STUDY ON SETTLEMENT BEHAVIOUR OF LAYERED SOILS

K. Venkat Raman[1], P. Dayakar[1], Dr. K.V.B. Raju [2]
[1]Department of Civil Engineering, Bharath University, Selaiyur, Chennai, Tamilnadu, India.
[2]Director, GITAM University, Bengaluru, Karnataka, India.

ABSTRACT

Design of the foundation structure mainly depends on the bearing capacity and settlement of the soil. The layered soils are consisting of different shear strength. The soil may be layered in the depth the shear capacity is of different parameters. In this study an attempt is made to find the bearing capacity and the settlement behavior of the layered soils, by the plate load test with 4cm x 4cm plate. The layered soil is formed in the tank of 20cm x 20cm x 20cm by the triaxial loading frame. Here the condition of the soil is been differentiate in the three different states loose state, medium dense state and dense state. Tests were conducted on two layers of soils. Fine gravel layer overlain sand layer were tested using mild steel plates of square shapes. The effect of the placement of layers on the bearing capacity, settlement characteristics of footing, has been studied and an equation for predicting the bearing capacity of two layered granular soils is developed based on the plate load test data.

INTRODUCTION

Homogeneous soils are very rarely found in nature. In most of the cases, the foundations are located on a natural stratified soil deposits exhibiting varying strength characteristics. A very common kind of such of soil deposits is a soil layer of finite thickness overlying thick stratum of another soil of different strength characteristics than overlaying soil. Meyerhof (1963) proposed modified bearing capacity factors to develop a methodology of estimation of ultimate bearing capacity of a satisfied soil system with a stronger sand layer overlying a clayey soil layer. Meyerhof and Hanna (1978) developed a generalized theory to estimate the ultimate bearing capacity of shallow rough continuous foundation supported by a strong soil layer underlain by a weaker soil layer.

Madhav and Sharma (1991) studied the bearing capacity of soft clay deposits overlain by a stiffer layer or crust. The bearing capacity of the lower soft soil was estimated considering the load spread outside the footing width as a variable surcharge stress. The improvement in bearing capacity has been obtained as a function of the extent and distribution of the surcharge stress.

The effect of shape and size with the different size of plates square are used. Loading tests were performed on sand and clay prepared in mild steel mould glass tank, (acrylic tank) of 20cm X 20cm X 20cm applied through model footings resting on the surface of sand and clay layers. A loading frame of 2000KN capacity, to find out the load- settlement behavior of layered soil by providing one soft layered soil to other soft layered soil

MATERIALS

Soil is important material in layered soil. In this study an attempt is made to select the soil in way is should suitable to layers, so it should be of problematic soil which is of contain more clayey. The specimen selected is of soil & sand in order to have more bearing capacity so that we can clearly get the ability thus or increased strength of the layered soil.

Soil 1: (clay)

Clay as a sampled from closed by site was used as material in the present investigation. Following parameters we obtained by conducted the test on soil 1(clay).

Liquid limit of clay = 78%

Plastic limit of clay = 28.18%

Specific gravity of clay = 2.35

Compaction of clay δd= 1.59g/cc

Optimum moisture content (Omc) = 18.92%

Soil 2: (sand)

Medium fine sand obtained from nearby site was used as material in present investigation. Following parameters of sand are obtained by sieve analysis.

