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Evaluation of Relationship between Bearing Capacity and Density of Soil

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***Abstract*— Now a day for construction of heavy structures Soil bearing capacity calculation is more important for stability, durability, and construction and planning purposes. To determine the bearing capacity of soil heavy equipment are required and it should be avoided by using the relationship between safe bearing capacity and dry unit wt. of soil. Practically, as density of soil is increases then the safe bearing capacity of soil is also increase. There for by knowing the density of soil safe bearing capacity of soil is easily determined. So, we decide to work on these concept/ideas. By using this concept field test works are minimized in large construction works, long highway construction works for same soil property. For determining this relationship Standard penetration equipment, core cutter, direct shear test machine etc. are used in this project work.**

***Index Terms*— Dry Unit Weight , Bearing capacity of Soil , Direct Shear test , Sieve Analysis.**

I. INTRODUCTION

Bearing Capacity of soil: In geotechnical engineering, bearing capacity is the capacity of soil to support the loads applied to the ground.

Ultimate Bearing Capacity: The ultimate bearing capacity is defined as the maximum gross pressure intensity at the base of the foundation at which the soil does not fail in shear.

Allowable bearing capacity: The net load intensity at which no failure occurs is called allowable bearing capacity. Calculating the gross allowable load bearing capacity of shallow foundation requires the application of the factor of safety (FS) to the gross ultimate bearing capacity.

q Allowable = q ultimate / FS

Net ultimate bearing capacity: It is defined as the ultimate pressure per unit area of the foundation that can be supported by the soil in excess of the pressure caused by the surrounding soil at the foundation level. If the difference between the unit weight of the soil and the concrete is negligible, then

q net(u) = q(u) – q

q allowable (net) = (q(ultimate)-q) / FS

Safe bearing capacity: The maximum Pressure that a soil bears without shear failure is known as safe bearing capacity.

Soil-Bearing Capacity for Shallow FoundationsThe lowest part of a structure is generally referred to as the foundation. Its function to transfer the load of the structure to the soil on which it is resting. A properly de-signed foundation transfers the load throughout the soil without overstressing the soil. Overstressing the soil can result in either excessive settlement or shear failure of the soil, both of which causeddamageto the structure. Thus, geotechnical and structural engineers who design foundations must evaluate the bearing capacity of soils.

Depending on the structure and soil encountered. Various types of foundations are used. the most common types of foundations Aspreadfooting is simply an enlargement of a load-bearing wall or column that makes it possible to spread the load of the structure over a larger area of the soil. In soil with low load-bearing capacity, the size of the spread lootings required impracticably large. In that case, it is more economical to construct the entire structure over a concrete pad. This is called a mat foundation.

Pile and drilled shaft foundations are used for heavier structures when great depth is required for supporting the load. Piles are structural members made of timberConcreteor steel that transmit the load. of the superstructure to the lower layers of the soil. According to how they transmit their load into the subsoil, piles can be divided into two categories: friction piles and end-bearing piles. In the case of friction piles, the superstructure load is resisted by the shear stressesgeneratedalong the surface of the pile. In the end-bearing pile, the load carried by the pile is trans-mitted at its tip to a firm stratum. in the case of drilled shafts. A shaft is drilled into the subsoil and is then filled with concrete. A metal casing may be used while the shafts being drilled. The casing may be left in place or may be withdrawn during the placing of concrete. Generally, the diameter of a drilled shaft is much larger than that of a pile. The distinction between piles and drilled shafts becomes easy at an approximate diameter of 1 m (3 ft.), and the definitions and nomenclature are inaccurate. Spread footings and mat foundations are generally referred to as shallow foundation, whereas pile and drilled shaft foundations are classified asdeep foundations. In a more general sense, shallow foundations are foundations that have a depth of embedment to width ratio of approximately less than four. When the depth-of-embedment-to-width ratio of a foundation is greater than four, it may be classified as a deep foundation.

Density of Soil:

Bulk Density: Bulk density is defined as the dry weight of soil per unit volume of soil. Bulk density considers both the solids and the pore space; whereas, particle density considers only the mineral solids.

Dry density: **Dry density** is the dry mass of soil per unit volume. The **dry density** is usually expressed as either g/cm3 or t/m3.

Saturated unit weight:Saturated unit weight is the saturated weight of soil per unit volume. A saturated soil has a degree of saturation equal to 100%. The **saturated unit weight** is usually expressed as kN/m3.

Submerged density: The submerged density of the soil is

defined as the submerged mass per unit total volume.Bulk density is an indicator of soil compaction and soil health. It affects infiltration, rooting depth/restrictions, available water capacity, soil porosity, plant nutrient availability, and soil microorganism activity, which influence key soil processes and productivity. It is the weight of dry soil per unit of volume typically expressed in grams/cm3. Total volume of surface soil is about 50% solids, mostly soil particles (45%), and organic matter (generally < 5%); and about 50% pore space which are filled with air or water. When determining bulk density, the amount of soil moisture must be determined. Available water capacity is the amount of soil moisture available to plants, varies by texture, and is reduced when compaction occurs. Bulk density can be managed, using measures that limit compaction and build soil organic matter.

