

## GEO-TECHNICAL INVESTIGATION AND SOIL EXPLORATION

TEST – REPORT ON SUB-SOIL INVESTIGATION AT THE  
PROPOSED SITE FOR CONSTRUCTION OF RESIDENTIAL  
AND NON-RESIDENTIAL BUILDINGS OF 05TH VAHINI OF  
U.P. SPECIAL SECURITY FORCES AT SAHARANPUR (U.P.)



*FIELD AND LABORATORY TEST WORK CONDUCTED BY :*

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**-: HOUSE FOR :-**

### **Soil / Material Testing, Geological Investigation, Quality Control & Survey of sites**

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### **ACKNOWLEDGEMENT**

*We are grateful to the Director M/s Mother's Pride Infrastructures Pvt. Ltd. Near Haniman Chauraha Gomti Nagar Lucknow providing an opportunity to carry out soil investigation work for proposed Construction of Residential and Non-Residential Buildings Of 05Th Vahini Of U.P. Special Security Forces at District- Saharanpur (U.P.)*

**ABC CONSULTANTS**

**(Soil Investigations and Laboratory Works)**



**Authorized Signatory**

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## **1.0 INTRODUCTION :**

1.1 This report cover the results of field and Laboratory test conducted at the proposed site for Construction of Residential and Non-Residential Buildings Of 05Th Vahini Of U.P. Special Security Forces at District- Saharanpur (U.P.) These Investigations have been made to find out the allowable pressure of the soil required for the safe and economical design and execution of engineering works. The work of soil investigation was entrusted to **ABC CONSULTANTS, Administrative Office:- C-1074/75, SECTOR – B. MAHANAGAR, LUCKNOW**

1.2 It was decided by the concerned to conduct boring at five point. Bore holes no.1, 2, 3, 4 & 5 each up to depth of 40. 0 meter at the points marked by them at the site. Accordingly, the boring was conducted in accordance to I.S:1892–2020. Disturbed & undisturbed soil samples were collected along with conducting the standard penetration test at an interval of 1.5 meter. Or change of strata which ever met earlier starting from boring points to the termination of bore holes.

### **2.1.1 UNDISTURBED SOIL SAMPLES:**

These samples have been collected by the oven dry sampler. After recovery of soil samples from the bore holes the ends of the tube have been cleaned waxed and marked properly. The depth of undisturbed soil samples have been indicated on the bore log chart as well on the Laboratory test result sheet attached. The soil samples have been collected as per I.S. 1892 – 1979.

### **2.1.2 DISTURBED SOIL SAMPLES:**

The depth of the disturbed soil samples have been indicated on the bore log chart as well as on the Laboratory test result and were collected in polythene bags & properly leveled.

### **2.2 STANDARD PENETRATION TEST:**

The Standard Penetration Test has been conducted in the bore log charts at the intervals of 1.5 meter as per latest IS: 2131-1981 i.e. "Method for standard penetration test for soils".

In this depth Standard split spoon sampler is driven in to the soil are required depth, with the help of drive weight of 63.5 kg falling freely under gravity through a vertical height of 75cm. The number of blows for every 15 cms is recorded. The number of below for the first 15 cm. is neglected due to local disturbance and as a seating drive. The number of blows next 30 cm. are recorded as penetration blows 'N' of the soil at the depth. The result of the standard penetration test have been indicated on the laboratory test results sheet as well as on the bore log chart.

### 3.0 **LABORATORY WORK**

#### 3.1 **UNDISTURBED SOIL SAMPLES:**

The Undisturbed soils collected from the boreholes have been tested for the following to determine the engineering properties of soil as per requirement.

- a) Sieve Analysis (I.S. Code 2720 (Part IV)-2007
- b) Atterberg's Limit (Via Liquid and Plastic Limit & Plasticity Index)  
(I.S. Code 2720 (Part V)-2007
- c) Particle size analysis (I.S. Code 2720 (Part IV)-2007
- d) Bulk and Dry Density (I.S. Code 2720 (Part XXIX)-2007
- e) Natural Moisture Content (I.S. Code 2720 (Part II)-2010
- f) Shear Parameters  $C$  &  $\Phi$  (I.S. Code 2720 (Part XII & XIII)-2007
- g) Consolidation Test (For determination of  $C_c$  values of clayey soil samples)  
(I.S. Code 2720 (Part XV)-2007
- h) Specific Gravity (I.S. Code 2720 (Part III)-2007

#### 3.2 **DISTURBED SOIL SAMPLES :**

The disturbed soil samples have been tested for the following parameters.

