

GEOTECHNICAL INVESTIGATION REPORT



SA CHAUDHURI & ASSOCIATES

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GEO TECHNICAL INVESTIGATION REPORT
OF

**PLAN FOR PROPOSED FIVE (G+4) STORIED
RESIDENTIAL APARTMENT OF ,
OWNER:- SRI. NABENDU GHOSH ,
OVER, R.S. PLOT NO:1987, L.R. PLOT NO.-4238,
J.L. NO - 119,KHATIAN NO.:-13343,
OF MOUZA - BHIRINGI, P.S.-DURGAPUR,
DIST. -PASCHIM BARDHAMAN,
UNDER D.M.C .HOLDING:-235/N/1 WARD NO:- 20,
ASSESSMENT NO: 3309403043901
STREET NAME: AUROBINDA PALLY,BHIRINGI DGP 13**

PREPARED BY:
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10/1S ANIL MOITRA ROAD, KOLKATA-700019



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CHAPTER - I

INTRODUCTION



OVER, R.S. PLOT NO:1987, L.R. PLOT NO.-4238,
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They took up a program for soil investigation work at the said premises in order to have an idea regarding allowable Bearing Capacity of the subsoil and the type of foundation which is expected to be suitable for the proposed structure.

M/S. SA CHAUDHURI & ASSOCIATES was awarded the contract for carrying out the subsoil investigation work. The job includes sinking of four nos. boreholes at predetermined positions, collecting of sufficient nos. of samples, testing of collected samples at Laboratory, submission of report, in duplicate, containing suggestion for suitable foundation system.

1.01 FIELD WORK

The fieldwork was started on 14/10/2014 and completed on 15/10/2014. The boring was advanced by a combination of Auger and Wash boring method as per IS 1892-1981 and standard penetration test (SPT) was conducted at suitable intervals, within the borehole, as per IS 2131-1981. Flush Jointed casings were used to prevent the caving of the sub-soil during boring work.

The undisturbed and disturbed samples were collected from suitable depths and were brought to the Laboratory for testing purpose. The water table was found to be at 1.50 m below the existing ground level (E.G.L.).



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1.02 FIELD INVESTIGATIONS

The programme of field work at the present site was consisted of the following :-

- I. Sinking of boreholes (2 Nos.)
- II. Collection of undisturbed soil sample from suitable depth below G.L.
- III. Conduction of standard penetration test at suitable depths below G.L.
- IV. Collection of disturbed soil samples.

1.03 TECHNIQUES OF BORING

Bentonite mud drilling technique developed by the Central Building Research Institute was adopted in this case.

Boring was done with soil cutter by direct and circulation throughout the borehole, the 5% bentonite slurry, ejecting out of the cutter, brought the cut materials to the surface. The bentonite slurry, by virtue of its density and thixotropy stabilises the borehole and prevented sand blowing, soft soil blowing and sedimentation. Thus the natural characteristic of the sub-soil strata was not disturbed and the firm base of the borehole could be reached for undisturbed soil sampling and conduction of standard penetration tests.

1.04 COLLECTION OF UNDISTURBED SAMPLES

Undisturbed soil samples were collected as per specification given is I S: 2131. After recovery of the samples, the sample tubes were properly sealed at both ends, marked and sent for laboratory testing

1.05 STANDARD PENETRATION TESTS

Standard penetration test were conducted at each borehole at suitable intervals of depth in between levels from which undisturbed samples were taken in the cohesive strata. S.P.T. was also conducted within the sandy strata. The tests were done with the standard split spoon sampler as per IS: 2131. The N-Values were obtained by counting the number of blows required to drive the spoon from 15 cm. to 45 cm.