II. OBJECTIVES

Different soils have a different bearing capacity with respect to density. For determining safe bearing capacity on site SPT and PLT are mostly conducted. These field tests are heavy, cumbersome and time consuming. Due to more costly most of the engineer's avoid the test. hence, it is very much need to determine SBC with respect to the above field test. hence if relationship between Density and SBC worked out then it will be much useful for engineer and practitioner. It can be seen that generally if Density of soil is more than its bearing resistance also more. Using this logical relationship further research work has been carried out.

III. METHODOLOGY

Site selection: To determine bearing capacity and density of the soil proper site selection is required. The site should be open ground, free from tree like obstruction, free from water body as far possible as. the site was neither in black cotton soil nor in hard rocky soil, it should be such that standard penetration test become easy. For that the site was selected near the west side of college of sinhgad college of engineering, kegaon, Solapur. For bearing capacity the standard penetration test was conducted on site and for determining density core cutter test is conducted. At that site three trial pit are taken to find SBC and density of soil. the trial pit consists of size 1mx1m in a plan on the ground, depth of that pit was 50cm in C-Φ soil was selected for each test. In one pit three test are conducted in vertical plane, then the total depth about 1.5m was achieved. from each test the reading was recorded at site and for lab work like determine water content, direct shear test etc. the soil sample was collected.

Venue: Jain temple,nearNBNSCOE,kegaon, Solapur.

FIG.PLAN OF PIT

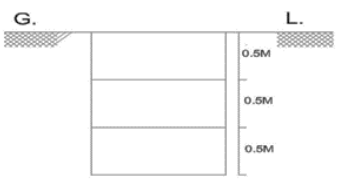


FIG.SECTIONAL ELEVATION

Test Conducted:

Standard penetration test: To determining the bearing capacity of soil Standard penetration test was conducted. this test gives resistance value for penetration of 30cm depth in soil.

density of soil: Density of soil is determined by various methods but mostly two methods are used these are

Sand replacement method

Core cutter method

For determining density of soil, the core cutter method preferred, because it easy to conduct the test

Direct shear test: Direct shear test was conducted for determining the c ℰ values of the soil in laboratory test.

Terzaghi's bearing capacity method: By using this method we calculated Safe Bearing Capacity of different test pits at different depth.

General equation of Terzaghi's bearing capacity

$$q_u = CN_C + \gamma D_f N_q + \frac{1}{2}\gamma B N_\gamma$$

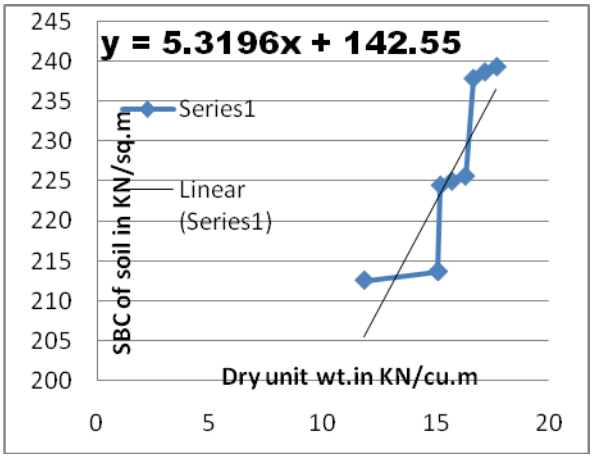
for square footing:-

$$q_u = 1.2\, CN_C + \gamma D_f N_q + 0.4\gamma B N_\gamma$$

IV. RESULT

Sr.no	Dry unit wt (KN/cu.m)	SBC by terzaghi's eq .(KN/sq.m)
1	11.82	212.56
2	15.077	213.658
3	15.08	213.659
4	15.187	224.47
5	15.69	225.00
6	16.29	225.631
7	16.64	237.892
8	17.152	238.71
9	17.18	214.36
10	17.679	239.366

For evaluate the equation for calculating the SBC based on density of soil, finally after calculating density for all pits and SBC for all pits. By taking number of readings graph is plot, based on those values.



V. CONCLUSION:

From the experimental and analytical study, the following empirical relationship between dry unit wt. and SBC of soil is as follows;

y = 5.3196x + 142.55

Where, Y=SBC of soil in KN/sq.m
X=dry unit wt. in KN/cu.m

If we know the unit wt of soil SBC can easily find out from the above equation at that particular soil.

Above equation is strictly applicable for the particular C-Φ soil mentioned earlier.

From this study five different relationships have been formed but, finally above relationship has been selected due its reliability.

This project work can be useful for design of foundation work at large scale, where soil is uniform.

For highway projects and for large scale project where SBC cab be found out performing above procedure.

This research work minimizes the effort, time, cost, man power for conducting field test for finding bearing capacity.

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