- a) Sieve Analysis (I.S. Code 2720 (Part IV)-2007
- b) Atterberg's Limits (I.S. Code 2720 (Part IV)-2007

The entire Laboratory has been carried out as per relevant I.S. code & has been tabulated.

### 4.0 **SOIL CLASSIFICATION:**

Soil classification has been done with the help of the soil properties obtained by laboratory test as per I.S. 1498 "Methods of classification and identification of soil for general engineering purposes".

#### 5.0 **GENERAL NATURE OF SOIL STRATA:**

The general nature of the soil strata met during boring in each of borehole No. 1, 2, 3, 4 & 5 are indicated on the bore log charts as well as on the laboratory test results sheet. The entire soil strata are comprised of 'CI' silty clay of medium plasticity, 'CL' silty clay of low plasticity, 'ML' sandy silt, 'SM' silty sand and 'SM/SP' poorly graded silty sand.

#### **STANDARD PENETRATION TEST:**

The 'N' values (or SPT values recorded ) during penetration test in the strata in all the bore holes No. 1, 2, 3, 4 & 5 were found vary from 7 to 42 indicate the consistency of the soil as medium.

#### 6.0 **WATER TABLE:**

The depth of water table was met up to 14.0 m depth during boring operation in all bore holes at the time of soil exploration in the month of since February 2024. Water is expected 1.00 m rise in post monsoon period. Accordingly, water table is assuming 13.0 m for calculation purpose.

#### 7.0 **INTERPRETATION OF THE TEST RESULTS:.**

7.1 The choice of the type of foundation depends upon the safe bearing capacity, design and layout of super structure, relative economics of various alternatives and practical consideration. In case of strip footing the safe bearing capacity / allowable bearing pressure, calculation is governed by IS: 6403-1981, for shear consideration & IS: 1904-1986 & IS: 8009 (Part-I)-1976, for consideration of settlement.

#### 7.2 **SHEAR CONSIDERATION :**

The modified bearing capacity formula are as below considering the shape of footing, inclination of loading, depth of embedment and effect of water table.

$$Q_s = 1/F [C.N_c.Sc.dc.ic. + q(N_q-1)S_q.dq.iq. + 0.50 \gamma B.N_\gamma.s_\gamma.d_\gamma.i_\gamma.w']$$

Where:

$Q_s$	= Bearing capacity on shear consideration in Kg/cm <sup>2</sup>
$F$	= Factor of safety
$\gamma$	= Unit weight of soil
$C$	= Cohesion in Kg/cm <sup>2</sup>
$q$	= effective overburden pressure Kg/cm <sup>2</sup>
$B$	= Width of footing
$w'$	= Correction factor for position of water table.
$N_c.N_q.N_\gamma$	= Non dimensional bearing capacity factors depends upon angle of internal friction $\phi$ and void ratio $e$
$S_c.S_q.S_\gamma$	= Shape factors
$d_c.d_q.d_\gamma$	= Depth factors
$i_c.i_q.i_\gamma$	= Inclination factors

### 7.3 SETTLEMENT CONSOLIDATION : (For Plastic soil)

The settlement in the plastic soil indicating some cohesion is given by the formula:

$$S = \frac{C_c}{1 + e_o} \times H \times \log_{10} \frac{P_o + \Delta P}{P_o}$$

Where:

$C_c$	=	Compression Index
$H$	=	Thickness of Plastic layer
$P_o$	=	Original Pressure at mid depth of Plastic layer



$\Delta P$  = Change in Pressure at mid depth of Plastic layer

$e_o$  = Void ratio for pressure  $P_o$

#### 7.4 **SETTLEMENT CONSIDERATION:** (For non Plastic soils)

The allowable bearing pressure is also to be so restricted that the anticipated settlements do not exceed the permissible settlement as specified in IS: 1904-1986, for a particular type of structure and nature of soil.

