Behaviour of Strip Footing Supported By Granular Trench Under Loading

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Abstract- *Rapid and urban growth demands more land for further development. Construction is often required to be carried out in land of poor geotechnical quality. Techniques to improve the performance of footings in such weak soils are presented here. Granular Trench (GT) is a replacement technique where the poor soil immediately below a footing is replaced with a good quality high frictional granular material. In Encapsulated Granular Trench (EGT), sand is confined by encapsulating the same in a geosynthetic wrap. Attempt has been made to pretension the geosynthetic and induces stresses within the encapsulating geosynthetic, which when loaded with footing will oppose the induced stresses. Laboratory UTM test was conducted on strip footings resting on stressed encapsulated granular trench or SEGT. Tests were conducted by varying the density of the filling material, different trench shapes, and different geometry. Triangular trench has more load carrying capacity than rectangular shaped trench that is due to its load distribution pattern. Triangular shaped trench distribute the upcoming load in the form of inverted arch. Medium densed sand condition is most favourable condition for better performance of granular trench. Settlement and bearing capacity of footing increases twice and six times respectively by the addition of granular trench.*

Keywords- Encapasulated granular trench, Granular trench, Geosynthetic, Demolition waste

I. INTRODUCTION

The concept of soil reinforcement is extensively used in many geotechnical structures including retaining walls, embankments, foundations, highways, airport pavements and railway tracks. Strip footings are often supported on granular trenches below the footing level in weak soil. Granular Trench is a replacement technique whereby the weak soil below the footing is replaced with a good quality compacted frictional fill. The improved strength and deformation properties of the replacement material improve the overall performance of the footing resting over it. One of the common ways to increase bearing capacity in weak soils is to use granular trench. Trenching can be built easier, faster and cheaper than deep foundations. It is the plane strain version of a granular pile. A controlled and careful application of granular trenches can yield satisfactory results. The choice of a particular technique depends upon the soil profile at a site, quality of materials used in the technique, nature of pore fluid and the method of implementing the technique.

II. OBJECTIVES

- To determine the index properties of soil
- To determine load settlement behavior of soil
- To determine bearing capacity of soil
- To compare the results before and after modification of soil

III. MATERIALS AND METHODOLOGY

The materials such as beach sand collected from chavakkad beach and demolition waste are collected from the college campus. The strip footing and the tank were made using the galvanized iron with a size of 30 x30 x 30 cm.

The experimental test conducted was compression test using the UTM. The conclusion of this study made from the load settlement curve from the compression test. The bearing capacity of the soil is obtained by dividing the load and the area of the footing. The experiment was done for both medium dense sand and loose sand. The sand bed is placed to the desired thickness at the desired relative density by sand raining technique. The trench of the required size is formed. Geosynthetic is then laid with the ends spread over the sand bed. Then it is filled with demolition waste. The geosynthetic is then folded over the filled trench and is overlapped. On the exposed face a thick layer of sand is placed.

The footing is placed over the completed trench and loaded. Rectangular and the triangular trenches were used to determine, which is the optimum shape to acquire greater the bearing capacity of soil. The geotextiles were laid above the soil experiment was done for both loose and medium dense sand. Conclusion of the study made from load settlement behavior of sand in medium and loose state with rectangular

and triangular trench. Vertical load was applied to the model footing by means of a compression testing machine. Figure shows the experimental set up of the study.

Fig. 3.1 Strip Footing Resting on Sand Bed

IV. RESULTS AND DISCUSSION

The tests for index properties and engineering properties of beach sand and demolition waste were determined by conducting series of laboratory experiments. Magnitudes of the applied load were recorded with the help of a sensitive proving ring of 100kN capacity. To record the vertical settlement of footing for each increment of load applied, one sensitive dial gauges of least count of 0.01mm were used. The settlement was noted for each increment of load. The dial gauges were mounted on the arm of the UTM by means of magnetic bases Properties of sand and demolition waste were tabulated in table 4.1and 4.2.

