Effect of anchor system on bearing capacity of coir geotextile reinforced beds

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ABSTRACT: Scarcity of land with good bearing capacity is one of the major problems the world faces now. This leads to the construction of buildings on available land which may not be good with respect to its bearing capacity. For safety of buildings it is there for necessary to improve the quality of ground by the adoption of some suitable ground improvement technique. The method of ground improvement technique adopted depends on the soil to be treated and the availability of materials required for improving the soil and also on the cost effectiveness. Development of suitable ground improvement technique has been one of the major challenges of geotechnical engineers for more than a century. Effort of geotechnical engineers is to develop technically viable and economically feasible methods to improve the properties of soil to suit the requirements of engineering structures. In this present study, the effect of coir geotextile anchor system on ultimate bearing capacity is investigated by a series of plate load tests in the laboratory. The influence of parameters such as number of geotextile anchor system, width of geotextile and distance between geotextile layers in sand bed is studied. It has been observed that an increase in bearing capacity and reduction in the foundation settlement with increase in width and number of layers.

Keywords: Natural geotextile, Anchor system, Bearing capacity, Settlement

1 INTRODUCTION

Ground improvement is the field in which the engineer forces the ground to adapt to the project's requirement instead of altering the design to suite the natural limitation of the ground. Development of ground Improvement techniques has been one of the major challenges of geotechnical engineers. As a result of these challenges several methods have been developed, which can be mainly grouped as mechanical modification, hydraulic modification, chemical modification and modification by inclusion and confinement. By suitable ground improvement technique the bearing capacity of soil is considerably increased and thus reduces the foundation settlement.

Implementation of coir geotextiles in civil projects is increasing rapidly. Now-a-days natural material is introduced as reinforcement to improve the engineering properties of soil. Coir is a natural fiber extracted from the husk of coconut and is found between the hard, internal shell and the outer coat of coconut. Several studies have been reported on stabilization of soil using coir fiber. Coir is an easily available material in India and is found to be stronger and durable compared to other natural fibers. One of the uses of this soil reinforcement element increases the ultimate bearing capacity (UBC) and also decreases the foundation settlement. The use of reinforcement elements increases the resisting forces in the soil mass through tensile forces mobilized in these elements. By changing the traditional coir geotextile structure and adding nail and washer as anchor to the reinforcement geotextile, this system is called "geotextile-anchor" system (G-A).

In this study, investigation is carried out on the reinforcing efficiency of coir geotextile anchor system within a homogeneous sand bed supporting a circular footing. In addition the factors affecting the performance of coir geotextile anchor system is also investigated.

1.1 *Scope of the study*

Geosynthetic reinforced granular soil system is being used as the foundation for residential houses, industrial buildings, unpaved roads and other lightly loaded structures. Geosynthetic products have a long life and do not undergo biological degradation, but are liable to create environmental problems in the long run. Throughout the world growing awareness of the sustainable development to preserve the environment has led to the rehabilitation of areas damaged either by natural or industrial causes. In effecting this, the use of natural and biodegradable materials is gaining popularity. It is found that the synthetic materials can be replaced by naturally available materials like coir. But no many studies are conducted to study the settlement behaviour of the coir geotextile anchoring system as reinforced soil. Therefore this study is intended to bring out the effectiveness of natural and biodegradable coir geotextile anchoring system as reinforcement in soil. The present study aims to determine the effect of coir geotextile anchor system on ultimate bearing capacity and effect of varying width of geotextile, number of geotextile anchor layer and distance between layers.

1.2 *Objectives*

The objectives of the present study are

- To find out the bearing capacity of the soil using coir geotextile anchoring system by conducting plate load test
- To study the effect of varying,
  - Distance between the layers
  - Width of geotextile
  - Number of geotextile layer

2 EXPERIMENTAL METHODOLOGY

2.1 *Materials used*

Coir which is abundantly available in India, especially in Kerala has been used to develop the geotextile. River sand, which is easily available in Trivandrum, has been used as bed to geotextile to carry out the entire tests. Natural Plane weaven coir woven geotextiles were used. It was obtained from Alappuzha, Kerala, India. Coir Board specification of the material is H2M5. Table 1 shows the properties of coir geotextile. The coir geotextile and nail and washer (anchor) shown in Figures 1 and 2 respectively. Dry river sand passing through IS sieve 4.75 mm was used for the entire experimental program. The sand was classified as poorly graded sand. Properties of sand used for the present study are listed in Table 2.