#### 8.0 **COMPUTATION OF BEARING CAPACITY:**

##### 8.1 **BEARING CAPACITY FROM SHEAR CRITERIA:**

Bearing capacity calculations were carried out for Isolated / R.C.C. Raft Foundation at depth 1.00m, 1.50m, 2.00m & 3.00m below ground level with width of foundation 1.00m, 1.50m, 2.00m & (10.0x10.0) m. However governing values of bearing capacity were found the calculations for the same are produced below:

##### 8.1.1 **Bearing capacity Calculation:**

Governing soil parameters are from bore hole no. 01

1. Angle of internal friction  $\phi$  =  $7^\circ$
2. Cohesion  $C$  =  $0.33 \text{ Kg/cm}^2$
3. Unit weight of soil  $\gamma$  =  $1.76 \text{ gm/cc}$
4. Submerged density of soil  $\gamma$  = -
5. Specific Gravity = 2.72
6. Dry Density =  $1.60 \text{ gm/cc}$
7. Void ratio  $e_o$  = 0.70
8. Condition = Medium (Interpolation)
9. Bearing Capacity Factor

Shear Parameters	Nc	Nq	Nr
General Shear failure $e_o \leq 0.55$	7.230	1.930	0.760
Local Shear failure $> 0.75$	6.400	1.533	0.420
Interpolated value for $e_o = 0.70$	6.608	1.632	0.505

10. Water Table correction Factor  $w'$  = 1.0
11. Overburden pressure  $q$  at depth 1.00 m =  $0.176 \text{ Kg/cm}^2$



12. Type of foundation = Isolated Foundation
13. Depth of foundation  $d_f$  = 1.00 m
14. Width of footing = 1.00 m
15. Shape factors

$$S_c = 1.30 \quad S_q = 1.20, \quad S_\gamma = 0.80$$

16. Inclination factors

$$i_c = 1.0, \quad i_q = 1.0, \quad i_\gamma = 1.0$$

17. Depth Factors

$$d_c = 1.226 \quad d_q \text{ \& } d_\gamma = 1.0$$

18. Factor of safety  $f = 3.0$

**Bearing Capacity: -**

$$\begin{aligned} Q_c &= 1/3 [0.2472 \times 6.608 \times 1.226 \times 1.30 \times 1.0 + 0.176 \times (1.632 - 1.0) \times 1.20 \times 1.0 + 0.5 \\ &\quad \times 1.76 \times 1.00 \times 0.505 \times 0.80 \times 1.0 \times 1.0 / 10.0] \\ &= 1/3 [2.603 + 0.133 + 0.036] \text{ Kg/cm}^2 \\ &= 0.924 \text{ Kg/cm}^2 \end{aligned}$$

**8.1.2 Bearing capacity Calculation:**

Governing soil parameter are from bore hole no. 01

1. Angle of internal friction  $\phi = 3^\circ$
2. Cohesion  $C = 0.33 \text{ Kg/cm}^2$
3. Unit weight of soil  $\gamma = 1.76 \text{ gm/cc}$
4. Submerged density of soil  $\gamma = -$
5. Specific Gravity = 2.72
6. Dry Density = 1.60 gm/cc
7. Void ratio  $e_o = 0.70$
8. Condition = Medium (Interpolation)
9. Bearing Capacity Factor

Shear Parameters	Nc	Nq	Nr
General Shear failure $e_0 \leq 0.55$	7.230	1.930	0.760
Local Shear failure $> 0.75$	6.400	1.533	0.420
Interpolated value for $e_0 = 0.70$	6.608	1.632	0.505

10. Water Table correction Factor  $w'$  = 1.0
11. Overburden pressure  $q$  at depth 1.50 m = 0.264 Kg/cm<sup>2</sup>
12. Type of foundation = Isolated Foundation
13. Depth of foundation  $d_f$  = 1.50 m
14. Width of footing = 1.50 m
15. Shape factors  
 $S_c = 1.30$     $S_q = 1.20$ ,    $S_\gamma = 0.80$
16. Inclination factors  
 $i_c = 1.0$ ,    $i_q = 1.0$ ,    $i_\gamma = 1.0$
17. Depth Factors  
 $d_c = 1.226$     $d_q \text{ \& } d_\gamma = 1.0$
18. Factor of safety  $f = 3.0$

**Bearing Capacity: -**

$$\begin{aligned}
 Q_c &= \frac{1}{3} [0.2472 \times 6.608 \times 1.226 \times 1.30 \times 1.0 + 0.264 \times (1.632 - 1.0) \times 1.20 \times 1.0 + 0.5 \\
 &\quad \times 1.76 \times 1.50 \times 0.505 \times 0.80 \times 1.0 \times 1.0 / 10.0] \\
 &= \frac{1}{3} [2.603 + 0.200 + 0.053] \text{ Kg/cm}^2 \\
 &= 0.952 \text{ Kg/cm}^2
 \end{aligned}$$

