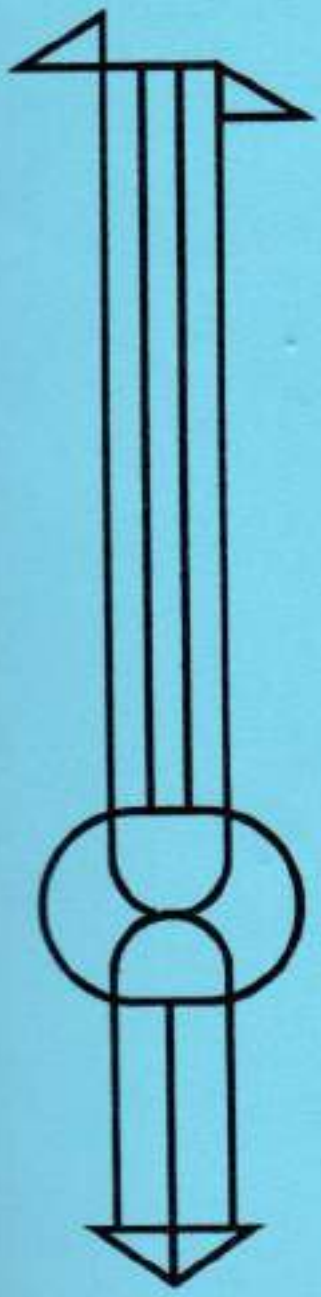
Report
On
Sub - Soil Investigation
For
Proposed Building
At
Mouza-Purba Barisha, Pre. No. - 1095,
Mahatma Gandhi Road,R.S. Dag
Nos.-3614 / 3799 & 3655, R.S. Khatian
Nos.- 1831 & 3103. J.L.No.-23,
P.S.-Thakurpukur, Kolkata - 700 063,
Dist. - 24Pgs.(S).



THE ONLY AUTHENTIC ONE

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&

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REPORT NO. : GT / GA / 44 / 2019 - 2020

REPORT SHEET

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REPORT
ON
SUB - SOIL INVESTIGATION
FOR
PROPOSED BUILDING
AT
MOUZA-PURBA BARISHA, PRE. NO. - 1095, MAHATMA GANDHI ROAD, R.S. DAG NOS.-3614 / 3799 & 3655, R.S. KHATIAN NOS.- 1831 & 3103, J.L.NO.-23, P.S.-THAKURPUKUR, KOLKATA - 700 063, DIST. - 24PGS.(S).

CONTENTS

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1. INTRODUCTION

The work of sub-soil exploration for the Proposed Building at Mouza – Purba Barisha, Pre. No. - 1095, Mahatma Gandhi Road, R.S. Dag Nos. – 3614 / 3799 & 3655, R.S. Khatian Nos. – 1831 & 3103, J.L. No. – 23, P.S. – Thakurpukur, Kolkata - 700 063, Dist. – 24 Pgs.(S) was awarded to M/S. GEOTEST ENGINEERS PVT. LTD. of 6A, Milan Park, Kolkata - 700 084 by the Client GUNJAN AGENCY PVT. LTD. & TEXILA COMMERCE PVT. LTD. The sub-soil investigation purpose for the proposed Building at the aforesaid site was to determine the sub-soil condition and to ascertain the foundation types that would be suitable for the proposed building. The Fieldwork was done in the month of July, 2019. Laboratory tests were conducted on soil samples at our own laboratory, for the analysis of sub-soil condition at the site.

2. SCOPE OF INVESTIGATION

In an attempt for optimization in the design of foundations for the proposed building at this site, geotechnical investigation programme had been divided mainly into two parts, like, field works part unfurling the sub-surface deposit types and their states of occurrences in-situ and laboratory tests part which would help to determine the relevant physical and the geotechnical properties of the sub-surface deposits leading to finalization of foundation type and foundation design bearing capacity with particular reference to the sub-surface deposit types and their strength parameters and settlement potentials in-situ. The scope is summarized as follows:-

(a) *Sinking 2 (two) numbers, 150 mm. dia., exploratory boreholes, both with termination depth of about 25.00 m. below E.G.L. at prefixed location at the site. The borehole numbers, depths & locations were finalized & fixed by the* ***Client****. For location of the exploratory boreholes please refer 'Borehole Location Plan' of this report, in* ***ANNEXURE****.*

(b) *Collection of representative 100 mm dia. undisturbed soil samples as per the provisions as laid down in IS: 2132 (1986) as well as representative disturbed soil samples from the exploratory boreholes for carrying out detailed laboratory analysis which would help adoption of strength, settlement and other relevant parameters of the sub-surface deposits for finalisation of foundation type and thereafter for design of foundations of the proposed building.*

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(c) *Carrying out standard penetration tests as per the provisions laid down in IS: 2131 (1981) in both the boreholes and subsequently maintaining penetration chart, depth-wise, upto the test depth in both the exploratory boreholes at this site.*

After completion of the above mentioned field works, the appropriate laboratory tests, as were applicable to the sub-surface deposit types which were encountered at the explored location, were conducted to determine the physical and the relevant geotechnical properties of the sub-surface deposits and subsequently to finalize type and thereafter for design of foundation for the proposed building to be constructed at this site under investigation.

3. FIELD WORK

A brief description of boring method, field tests, sample collection etc. and type of equipment, are furnished below.

3.1 Rig

The entire fieldwork was done by deploying single number of rig.

3.2 Boring

Boring through the soil was carried out by Shell & Auger boring technique upto their termination depths below E.G.L. in both the boreholes by Mechanically Power Driven Winch, by providing casing throughout the explored depth.

3.3 Representative Sample

Representative samples were collected from auger, S.P.T. sampler and cutting shoe of undisturbed sampling assembly. This was done to maintain a continuous record of strata encountered. The samples were labeled and placed in airtight polythene bags and shifted to the laboratory for testing and classification.

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3.4 ***Standard Penetration Test (S.P.T.)***

This test was conducted at the boring points at suitable intervals. The number of blows required for last 30.00 cm penetration of split spoon sampler out of a total penetration of 45.00 cm driven by a 63.50 kg hammer falling freely through a height of 75.00 cm was recorded as 'N' values. The sample from split spoon were collected after each test and were labeled and placed in air-tight polythene bags before sending to the laboratory for identification and testing. The test procedure was performed to IS: 2131 (1981) (Reaffirmed 1987). The Split Spoon Sampler was as per I.S. 9640:1980 (Reaffirmed 1987).

3.5 ***Undisturbed Samples***

Undisturbed samples were collected as per I.S.2132 (1986) by means of a two-tier 100.00 mm I.D. open driven sampling assembly having area ratio of 15%. The sampling assembly (as per I.S. 11594: 1985) was driven to the required depth manually with the help of jarring link. Samples collected in the lower tube were retained, labeled and waxed at both ends before sending it to the laboratory.

3.6 ***Ground Water Table***

Ground water table observation was made during boring in both the boreholes after 24 hours of completion of boreholes.

It was observed that the ground water table was at an average depth of about 0.25 m. below Road Level during the period of fieldwork from 17.07.19 to 19.07.19.

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4. *LABORATORY INVESTIGATION*

For proper identification and classification of the sub-surface deposits and for deriving adequate informations regarding its relevant physical and the geotechnical properties at the site under investigation, most or all of the following laboratory tests pertaining to the actual soil types, occurring at this site, were conducted on the representative soil samples, collected from both the exploratory boreholes.

- *(a) Grain size analysis.*
  - *(i) Pipette analysis for cohesive soil samples.*
  - *(ii) Sieve analysis for cohesionless soil samples.*
- *(b) Liquid limit and plastic limit for cohesive soil samples.*
- *(c) Specific Gravity.*
- *(d) Natural moisture content.*
- *(e) Natural density and dry density.*
- *(f) Unconfined compression tests on undisturbed cohesive soil samples.*
- *(g) Triaxial shear tests in unconsolidated undrained condition on cohesive soil samples for determination of strength parameter values like, cohesion, C_{uu} and angle of internal friction, ϕ_{uu}.*
- *(h) Consolidation tests on cohesive soil samples for determination of settlement potentials.*
- *(i) Void ratio.*

All or most of the above-mentioned laboratory tests on the representative soil samples were conducted as per the relevant provisions as laid down in the different sections of IS: 2720.

*The result after the relevant laboratory tests on the representative soil samples have been presented in tabular form in 'Laboratory Test Result Sheet' at the **ANNEXURE** of this report.*

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5. SUB-SOIL STRATIFICATION

The sub-soil profile as revealed by both the boreholes is shown in 'Sub-Soil Profile' and in 'TABLE 1'. On the basis of extensive field and laboratory tests on disturbed and undisturbed soil specimens and on visual inspection, the classification of different strata and engineering properties of soil are discussed below:

Stratum I ***Reclaimed top fill of soft brownish grey silty clay / clayey silt with traces of tree plants and brick prices.***

*This layer extends from *E.G.L. to 1.20 m. below E.G.L. in B.H.1 & from *E.G.L. to 1.30 m. below E.G.L. in B.H.2. This layer consists of reclaimed top fill of soft brownish grey silty clay / clayey silt with traces of tree plants and brick prices.*

I.S. Classification	=	*CH – MH*

Stratum II ***Soft / firm brownish grey / grey silty clay with traces of rusty brown silt spots and kankars.***

This layer extends from 1.20 m. to 5.20 m. below E.G.L. in B.H.1 and from 1.30 m. to 5.40 below E.G.L. in B.H.2. This layer contains soft / firm brownish grey / grey silty clay with traces of rusty brown silt spots and kankars. Field 'N' value of this layer ranges from 03 to 04, indicating its soft / firm state of consistency. The relevant engineering properties are mentioned herewith :

Field 'N' value	=	*03 to 04*
Bulk Unit Weight	=	*18.00 kN/m³ to 18.59 kN/m³*
Dry Unit Weight	=	*13.44 kN/m³ to 14.07 kN/m³*
Natural Moisture Content	=	*31.82 % to 33.85 %*
Liquid Limit	=	*63 % to 66 %*
Plastic Limit	=	*23 % to 24 %*
Undrained cohesion 'C'	=	*28.80 kN/m²* *(From U.C.S. Test)*

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Undrained cohesion 'C_u' = *27.02 kN/m² to 29.43 kN/m²*
(From Triaxial U. U. Test)

Undrained angle of shear resistance 'ϕ_u' = *0°*
(From Triaxial U. U. Test)

Specific gravity = *2.64 to 2.67*

Initial void ratio 'e_0' = *0.846 to 0.893*

Grain Size Analysis (Hydrometer Analysis):

Gravel = *01 %*

Sand = *03 % to 05 %*

Silt = *52 % to 54 %*

Clay = *42 % to 44 %*

I.S. Classification = *CH*

The following are the average coefficient of volume compressibility (m_v) values of this stratum:

Pressure Range in kg/cm²	***m_v (m²/kN)***
0.00 – 0.25	*0.000500*
0.25 – 0.50	*0.000442*
0.50 – 1.00	*0.000321*
1.00 – 2.00	*0.000223*
2.00 – 4.00	*0.000146*
4.00 – 8.00	*0.000096*

Stratum III ***Very soft / soft grey silty clay with varying percentage of decomposed wood (traces to medium to high percent).***

This layer extends from 5.20 m. to 14.30 m. below E.G.L. in B.H.1 and from 5.40 m. to 14.20 below E.G.L. in B.H.2. This layer contains very soft / soft grey silty clay with varying percentage of decomposed wood. Traces to medium to high percentage of decomposed wood were observed in B.H.1 & traces to medium percentage of decomposed wood were observed in B.H.2. Field 'N' value of this layer ranges from 02 to 03, indicating its very soft / soft state of consistency. The relevant engineering properties are mentioned in the next page :

