control differential settlement as there is variation of strength in different places of the site.
- 4) Gap between two adjacent footings be 67% (which can be changed by concerned structural engineer) of the average width of the adjacent Footing.
- 5) Construction in stage is also recommended.
- 6) Joint in structure through slab, beams, columns, etc, dividing the building into two independent structural units should be at corners of L,H,T and C shaped structures and at 30 m intervals in long uniform structures.

Subhankar Roy
01.11.2022

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For BS Projects & Engineers Pvt. Ltd.

Bhaskar Roy
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17

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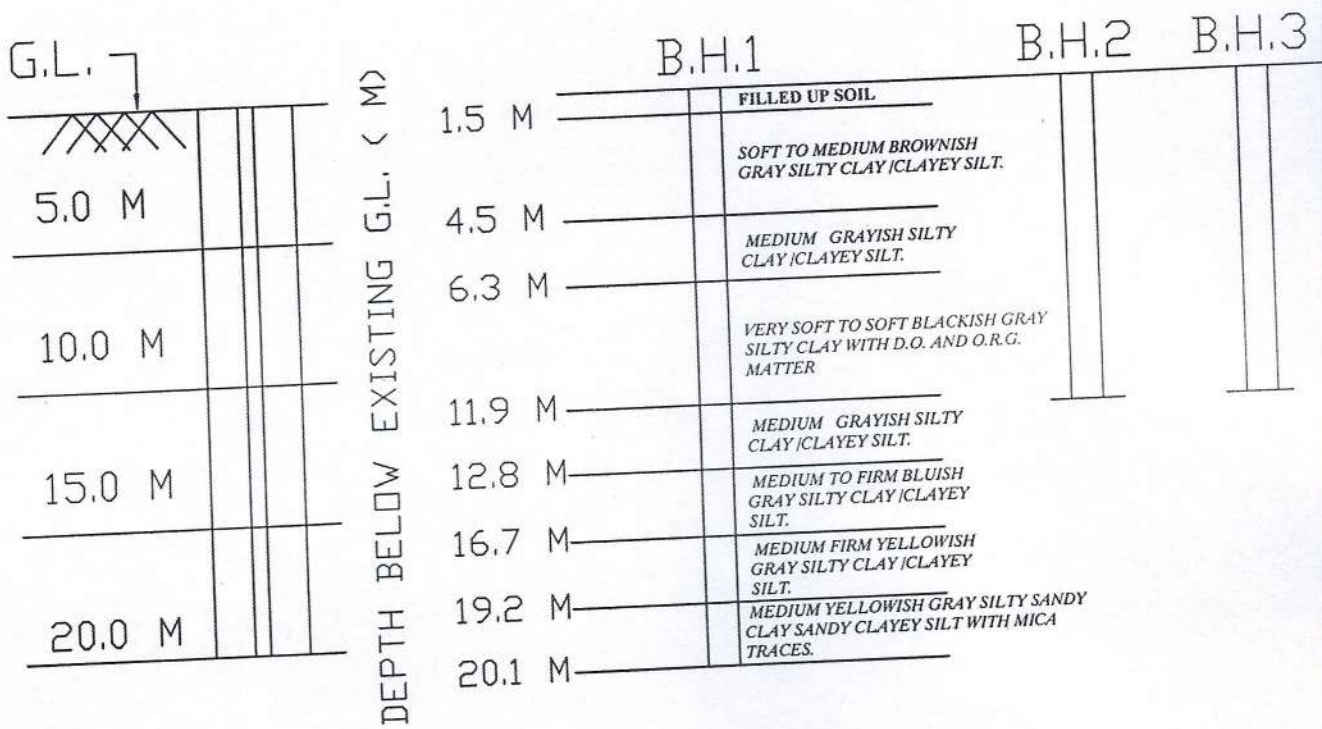
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JOB NO.

GENERALISED SOIL PROFILE

PREMISES NO. - 933, RAJA RAMMOHAN ROY ROAD, WARD NO. - 121, BOROUGH NO. - XIV, P. S. - BEHALA, DIST. - SOUTH 24 PGS., KOLKATA - 700008, UNDER K.M.C. (S.S.UNIT), STATE - WEST BENGAL.