Coefficient of curvature Cc= 0.31

Coefficient of uniformity Cu= 3.2

Specific gravity of sand = 2.63

Compaction of sand δd = 1.80g/cc

Optimum moisture content (Omc) = 5.66%

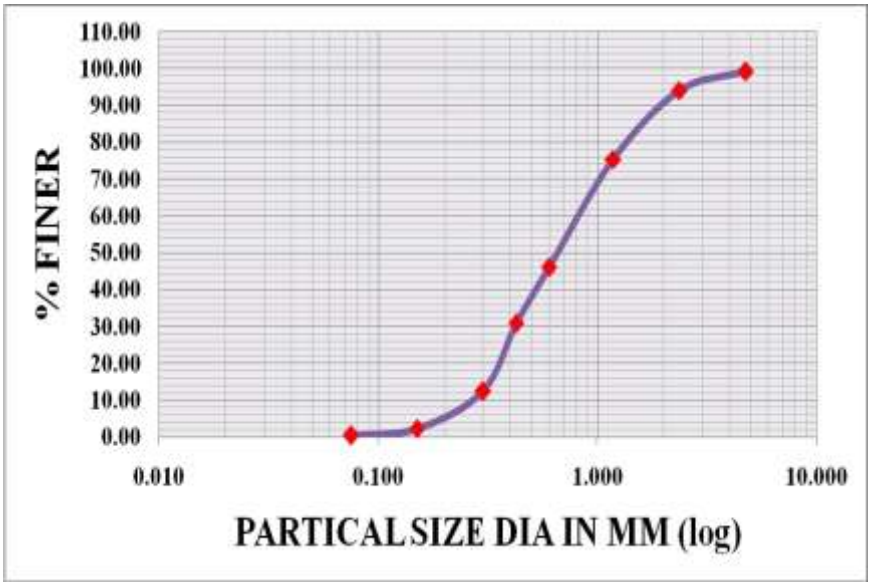

Fig 1. Grain size distribution curve for the soil 2 (sand)

Table 1. Properties of the soil 2 (sand)

PROPERTIES	VALUES
D_{60}, mm	2.4
D_{30}, mm	0.39
D_{10}, mm	0.098
C_c	0.31
C_u	3.2

METHOLOGY

The soil samples are arranged in the form which is shown in the figure 2. In which the first set up of one layer clay and one layer sand and the next setup it is made as the first layer with clay and second layer with sand and third layer with clay and in the next set up shown the first layer is of sand and second layer of clay and third layer is of sand. All the shown setups are tested in the loading frame using 4cm X 4cm plate.

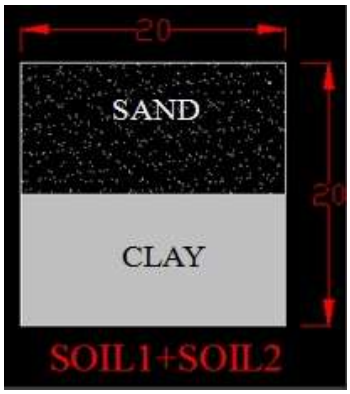

Fig. 2 Case 1 sand + clay

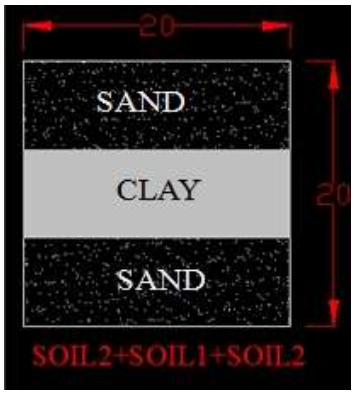

Fig. 3 Case2 clay +sand + clay

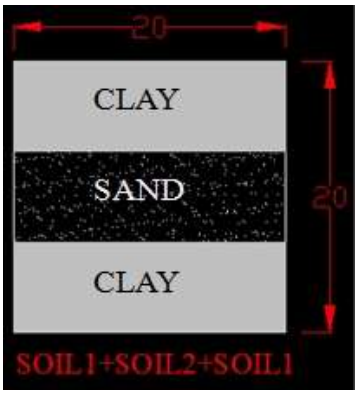

Fig. 4 Case3 sand +clay + sand

The sample is placed in triaxial loading machine, and a steel plate of 4cm X 4cm is placed at the top centre as shown in Figure 3. A steel spherical ball is placed over the centre of the loading test plate. A load cell is placed over the spherical steel ball, in order to take the reading of the load which applied. The LVDT (Linear Variable Differential Transformer) which help to find the deflections (or) displacement in the plate which is placed on the solid part of the acrylic tank. The triaxial load machine is switched on the forward button for applying load at the constant gear. The reading can be noted load corresponding to the displacement. Similarly this method is repeated for all the specimens.