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Field 'N' value	=	*02 to 03*
Bulk Unit Weight	=	*16.27 kN/m³ to 17.39 kN/m³*
Dry Unit Weight	=	*10.49 kN/m³ to 12.66 kN/m³*
Natural Moisture Content	=	*37.30 % to 55.10 % / **214.80 %*
Liquid Limit	=	*74 % to 84 %*
Plastic Limit	=	*22 % to 28 %*
Undrained cohesion 'C'	=	*16.73 kN/m² to 18.36 kN/m² (From U.C.S. Test)*
Undrained cohesion 'C_u'	=	*18.34 kN/m² to 24.14 kN/m² (From Triaxial U. U. Test)*
Undrained angle of shear resistance 'ϕ_u'	=	*0⁰ (From Triaxial U. U. Test)*
Specific gravity	=	*2.49 to 2.55*
Initial void ratio 'e_0'	=	*0.951 to 1.363*
Grain Size Analysis (Hydrometer Analysis):		
Sand	=	*01 % to 03 %*
Silt	=	*51 %*
Clay	=	*46 % to 48 %*
I.S. Classification	=	*CH – OH*

The following are the average coefficient of volume compressibility (m_v) values of this stratum:

Pressure Range in kg/cm²	***m_v (m²/kN)***
0.00 – 0.25	*0.000649*
0.25 – 0.50	*0.000576*
0.50 – 1.00	*0.000416*
1.00 – 2.00	*0.000276*
2.00 – 4.00	*0.000199*
4.00 – 8.00	*0.000132*

*****Very high values due to presence of very high percentage of decomposed wood in soil sample.***

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Stratum IV ***Stiff bluish grey / mottled brown silty clay with traces of rusty brown silt spots and kankars.***

This layer extends from 14.30 m. to 20.20 m. below E.G.L. in B.H.1 and from 14.20 m. to 20.50 below E.G.L. in B.H.2. This layer contains stiff bluish grey / mottled brown silty clay with traces of rusty brown silt spots and kankars. Field 'N' value of this layer ranges from 08 to 13, indicating its stiff state of consistency. The relevant engineering properties are mentioned herewith:

Field 'N' value	=	*08 to 13*
Bulk Unit Weight	=	*19.17 kN/m³ to 20.10 kN/m³*
Dry Unit Weight	=	*15.01 kN/m³ to 16.48 kN/m³*
Natural Moisture Content	=	*21.92 % to 27.63 %*
Liquid Limit	=	*60 % to 65 %*
Plastic Limit	=	*20 % to 22 %*
Undrained cohesion 'C_u'	=	*78.91 kN/m²*
		(From U.C.S. Test)
Undrained cohesion 'C_u'	=	*73.58 kN/m² to 96.88 kN/m²*
		(From Triaxial U. U. Test)
Undrained angle of shear resistance 'ϕ_u'	=	*0°*
		(From Triaxial U. U. Test)
Specific gravity	=	*2.70*
Initial void ratio 'e_0'	=	*0.661 to 0.746*
Grain Size Analysis (Hydrometer Analysis):		
Sand	=	*07 % to 18 %*
Silt	=	*46 % to 49 %*
Clay	=	*36 % to 44 %*
I.S. Classification	=	*CH*

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The following are the average coefficient of volume compressibility (m_v) values of this stratum:

Pressure Range in kg/cm²	*m_v (m^2/kN)*
0.00 – 0.25	*0.000407*
0.25 – 0.50	*0.000344*
0.50 – 1.00	*0.000254*
1.00 – 2.00	*0.000179*
2.00 – 4.00	*0.000119*
4.00 – 8.00	*0.000074*

Stratum V ***Very stiff brown sandy clayey silt with traces of mica.(Present in B.H.1 only)***

This layer extends from 20.20 m. to the borehole termination depth of about 25.95 m. below E.G.L. in B.H.1. This layer contains very stiff brown sandy clayey silt with traces of mica. Field 'N' value of this layer ranges from 22 to 25, indicating its very stiff state of consistency. The relevant engineering properties are mentioned herewith:

Field 'N' value = *22 to 25*

Bulk Unit Weight = *18.57 kN/m^3*

Dry Unit Weight = *14.64 kN/m^3*

Natural Moisture Content = *26.82 %*

Liquid Limit = *40 %*

Plastic Limit = *20 %*

Undrained cohesion 'C_u' = *63.89 kN/m^2*
(From Triaxial U. U. Test)

Undrained angle of shear resistance 'ϕ_u' = *12^0*
(From Triaxial U. U. Test)

Specific gravity = *2.71*

Initial void ratio 'e_0' = *0.726*

Grain Size Analysis (Hydrometer Analysis):

Sand = *19 %*

Silt = *61 %*

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Clay = *20 %*

I.S. Classification = *MI*

The following are the coefficient of volume compressibility (m_v) values of this stratum:

Pressure Range in kg/cm²	***m_v (m^2/kN)***
0.00 – 0.25	*0.000393*
0.25 – 0.50	*0.000304*
0.50 – 1.00	*0.000231*
1.00 – 2.00	*0.000156*
2.00 – 4.00	*0.000101*
4.00 – 8.00	*0.000066*

Stratum VI ***Medium compact brown silty fine sand with traces of mica.(Present in B.H.2 only)***

This layer extends from 20.50 m. to the borehole termination depth of about 25.95 m. below E.G.L. in B.H.2. This layer contains medium compact brown silty fine sand with traces of mica. Field 'N' value of this layer ranges from 22 to 26, indicating its medium degree of compactness. The relevant engineering properties are mentioned herewith:

Field 'N' value = *22 to 26*

Liquid Limit = *N.P.*

Plastic Limit = *N.P.*

Natural Moisture Content = *15.99 %*

Bulk Unit Weight = *16.90 kN/m^3*

Grain Size Analysis (Sieve Analysis):

Sand = *71 %*

Silt + *Clay* = *29 %*

I.S. Classification = *SM*

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TABLE - 1

AVERAGE SUB-SOIL PROFILE

Stratum	Description	Average Thickness	Range of Field 'N' value	IS Classification
I	Reclaimed top fill of soft brownish grey silty clay / clayey silt with traces of tree planis and brick prices.	1.25 m.	--	CH – MH
II	Soft / firm brownish grey / grey silty clay with traces of rusty brown silt spots and kankars.	4.05 m.	03 to 04	CH
III	Very soft / soft grey silty clay with varying percentage of decomposed wood (traces to medium to high percent).	8.95 m.	02 to 03	CH – OH
IV	Stiff bluish grey / mottled brown silty clay with traces of rusty brown silt spots and kankars.	6.10 m.	08 to 13	CH
V	Very stiff brown sandy clayey silt with traces of mica.(Present in B.H.1 only).	More than 5.75 m. in B.H.1.	22 to 25	MI
VI	Medium compact brown silty fine sand with traces of mica. (Present in B.H.2 only)	More than 5.45 m. in B.H.2.	22 to 26	SM

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6. BEARING CAPACITY OF CONVENTIONAL SHALLOW, RIGID RAFT, TIMBER PILE & DEEP FOUNDATIONS

6.1.1 Computation of net safe bearing capacities for shallow foundations

For computation of net safe bearing capacity values for design of shallow foundations, ultimate net bearing capacity formula as per "Code of Practice for Determination of Bearing Capacity of Shallow Foundations (First Revision)", IS: 6403 (1981) will be used.

As per the clause 5.1.2 of IS: 6403 (1981), the ultimate net bearing capacity of shallow foundations in case of general shear failure,

$$q_d = C_u N_c S_c d_c i_c + q(N_q - 1) S_q d_q i_q + 0.5 B \gamma N_\gamma d_\gamma S_\gamma i_\gamma w'$$

and the same in case of local shear failure,

$$q_d = 2/3 C_u N_c' S_c d_c i_c + q(N_q' - 1) S_q d_q i_q + 0.5 B \gamma N_\gamma' d_\gamma S_\gamma i_\gamma w'$$

where, N_c, N_q, N_γ and N_c', N_q', N_γ' are the bearing capacity factors in case of general shear and local shear failure conditions respectively.

S_c, S_q and S_γ	*are the shape factors.*
d_c, d_q and d_γ	*are the depth factors.*
i_c, i_q and i_γ	*are the inclination factors.*
B	*is the least dimension of the foundation in metre.*
q	*is the effective surcharge at the base level of foundation in kN/m^2.*
γ	*is the bulk unit weight of foundation soil in kN/m^3.*
w'	*is the correction factor for location of water table.*

In case of foundations resting on cohesive soils, as the rate of gradual building up of load intensity at the foundation level will be more than the rate of dissipation of excess pore water pressure from the cohesive soil due to low to very low range of co-efficient of permeability values of the same, the computation of net safe bearing capacity values for foundations resting on cohesive foundation medium will be governed by undrained analysis, i.e. $\phi = 0^0$ analysis will prevail.

Computation of net safe bearing capacity values for shallow foundations resting on cohesive stratum, at 1.50 m. depth below Road Level the following formula will be used.

$$q_{ns} = q_d / F.O.S. = C_u N_c S_c d_c i_c / F.O.S.$$

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6.1.2 ***Foundation Settlement***

Settlement is calculated on the basis of the following formulae

Immediate Settlement (S_i) = $q_{ns}\, B\, (1 - \mu^2)\, I_f / E$

Where, q_{ns} = Net foundation pressure.

B = Width of footing.

μ = Poisson's Ratio of soil.

I_f = Influence Factor.

E = Modulus of Elasticity.

Corrected immediate settlement, $S_{ic} = S_i C_c$

Where, C_c = Depth correction factor as per fig.12 of I.S.8009 (Part 1) 1976 (Reaffirmed 2003).

Consolidation settlement

Assuming the influence zone for 20% stress contour, upto twice the width of footing, the total consolidation settlement is given by

$S_c = \Sigma m_v\, \Delta P\, H$ as per IS: 8009 (Part I)

Where, m_v = Coefficient of volume change.

ΔP = Pressure increment at centre of the layer.

H = Thickness of the stratum.

Corrected consolidation settlement, $S_{cc} = S_c C_b C_c$

Where, C_b = Pore Pressure correction factor.

C_c = Depth correction factor as per fig.12 of I.S.8009 (Part 1) 1976. (Reaffirmed 2003)

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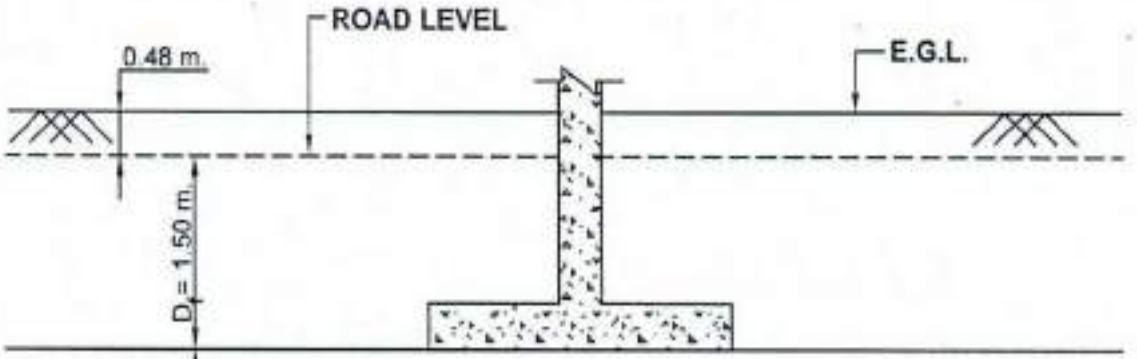
FOUNDATION DESIGN MODEL

FOR SHALLOW FOUNDATION

DEPTH OF FOUNDATION = 1.50 M. BELOW ROAD LEVEL

(NOT TO SCALE)



STRATUM II

3.30 m.

