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Subsoil Investigation and Design of Suitable Foundation for a Commercial Complex

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ABSTRACT:

At present India is the second largest populated country in the world next to china. So to meet the needs of largest population now and in future, many infrastructure developments has to be made. The infrastructure has to ensure the safety and it should be stable such that it should not cause any loss of life and property. In addition to structural safety the project should be economical and most useful for the community. After Bhuj earthquake in Gujarat the buildings got collapsed. This is due to inadequate sub soil exploration before building construction. The main aim of sub surface exploration is to ascertain the nature of soil layers in building construction site. By knowing the nature of soil layers in the construction site, the depth of foundation can be determined. With the help of index and engineering properties the suitable type of foundation can be designed and this proves economical. This stands apart from the conventional building practice which does not consider the variation of soil strata. The project site is located at Neelambur, Coimbatore districtalongside of National Highway 47.The project is about subsoil investigations and design of suitable foundation for commercial complex. The commercial complex is G+3 building. The choice of different types of foundation is made and the use of mixed type of foundation design reduces the cost and proves economical.

1. INTRODUCTION

Construction field is the faster growing industry compared with other fields of engineering, because of larger investments made on it. And especially in government sectors there are many people welfare projects that are to be executed in tier I and tier II cities in near future. Percentage of fund sanctioned in the budget for infrastructure developments is unusually higher every year. Coimbatore comes under the group of Tier II cities. It is important to implement many of the development schemes in these type of cities to ease the faster growing population and to facilitated better connectivity. Schemes like Metro rail, Bus rapid transit system and many other infrastructure developments are to be implemented here with the help of funds from State, Central and public-private partnership programmes. As a dream towards **2020**, India should be well developed in infrastructure facilities with efficient pre-planning. The subsoil investigation is the exploration of soil with the help of standard field experiments that are commonly performed. With the help of above performed test, we are comfortable to find the exact picture of soil profile. The most commonly performed field test were Standard penetration test and wash boring. The standard penetration test is the most commonly used in-situ test. The test is most commonly used for determining the relative density and the angle of shearing resistance of cohesionless soils. It can also be used for determining the unconfined compressive strength of cohesive soils. Wash boring mainly used for advancing hole in the ground. In wash boring hole is advanced by a combination of chopping action and a jetting action, as the drilling bit and the accompanying water jet disintegrate the soil. The water and chopped soil particles rise upward through the annular space between the drill rod and casing. It is collected in a tub or pit in the soil through a T shaped pipe fitted at the top of drilling rod. In stable cohesive soil casing is required only in the top portion. Sometimes instead of casing special drilling fluids made of suspension or emulsions of fat clays or bentonite combined with chemical additives are used for supporting the walls of the hole. Here our project deals with design of suitable foundation for a commercial complex with the help of subsoil investigations conducted at **Neelambur, Coimbatore** in alongside of **National Highway 47**. As a part of community development programme our project aims at providing world class qualitative infrastructure facility with lesser cost involved and with better preplanning to sustain all the uncertainties. The project aims at reducing the uncertainties with the help of subsoil investigations. The sample collected in field is used for laboratory test. The laboratory experiments will be conducted for determination of index and engineering properties of soil. The bore log report was prepared with the help of field results and SPT was correlated to find the bearingcapacity of soil. The bearing capacity value was used for design of foundation with adequate factor of safety. The designed foundation was checked for adequacy.

