Improvement in Bearing Capacity and Soil Reinforcement Friction

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Abstract- *Bearing capacity of foundation beds is one of the most important criteria to make an efficient structure for sustaining higher loading. There are various methods for improving bearing capacity like soil nailing, vibro-compaction, vacuum consolidation, reinforcement etc Reinforcing the soil bed is the most efficient and effective method for loose soils. A reinforce soil possesses many novel characteristics, which render it eminently suitable for construction of geotechnical construction. The reinforcement can easily be handled, stored and installed. Improvement of the bearing capacity of weak soil is one of the potential fields of application of reinforced soil. Though the concept of reinforced soil is simple, the technique has yet not been fully exploited, as there are very few studies available pertaining methods of analysis and design. The reinforcement mechanism is not clearly understood. A program of laboratory scale plane-strain bearing capacity tests under monotonic loading has been carried out which considers the reinforcing mechanism of the Geotextile. The applicability of a method for predicting bearing capacity of sand overlying soft clay with geotextiles reinforcement at sand-clay interface.*

Keywords- Bearing capacity, reinforcement, soil, technique, improving.

I. INTRODUCTION

Bearing capacity of foundation beds is one of the inescapable interests for geotechnical engineers all over the world. Although widely studied, the vistas of further researching and exploration to uncover the missing facts and interpretations seem to be endless. The problem of determination of appropriate bearing capacity becomes much more complicated for reinforced foundation beds. Reinforcing of soil can be achieved by embedding various types of
Materials such as metallic strips, geo-textiles. geogrids and even rope fibers. The orientations of the inclusions can be horizontal, vertical or inclined, depending on the requirement for a particular problem. These inclusions result insignificant modification of the failure zones of a foundation in respect to what observed for a foundation in a natural soil bed. In such circumstances, the bearing capacity theories fail to replicate the failure modes of reinforced foundation beds, and hence, needs substantial modification and refinement. In this aspect, too, a significant contribution has been provided by several researchers and bearing capacity theories for reinforced foundation beds have also been proposed. However, it has been observed that in several instances, even the refined bearing capacity theories fail to provide a reasonable prediction the bearing capacity as measured in the field. Failure surfaces determined from experimentations in situ and laboratory are found to differ

Largely with that as assumed in the theoretical analysis. For single- or multi-layered reinforced foundation beds, the failure surface is significantly affected by the interference of several physical elements of the system such as the relative length of the footing and reinforcement, relative depth of reinforcement beneath the footing, covering ratio of the reinforcement, number of layers of reinforcement, the tensile strength of the reinforcement, the unit weight and the angle of internal friction of the granular till. Hence, for such cases, assuming a theoretical failure surface to predict the bearing capacity becomes even more complicated. The solution to such problem can be determined by approaches.

II. GEOSYNTHETICS

Geosynthetics have become well established construction materials for geotechnical and environmental applications in most parts of the world. Because they constitute manufactured materials, new products and applications arc developed on a routine basis to provide solutions to routine and critical problems alike.

Geosynthetics have been increasingly used in geotechnical and environmental engineering for the last 4 decades. Over the years, these products have helped designers and contractors to solve several types of engineering problems where the use of conventional construction materials would be

restricted or considerably more expensive There are a significant number of geosynthetic types and geosynthetic applications lo geotechnical and environmental engineering.

III. TYPES OF GEOSYNTHETICS

Geosynthetics is a generic term which collectively describes:

1. Geotextiles
2. Geomembrane,
3. Geonets,
4. Geogrid,
5. Geocompositc.

IV. LITERATURE REVIEW

Bestun J. Nareeman and Mohammed Y. Fattah, 2012. This study investigates the effect of soil reinforcement using geonet on the shear strength, consolidation and swelling of silty soil. The tests that carried out are classified into two categories: First; tests on soil without reinforcement and second tests on soil with reinforcement. The loading test was conducted on small scale model using different layers of reinforcement. The results showed that the shear strength parameters could be improved by using geonet reinforcement. Moreover, the settlement and swelling of silty soils are decreased by using geonet.

Prof. Georg Heerten, 2007 Due to the globalization of the world economy and the global increase of trade, there is an increasing shipment of goods, which creates high demands on the maintenance and development of an efficient infrastructure (roads, railways and waterways). The development of infrastructural projects will be a booming sector of the construction industry around the world with the highest demands in Asia and Europe. Sustainability concepts for the construction activities and funding problems of the contracting authorities are current boundary conditions which can be accommodated optimally with geosynthetic construction methods. At the same time, besides the technical advantages, economical and ecological advantages can be used too – saving construction costs and taking care of building material resources. This paper will provide a state-of-the-art report about international infrastructural projects.

Omid Sargazi, Ehsan Seyedi Hosseininia, 2017, This paper presents a study on the bearing capacity of eccentrically-loaded rough ring footings resting over cohesionless soil. To this aim, a series of 3D numerical simulations were performed using the finite difference method. In order to consider the effect of load eccentricity, reduction factor method is applied. In this method, the ratio of an eccentrically-loaded bearing capacity to the bearing capacity of the same footing under vertical load is defined. Comparison between the results of the numerical simulations with those of analytical solutions and experimental data indicates good agreement. A mathematical expression is also introduced for eccentrically-loaded ring footings.

Aydogamus et al. 2006, the advances in geosynthetics materials and applications for soil reinforcement and environmental protection works and their study mainly based on recent advances on geosynthetics products, applications and design methodologies for reinforced soil and environmental protection works. Geosynthetics have great potential to be used as cost-effective solutions for several engineering problems. This paper presented recent advances in geosynthetic products, on the utilization of these materials in reinforced soil structures and in environmental applications. Manufacturing of geosynthetics products allows incorporating recent advances in material sciences.PVA, works in textile grid applications to withstand high alkali environments and especially the combination of lime and cement stabilizers and PVA grids in cohesive soils where there appears to be a synergistic effect resulting in higher strength and higher resistance to pullout failure.