$C_{min.}$ = 27.02 kN /m^2

m_{v1} = 0.000442 m^2/ kN

(From pressure range - $^1/_4$ to $^1/_2$ kg/cm^2)

STRATUM III

9.00 m.

m_{v2} = 0.000496 m^2/ kN

(From pressure range - $^1/_4$ to $^1/_2$ kg/cm^2)

&

(From pressure range - $^1/_2$ to 1 kg/cm^2)

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TABLE 2(A)

Shallow Foundation : Bearing Capacity and Probable Settlement Values

Depth of foundation = 1.50 m. below Road Level

Factor of Safety in shear = 2.50

Type of footing	Size of footing (m x m)	Net safe bearing capacity in shear (kN/m^2)	Total expected settlement (mm)	Net allowable bearing pressure to restrict settlement within *75.00 mm (i.e. safe both in shear and settlement) (kN/m^2)
ISOLATED SQUARE	1.50 x 1.50	86.70	23.00	86.70
	2.00 x 2.00	83.10	34.00	83.10
	2.50 x 2.50	80.90	47.00	80.90
	3.00 x 3.00	79.40	59.00	79.40
	3.50 x 3.50	78.40	70.00	78.40
	4.00 x 4.00	77.60	80.00	72.80
RECTANGULAR	1.50 x 3.00	73.30	29.00	73.30
	2.00 x 4.00	70.30	41.00	70.30
	2.50 x 5.00	68.40	55.00	68.40
	3.00 x 6.00	67.20	68.00	67.20
	3.50 x 7.00	66.30	79.00	62.90
	4.00 x 8.00	65.70	90.00	54.80
SINGLE DIRECTION CONTINUOUS STRIP	1.00 m. wide	72.20	25.00	**72.20
	1.50 m. wide	66.70	37.00	**66.70
	2.00 m. wide	63.90	50.00	**63.90
	2.50 m. wide	62.20	65.00	**62.20
	3.00 m. wide	61.10	80.00	**57.30
	3.50 m. wide	60.30	93.00	**48.60

*As per Table – 1 of I.S.1904 (1986) for isolated foundation for Multistoried Buildings in plastic clay, like in present case.

**Bothways interconnecting strip footing, if used, should not be designed with these values of bearing capacity.

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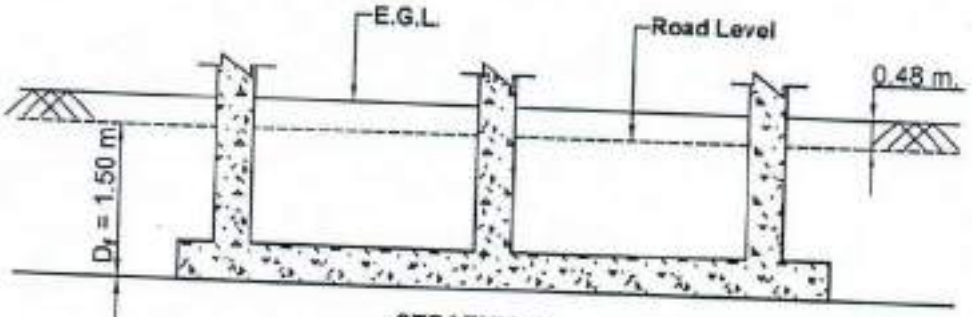
FOUNDATION DESIGN MODEL

FOR SHALLOW FOUNDATION AS RIGID RAFT

DEPTH OF FOUNDATION = 1.50 M. BELOW ROAD LEVEL

(DRAWING NOT TO SCALE)



STRATUM - II

3.30 m.

Cavg. = 28.42 kN / m^2

mv_1 = 0.000442 m^2/ kN

(From pressure range - $^1/_4$ to $^1/_2$ kg/cm^2)

STRATUM - III

9.00 m.

Cavg. = 19.13 kN / m^2

mv_2 = 0.000496 m^2/ kN

(From pressure range - $^1/_4$ to $^1/_2$ kg/cm^2)

&

(From pressure range - $^1/_2$ to 1 kg/cm^2)

STRATUM - IV

1.20 m.

mv_3 = 0.000216 m^2/ kN

(From pressure range - $^1/_2$ to 1 kg/cm^2)

&

(From pressure range - 1 to 2 kg/cm^2)

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TABLE - 2(B)

Shallow Rigid Raft Foundation / both ways continuous strip footing (Virtual raft):

Bearing Capacity and Probable Settlement Value

Depth of foundation = 1.50 m. below Road Level

Factor of Safety in shear = 3.00

Type of Footing	*Tentative Size (m x m)*	*Net Safe bearing capacity from shear criterion (kN/m^2)*	*Estimated Total Settlement corresponding to Net Safe bearing pressure from shear criterion (mm)*	*Net Allowable bearing pressure for a total settlement of *125.00 mm (kN/m^2)*	*Design Net Allowable bearing pressure (least among shear and settlement criteria i.e., safe both in shear and settlement) (kN/m^2)*
RIGID RAFT/ BOTH WAYS CONTINUOUS STRIP FOOTING (VIRTUAL RAFT)	*9.00 x 16.00*	*47.00*	*102.00*	*57.60*	*47.00*

**As per Table – 1 of I.S.1904 (1986) for Raft foundation for Multistoried Building in Plastic Clay, like in present case.*

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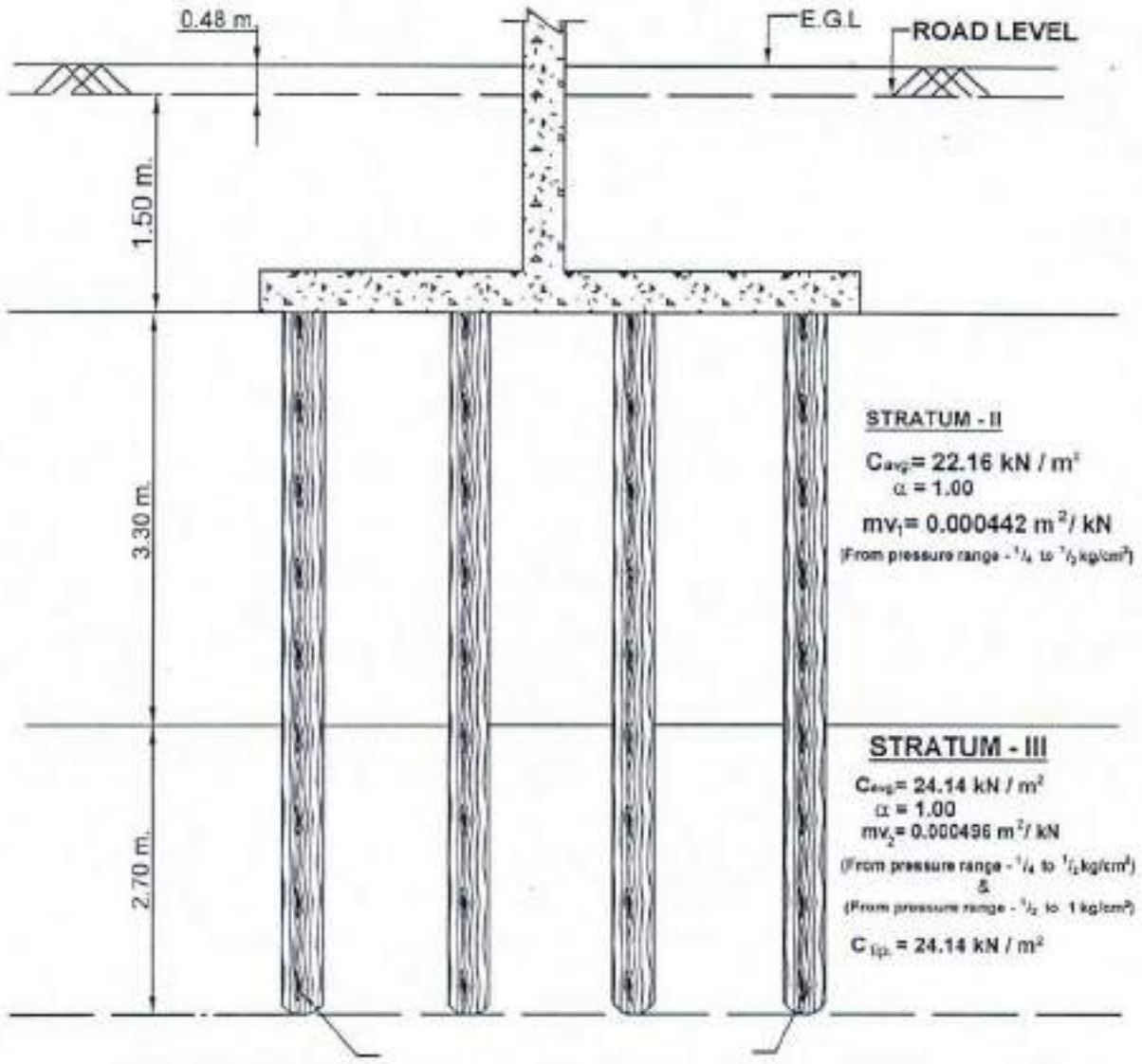
FOUNDATION DESIGN MODEL
FOR SHALLOW FOUNDATION RESTING ON REINFORCED SOIL MASS (BY TIMBER PILING)
DEPTH OF FOUNDATION = 1.50 m BELOW ROAD LEVEL.

(DRAWING NOT TO SCALE)



TIMBER PILE (6" dia at top and 4" dia at toe, 6m long @ 600 mm C/C)

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6.2. ***Improved bearing capacity of composite soil mass reinforced with vertical timber piles (sal balla, not eucalyptus balla) above which footings are to be placed at 1.50 m. below Road Level.***

Termination depth of timber piles = 7.50 m. below Road Level.

Assumed cut-off level = 1.50 m. below Road Level.

Length of timber pile = 6.00 m.

TABLE 2(C)

Dia. of timber pile (mm)	*Center to center spacing of timber piles in staggered triangular pattern through out the foundation area (mm)*	*Size of Footing (m)*	*Recommended Improved Net Allowable Bearing Capacity of reinforced composite soil mass in shear (kN/m^2)*	*Total Expected Settlement (mm)*	*Net Allowable Bearing Pressure to restrict settlement within *75.00 mm (i.e. safe both in shear and settlement) (kN/m^2)*
(6"ϕ at top & 4"ϕ at bottom)	*600.00*	*2.00 m. Square*	*90.00*	*26.00*	*90.00*
		2.50 m. Square	*90.00*	*36.00*	*90.00*
		3.00 m. Square	*90.00*	*47.00*	*90.00*
		3.50 m. Square	*90.00*	*53.00*	*90.00*
		4.00 m. Square	*90.00*	*59.00*	*90.00*
		2.00 m. x 4.00 m.	*90.00*	*36.00*	*90.00*
		2.50 m. x 5.00 m.	*90.00*	*50.00*	*90.00*
		3.00 m. x 6.00 m.	*90.00*	*63.00*	*90.00*
		3.50 m. x 7.00 m.	*90.00*	*70.00*	*90.00*
		4.00 m. x 8.00 m.	*90.00*	*77.00*	*87.70*
		1.50 m. wide strip	*90.00*	*34.00*	*90.00*
		2.00 m. wide strip	*90.00*	*49.00*	*90.00*
		2.50 m. wide strip	*90.00*	*65.00*	*90.00*
		3.00 m. wide strip	*90.00*	*81.00*	*83.30*
		3.50 m. wide strip	*90.00*	*90.00*	*75.00*

**As per Table – 1 of I.S.1904 (1986) for isolated foundation for Multistoried Building in plastic clay, like in present case.*

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6.3. ***Deep Foundations: R.C. Bored Pile***

The load carrying capacities of R.C. Bored Piles, for various dia., are calculated on the basis of I.S. Code of Practice of design and construction of pile foundations, ***IS: 2911 (Part I / Sec 2) – 2010.***

Using the static formula,

For piles in granular soils

$Q_u = A_p (1/2\ D\gamma N_\gamma + P_d N_q) + \sum K P_d \tan \phi A_s$ ***[I.S. 2911 (Part I / sec-2)-2010, Annex -B: clause 6.3.1.1 and 6.3.2],***

Where, A_p = *Cross-sectional area of pile toe.*

D = *Stem diameter.*

γ = *Effective unit weight of soil at pile toe.*

P_d = *Effective overburden pressure at pile toe.*

A_s = *Surface area of pile shaft.*

N_γ, N_q = *Bearing capacity factors depending on* ϕ.