2.METHODOLOGY:

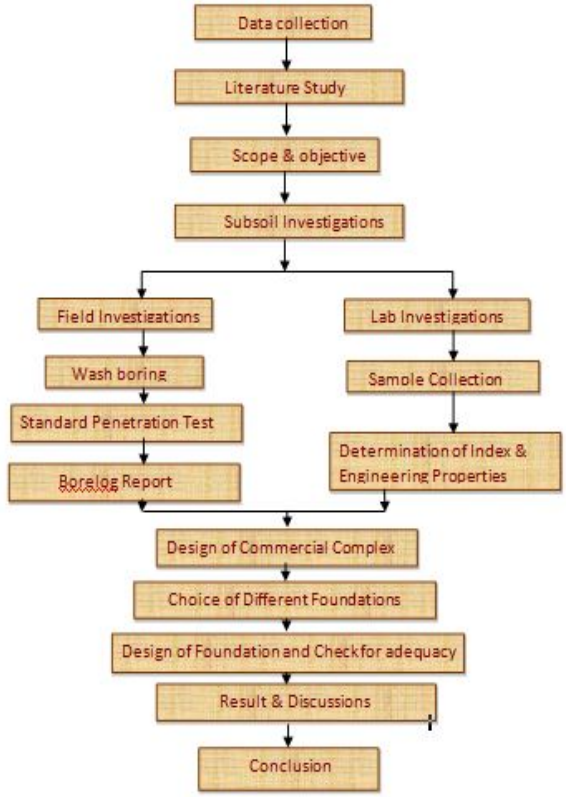


Figure 1

3.RESULTS &DISCUSSIONS :

3.1 Site Selection

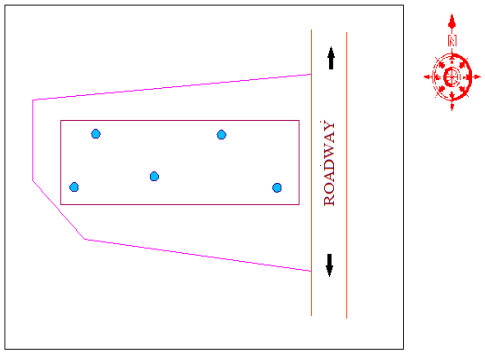
The site selection is the important process in many soil related works because soil strata will vary from site to site. In this chapter the site location and characteristics of site is determined. After selection of site, the no of boreholes is determined with the help of standard procedures

3.2 Site Location

Project location (Indicated in red box): Near NH 47, Neelambur, Coimbatore

Figure 2

LOCATION OF BORE HOLES



3.3 Sample Collection

Sample collection involves collection of soil sample with certain precautionary measure. The soil samplecollected for determination of index and engineering properties should be handled carefully to reduce disturbance. The soil sample should be collected from 1m depth. For determination of field moisture content the soil sample should be collected and brought to laboratory without any contact with air. The sample should be packed in a closed air-tight polythene cover to avoid any disturbance. The sample brought should be tested within hours. Then for determination of field density, the standard core cutter sampler is used and sample is collected without any disturbance.

3.4 Field Investigations

Field investigations include site reconnaissance, plotting the location of bore holes and some of the standard test followed is Wash Boring and Standard Penetration Test. The above mentioned test is conducted in the field to find out the type of soil below earth and to find their bearing capacity. Since soil is a complex material, number of field and lab investigations has to be done to find out the complex nature of soil.

3.5 Site Reconnaissance & Location of Bore Holes

Site reconnaissance is the first step in the sub surface exploration programme. This includes a visit to the site and to study the maps and other relevant records. It helps in deciding future programme of site investigation, scope of work, methods of exploration to be adopted, types of samples to be taken and the laboratory testing and in-situ testing.Location and spacing of bore holes mainly on variation of strata in horizontal direction. For small less important buildings even one bore hole of trail pit is sufficient. But for compact buildings , covering an area of about 0.4 hectares, there should be at least 5 bore holes , one at the centre and four near the corners.

3.6 Wash Boring

The wash boring was started after the SPT test and test was continued till water block was interrupted. The test sample was collected after the removal of sampler. For this test special type of split spoon sampler was used. The wash samples collected in the tub do not represent the soil in its true condition. The strata change can be identified by change in colour of the wash samples collected. The depth of boring done based on the client requirements, Here for our site boring was done for a depth of 10m.