Fig 5. Experimental set up for testing the soil specimen

RESULT AND DISCUSSION

To determine the increase in the bearing capacity of the layered soil, the plate load test with 4cm X 4cm plate is conducted in the same tank with the soil specimens who are of loose state, medium dense state and dense state. Fig 4 shows the load settlement curve for fully filled soil. Therefore the plate load test determination is very much necessary to assess the increase in strength of the grouted soil mass.

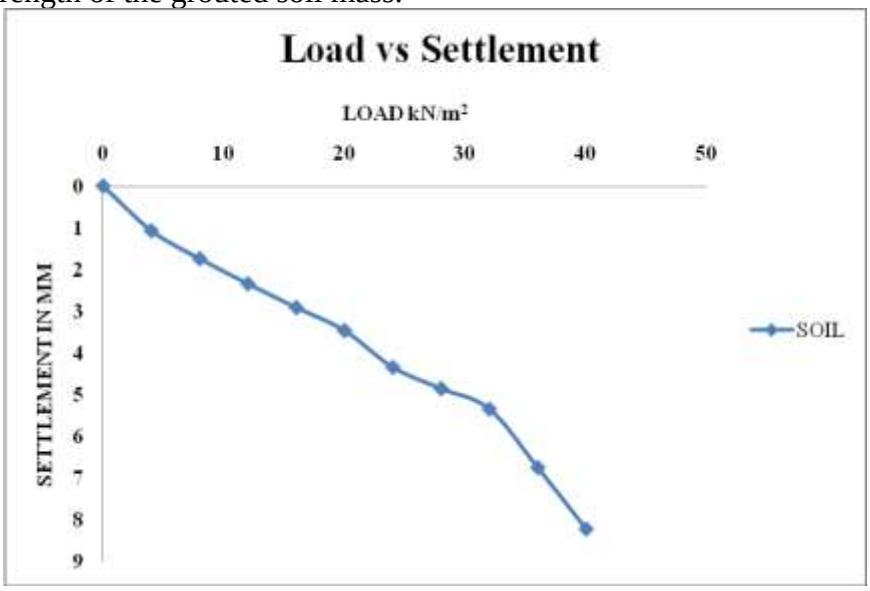

Fig.6 load settlement curves for soil

The graphical representation (fig 7) shows an increment of 35% in load bearing capacity when compare to the medium dense state and 60 % of increment in there bearing capacity of the layered soil in case 1(sand + clay)