For piles in cohesive soils

$Q_u = A_p N_c C_p + \sum \alpha C A_s$ ***[I.S. 2911 (Part I / sec-2)-2010, Annex -B: clause 6.3.1.1 and 6.3.2],***

Where, A_p = *Cross-sectional area of pile toe.*

N_c = *Bearing capacity factor = 9.0.*

C_p = *Average cohesion at pile toe.*

α = *Reduction factor.*

C = *Average cohesion throughout the length of pile.*

A_s = *Surface area of pile shaft.*

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FOUNDATION DESIGN MODEL FOR R.C. BORED CAST IN-SITU PILE

Termination Depth = 15.00 m., 18.00 m., 20.00 m. & 22.00 m. below Road Level
Cut - off Level = 1.50 m. below Road Level
(Drawing Not To Scale)

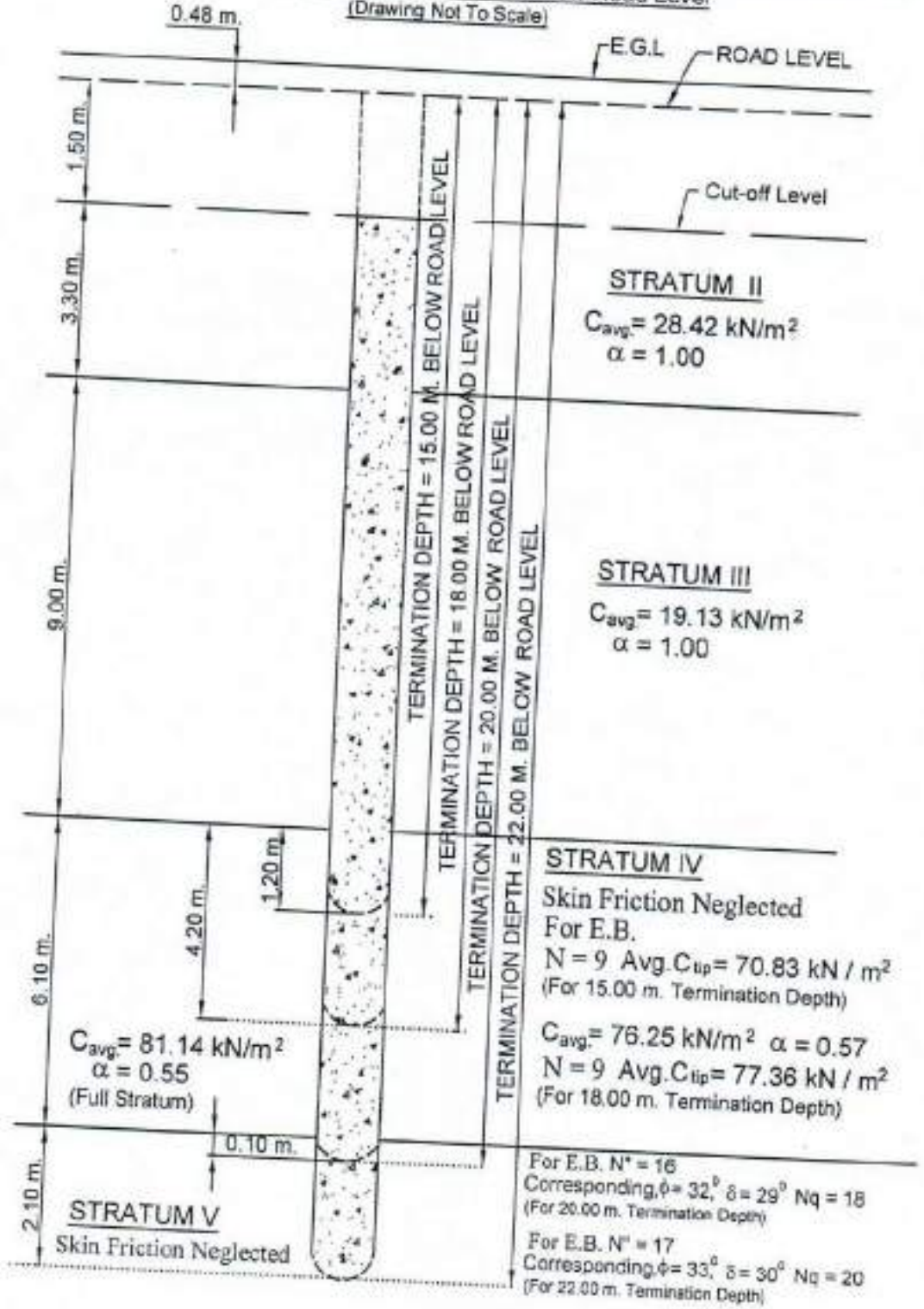

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TABLE 2(D)
Load Carrying Capacities of R.C. Bored Piles of Straight Shaft
Assumed Cut – off level = 1.50 m. below Road Level

Termination Depth of pile Below Road Level (m)	Cut-off Length Below Road Level (m)	Shaft Length (m)	Dia. of Pile (mm)	Recommended working Load on single pile in Axial Compression (kN)	Safe vertical Pull-out capacity with F.O.S. = 3.00 (kN)	Depth of fixity Below cut off Level (m)	Safe Lateral Capacity* (kN)	Safe Vertical Compressive Load capacity of single pile during seismic condition (kN)
15.00	1.50	13.50	400 ϕ	200.00	123.00	4.38	22.40	265.00
			450 ϕ	225.00	140.00	4.95	24.90	298.00
			500 ϕ	250.00	158.00	5.48	28.00	331.00
18.00	1.50	16.50	400 ϕ	330.00	202.00	4.38	22.40	459.00
			450 ϕ	380.00	230.00	4.95	24.90	516.00
			500 ϕ	420.00	258.00	5.48	28.00	574.00
20.00	1.50	18.50	400 ϕ	400.00	242.00	4.38	22.40	563.00
			450 ϕ	455.00	274.00	4.95	24.90	634.00
			500 ϕ	500.00	307.00	5.48	28.00	704.00
22.00	1.50	20.50	450 ϕ	460.00	276.00	4.95	24.90	748.00
			500 ϕ	500.00	310.00	5.48	28.00	831.00
			600 ϕ	600.00	379.00	6.60	33.20	997.00

N.B. : *These are the capacities of pile derived from sub-soil properties, not the structural capacities.*

**Corresponding to 5.00 mm deflection of pile head at pile cap base level under fixed head condition, as per clause 8.4. of I.S.2911(Part4):2013.*

Pile is considered to be fixed head and considering Grade of Concrete to be M25.

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7. RECOMMENDATIONS

From the information as supplied by the client, it is known that there is proposal for the construction of a (G+4) storied building at the site. However, whatever be the type, height and nature of the building, its foundation design should satisfy two basic criteria. They are as follows:

(a) *There must be adequate factor of safety against shear failure.*

(b) *The settlement of footings must be within permissible limits as defined in IS: 1904 (1986).*

Considering the above mentioned criteria & subsoil condition as encountered in the entire site, it is suggested to try to resort to shallow foundations in the form of isolated & or combined & or one way continuous strip footings or a judicious combination of some or all of them depending on column position and spacing, to be designed with the bearing capacity values as given in ***TABLE 2(A),*** *of previous chapter, for foundation design purposes.*

If this bearing capacity of ***TABLE 2(A)*** *falls short, by providing adequate footing area, without overlapping, then, shallow foundation in the form of a rigid raft / bothways interconnecting footing, can be tried out, with the bearing capacity values as provided in* ***TABLE 2(B)*** *of the previous chapter.*

However, if it is not possible to do the foundation design with the bearing capacity as given in the ***TABLE 2(B),*** *or if the designer wants to avoid raft foundation, then ground improvement can be done by Timber Piles. The improved bearing capacity of shallow foundations resting on ground reinforced with vertical timber piling, is provided in* ***TABLE 2(C)*** *of previous chapter.*

For Ground Improvement by timber piling to be done, it is suggested to excavate the entire foundation area (may be in phases) upto 1.50 m. below Road Level, drive the timber piles of 6.00 m. long, 6" dia. at top and 4" dia. at tip, to be driven at 600 mm c/c staggered triangular spacing & then to design & place the shallow footings in the form of shallow footings with net allowable bearing pressure as given in ***TABLE 2(C)*** *of previous chapter. Timber piles are to be driven irrespective of column and foundation position, for the entire*

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foundation area & its horizontal extent should go at least 0.50 m. extra beyond the outer periphery of the proposed foundations on outer sides of the proposed buildings. Timber piles should be coated with creosote coating before driving.

Complete submergence of timber piles below ground water table can be envisaged & hence its long-term performance can also be expected.

For shallow footings to be provided after ground improvement, they should be properly connected in all directions by suitable tie-beams to arrest / check differential settlement.

It is very important to note that quality of timber piling is very important to get a successful timber piling job. Undersized timber piles (be it in dia & or be it in length) should never be used. In many cases, casual approach is taken in timber pile spacing which is driven @ 700 mm to 800 mm c/c spacing. In those cases, long term foundation settlement problem persists even after timber pile driving. Another important point to note is that, sal balla should be used, not eucalyptus balla.

In present case, if undersized timber piles are used & if spacing is increased from 600 mm c/c to more, then it cannot be confidently said that timber piling will be successful.

The last option is to go for deep foundation in the form of R.C. Bored Piles, the load capacities of which are provided in ***TABLE 2(D)*** *of previous chapter.*

If pile foundation is used & if having termination depth of 15.00 m. below Road Level. is used, the entire piling job can be done by Hand Auger piling method, although DMC piles would produce better quality pile.

But if pile foundation is used & if pile having termination depth of 18.00 m. or 20.00 m. or 22.00 m. below Road Level, is used, D.M.C. method of piling is strongly suggested.

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It is strongly recommended that the design load carrying capacities should be verified as per routine Load Test on working pile to be done as per IS: 2911 (Part 4):2013, if R.C. Bored Piles are used.

For R.C. bored piles to be used, while considering the seismic effect, the skin friction component of the pile load capacities, may be increased by 25 % as per Table 1 (clause 6.4.2.1) of IS: 1893 (Part I): 2016 & the increased load capacity are provided in extreme R.H.S column of ***TABLE 2 (D)****. However, no percentage increase in SBC of shallow foundations as given in* ***TABLE 2(A), TABLE 2(B) & TABLE 2(C)*** *is allowed under seismic condition in present type of sub soil condition, as per (clause 6.4.2.1) of IS: 1893 (Part I): 2016.*

It is strongly recommended that the design load carrying capacities should be verified with routine Load Test on working pile to be done as per IS: 2911 (Part 4):2013, if R.C. Bored Piles are used.

Now-a-days, to ensure and assess quality control in R.C. piling job, load test as per IS: 2911 (Part 4) is not solitarily enough. It is suggested that load tests should be supplemented by low-strain non-destructive integrity tests on piles, in early, intermediate and last stage of piling job, if R.C. Bored Piles are used.

Ground water level during the period of fieldwork was observed at a depth of about 0.25 m. below Road Level. Since the fieldwork was done in the month of July, it can be considered as high water table location, which can be normally expected to go down in dry season. So, it is envisaged that, constant pumping will be necessary to keep the excavation water free, due to the position of water table much above the founding depth in case of conventional shallow foundation, rigid raft & timber pile foundation & much above the cut off level in case of concrete piles. However, situation may be worsened if foundation excavation is done in heavy and continuous monsoon, when water table may rise near E.G.L. and constant and continuous dewatering might be necessary to keep foundation trenches water free.

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No local information regarding highest position of ground water table during Monsoon was available from the site. However, for design purposes, it is advisable to consider the worst possible condition of standing water level to merge with E.G.L., which has been done in present case. Hence our results of bearing capacity of conventional shallow foundation, Rigid Raft foundation, Timber Pile foundation and load carrying capacities of R.C. Bored Piles as given in ***TABLE 2(A), TABLE 2(B), TABLE 2(C) & TABLE 2(D)*** *respectively, will not be affected by fluctuation of Ground Water Table position, since those were determined under worst condition.*

Last but not the least, due considerations should be given to open excavation of any sort. All sorts of precautionary measures like earth retainment by any suitable method, are to be adopted to avoid excessive ground settlement and damage to adjoining structures.