3.7 Standard Penetration Test

The Standard penetration test is conducted in a bore hole using standard split spoon sampler normally for cohesionless soils. When the bore hole is drilled to desired depth drilling tools are removed and the lowered to the bottom of the bore hole. The sampler is driven in the soil by a drop hammer of 63.5kg mass falling through a height of 750mm at the rate of rate of 30 blows per minute. The number ofblows required to drive 300mm of the sample is counted. After the completion of Standard penetrationtest, Wash boring is continued with necessary arrangements before experiment.

3.8 Subsoil Investigations – Lab Investigations

Determination of Index And Engineering Properties

Determination of index and engineering properties is the major part of subsurface exploration. The properties which are used for identification and classification of soils are called index properties. Based on engineering properties strength of the soil is ascertained.

The following properties of soil is determined:

1. Natural water content
2. Liquid limit
3. Plastic limit
4. Shrinkage limit
5. Unconfined Compressive Strength
6. California Bearing Ratio
7. Free swell
8. Specific gravity
9. Grain size distribution

3.9 Interpretation Of Test Results Calculation Of Bearing Capacity Geometrical Data:

Shape of the Foundation = square
Shape considered for bearing capacity design = square
Size of footing (B) 3.00m
Breadth to Length Ratio of Foundation (B/L) 1.00m
Depth of Foundation below E.G.L (D_f) 2.50m
Inclination of the Vertical Load with the Vertical (α) 0.00 Deg.

SOIL DATA:

Type of Bearing Strata: SOFT CLAY
Design SPT "N" value of the Bearing strata: 50
Type of shear Failure: General
Cohesion in ton/m2 = 10.25
Angle of internal friction = 37 Deg

DESIGN PARAMETERS:

Saturated density of soil above the foundation depth (Ƴbulk) = 19.00 kN/m3
Effective overburden pressure at foundation level (q) 10.00 kN/m2
Water Table Correction Factor (RW) = 0.50

SAFE BEARING CAPACITY:

Safe bearing capacity (SBC) = 3.5 (N-3) {(B+0.3)/2B} 2 X RW X FD +P
= 368.54 KN/m2

Analysis & Design Of Commercial Complex

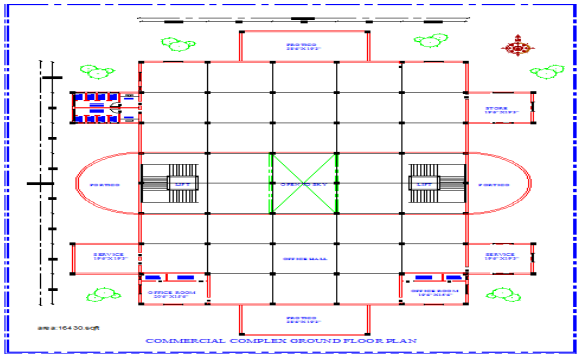


Figure.4

CALCULATION OF LOADS

FLOOR LOAD:

Assuming the slab thickness as 150 mm
Assume the density of concrete as 24 kN/m^3
Dead load = 4.8 kN/m^2
Live load = 2 kN/m^2
For passage and balconies = 3 kN/m^2

DEAD WEIGHT OF BRICK MASONRY:

Self weight of brick work = 13.9 kN/m
Self weight of parapet wall = 3.96 kN

DESIGN OF MIXED FOUNDATION AND CHECK FOR ADEQUACY

Spread footing

Spread footings are used for distributing concentrated column loads over a large area so that the bearing pressure is less than or equal to allowable soil pressure. Spread footing can be designed as reinforced or plain concrete footings

REINFORCEMENT DETAILS:

Total load = 496.65 KN
Footing area =1.083 m^2
Let B= 1.5 m
D= 0.75 m
Assume footing size as 1.5m x 0.75 m
Actual area of footing A_0 = 1.125 m^2

Depth of footing :

From Moment considerations,
D = 125 mm
From Shear considerations,
D = 600mm

Reinforcement in footing:

Longer direction
A_{st} = 8.11 mm^2
Assume, a minimum percentage of 16mm φ bars at 160mm centre to centre distance
Shorter direction 12mm bars at 250mm centre to centre distance.