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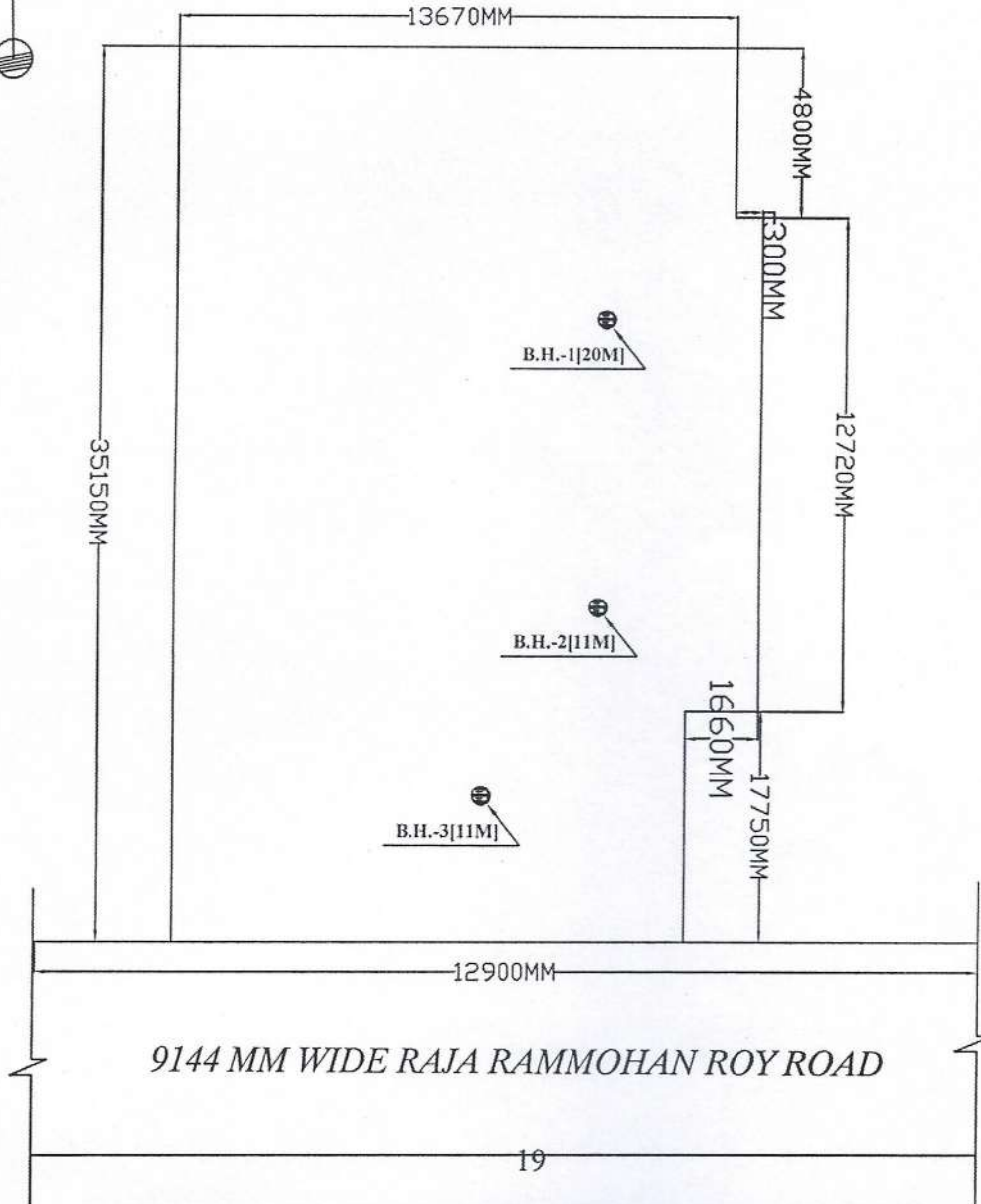
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JOB NO.

SITE LAYOUT

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JOB NO.

BORE LOG DATA SHEET

Site: - PREMISES NO. - 933, RAJA RAMMOHAN ROY ROAD, WARD NO.- 121,
BOROUGH NO.- XIV, P. S.- BEHALA, DIST- SOUTH 24 PGS., KOLKATA - 700008,
UNDER K.M.C.(S.S.UNIT), STATE - WEST BENGAL.