For and on behalf of ***GEOTEST ENGINEERS PVT. LTD.***

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ANNEXURE

REPORT SHEET

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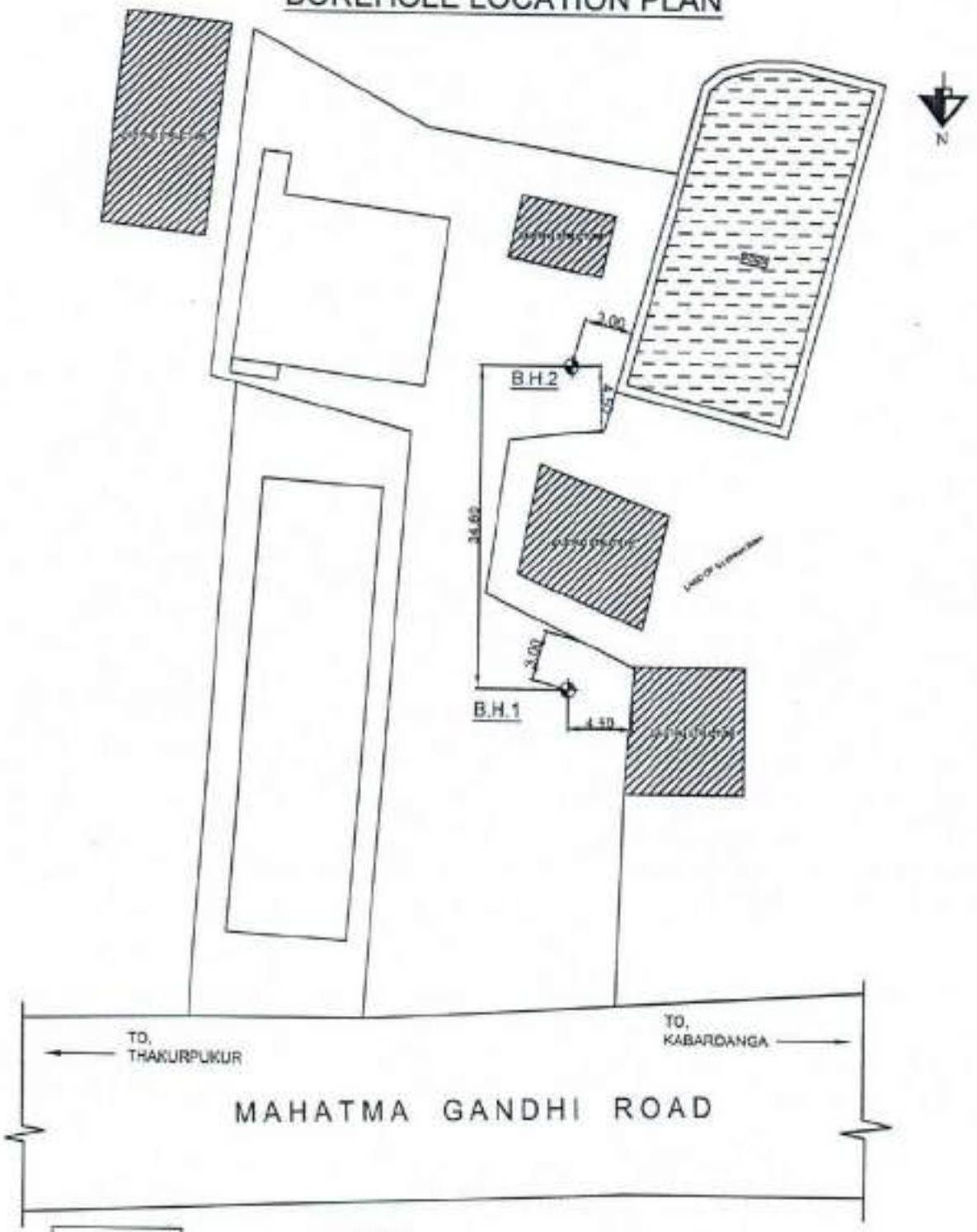
BOREHOLE LOCATION PLAN



LEGEND	
B.H.	◆

NOTE
i) Drawing not to scale.
ii) All dimensions are in m.
iii) All dimensions are approximate.

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BORE LOG DATA SHEET

Type of boring	Shell and Auger	Bentonite Mud Boring	Drilling	REPORT NO.: GT / GA / 44 / 2019 - 2020	Bore Hole No. 1
Dia of Hole	150 mm.	--	--	Coordination Sext Angles	As per Borehole Location Plan.
Depth	25.95 m.	--	--	Ground Bed RL	About 0.50 m. above Road Level. (approx.)
Commenced on: 17.07.19		Completed on: 19.07.19		Location:	***Mouza- Purba Barisha, P.S- Thakurpukur, Dist.-24 Pgs.(S)***
Ground Water Table: 0.75 m.					

Description of strata	I.S. Classification	Depth in 'M' From	Depth in 'M' To	Thickness in 'M'	'N' Value	SAMPLES Type	Depth in 'M'
Reclaimed top fill of soft brownish grey silty clay / clayey silt with traces of trees plants and brick pieces.	CH – MH	0.00	1.20	1.20	-- -- --	D D D	0.00 0.50 1.00
Soft / firm brownish grey silty clay with traces of rusty brown silt spots and kankars.	CH	1.20	5.20	4.00	-- -- 04 -- --	U D P D U	1.50 – 1.95 2.50 3.00 – 3.45 4.00 4.50 – 4.95
Very soft / soft grey silty clay with varying percentage of decomposed wood. (traces to medium to high percent)	CH – OH	5.20	14.30	9.10	-- 03 -- -- -- 02 -- -- -- 02 -- --	D P D U D P D U D P D U	5.50 6.00 – 6.45 7.00 7.50 – 7.95 8.50 9.00 – 9.45 10.00 10.50 – 10.95 11.50 12.00 – 12.45 13.00 13.50 – 13.95

Borehole Continued...

S. S.: Raja Acharya.

D – Disturbed Sample | U – Undisturbed Sample | P – Standard Penetration Test

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BORE LOG DATA SHEET

Type of boring	Shell and Auger	Bentonite Mud Boring	Drilling	REPORT NO.: GT / GA / 44 / 2019 - 2020	Bore Hole No. 1
Dia of Hole	150 mm.	--	--	Coordination Sext Angles	As per Borehole Location Plan.
Depth	25.95 m.	--	--	Ground Bed RL	About 0.50 m. above Road Level. (approx.)
Commenced on: 17.07.19		Completed on: 19.07.19		Location:	***Mouza- Purba Barisha, P.S- Thakurpukur, Dist.-24 Pgs.(S)***
Ground Water Table: 0.75 m.					

Description of strata	I.S. Classification	Depth in 'M' From	Depth in 'M' To	Thickness in 'M'	'N' Value	SAMPLES Type	Depth in 'M'
Stiff bluish grey / mottled brown silty clay with traces of rusty brown silt spots and kankars.	CH	14.30	20.20	5.90	-- 09 -- -- -- 08 -- --	D P D U D P D U	14.50 15.00 – 15.45 16.00 16.50 – 16.95 17.50 18.00 – 18.45 19.00 19.50 – 19.95
Very stiff brown sandy clayey silt with traces of mica.	MI	20.20	25.95		22 -- 24 25	P U P P	21.00 – 21.45 22.50 – 22.95 24.00 – 24.45 25.50 – 25.95
Borehole Terminated.							

S. S.: Raja Acharya.

D – Disturbed Sample | U – Undisturbed Sample | P – Standard Penetration Test

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BORE LOG DATA SHEET

Type of boring	Shell and Auger	Bentonite Mud Boring	Drilling	REPORT NO.: GT / GA / 44 / 2019 - 2020	Bore Hole No. 2
Dia of Hole	150 mm.	--	--	Coordination Sext Angles	As per Borehole Location Plan.
Depth	25.95 m.	--	--	Ground Bed RL	About 0.45 m. above Road Level. (approx.)
Commenced on: 18.07.19		Completed on: 19.07.19		Location:	*Mouza- Purba Barisha, P.S- Thakurpukur, Dist.-24 Pgs.(S)*
Ground Water Table: 0.70 m.					

Description of strata	I.S. Classification	Depth in 'M' From	Depth in 'M' To	Thickness in 'M'	'N' Value	SAMPLES Type	Depth in 'M'
Reclaimed top fill of soft brownish grey silty clay / clayey silt with traces of tree plants and brick prices.	CH – MH	0.00	1.30	1.30	-- -- --	D D D	0.00 0.50 1.00
Soft / firm brownish grey / grey silty clay with traces of rusty brown silt spots and kankars.	CH	1.30	5.40	4.10	03 -- -- -- 04	P D U D P	1.50 – 1.95 2.50 3.00 – 3.45 4.00 4.50 – 4.95
Very soft / soft grey silty clay with varying percentage of decomposed wood. (traces to medium percent)	CH – OH	5.40	14.20	8.80	-- -- -- 03 -- -- -- 02 -- -- -- 22	D U D P D U D P D U D P	5.50 6.00 – 6.45 7.00 7.50 – 7.95 8.50 9.00 – 9.45 10.00 10.50 – 10.95 11.50 12.00 – 12.45 13.00 13.50 – 13.95

Borehole Continued...

S. S.: Raja Acharya.

D – Disturbed Sample | U – Undisturbed Sample | P – Standard Penetration Test

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BORE LOG DATA SHEET

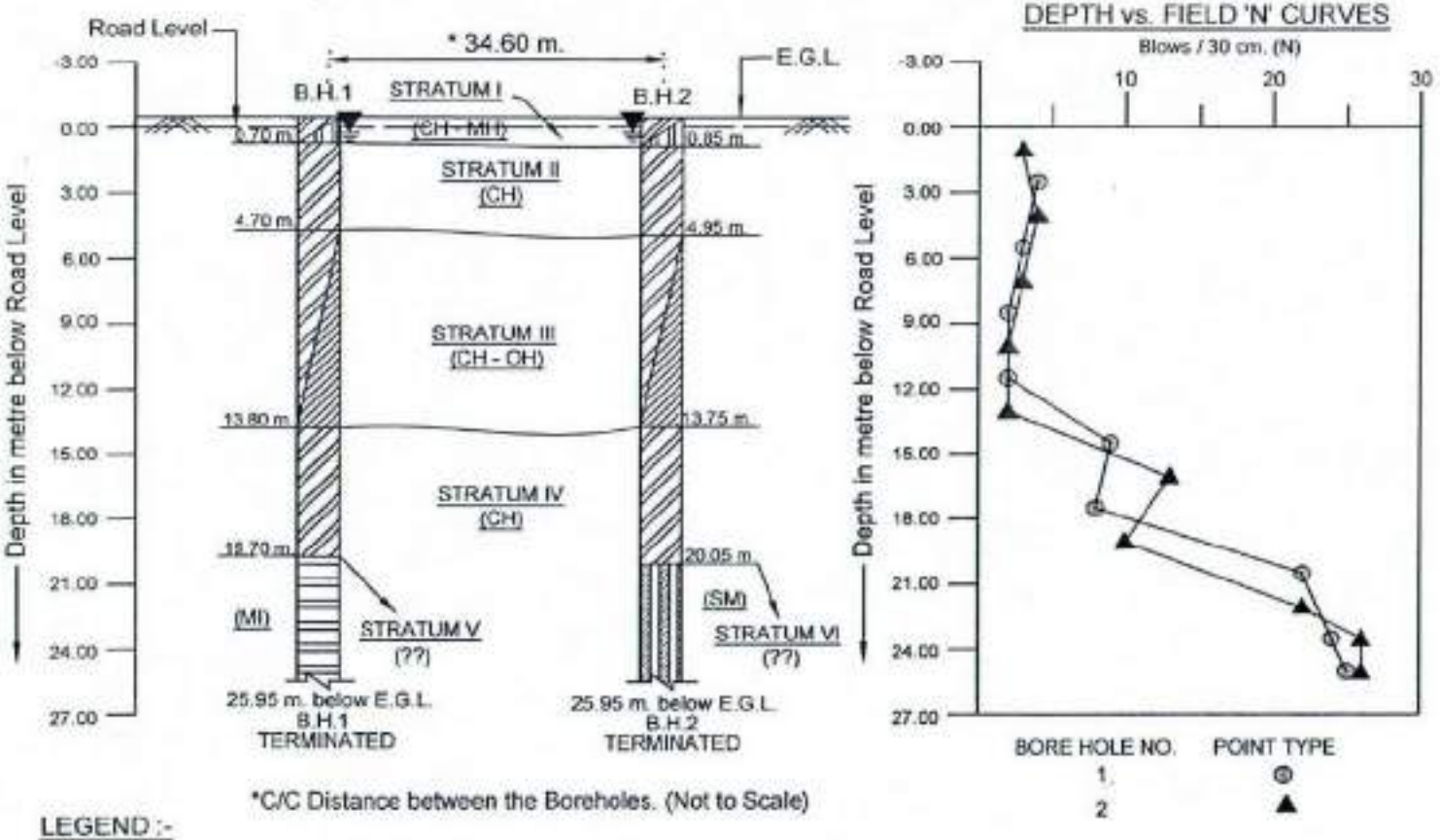
Type of boring	Shell and Auger	Bentonite Mud Boring	Drilling	REPORT NO.: GT / GA / 44 / 2019 - 2020	Bore Hole No. 2
Dia of Hole	150 mm.	--	--	Coordination Sext Angles	As per Borehole Location Plan.
Depth	25.95 m.	--	--	Ground Bed RL	About 0.45 m. above Road Level. (approx.)
Commenced on: 18.07.19		Completed on: 19.07.19		Location:	*Mouza- Purba Barisha, P.S- Thakurpukur, Dist.-24 Pgs.(S)*
Ground Water Table: 0.70 m.					