**8.1.3 Bearing capacity Calculation:**

Governing soil parameter are from bore hole no. 01

1. Angle of internal friction  $\phi$  = 9°
2. Cohesion  $C$  = 0.27 Kg/cm<sup>2</sup>
3. Unit weight of soil  $\gamma$  = 1.80 gm/cc
4. Submerged density of soil  $\gamma$  = -
5. Specific Gravity = 2.69
6. Dry Density = 1.61 gm/cc

7. Void ratio  $e_0$  = 0.67  
 8. Condition = Medium (Interpolation)  
 9. Bearing Capacity Factor

Shear Parameters	Nc	Nq	Nr
General Shear failure $e_0 \leq 0.55$	7.980	2.290	1.070
Local Shear failure $> 0.75$	6.870	1.750	0.607
Interpolated value for $e_0 = 0.67$	7.314	1.966	0.792

10. Water Table correction Factor  $w'$  = 1.00  
 11. Overburden pressure  $q$  at depth 2.00 m = 0.360 Kg/cm<sup>2</sup>  
 12. Type of foundation = Isolated Foundation  
 13. Depth of foundation  $d_f$  = 2.00 m  
 14. Width of footing = 2.00 m

15. Shape factors

$$S_c = 1.30 \quad S_q = 1.20, \quad S_\gamma = 0.80$$

16. Inclination factors

$$i_c = 1.0, \quad i_q = 1.0, \quad i_\gamma = 1.0$$

17. Depth Factors

$$d_c = 1.234 \quad d_q \text{ \& } d_\gamma = 1.0$$

18. Factor of safety  $f$  = 3.0

Bearing Capacity: -

$$\begin{aligned}
 Q_c &= \frac{1}{3} [0.2160 \times 7.314 \times 1.234 \times 1.30 \times 1.0 + 0.360 \times (1.966 - 1.0) \times 1.20 \times 1.0 + 0.5 \\
 &\quad \times 1.80 \times 2.00 \times 0.792 \times 0.80 \times 1.0 \times 1.0 / 10.0] \\
 &= \frac{1}{3} [2.534 + 0.417 + 0.114] \text{ Kg/cm}^2 \\
 &= 1.022 \text{ Kg/cm}^2
 \end{aligned}$$

#### 8.1.4 Bearing capacity Calculation:

Governing soil parameter are from bore hole no. 01

1. Angle of internal friction  $\phi$  = 9°  
 2. Cohesion  $C$  = 0.27 Kg/cm<sup>2</sup>  
 3. Unit weight of soil  $\gamma$  = 1.80 gm/cc

4. Submerged density of soil  $\gamma$  = -
5. Specific Gravity = 2.69
6. Dry Density = 1.61 gm/cc
7. Void ratio  $e_0$  = 0.67
8. Condition = Medium (Interpolation)
9. Bearing Capacity Factor

Shear Parameters	Nc	Nq	Nr
General Shear failure $e_0 \leq 0.55$	7.980	2.290	1.070
Local Shear failure $> 0.75$	6.870	1.750	0.607
Interpolated value for $e_0 = 0.67$	7.314	1.966	0.792

10. Water Table correction Factor  $w'$  = 1.00
11. Overburden pressure  $q$  at depth 3.00 m = 0.540 Kg/cm<sup>2</sup>
12. Type of foundation = Isolated Foundation
13. Depth of foundation  $d_f$  = 3.00 m
14. Width of footing = 2.00 m
15. Shape factors

$$S_c = 1.30 \quad S_q = 1.20, \quad S_\gamma = 0.80$$

16. Inclination factors

$$i_c = 1.0, \quad i_q = 1.0, \quad i_\gamma = 1.0$$

17. Depth Factors

$$d_c = 1.351 \quad d_q \text{ \& } d_\gamma = 1.0$$

18. Factor of safety  $f$  = 3.0

Bearing Capacity: -

$$\begin{aligned}
 Q_c &= 1/3 [0.2160 \times 7.314 \times 1.351 \times 1.30 \times 1.0 + 0.540 \times (1.966 - 1.0) \times 1.20 \times 1.0 + 0.5 \\
 &\quad \times 1.80 \times 2.00 \times 0.792 \times 0.80 \times 1.0 \times 1.0 / 10.0] \\
 &= 1/3 [2.775 + 0.626 + 0.114] \text{ Kg/cm}^2 \\
 &= 1.172 \text{ Kg/cm}^2
 \end{aligned}$$