1.06 COLLECTION OF DISTURBED SAMPLES

Disturbed samples are collected manually from the Auger and from Split Spoon Sampler. These samples are taken in polythene bags, sealed properly to make it water tight and sent to Laboratory. These samples are used for Grain Size analysis, Atterburg tests etc. These are also enable to locate the change of layers,



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CHAPTER – II

LABORATORY INVESTIGATIONS



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2.0 LABORATORY TEST

The programme of the laboratory testing was consisted of the followings :

- i. Determination of natural moisture contents (N.M.C);
- ii. Mechanical analysis;
- iii. Grain size distribution ;
- iv. Determination of Atterburg limits(Liquid Limit and plastic limit);
- v. Tri-axial tests;
- vi. Consolidation tests;

2.01 NATURAL MOISTURE CONTENT

It is the ratio of the weight of water to the dry weight of soil determined by oven drying.

2.02 BULK DENSITY

It is the weight of the undisturbed samples for unit volume determined by taking the weight and volume of the specimen.

2.03 GRAIN SIZE DISTRIBUTION

By this test, the percentage of sand, silt and clay constituting the soil are determine based on stoke's law, by virtue of velocity of falling particles. Known weight of soil is dispersed in known volume of water and the purpose is served by pipetting out the mixture after required intervals and oven drying

2.04 ATTERBURG LIMITS

These are arbitrary moisture contents to determine the instant at which the soil is on the verge of being viscous liquid, liquid limit or non-plastic (Plastic) limit. Liquid limit is determined with the help of a liquid limit apparatus, Plastic limit is the water content at which the soil begins to crumble when rolled out into a thin thread of 3 mm diameter.

2.05 TRI-AXIAL TEST

These tests were conducted on the clay/clayey silt samples to determine their shear strengths. The samples were tested under quick condition at the rate of 1.25 mm min. and were loaded upto maximum of 20% axial strain. The cell pressure employed during the tests were 1.0 kg/cm² and 1.5 kg/cm².

2.06 CONSOLIDATION TEST

This test is necessary to estimate the settlement characteristics of cohesive soils. In the consolidometer ring (6.25 cm dia.) a 2 cm high sample is taken with porous stones on top and bottom. After saturation, a compressive load is applied and maintained for 24 hours. The compression of the sample is measured at regular intervals by a dial gauge. Thus load increment is made and the procedure is repeated. From the results obtained, e-log_p curve is drawn to estimate the compression index (c_c).



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CHAPTER – III

SUB-SOIL PROFILE



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3.0 SUBSOIL PROFILE AND PROPERTIES

Two nos. boreholes, one upto 20.0 m and rest one upto 10.0 m, below ground level were made in pre-determined positions to assess the subsoil profile and the engineering properties of soil to determine the foundation system for the proposed structure.

Depending on colour, constituents, consistency etc. revealed from two nos. boreholes, the total subsoil profile is found to be made with a single deposit of fine to medium sand with a small surface filling at top. The subsoil profile thus obtained is shown in 'Borehole logs'.

To assess the characters of each layer elaborately, brief description of each stratum is given below:-

3.01 CLASSIFICATION OF STRATA

STRATUM I

A layer which varies from 0.10m To 3.00 average from E.G.L. as per the longitudinal aspects of the site. This layer consists of /yellowish black clayey silt with sand/ mica particles suitable for any type of moderate foundation. The subsoil parameters are generalized and given below:

Field 'N' value :	3-6
Bulk Density	1.50 to 1.75
Dry density	1.09 to 1.58
Natural moisture content	15%- 18%
Liquid limit	18%
Plastic limit	12-13
Untrained cohesion Cc	5.00-5.25 n/mm ²
Specific gravity	2.56-2.625
Initial void ratio e ₀	0.625
Sand	18
Silt	35
clay	47

STRATUM II

THIS strata consists of yellowish gray silty clay with sand and mica with dense strata whose densification increases with the increment of depth of the said stratum.

The 'N' values are ranging from 25 to 35 showing its consistency for keeping the load intensity of the proposed structure. Extension of the stratum goes up to 6.00M.