Description of strata	I.S. Classification	Depth in 'M' From	Depth in 'M' To	Thickness in 'M'	'N' Value	SAMPLES Type	Depth in 'M'
Stiff bluish grey / mottled brown silty clay with traces of rusty brown silt spots and kankars.	CH	14.20	20.50	6.30	-- -- -- 13 -- -- -- 10	D U D P D U D P	14.50 15.00 – 15.45 16.00 16.50 – 16.95 17.50 18.00 – 18.45 19.00 19.50 – 19.95
Medium compact brown silty fine sand with traces of mica.	SM	20.50	25.95		-- 22 26 26	U P P P	21.00 – 21.45 22.50 – 22.95 24.00 – 24.45 25.50 – 25.95
Borehole Terminated.							

S. S.: Raja Acharya.

D – Disturbed Sample | U – Undisturbed Sample | P – Standard Penetration Test

SUB SOIL PROFILE



*C/C Distance between the Boreholes. (Not to Scale)

LEGEND :-

STRATUM I	Reclaimed top fill of soft brownish grey silty clay / clayey silt with traces of tree plants and brick prices.
STRATUM II	Soft / firm brownish grey / grey silty clay with traces of rusty brown silt spots and kankars.
STRATUM III	Very soft / soft grey silty clay with varying percentage of decomposed wood (traces to medium to high percent).
STRATUM IV	Stiff bluish grey / mottled brown silty clay with traces of rusty brown silt spots and kankars.
STRATUM V	Very stiff brown sandy clayey silt with traces of mica.(Present in B.H.1 only)
STRATUM VI	Medium compact brown silty fine sand with traces of mica. (Present in B.H.2 only)

During the fieldwork, E.G.L was about 0.50 m. & 0.45 m. above Road Level in B.H.1 & B.H.2 respectively.

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GEOTEST ENGINEERS PRIVATE LIMITED
6A, MILAN PARK, KOLKATA – 700084.

Laboratory Test Results

LAB- 14
Issue -01

Location: Mouza- Purba Barisha, P.S- Thakurpukur, Dist.-24 Pgs.(S)

B.H. No.	Stratum	TYPE	Depth in Metre below EGL	DESCRIPTION	Natural Moisture Content %	Unit Weight (kN/m³)		Liquid Limit %	Plastic Limit %	U.C.S. 'C' kN/m²	Triaxial / Direct Shear		Specific Gravity 'G'	Initial Void Ratio 'e₀'	GRAIN SIZE				
						Bulk	Dry				'C' kN/m²	'ϕ'			TYPE	Gravel %	Sand %	Silt %	Clay %
1.	II	U	1.50 to 1.95	Brownish grey / grey silty clay with traces of kankars and rusty brown silt spots.	33.85	18.00	13.44	66	24	28.80	--	--	2.64	0.893	H.A.	01	03	52	44
											Tr. U. U. Test								
1.	II	U	4.50 to 4.95	Brownish grey / grey silty clay with rusty brown silt	31.82	18.55	14.07	63	23	--	29.43	0^0	2.66	0.846	H.A.	--	05	53	42
1.	III	U	7.50 to 7.95	Grey silty clay with medium percentage of decomposed wood.	55.10	16.27	10.49	77	25	16.73	--	--	--	--	--	--	--	--	--
1.	III	U	10.50 to 10.95	Grey silty clay with high percentage of decomposed wood.	214.80*	--	--	--	--	--	--	--	--	--	--	--	--	--	--

*Very high values due to presence of very high percentage of decomposed wood in soil

Note: 1) **Atterberg's limit tests have been conducted on air dried samples.**
2) **Triaxial tests have been conducted with minimum cell pressure equal to or slightly greater than the geostatic Stress at 'in-situ' condition from where the Sample had been procured.**

Abbreviation: U = Undisturbed Sample, P = SPT Sample, H.A. = Hydrometer Analysis, S.A. = Sieve Analysis.

GEOTEST ENGINEERS PRIVATE LIMITED
6A, MILAN PARK, KOLKATA – 700084.

Laboratory Test Results

LAB- 14
Issue -01

Location: Mouza- Purba Barisha, P.S- Thakurpukur, Dist.-24 Pgs.(S)

B.H. No.	Stratum	TYPE	Depth in Metre below EGL	DESCRIPTION	Natural Moisture Content %	Unit Weight (kN/m³)		Liquid Limit %	Plastic Limit %	U.C.S. 'C' kN/m²	Triaxial / Direct Shear		Specific Gravity 'G'	Initial Void Ratio 'e₀'	GRAIN SIZE				
						Bulk	Dry				'C' kN/m²	'ϕ'			TYPE	Gravel %	Sand %	Silt %	Clay %
											Tr. U. U. Test								
1.	III	U	13.50 to 13.95	Grey silty clay with medium percentage of decomposed wood.	54.77	16.36	10.57	84	28	--	18.34	0^0	2.49	1.363	H.A.	--	01	51	48
1.	IV	U	16.50 to 16.95	Mottled brown silty clay with rusty brown silt spots.	25.03	19.59	15.66	60	20	78.91	--	--	--	--	--	--	--	--	--
1.	IV	U	19.50 to 19.95	Mottled brown silty clay with rusty brown silt spots and sandy traces.	24.51	19.76	15.87	62	21	--	96.88	0^0	2.70	0.661	H.A.	--	18	46	36
1.	V	U	22.50 to 22.95	Mottled brown clayey silt with traces of micacious fine sand.	26.82	18.57	14.64	40	20	--	63.89	12^0	2.71	0.726	H.A.	--	19	61	20

GEOTEST ENGINEERS PRIVATE LIMITED
6A, MILAN PARK, KOLKATA – 700084.

Laboratory Test Results

LAB- 14
Issue -01

Location: Mouza- Purba Barisha, P.S- Thakurpukur, Dist.-24 Pgs.(S)

B.H. No.	Stratum	TYPE	Depth in Metre below EGL	DESCRIPTION	Natural Moisture Content %	Unit Weight (kN/m³)		Liquid Limit %	Plastic Limit %	U.C.S. 'C' kN/m²	Triaxial / Direct Shear		Specific Gravity 'G'	Initial Void Ratio 'e_0'	GRAIN SIZE				
						Bulk	Dry				'C' kN/m²	'φ'			TYPE	Gravel %	Sand %	Silt %	Clay %
											Tr. U. U. Test								
2.	II	U	3.00 to 3.45	Grey silty clay.	32.15	18.59	14.06	64	23	--	27.02	0^0	2.67	0.858	H.A.	--	04	54	42
2.	III	U	6.00 to 6.45	Grey silty clay with traces of decomposed wood.	37.30	17.39	12.66	74	26	--	24.14	0^0	2.55	0.951	H.A.	--	03	51	46
2.	III	U	9.00 to 9.45	Grey silty clay with medium percentage of decomposed wood.	46.31	16.44	11.23	78	22	18.06	--	--	--	--	--	--	--	--	--
2.	III	U	12.00 to 12.45	Grey silty clay with medium percentage of decomposed wood.	46.01	16.29	11.15	75	26	18.36	--	--	--	--	--	--	--	--	--

GEOTEST ENGINEERS PRIVATE LIMITED 6A, MILAN PARK, KOLKATA – 700084.	**Laboratory Test Results**	LAB- 14 Issue -01

Location: **Mouza- Purba Barisha, P.S- Thakurpukur, Dist.-24 Pgs.(S)**

B.H. No.	Stratum	TYPE	Depth in Metre below EGL	DESCRIPTION	Natural Moisture Content %	Unit Weight (kN/m³)		Liquid Limit %	Plastic Limit %	U.C.S. 'C' kN/m²	Triaxial / Direct Shear		Specific Gravity 'G'	Initial Void Ratio 'e₀'	GRAIN SIZE				
						Bulk	Dry				'C' kN/m²	'ϕ'			TYPE	Gravel %	Sand %	Silt %	Clay %
											Tr. U. U. Test								
2.	IV	U	15.00 to 14.45	Bluish grey silty clay with rusty brown silt spots.	27.63	19.17	15.01	65	22	--	73.58	0^0	2.70	0.746	H.A.	--	07	49	44
2.	IV	U	18.00 to 17.45	Mottled brown silty clay with rusty brown silt spots.	21.92	20.10	16.48	61	20	--	75.19	0^0	--	--	--	--	--	--	--
2.	IV	P	19.50 to 19.95	Mottled brown silty clay with rusty brown silt spots and sandy traces.	--	--	--	64	19	--	--	--	--	--	H.A.	--	13	47	40
2.	VI	U	21.00 to 21.45	Brown silty fine sand with traces of mica.	15.99	16.90	--	NP	NP	--	--	--	2.72	--	S.A.	--	71	←29→	

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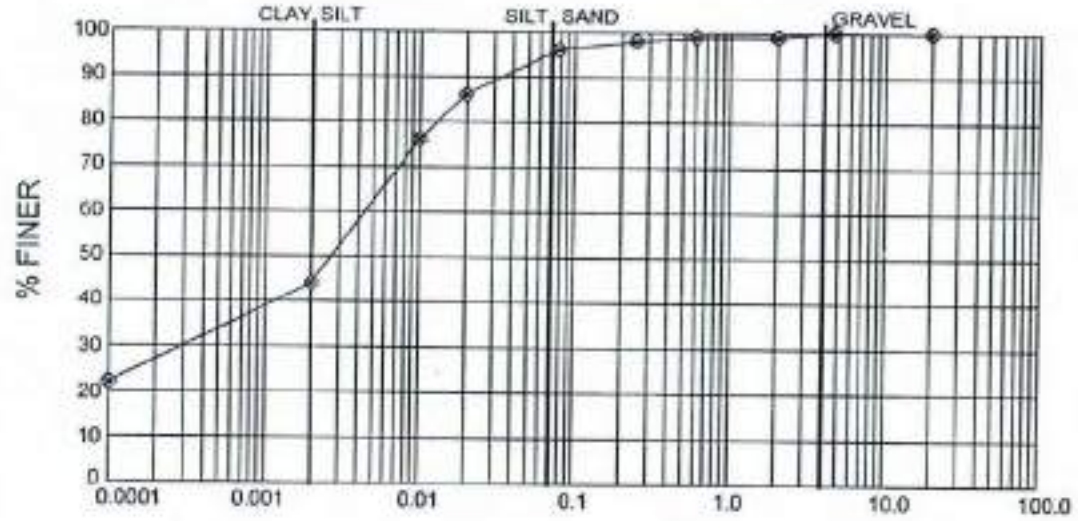
5.a. PARTICLE-SIZE DISTRIBUTION CURVE OF HYDROMETER ANALYSIS

PARTICLE-SIZE DISTRIBUTION CURVE

Location : Mouza- Purba Barisha, P.S- Thakurpukur,Dist.-24 Pgs.(S).