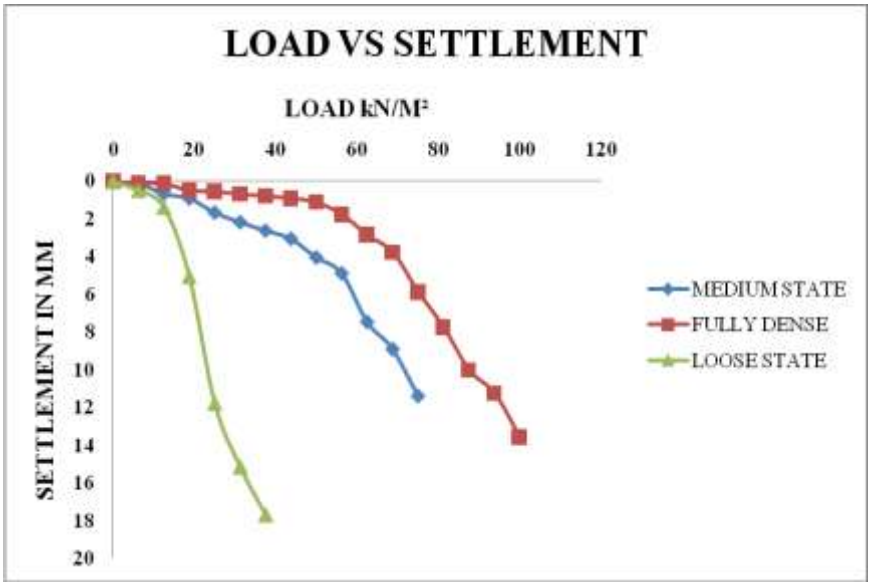

Fig.7 Load settlement curves for the case 1 (sand + clay)

Thus the fig 8 shows the difference in load settlement with an increment of 20% in case of loose state and 30 - 40% of decrease in the case of medium dense state as well as the dense state, when compare to the settlement behavior and bearing capacity of the case 1 (sand + clay).

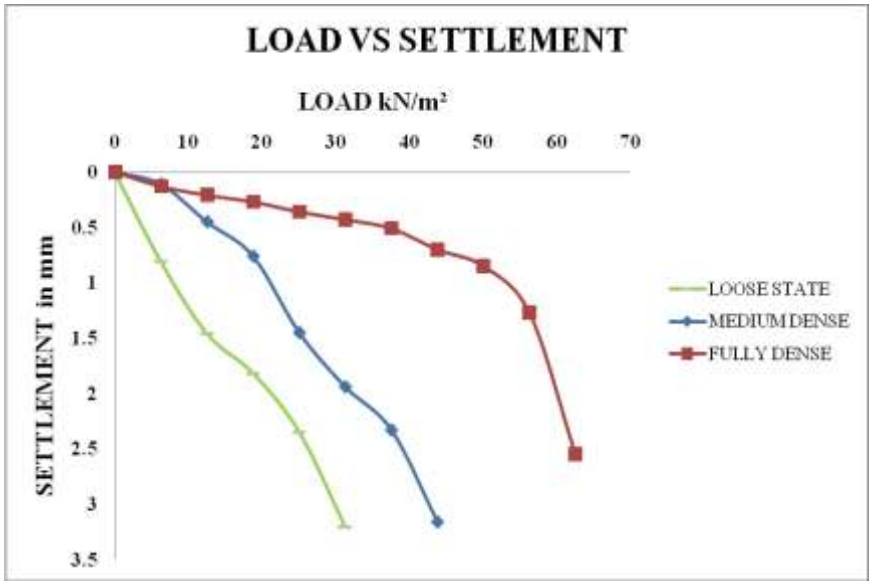

Fig 8 Load settlement curves for the case 2 (sand+ clay + sand)

In case 3 (fig 9) the load bearing capacity and the settlement behavior of the soil is been has an increment of 52% in loose state and 89% of increment in medium dense state and 94 % of increment in dense state when compare to the case 1 (fig 7)