### 8.1.5 Bearing capacity Calculation:

Governing soil parameter are from bore hole no. 01

1. Angle of internal friction  $\phi$  =  $7^\circ$
2. Cohesion C =  $0.27 \text{ Kg/cm}^2$
3. Unit weight of soil  $\gamma$  =  $1.80 \text{ gm/cc}$
4. Submerged density of soil  $\gamma$  = -
5. Specific Gravity = 2.69
6. Dry Density =  $1.61 \text{ gm/cc}$
7. Void ratio  $e_0$  = 0.67
8. Condition = Medium (Interpolation)
9. Bearing Capacity Factor

Shear Parameters	Nc	Nq	Nr
General Shear failure $e_0 \leq 0.55$	7.980	2.290	1.070
Local Shear failure $> 0.75$	6.870	1.750	0.607
Interpolated value for $e_0 = 0.67$	7.314	1.966	0.792

10. Water Table correction Factor  $w'$  = 1.0
11. Overburden pressure  $q$  at depth 2.00 m =  $0.360 \text{ Kg/cm}^2$
12. Type of foundation = R.C.C. Raft Foundation
13. Depth of foundation  $d_f$  = 2.00 m
14. Width of footing = (10.0x10.0) m

15. Shape factors

$$S_c = 1.20 \quad S_q = 1.20, \quad S_\gamma = 0.60$$

16. Inclination factors

$$i_c = 1.0, \quad i_q = 1.0, \quad i_\gamma = 1.0$$

17. Depth Factors

$$d_c = 1.046 \quad d_q \text{ \& } d_\gamma = 1.0$$

18. Factor of safety  $f$  = 3.0

**Bearing Capacity: -**

$$\begin{aligned}
 Q_c &= 1/3 [0.2160 \times 7.314 \times 1.046 \times 1.20 \times 1.0 + 0.360 \times (1.966 - 1.0) \times 1.20 \times 1.0 + 0.5 \\
 &\quad \times 1.80 \times 10.0 \times 0.792 \times 0.60 \times 1.0 \times 1.0 / 10.0] \\
 &= 1/3 [1.983 + 0.417 + 0.428] \text{ Kg/cm}^2 \\
 &= 0.943 \text{ Kg/cm}^2
 \end{aligned}$$

### 8.1.6 Bearing capacity Calculation:

Governing soil parameter are from bore hole no. 01

1. Angle of internal friction  $\phi$  =  $7^\circ$
2. Cohesion C =  $0.27 \text{ Kg/cm}^2$
3. Unit weight of soil  $\gamma$  =  $1.80 \text{ gm/cc}$
4. Submerged density of soil  $\gamma$  = -
5. Specific Gravity =  $2.69$
6. Dry Density =  $1.61 \text{ gm/cc}$
7. Void ratio  $e_0$  =  $0.67$
8. Condition = Medium (Interpolation)
9. Bearing Capacity Factor

Shear Parameters	Nc	Nq	Nr
General Shear failure $e_0 \leq 0.55$	7.980	2.290	1.070
Local Shear failure $> 0.75$	6.870	1.750	0.607
Interpolated value for $e_0 = 0.67$	7.314	1.966	0.792

10. Water Table correction Factor  $w'$  =  $1.0$
11. Overburden pressure  $q$  at depth  $3.00 \text{ m}$  =  $0.540 \text{ Kg/cm}^2$
12. Type of foundation = R.C.C. Raft Foundation
13. Depth of foundation  $d_f$  =  $3.00 \text{ m}$
14. Width of footing =  $(10.0 \times 10.0) \text{ m}$
15. Shape factors
 
$$S_c = 1.20 \quad S_q = 1.20, \quad S_\gamma = 0.60$$
16. Inclination factors
 
$$i_c = 1.0, \quad i_q = 1.0, \quad i_\gamma = 1.0$$
17. Depth Factors

$$d_c = 1.070 \quad d_q \text{ \& } d_\gamma = 1.0$$

$$18. \quad \text{Factor of safety} \quad f = 3.0$$

**Bearing Capacity: -**

$$\begin{aligned} Q_c &= 1/3 [0.2160 \times 7.314 \times 1.070 \times 1.20 \times 1.0 + 0.540 \times (1.966 - 1.0) \times 1.20 \times 1.0 + 0.5 \\ &\quad \times 1.80 \times 10.0 \times 0.792 \times 0.60 \times 1.0 \times 1.0 / 10.0] \\ &= 1/3 [2.028 + 0.626 + 0.428] \text{ Kg/cm}^2 \\ &= 1.027 \text{ Kg/cm}^2 \end{aligned}$$