Borehole No : 1

Commenced on: 13.10.2022

Completed on :

Field test	No	Sample	No	Borehole Diameter : 150 mm
Penetrometer (P)	10	Undisturbed (U)	2	RL of Ground :
Cone Pen (PC)	0	Disturbed (D)	2	Termination Depth: 20.1 m
Vane	0	(V) Water	0	Ground Water : 1.2m

*Suffix 'P' for sample Penetrometer Depth

standing water level: NILL

'V' for sample at Vane depth

(NOTE: ALL DEPTH MEASURED BELOW GROUND LEVEL)

Description	From	To	Thk. (m)	N- value	Type no	Depth (m)
Filled up soil.	E.G.L	1.5	1.5		D	0.5
Soft to medium	1.5				D	1.0
brownish gray silty		4.5	3.0		U	1.50-2.10
clay/clayey silt.				6	P	3.00-3.45
Medium grayish silty	4.5				U	4.50-5.10
clay/clayey silt.		6.3	1.8		P	6.00-6.60
Very soft to soft	6.3			3	P	7.50-8.10
blackish gray silty clay		11.9	5.6	2	P	9.00-9.60
with D. O and O.R.G matter.				3	P	10.50-11.10
Medium grayish silty	11.9					
clay/clayey silt.		12.8	0.9			

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JOB NO.

BORE LOG DATA SHEET

Site: - PREMISES NO. - 933, RAJA RAMMOHAN ROY ROAD, WARD NO.- 121,
BOROUGH NO.- XIV, P. S.- BEHALA, DIST- SOUTH 24 PGS., KOLKATA - 700008,
UNDER K.M.C. (S.S.UNIT), STATE - WEST BENGAL.

Borehole No : 1

Commenced on: 13.10.2022

Completed on :

Field test	No	Sample	No	Borehole Diameter : 150 mm
Penetrometer (P)	10	Undisturbed (U)	2	RL of Ground :
Cone Pen (PC)	0	Disturbed (D)	2	Termination Depth: 20.1 m
Vane	0	(V) Water	0	Ground Water : 1.2 m

*Suffix 'P' for sample Penetrometer Depth

standing water level: NIL

'V' for sample at Vane depth

(NOTE: ALL DEPTH MEASURED BELOW GROUND LEVEL)

Description	From	To	Thk. (m)	N- value	Type no	Depth (m)
Medium to firm bluish gray silty clay/clayey silt.	12.8			7	P	12.00-12.60
		16.7	3.9	11	P	15.00-15.60
Medium to firm yellowish gray silty clay/clayey silt.	16.7			14	P	18.00-18.60
		19.2	2.5	18	P	19.50-20.10
Medium yellowish gray silty sandy clay/ sandy clayey silt with mica traces.	19.2			22	P	22.00-22.60
		20.1 or more	0.9 or more			

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JOB NO.

BORE LOG DATA SHEET

Site: - PREMISES NO. - 933, RAJA RAMMOHAN ROY ROAD, WARD NO.- 121, BOROUGH NO.- XIV, P. S.- BEHALA, DIST- SOUTH 24 PGS., KOLKATA - 700008, UNDER K.M.C.(S.S.UNIT), STATE - WEST BENGAL.

Borehole No : 2

Commenced on: 13.10.2022

Completed on :

Field test	No	Sample	No	Borehole Diameter : 150 mm
Penetrometer (P)	7	Undisturbed (U)	0	RL of Ground :
Cone Pen (PC)	0	Disturbed (D)	2	Termination Depth: 11.1m
Vane	0	(V) Water	0	Ground Water : 1.2 m

*Suffix 'P' for sample Penetrometer Depth

standing water level: NILL

'V' for sample at Vane depth

(NOTE: ALL DEPTH MEASURED BELOW GROUND LEVEL)

Description	From	To	Thk. (m)	N-value	Type no	Depth (m)
Filled up soil.	E.G.L	1.4	1.4		D	0.5
Soft to medium brownish gray silty clay/clayey silt.	1.4	4.6	3.2	5	P	1.50-2.10
Medium grayish silty clay/clayey silt.	4.6	6.2	1.6	6	P	3.00-3.45
Very soft to soft blackish gray silty clay	6.2	11.1	4.9	7	P	4.50-5.10
with D. O and O.R.G matter.		or more	or more	5	P	6.00-6.60
				3	P	7.50-8.10
				2	P	9.00-9.60
				7	P	10.50-11.10