The subsoil parameters are generalized and given below:

Field 'N' value :	5-18
Bulk Density	1.60/1.75
Dry density	1.29-1.42
Natural moisture content	15%
Liquid limit	18%
Plastic limit	12-14
Untrained cohesion Cc	5.60-6.25 n/mm ²
Specific gravity	2.584
Initial void ratio e ₀	1.452
Sand	23



Silt	41
clay	36

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CHAPTER – IV

FOUNDATIONS & BEARING CAPACITY



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4.0 DISCUSSIONS ON FOUNDATION

The structure for which the subsoil exploration was conducted is a proposed multistoried building. So the loads coming on foundations may be moderate to high, though it largely depends on column grids.

From the exploratory borings, field tests and after rigorous study of laboratory test results, it is found that the topmost layer of 1.0 m thickness is a filled up one with heterogeneous materials. The single stratum of the profile is of reddish grey fine to medium sand, found upto 20.0 m from existing G. L.

Depth of standing water level is found at 4.0 m the below the existing ground level.

Considering all the above factors and also keeping in mind the economic point of view, it is suggested that shallow foundation in different form may be provided for the structure in discussion.

The depth of foundation is considered as 1.50 m below G. L.

The Net Allowable Bearing Capacity for different shape and size of shallow footings are calculated and some sample calculation is shown in following pages.



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4.01 CALCULATIONS

BEARING CAPACITY OF SOIL FOR ISOLATED SQUARE FOUNDATION

The Ultimate Bearing Capacity of soil as our case is, can be obtained by using the following relation:-

$$Q_{ult} = C N_c S_c d_c i_c$$

Where C= Cohesion

N_c = Bearing Capacity Factor

S_c = Shape factor -1.30 for isolated square

d_c = Depth factor

i_c = Inclination Factor = 1.0 for vertical loadings

3.0M x 3.0M FOOTING

$$Q_{ult} = 4.95 \times 5.14 \times 1.175 \times 1.30 \times 1.0 = 38.86 \text{ t/m}^2$$

Using a factor of safety of 3.00 the Safe Net Bearing Capacity is given by

$$Q_{safe} = 12.95 \text{ T/m}^2$$

2.0M x 2.0M FOOTING

$$Q_u = 4.95 \times 5.14 \times 1.30 \times 1.2625 \times 1.30 \times 1.0 = 41.75 \text{ t/m}^2$$

Using a factor of safety of 3.00 the Safe Net Bearing Capacity is given by

$$Q_{safe} = 13.91 \text{ T/M}^2$$

1.50mx1.50m FOOTING

$$Q_{ult} = 4.95 \times 5.14 \times 1.35 \times 1.30 \times 1.0 = 44.65 \text{ T/M}^2$$

Using a factor of safety of 3.00, the Safe Net Bearing Capacity is given by

$$Q_{safe} = 14.88 \text{ T/m}^2$$

STRIP FOOTING

3.00M WIDE FOOTING

$$Q_u = 5.50 \times 5.14 \times 1.75 \times 1.0 = 29.89 \text{ t/m}^2$$

Using a factor of safety of 2.5 the Safe Net Bearing Capacity is given by

$$Q_{safe} = 11.96 \text{ T/m}^2$$

2.00M WIDE FOOTING

$$Q_u = 5.50 \times 5.14 \times 1.2625 \times 1.0 = 32.12 \text{ t/m}^2$$

Using a factor of safety of 2.5 the Safe Net Bearing Capacity is given by

$$Q_{safe} = 12.84 \text{ T/m}^2$$

FOR RAFT FOUNDATION:

$$Q_u = 5.50 \times 5.14 \times 1.3 = 33.07 \text{ t/m}^2$$

Using factor of safety 2.50 the net bearing capacity

$$Q_u = 13.23 \text{ t/M}^2$$



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SETTLEMENTS FOR FOUNDATIONS

Now we will justify the safe bearing of soil in respect of serviceability aspect. There are two types of settlements i) Immediate settlement, which occurs without time lag after loading on foundation. ii) Consolidation Settlement, which is a time dependent settlement and happens over a long period mainly dominant in case of cohesive soils.