**8.2 BEARING CAPACITY FROM SETTLEMENT CRITERIA:**

**Estimation of Settlement: -**

Bearing Capacity from settlement consideration is the bearing pressure, which restricts the settlement within permissible limits. Bearing capacity as obtained from the previous section is tried first as the bearing pressure to compute the settlement of foundation. If settlement thus obtained is excessive, lower values of bearing pressures are tried. The settlement calculation shown below is corresponding to safe bearing pressure. The soil in the effective zone below footing level is non-cohesive soil hence the settlement for both layers has been computed accordingly.

**Settlement of Non - Cohesive soil**

Standard penetration resistance at different depths in the effective zone will determine the settlement of sandy strata. S.P.T. values of sandy strata in the effective zone have been corrected for overburden as per I.S. 2131 – 1981

The recorded and corrected S.P.T. values are given below.

Depth below ground level (meter)	Over burden (Kg/cm <sup>2</sup> )	correction factor	S.P.T. Value recorded	Lowest Corrected S.P.T. Value
			Bore hole-1	
3.35-3.80	0.684	1.121	9	10.08
4.85-5.30	0.943	1.020	11	11.22
6.35-6.80	1.202	0.932	13	12.11
7.85-8.30	1.464	0.879	15	13.18
9.35-9.80	1.756	0.820	18	14.76
10.85-11.30	2.053	0.770	21	16.17
12.35-12.80	2.317	0.739	23	16.99
13.85-14.30	2.585	0.702	25	17.55
15.35-15.80	2.742	0.684	24	16.41
16.85-17.30	2.901	0.660	26	17.16
18.35-18.80	3.060	0.640	27	17.28



The average and lowest corrected S.P.T. value is given below.

S.No.	Average Lowest corrected Value
1	10.65
2	14.56
3	14.81

Lowest average corrected S.P.T. Value have been taken used for analysis.

### **8.2.1 BEARING CAPACITY FROM SETTLEMENT FAILURE CRITERIA :**

#### **Settlement of Cohesive soil at 1.00 m Depth**

Description	Calculation
Thickness of compressible layer	1.50
Mid depth of clay layer	0.75
Pressure at foundation level	0.176
Po original pressure at mid depth	0.308
Net safe bearing capacity	0.924
Change pressure at foundation level	0.748
Influence factor	0.688
Change pressure at mid layer	0.515
$P_0 + \Delta P / P_0$	2.671
$\log P_0 + \Delta P / P_0$	0.426
Void ratio $e_0$	0.70
Compression Index $C_c$	0.147
Settlement	5.53
Settlement after applying rigidity factor	4.420

The settlement is less than permissible limit 5.0 cm as per I.S: 1904 - 1986.

Then safe Bearing capacity 9.24 t/m<sup>2</sup>.

### 8.2.2 BEARING CAPACITY FROM SETTLEMENT FAILURE CRITERIA :

#### Settlement of Cohesive soil at 1.50 m Depth

Description	Calculation
Thickness of compressible layer	2.25
Mid depth of clay layer	1.125
Pressure at foundation level	0.264
Po original pressure at mid depth	0.462
Net safe bearing capacity	0.952
Change pressure at foundation level	0.688
Influence factor	0.688
Change pressure at mid layer	0.474
$P_0 + \Delta P / P_0$	2.025
$\log P_0 + \Delta P / P_0$	0.306
Void ratio $e_0$	0.70
Compression Index $C_c$	0.147
Settlement	5.95
Settlement after applying rigidity factor	4.763

The settlement is less than permissible limit 5.0 cm as per I.S: 1904 - 1986.

Then safe Bearing capacity 9.52 t/m<sup>2</sup>.

### 8.2.3 Settlement of Non - Cohesive soil:

Settlement of a footing with width 'B' under unit intensity of pressure resting on cohesion less deposit with known standard penetration test values can be determine from I.S. 8009: 1981

The settlement of any other pressure is computed by assuming that the settlement is proportional to the intensity of pressure.