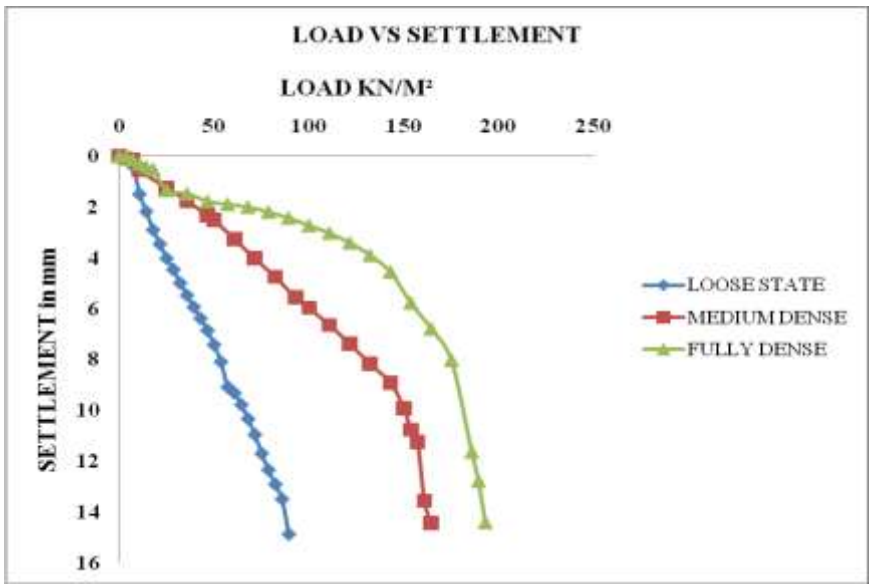

Fig 9 Load settlement curves for the case 3 (clay + sand + clay)

When compare to case 2 with case 3 there is an increment of 33% in the loose state, 90 – 95% of increment in the medium dense and dense state in the load bearing capacity and the settlement behavior of the layered soil by the plate load test using plate 4cm X 4cm.

CONCLUSION

The efficiency of the layered soil depends on the nature and the settlement behavior of the soil and sand. The following conclusions are drawn from the plate load tests. It can be seen that as the layer of the problematic soil increases the bearing capacity of the soil also increases. In this study the ultimate load increases by the 10 to 20 times when compare to the case1 of loose state of the soil with case 3 and 15 to 18 times when compared to the case 1 of medium dense state of the soil with case 3 and 17 to 21.5 times when compared to the case1 of the dense state of the soil with case 3. It can be concluded that using the different layers of soil the settlement behavior and the bearing capacity of the soil will be increased.

REFERENCES

1. Ullagaddi P.B. & Nagaraj T.K (2010). "Experimental study on load settlement Behavior of sand Foundation", Indian Geotecnnical Conférence -2010, Geotrendz. IGS Mumbai Chapter & IIT Bombay.
2. Bowles J.E. (1988). Foundation analysis and design, 4thEd, McGraw-Hill, New York,N.Y.
3. Commissiong, D.M. (1968). "The ultimate bearing capacity of surface footing on dry sand overlying Verma et al, International Journal of Advanced Engineering Research and Studies E-ISSN2249–8974 IJAERS/Vol. II/ Issue III/April-June, 2013/142-149 saturated clay", M.Eng. Thesis, Nova Scotia technical College, Halifax, N.S.
4. Ghumman (1966), Effect of shape on bearing capacity of model footing in sand", M.Tech dissertation.
5. Hanna, A.M. (1982), "Bearing capacity of foundations on a weak sand layer overlying a strong deposit".Can.Geotech.J, 19.392-396.
6. Hanna, A.M., and Meyerhof G.G. (1980), "Design charts for ultimate bearing capacity of foundations on sand overlying soft clay". Can.Geotech.J, 17(2). 300- 303.
7. Madhav, M.R., and Sharma, J.S.N. (1991). "Bearing capacity of clay overlain by stiff soil", Journal of Geotechnical Engineering, ASCE, 117(12):1941-1948.
8. Meyerhof G.G. (1948), "An investigation of the bearing capacity of shallow footings on dry sand", 2nd international conference on SMEF, Vol. 1, p. 237-241.
9. Meyerhof.G.G. (1974), "Ultimate bearing capacity of footing on sand layer overlying clay". Can.Geotech.J, 11(2), 223-229.
10. Michalowski, R.L., and Shi, L. (1995). "Bearing capacity of footings over two-layer foundation soils", Journal of Geotechnical Engineering, ASCE, 121(5):421-428.
11. Ramasamy, G (1984), Estimation of settlement of footings on sand. A critical Reappraisal" Indian Geotechnical journal, Vol. 14, pp. 112-125.
12. Zhu, F., Clark, J.I., and Phillips, R. (2001)."Scale effect of strip and circular footings on a dense sand". J. Geotech. Geoenvioron Eng., 127(7), 613-621.