Immediate Settlement

The Immediate Settlement is given by

$$S_i = [q B (1 - u)^2 / E_u] \times I_f$$

Where q = Stress of soil

B = Breadth of footing

u = Poisson 's coefficient = .50

E = Young's Modulus = 1500

I_f = Influence factor

3.0M x 3.0M FOOTING

$$S_i = 15.54 \times 3.00 \times 0.75 / 1400 \times 0.82 = 24.95 \text{ MM}$$

$$P = 15.54 \times 3.0 \times 3.0 / 5.25 \times 5.25 = 5.07 \text{ T/m}^2$$

$$S_c = 0.0027 \times 5.07 \times 4.50 = 61.65$$

$$\text{Total Settlement} = 86.65 \text{ mm}$$

2.00x2.00m FOOTING

$$S_i = 16.10 \times 2.00 \times 0.75 / 1400 \times 0.82 = 1414 \text{ MM}$$

$$P = 16.10 \times 2.0 \times 2.0 / 3.50 \times 3.50 = 5.25 \text{ T/m}^2$$

$$S_c = 0.0027 \times 5.25 \times 3.50 = 49.68$$

$$\text{Total Settlement} = 63.82 \text{ mm}$$

3.0M wide FOOTING

IMMEDIATE SETTLEMENT

$$S_i = 9.67 \times 2 \times 0.75 / 1400 \times 1.70 = 8.80 \text{ MM}$$

CONSOLIDATION SETTLEMENT

$$S_c = 0.0027 \times 3.16 \times 4.0 = 34.18 \text{ mm}$$

$$\text{Total settlement} = 8.80 + 34.18 \text{ MM}$$

2.0M WIDE FOOTING

IMMEDIATE SETTLEMENT

$$S_i = 10.40 \times 3.0 \times 0.75 / 1400 \times 0.82 = 8.90 \text{ mm}$$

CONSOLIDATION SETTLEMENT

$$S_{ii} = 0.0027 \times 3.37 \times 6.25 = 56.00 \text{ mm}$$

$$\text{Total settlement} = 8.90 + 56 = 64.56 \text{ mm} < 75 \text{ mm}$$



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BEARING CAPACITY TABLE

TYPE OF FOOTING	SIZE OF FOOTING [M]	NET ALLOWABLE BEARING CAPACITY OF SOIL [T/M ²]	ESTIMATED SETTLEMENT [MM]
ISOLATED	1.50X1.50	14.75	22
SQUARE	2.00X2.00	14.00	37
	3.00X3.00	12.90	40
STRIP	1.50M WIDE	13.20	45
FOUNDATION	2.00M WIDE	12.50	53
	3.00M WIDE	11.50	65
RAFT FOUNDATION	15 .00M WIDE	11.00	68

NOTE: Net permissible settlement of the foundation:75mm

- 1) Any loose or filled up soil found at foundation bed must be lifted out and replaced by properly compacted sand cushion of 300mm.
- 2) Construction in stages is advisable.
- 3) Overstressing of soil due to closely spaced footings or vicinity of adjacent structures is not considered in this Report.
- 4) In case of any query arising out of this Report one may feel free to the undersigned.