B.H. NO.	DEPTH	CLAY %	SILT %			SAND %			GRAVEL %		LEGEND
			FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	FINE	COARSE	
1	1.50 m.	44	52			03			01		

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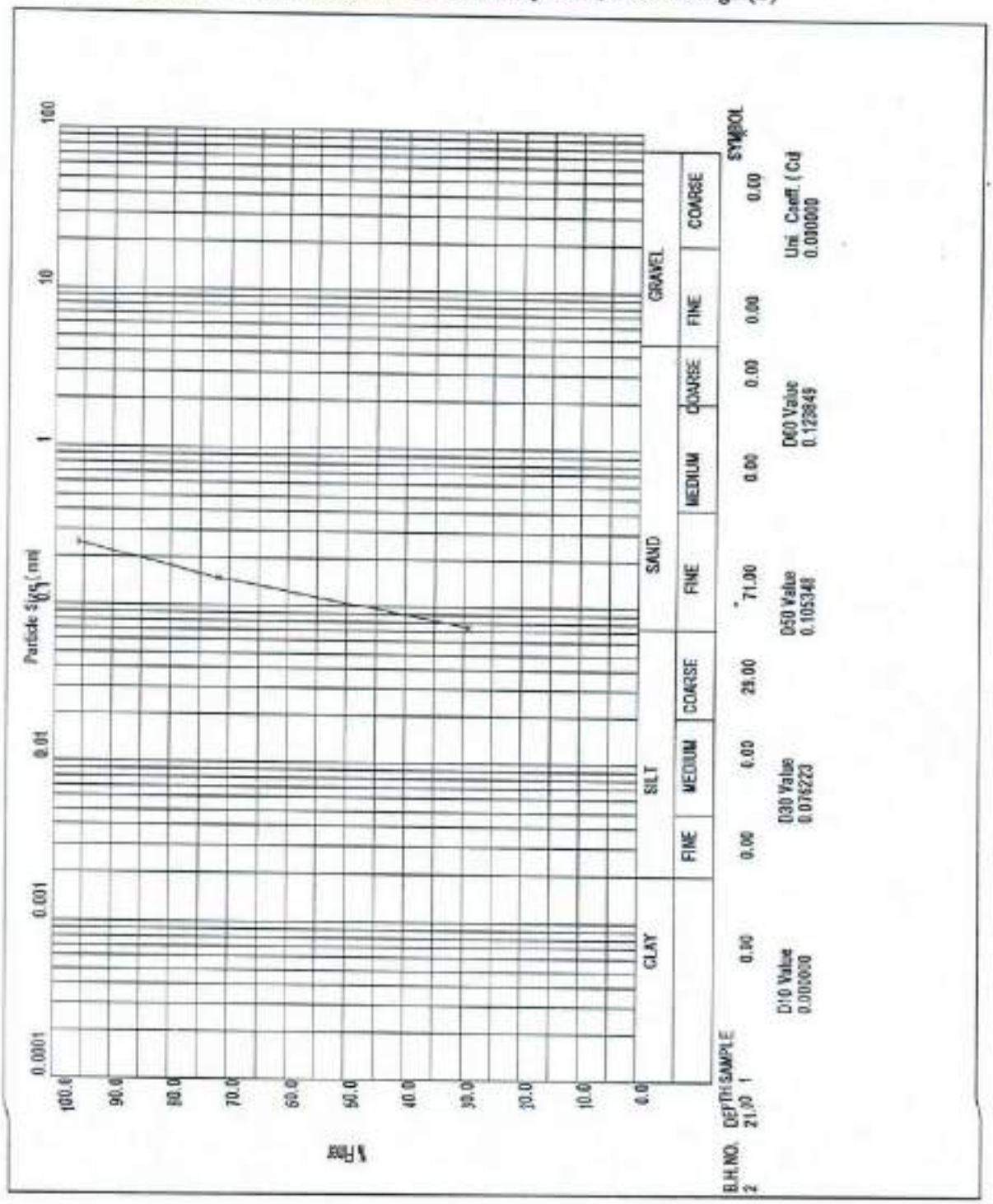
5.b. Particle Size Distribution Curve of Sieve Analysis

Project: Mouza- Purba Barisha, P.S- Thakurpukur, Dist.-24 Pgs.(S)



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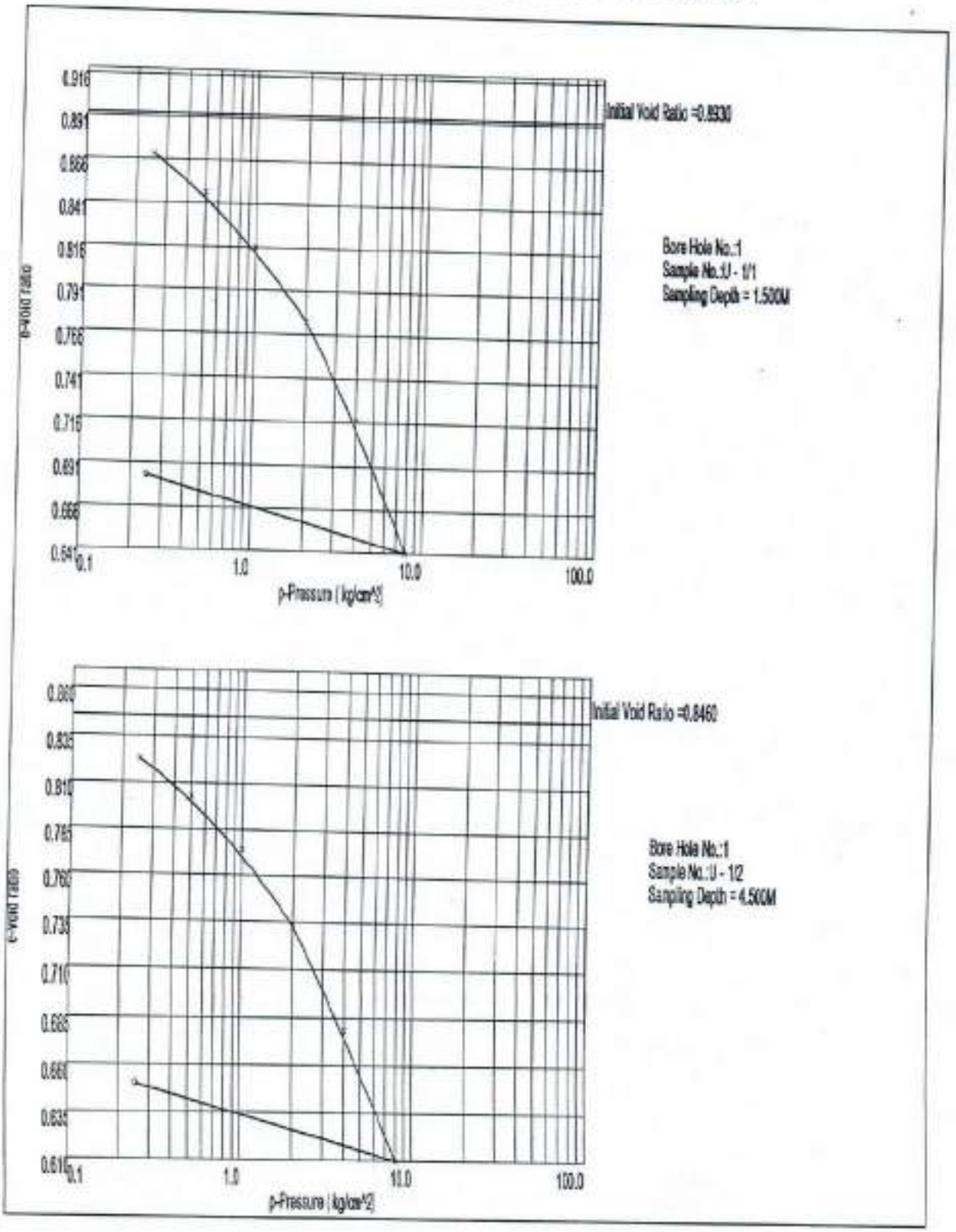
6a. e – log_{10} P Curves

Project: Mouza- Purba Barisha, P.S.- Thakurpukur, Dist.-24 Pgs.(S).



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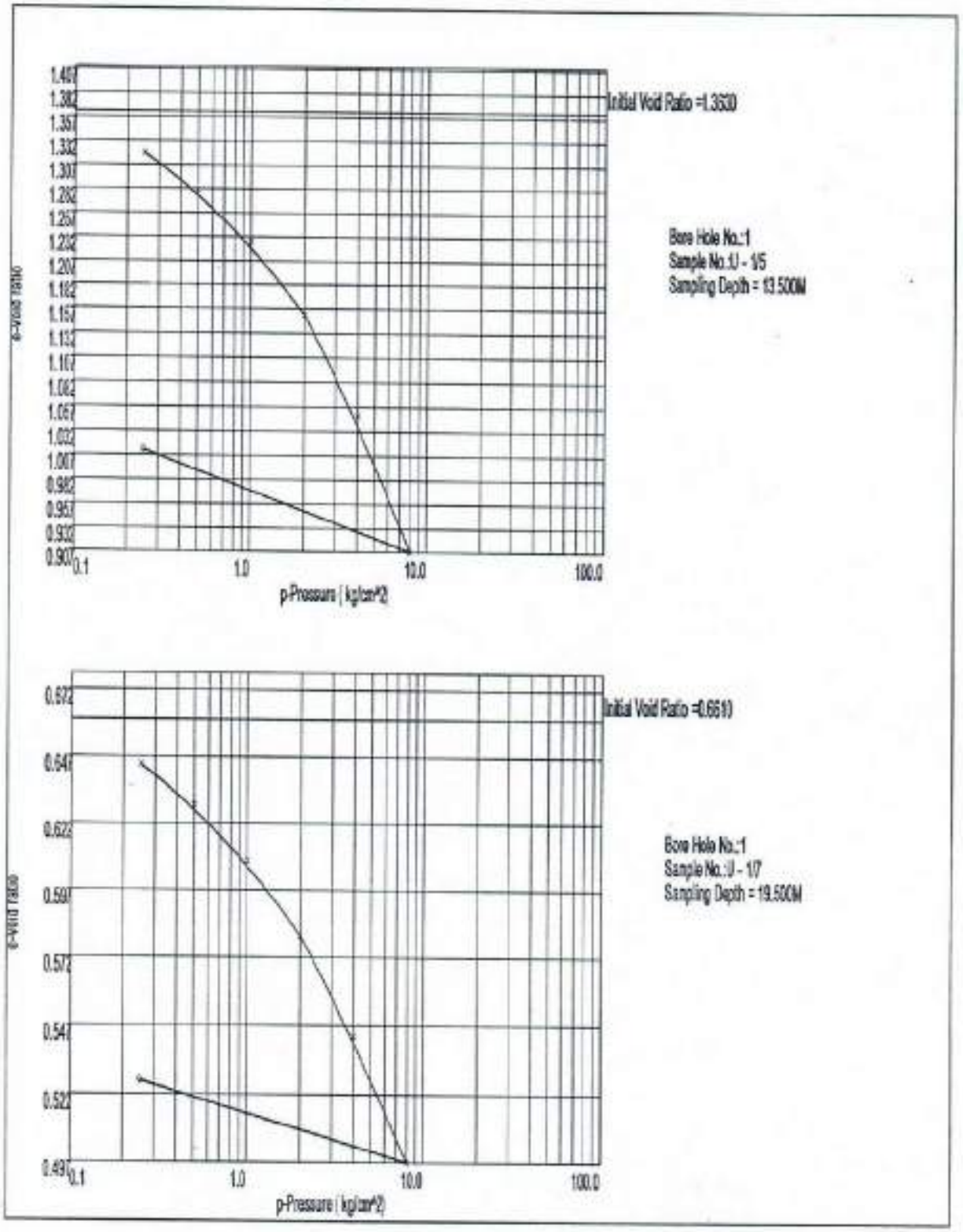
Project: Mouza- Purba Barisha, P.S.- Thakurpukur, Dist.-24 Pgs.(S).