Table 4.1 Properties of Beach Sand

Soil properties	Values
Specific gravity	2.66
Uniformity coefficient, Cu	2.37
Coefficient of curvature, Cc	0.73
Permeability value	9.17×10^{-4}
Dry density (loose condition), g/cc	1.587
Angle of internal friction (ϕ)	39°

Table 4.2 Properties of demolition waste

Soil properties	Values
Specific gravity	2.5
Uniformity coefficient, Cu	2.30
Coefficient of curvature, Cc	1.0708
Impact value (%)	81.75
Crushing value (%)	25.33

Figure 4.1 shows the load settlement characteristics of footing under load. Considering the shape of trench, rectangular trench fails at 10.5 kN load with a settlement of 25.7 mm and triangular trench with stand the load up to 12.5 kN with settlement 20.7 mm. Figure 16 shows the load settlement characteristics of footing under medium dense sand condition and it can be analyze that the triangular trench has higher efficiency to resist settlement under load than the rectangular trench. Also the footing with trench has high efficiency than the footing without trench.

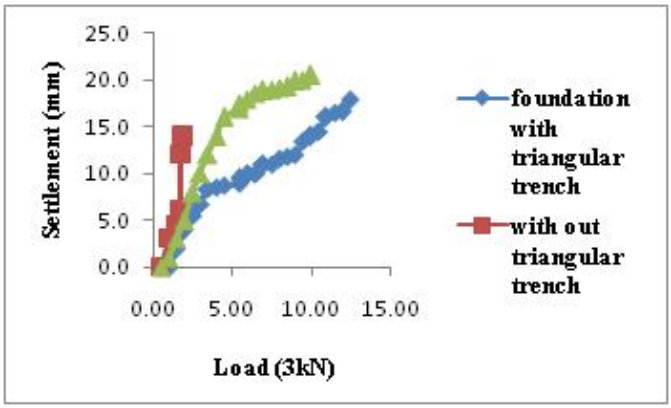

Fig 4.1 Load Settlement Characteristics of Footing under Medium Dense Sand Condition.

Figure 4.2 shows the comparison of load settlement behavior under 3 kN load those which the footing without trench fails. And from the figure it is clear that the footing without trench fails at a load 3 kN whereas the footing with rectangular trench has the settlement 8 mm at 3 kN and triangular trench has 6.7mm at 3 kN. It means triangular trench has more efficiency than the rectangular trench in medium dense sand condition.

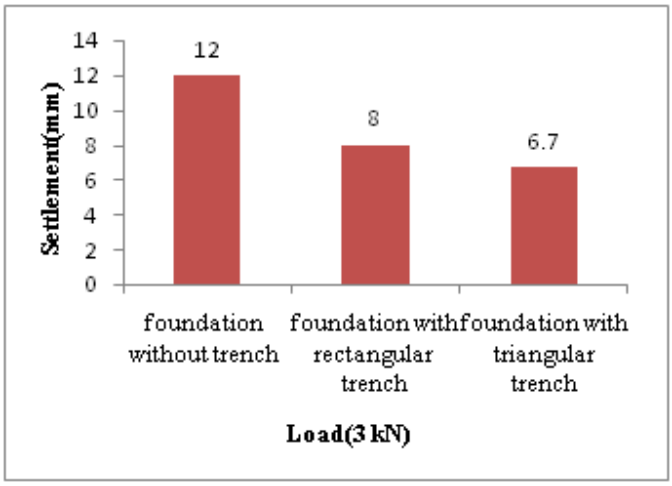

Fig 4.2 Comparison of Settlement of Foundation under 3 kN Load

Figure 4.3 shows the comparison of the bearing capacity of footing with and without trench. It reveals that the footing without trench has lesser bearing capacity than the footing with trench. Trench provides about eight times bearing capacity to footing than without trench. The bearing capacity of footing with triangular trench is high than rectangular footing, it is nearly two times.

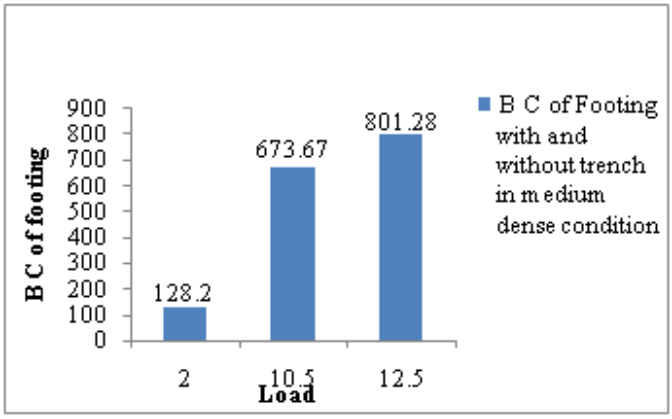

Fig 4.3 Comparison of Bearing Capacity of Footing

In loose sand condition the sand has very low strength and it shear at very small load. From the table it can be analyzed that the footing without trench fails at 1 kN. Considering the shape of trench rectangular trench fails at 4.5 kN load with a settlement of 25.8 mm and triangular trench with stand the load up to 6 kN with settlement 25.2 mm.