CONSULTING GEOTECHNICAL ENGINEER

Suvankar Chaudhuri

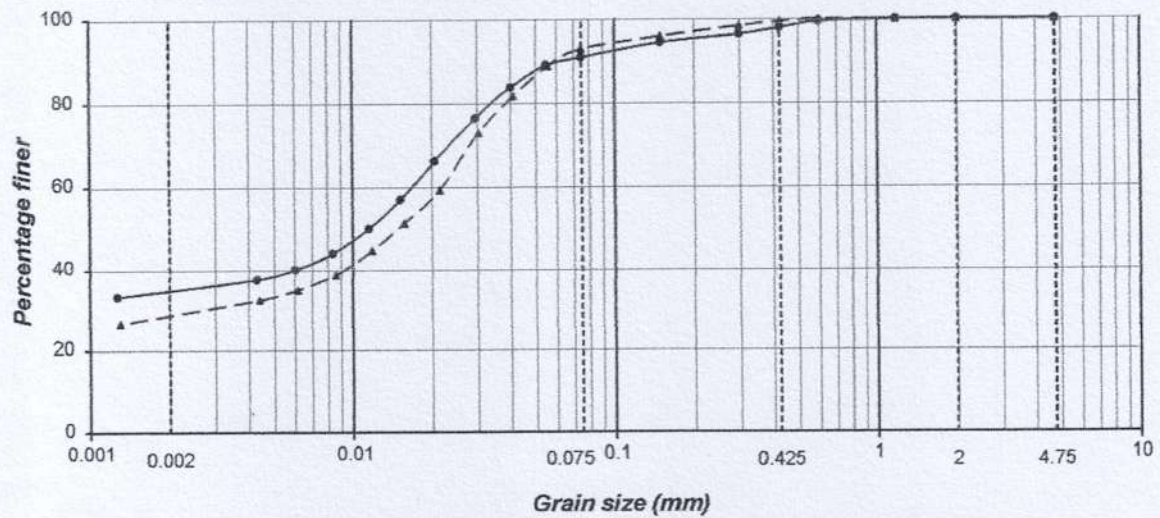
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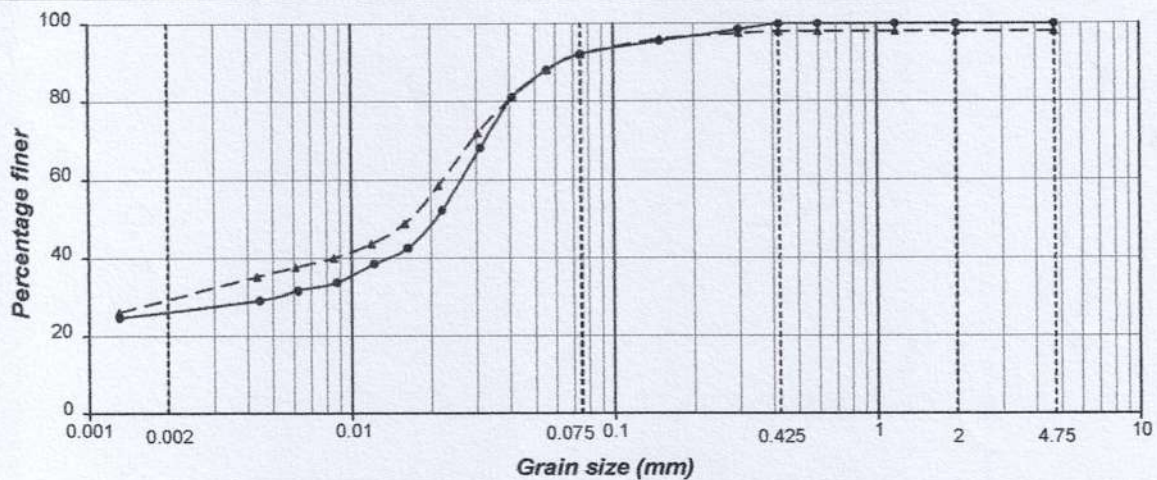


Grain Size Distribution Curves



Sample No.	Clay (%)	Silt (%)	Fine sand (%)	Medium sand (%)	Coarse sand (%)	Gravel (%)
BH-01:4.5m	35.0	56.0	7.0	2.0	0.0	0.0
BH-01:7.5m	29.0	63.0	7.0	1.0	0.0	0.0