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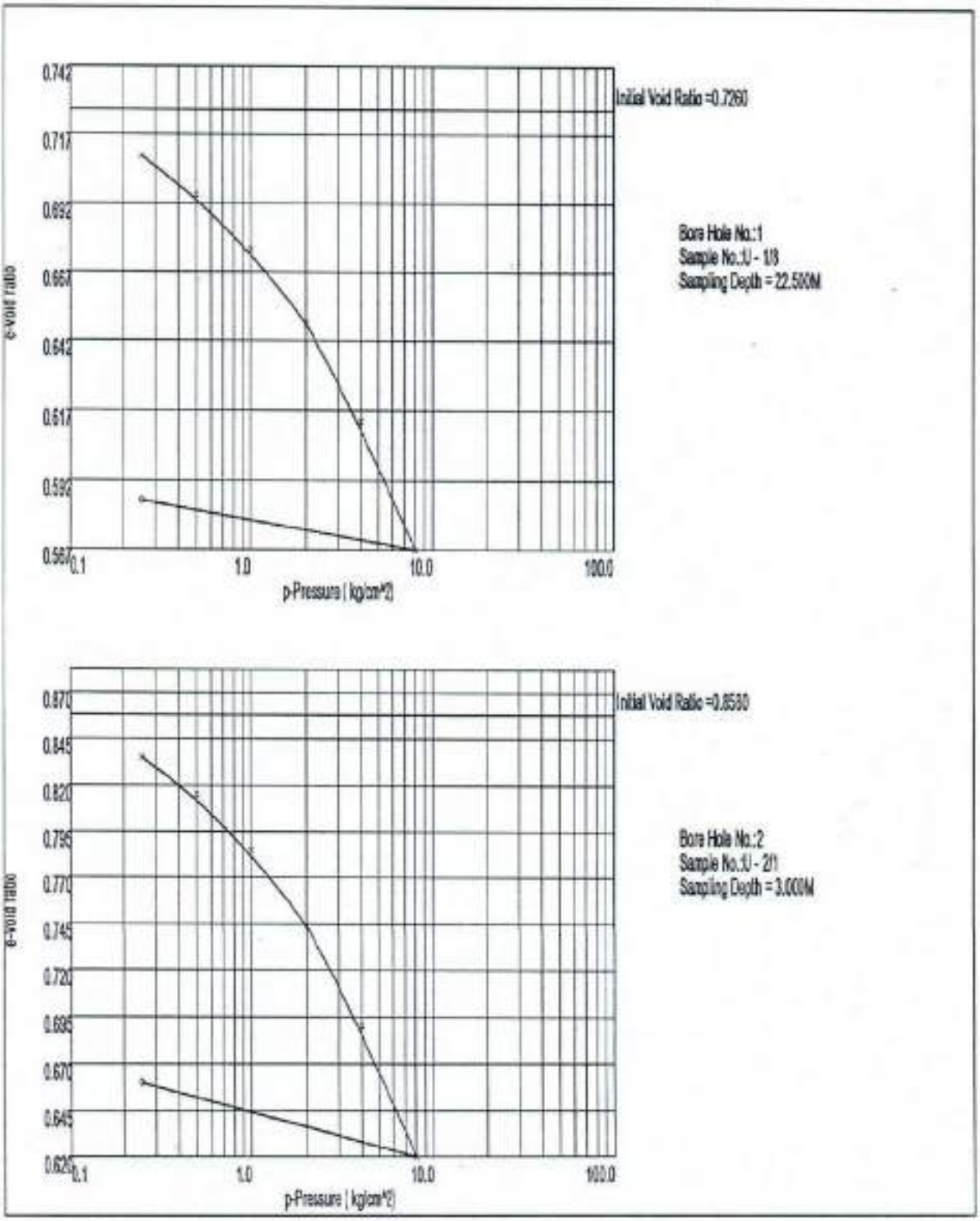

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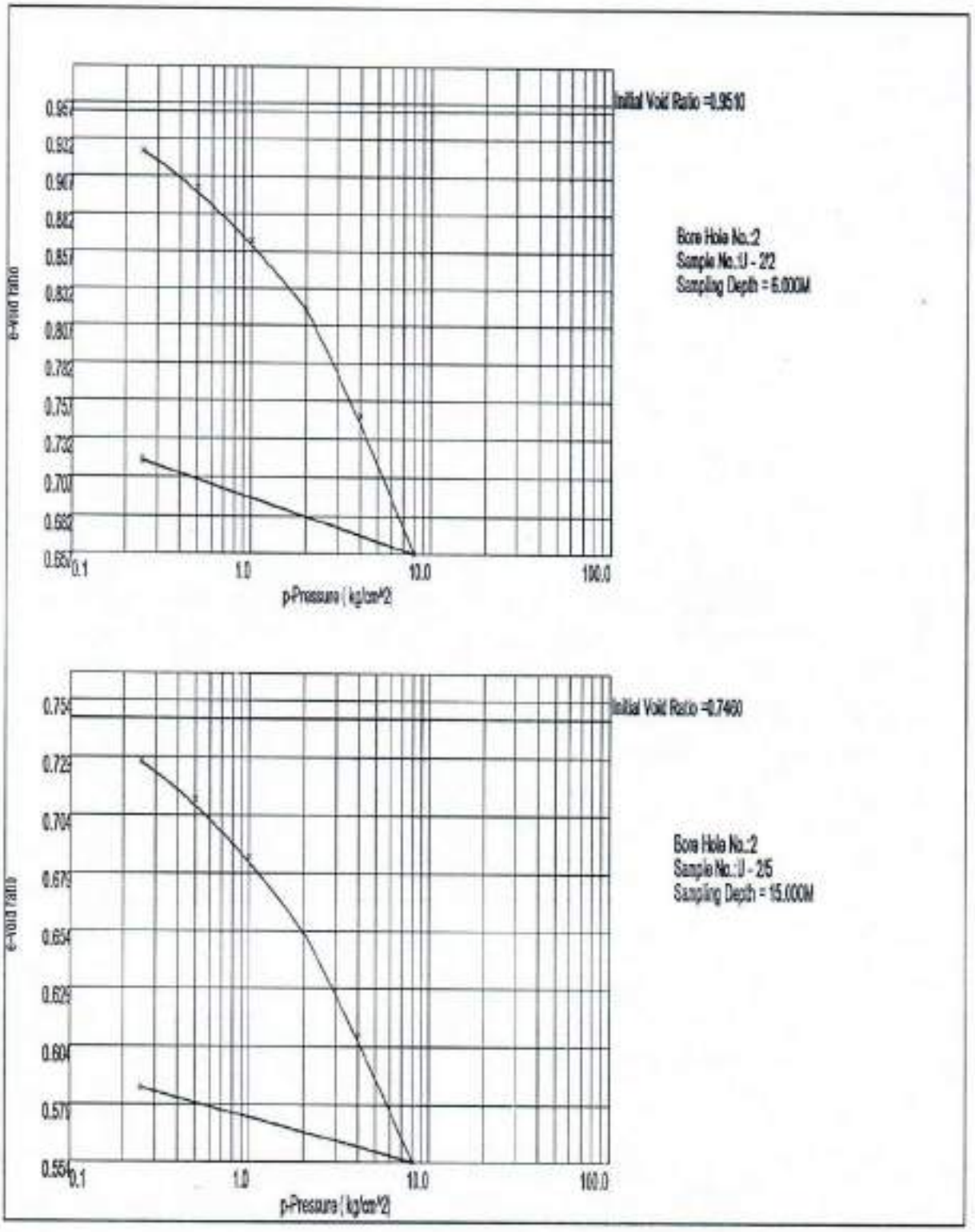

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6.b. *Chart for 'm_v' Values*

Site: Mouza- Purba Barisha, P.S- Thakurpukur, Dist.-24 Pgs.(S).

TABLE – 3

Chart for 'm_v' Values

Stratum	Sample No.	Depth in metre below E.G.L.	'm_v' (cm^2 / kg) Pressure Range in kg / cm^2					
			0 - 1/4	1/4 - 1/2	1/2 - 1	1 - 2	2 - 4	4 - 8
II	U – 1/1	1.50 – 1.95	0.0507	0.0464	0.0327	0.0227	0.0147	0.100
II	U – 1/2	4.50 – 4.95	0.0498	0.0433	0.0314	0.0222	0.0146	0.0093
III	U – 1/5	13.50 – 13.95	0.0744	0.0660	0.0463	0.0317	0.0217	0.0149
IV	U – 1/7	19.50 – 19.95	0.0409	0.0341	0.0242	0.0168	0.0111	0.0069
V	U – 1/8	22.50 – 22.95	0.0393	0.0304	0.0231	0.0156	0.0101	0.0066
II	U – 2/1	3.00 – 3.45	0.0495	0.0430	0.0322	0.0220	0.0145	0.0094
III	U – 2/2	6.00 – 6.45	0.0553	0.0492	0.0369	0.0235	0.0181	0.0115
IV	U – 2/5	15.00 – 15.45	0.0405	0.0346	0.0266	0.0189	0.0126	0.0078

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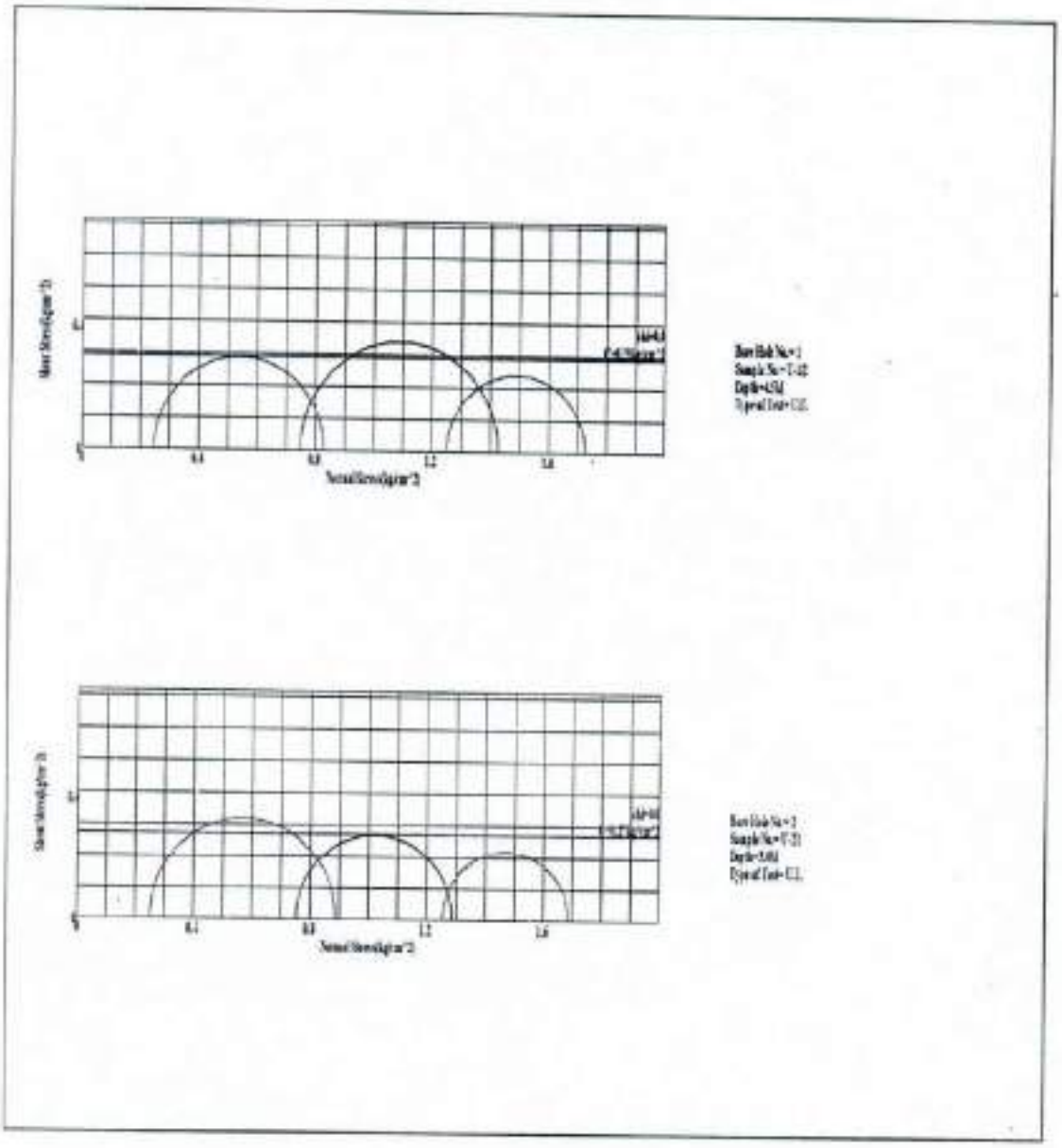
7. *Some Typical Mohr's Circles*

Project: Mouza- Purba Barisha, P.S.- Thakurpukur, Dist.-24 Pgs.(S).



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