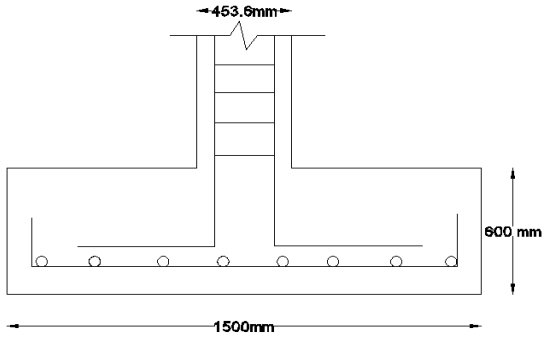


Figure 5

SPREAD FOOTING CROSS SECTION

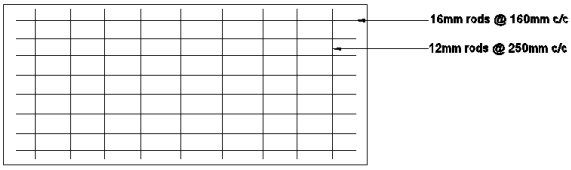


Figure 6

SPREAD FOOTING REINFRORCEMENT

3.10 DESIGN OF STRAP FOOTING

A strap footing consists of two spread footing joined by a rigid beam. The strap is not subjected to any direct soil pressure from. Its main function is to transfer the moment from the exterior footing to the interior footing.

L_1 = 2.4536 m,R_1= 1000 KN,R_2 = 1810 KN,A_1 = 3.25 m^2,A_2 = 5.88 m^2,B_1= 1.325 m q_1= 407.75 KN/m,B_2= 2.45 m,q_2= 738.77 KN/m
Intensity of pressure = 301.54 KN/m^2

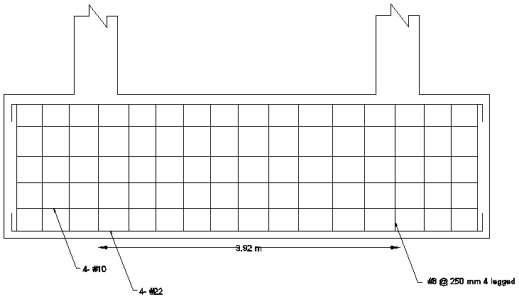


Figure 7

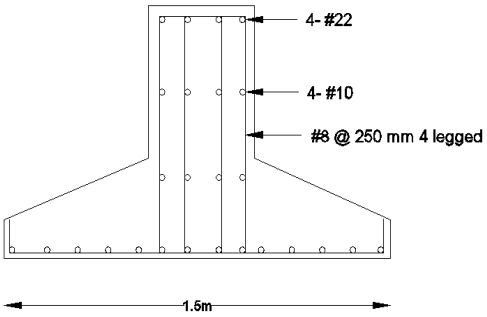


Figure 8

STRAP FOUNDATION

4. CONCLUSION

The following conclusions are drawn

- The soil obtained at Neelambur is classified as CI on its proportion. The % of Gravel, Sand, Silt and clay are 0, 38.3%, 21.5% and 40.2%
- The subsoil investigation in field is conducted by wash boring method. The SPT test is conducted at various depths.
  - For borehole no 1 the rock is found at the depth of 0.45m.
  - For borehole no 2, depth is 1.2m.
  - For borehole no 3, depth is 0.3m.
  - For borehole no 4, depth is 0.45m.
  - For borehole no 5, depth is 0.45m.
- The Allowable soil pressure for the proposed site of has found about 307.74 kN/m^2
- The liquid limit, plastic limit and free swell values are 34.4%, 24% and 25% respectively.
- The different types of foundations are provided based on the soil conditions and like spread footing, strap footing. Raft footing etc.
  - The compressive strength of rock is found to be 4.5Mpa
  - The safe bearing capacity of soil is 368.54kN/m^2

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