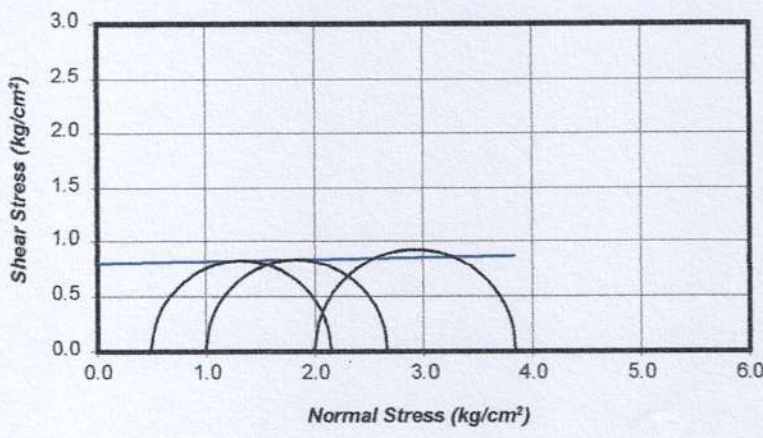
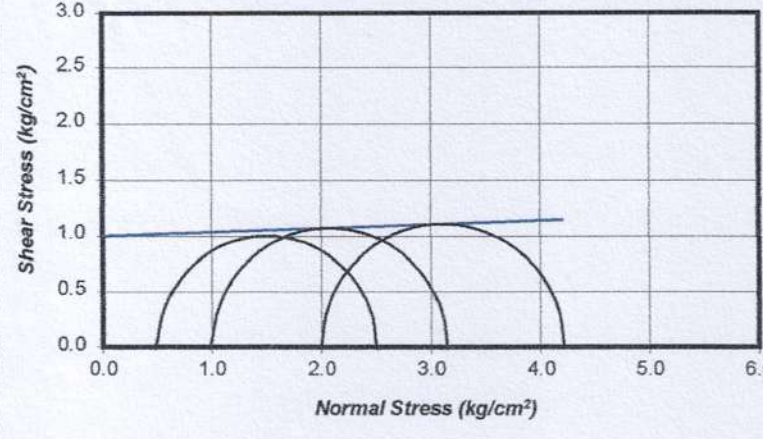
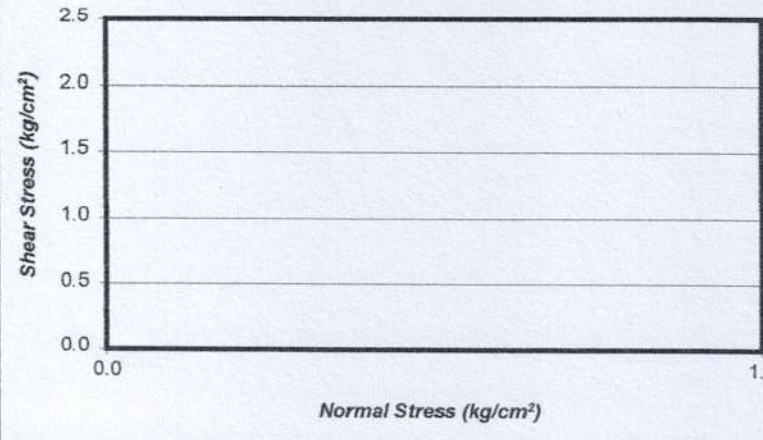
*Silt & Clay



Sample No.	Clay (%)	Silt (%)	Fine sand (%)	Medium sand (%)	Coarse sand (%)	Gravel (%)
BH-02:4.5m	26.0	66.0	8.0	0.0	0.0	0.0
BH-02:7.5m	30.0	62.0	6.0	0.0	0.0	2.0

*Silt & Clay



Mohr-Diagram 	Location : Paschim Bardhaman BH No.: BH-01 Depth: 4.50 m Test Type: UU c : 0.80 kg/sq. cm ϕ : 1 degree
Mohr-Diagram 	Location : Paschim Bardhaman BH No.: BH-02 Depth: 4.50 m Test Type: UU c : 1.00 kg/sq. cm ϕ : 2 degree
Mohr-Diagram 	Location : Paschim Bardhaman BH No.: Depth: Test Type: c : ϕ :