- (i) Thus, the settlement for unit pressure for the lowest corrected S.P.T. value and for 1.022 Kg/Sqcm<sup>2</sup>. as the allowable pressure for 2.00 m depth with isolated foundation of size 2.00 m is given below:

Type of Foundation	= Isolated foundation
Lowest corrected value	= 10.65
Settlement for unit pressure	= 3.760 cm.
Settlement for 1.022 Kg/sqcm <sup>2</sup>	= 3.842 cm.
Settlement after applying rigidity factor	= 3.074 cm.

The settlement is within permissible limit as per I.S: 1904 – 1986

Then safe Bearing capacity 10.22 t/m<sup>2</sup>.

- (ii) Thus, the settlement for unit pressure for the lowest corrected S.P.T. value and for 1.172 Kg/Sqcm<sup>2</sup>. as the allowable pressure for 3.00 m depth with isolated foundation of size 2.00 m is given below:

Type of Foundation	= Isolated foundation
Lowest corrected value	= 10.65
Settlement for unit pressure	= 3.760 cm.
Settlement for 1.172 Kg/sqcm <sup>2</sup>	= 4.406 cm.
Settlement after applying rigidity factor	= 3.525 cm.

The settlement is within permissible limit as per I.S: 1904 – 1986

Then safe Bearing capacity 11.72 t/m<sup>2</sup>.

- (iii) Thus, the settlement for unit pressure for the lowest corrected S.P.T. value and for  $0.943 \text{ Kg/Sqcm}^2$ . as the allowable pressure for 2.00 m depth with R.C.C. Raft foundation of size (10.0x10.0) m is given below:

Type of Foundation	= R.C.C. Raft foundation
Lowest corrected value	= 14.56
Settlement for unit pressure	= 2.428 cm.
Settlement for $0.943 \text{ Kg/sqcm}^2$	= 2.289 cm.
Settlement after applying rigidity factor	= 1.831 cm.

The settlement is within permissible limit as per I.S: 1904 – 1986

Then safe Bearing capacity  $9.43 \text{ t/m}^2$ .

- (iv) Thus, the settlement for unit pressure for the lowest corrected S.P.T. value and for  $1.024 \text{ Kg/Sqcm}^2$ . as the allowable pressure for 3.00 m depth with R.C.C. Raft foundation of size (10.0x10.0) m is given below:

Type of Foundation	= R.C.C. Raft foundation
Lowest corrected value	= 14.81
Settlement for unit pressure	= 2.3422 cm.
Settlement for $1.027 \text{ Kg/sqcm}^2$	= 2.405 cm.
Settlement after applying rigidity factor	= 1.924 cm.

The settlement is within permissible limit as per I.S: 1904 – 1986

Then safe Bearing capacity  $10.27 \text{ t/m}^2$ .

## 9.0 RECOMMENDATION:

- 9.1 The soil strata are effective zone comprises of cohesive & non-cohesive layers. The design load has therefore to ensure safety against failure due to shear failure.
- 9.2 The water table was met up to 14.00 m depth during boring operation in bore holes at the time of soil exploration. Water is expected 1.00 m rise in post monsoon period. Accordingly, water table is assuming 13.00 m for calculation purpose.
- 9.3 The values of net safe bearing capacity for Isolated / RCC Raft foundation below existing ground level are tabulated below: -

S. L. No.	Depth (m)	Type of foundation	Width of foundation (m)	Allowable Bearing Capacity	
				Kg/cm <sup>2</sup>	T/m <sup>2</sup>
1	1.00	Isolated foundation	1.00	0.924	9.24
2	1.50		1.50	0.952	9.52
3	2.00		2.00	1.022	10.22
4	3.00			1.172	11.72
5	2.00	R.C.C. Raft foundation	(10.0x10.0)	0.943	9.43
6	3.00			1.027	10.27

The 'CI' group soil is found in the effective zone below footing level. Accordingly, plinth beam, lintel beam and apron all around the structure will be provided.

The above recommendations are based on the field investigation data and the laboratory test result of the sample collected from site and our experience in this regards.

If the actual sub – soil condition during excavation for foundation differs from that has been reported a reference should be made to us for suggestion.



**ABC CONSULTANTS**  
(Soil Investigations and Laboratory Works)

Authorized Signatory