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BORE LOG DATA SHEET

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Borehole No : 3

Commenced on: 14.10.2022

Completed on :

Field test	No	Sample	No	Borehole Diameter : 150 mm
Penetrometer (P)	7	Undisturbed (U)	0	RL of Ground :
Cone Pen (PC)	0	Disturbed (D)	2	Termination Depth: 11.3m
Vane	0	(V) Water	0	Ground Water : 1.2 m

*Suffix 'P' for sample Penetrometer Depth
 'V' for sample at Vane depth

standing water level: NULL

(NOTE: ALL DEPTH MEASURED BELOW GROUND LEVEL)

Description	From	To	Thk. (m)	N- value	Type no	Depth (m)
Filled up soil.	E.G.L					
		1.5	1.5		D	0.5
Soft to medium brownish gray silty clay/clayey silt.	1.5				D	1.0
		4.5	3.0	6	P	1.50-2.10
				7	P	3.00-3.45
Medium grayish silty clay/clayey silt.	4.5				P	4.50-5.10
		6.2	1.7	7	P	4.50-5.10
				5	P	6.00-6.60
Very soft to soft blackish gray silty clay	6.2				P	7.50-8.10
		11.1 or more	5.1 or more	3	P	9.00-9.60
with D. O and O.R.G matter.				3	P	10.50-11.10

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JOB NO.

LABORATORY TEST RESULT DATA SHEET
 PREMISES NO. - 933, RAJA RAMMOHAN ROY ROAD, WARD NO.- 121,
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B.H no	Depth below gl (m)	n. m. c %	Bulk density (t/m ²)	L. L %	P L %	Triaxial test		Sp. gr (g)	Consolidation Properties		Grain size distribution Gravels Sand Silt Clay % % %
						C kg/ cm ²	ϕ degr ee		C _c	e ₀	
I	1.5	33	1.80	52	23	0.25	5°	2.65	0.235	0.865	6 48 46
	4.5	32	1.80	51	23	0.25	6°	2.65	0.230	0.860	4 57 39

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JOB NO.

LOCATION: PREMISES NO. - 933, RAJA RAMMOHAN ROY ROAD, WARD
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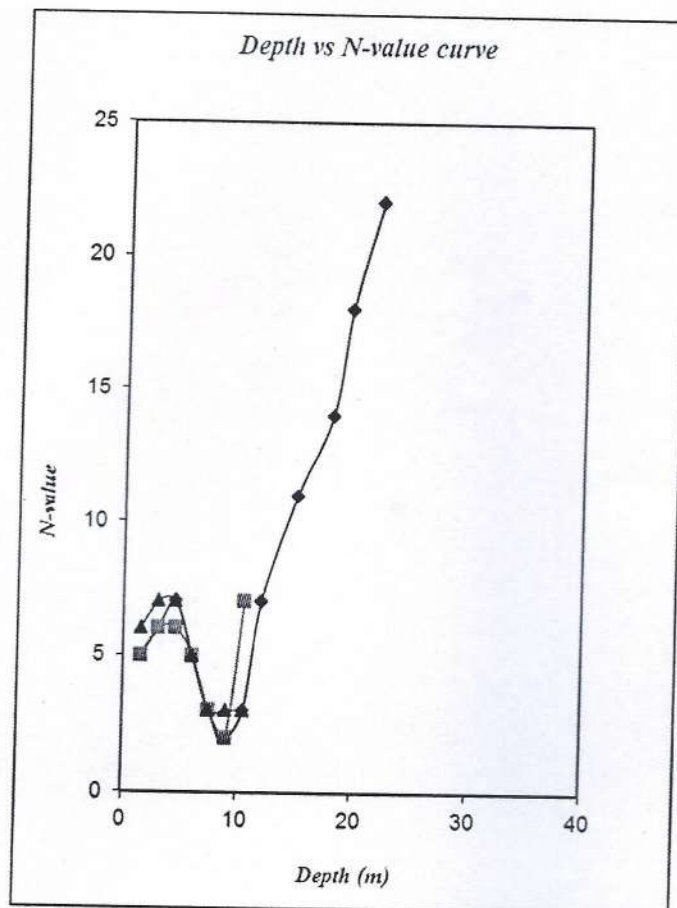


Fig. Annexure 5(a). Depth vs N value curve.

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