Figure 4.4 shows the load settlement characteristics of footing under loose sand condition and it can be analyze that the triangular trench has higher efficiency to resist settlement under load than the rectangular trench.

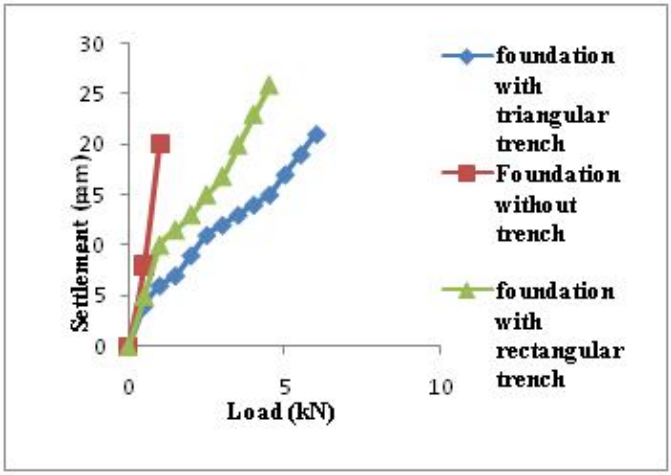

Fig 4.4 Load Settlement Characteristics of Footing under Loose sand Condition

In the figure 4.4 above shows the comparison of load settlement behavior under 1 kN load those which the footing without trench fails. And from the figure it is clear that the footing without trench fails at a load 3 kN whereas the footing with rectangular trench has the settlement 8 mm at 3 kN and triangular trench has 10mm at 3 kN. It means triangular trench has more efficiency than the rectangular trench in loose sand condition. And also the footing with trench provides better performance than footing without trench. Figure 4.5 shows the comparison of the bearing capacity of footing with and without trench. It reveals that the footing without trench has lesser bearing capacity than the footing with trench. Trench provides about six times bearing capacity to footing than without trench. The bearing capacity of footing with triangular trench is higher than rectangular footing, it is nearly four times.

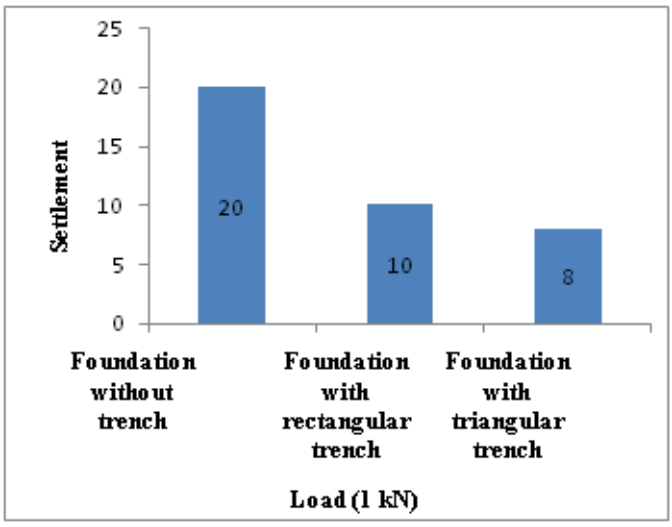

Fig 4.5 Comparison of the Bearing Capacity of Footing

V. CONCLUSIONS

This study made a comprehensive examination of the effectiveness bearing capacity on the addition of granular trench to the soil strata. Following are the important conclusions made from this experimental study

- Index properties and engineering properties were determined

- **Medium dense sand condition:**

- ✓ Load carrying capacity of foundation with granular trench is increased about four times than foundation without granular trench
- ✓ Settlement of foundation is reduces about twice the foundation without granular trench
- ✓ Bearing capacity of soil increases about six times by using granular trench

- **Loose sand condition:**

- ✓ Load carrying capacity and settlement of foundation with granular trench is increased about twice than foundation without granular trench
- ✓ Bearing capacity of soil increases about four times by using triangular granular trench and six times when using rectangular granular trench
- ✓ Triangular trench performs more better than rectangular trenches
- ✓ Medium dense sand condition is the more favorable condition for footing supported by granular trench

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