V. METHODOLOGY

BEARING CAPACITY

Bearing capacity is the power of foundation soil to hold the forces from the superstructure without undergoing shear failure or excessive settlement Foundation soil is that portion of ground which is subjected to additional stresses when foundation and superstructure are constructed on the ground.

The ultimate net bearing capacity can be obtained for strip footing as per IS 6405:1981 as follows.

In case of general shear failure

$$Q_{nu} = cNcSdc^1c + q(Nq - 1)Sq^1q^dq + 0.5\,\gamma BN_\gamma S_\gamma d_{\gamma i_\gamma w}$$

In case of local shear failure

$$Q_{nu} = (2\backslash 3)cNcSdci_c + q(Nq - 1)S_q i_q d_q + 0.5\,\gamma BN_\gamma S_\gamma d_{\gamma i_\gamma w}$$

Also the safe bearing pressure can be calculated from the permissible settlement value using chart given by lS: 8009-Part 1-1976

The allowable bearing pressure of a foundation is selected as the smaller of the net safe bearing capacity and the net safe bearing pressure. The allowable bearing pressure of a foundation on granular soil is usually governed by the settlement criterion unless the footing in narrow or the soil is loose. For footings of usual sizes the net safe bearing capacity is quite high for most natural sand deposits.

Factors influencing Bearing Capacity

Rearing capacity of soil depends on many factors. The following are some important ones.

i. Type of soil
ii. Unit weight of soil
iii. Surcharge load
iv. Depth of foundation
v. Mode of failure
vi. Si/e of footing
vii. Shape of tooling
viii. Depth of water table
ix. Eccentricity in tooting load
x. Inclination of tooting load or ground or base of" foundation.

Bearing Capacity Improvement Techniques

a. Preloading

Preloading has been used for many years without change in the method or application to improve soil properties. Preloading or pre-compression is the process of placing additional vertical stress on a compressible soil to remove pore water over time.

b. General grouting:

Grouting is the injection of pump able materials into a soil or rock formation to change the physical characteristics of the formation, grouting selection considerations are Site spiced requirement.

c. Soil nailing

The fundamental concept of soil nailing consists of reinforcing the ground by passive inclusions, closely spaced, to create in-situ soil and restrain its displacements.

d. Vacuum consolidation

Vacuum Consolidation is an effective means for improvement of bearing capacity of saturated soft soils. The soil site is covered with an airtight membrane and vacuum is created underneath it by using dual venture and vacuum pump.

e. Vibro-compaction

Vibro-compaction sometimes referred 'O as Vibrofloation is the rearrangement of soil particles into a denser configuration by the use of powerful depth vibration. Vibro-compaction is a ground improvement process for densifying loose sands to create stable foundation soils.

f. Vibro-replacement stone columns

Vibro-Replacement extends the range of soils that can be improved by vibratory techniques to include cohesive soils. Reinforcement of the soil with compacted granular columns or "stone columns'" is accomplished by the top feed method. The important Vibro-replacement stone columns are Ground conditions, Relative density. Degree of saturation. Permeation.

g. Reinforcement:

The technique of soil reinforcement is very much advantageous in bearing capacity improvement Reinforced soil foundation bed is a soil foundation containing horizontally embedded Geosynthctics thin fiatmctal strips, ties or grids. Apart from economic advantages, the reinforced soil bed opens up the possibilities of founding civil engineering structures soil conditions hitherto not suitable and even type of foundation could also be changed with the use of techniques.

Different reinforced materials

Different reinforcing materials can be used to increase the bearing capacity of soft soils. Amongst the commonly used materials are Mild Steel bars, High Tensile Steel. Geosynthetic material, Metal Wire- mesh and Bamboo. However many of them are prone to corrosion and therefore, suitable preservative treatment must be given before using them.

Before using the any of above reinforcing materials^ ii is required to compare their costing in addition to various other physical and mechanical properties according to the project requirement. Cost evaluation can be studied from the table provided. Thus from the table we observe that the cost of mild steel and polypropylene are equal. But on a practical aspect, the mild steel materials are prone to corrosion, so the cost of corrosion protection should also be added, which makes it more costly.

Benefits of reinforced soil

Reinforced soil is a very cost-effective technique compared to other construction techniques. The major benefits of reinforced soil are: The inclusion of reinforcement in soil improves the shear resistance of the soil thereby improving its structural capability The inclusion of reinforcement enables the use of low bearing capacity soil to be used as structural components.

Land acquisition can be kept to a minimum because reinforced structures can be made steeper that would otherwise be not possible

Construction time can be reduced when reinforced soil techniques are used.

VI. CONCLUSION

The ultimate bearing capacities obtained for different lasers of Geogrid (single, double, triple) at different depths were compared

Provision of the geocell reinforcement in reinforcing the sand layer significantly increases the load carrying capacity, reduces the footing settlement and decreases the surface heave of the footing bed more than the planar reinforcement with the same characteristics and the same mass used.

Overall, with increase in the number of planar reinforcement layers, the height of geocell reinforcement and the reinforcement width, the bearing pressure of the foundation bed increases and the footing settlement decreases. The efficiency of reinforcement was decreased by increasing the above parameters.

The optimum depth of the topmost layer of planar reinforcement is approximately 0.35 times of the footing width while the depth to the top of the geocell should be approximately 0.1 times of the footing width.

Three layers applied at subsequent depth (at 10, 20, 30 cm) exhibited and the maximum strength. That means bearing capacity of desert soil increases with increase in layer of geogrid layers.

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