Table 1. Properties of coir geotextile (H2M5)

Parameters	Value
Mass per unit area (gsm)	659
Thickness (mm)	7.82
Opening size (mm x mm)	20 x 15

Figure 1. Coir geotextile- H2M5

Figure 2. Anchor (Nail and washer)

Table 2. Properties of sand

Description	Value
Specific gravity	2.65
Coefficient of uniformity (C_u)	2.1
Coefficient of curvature (C_c)	0.9
Effective particle size, D_{10}(mm)	0.29
Soil classification	SP

2.2 *Laboratory model tests*

Plate load tests were conducted in a test bed cum loading frame assembly in the laboratory. Soil beds were prepared in the tank with inside dimensions 0.6 m x 0.6 m x 0.5 m. Model footing used was of 20 mm thick rigid square steel plate having width (B) 120 mm size. Footing was loaded with hydraulic jack supported against the reaction frame. The test setup is shown in Figure 3.

Figure 3. Plate load test set up

2.3 *Methodology*

After filling the tank, the surface was leveled and the test plate was placed centrally over the prepared soil bed such that the load from the loading jack was transferred concentrically to the footing. The magnitude of the loads applied was recorded with the help of sensitive precalibrated proving ring of 10kN capacity placed between the hydraulic jack and the reaction beam. Settlement of the footing was measured by two sensitive dial gauges which were placed on each sides of a rigid steel spacer. The dial gauges were mounted on a rigid steel channel section by means of magnetic bases. The settlement reported are the average of two dial gauge readings which were nearly identical. Before starting each test, the tank was fully emptied and replaced according to the test requirements. The reinforced sand bed was prepared in the tank. After placing the coir geotextile in the correct position by centering, the sand was filled at a relative density of 50% and a unit weight of 15kN/m^3. The height of fall to achieve the desired relative density was determined earlier by performing a series of trials with different height of fall. Different series of tests were carried out by varying different parameters such as distance between the layers (h), width of geotextile (b), number of geotextile layer(N). The height of sand layer above the first geotextile (u) and the width of anchoring (d) were kept constant in all the tests as u = 2 cm and d = 20 cm.

3 RESULT AND DISCUSSION

Results obtained from series of tests are presented as pressure - settlement curves. The pressure - settlement response of reinforced and unreinforced soil beds is shown in Figure 4. From the figure, it can be seen that the slope of the curves decreases with the addition of the coir geotextile. It further decreases with the incorporation of anchors. This implies that the strength improves by the addition of the anchor system.

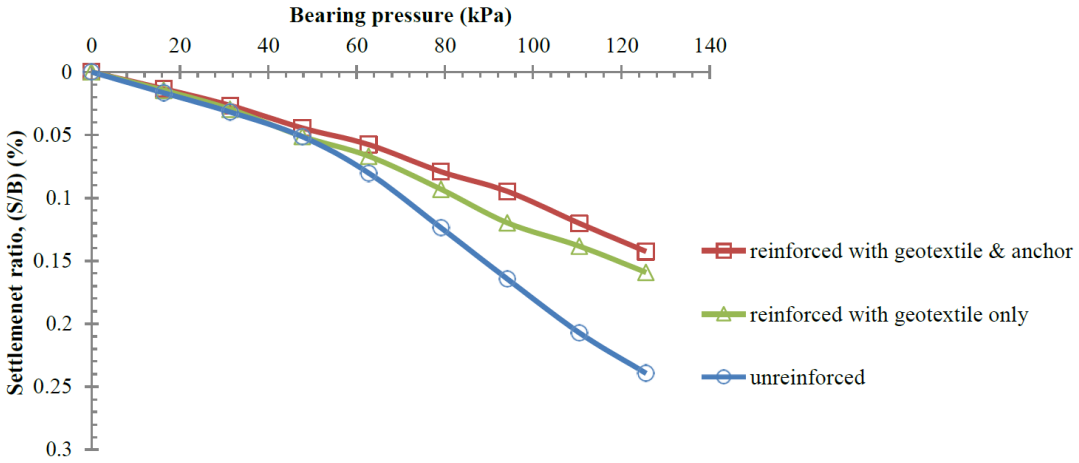

Figure 4. Variation of bearing pressure with footing settlement for unreinforced and reinforced soil

3.1 *effect of number of anchored coir geotextile*

The performance improvement due to the provision of coir geotextile reinforcement is represented using a non-dimensional improvement factor, termed as bearing capacity improvement factor (IF) which is defined as the ratio of bearing pressure with coir geotextile anchoring system at a given settlement to the corresponding pressure of unreinforced soil at the same settlement.

Bearing capacity improvement factor versus settlement curve for different number of anchored geotextiles is shown in Figure 5. From the figure, it can be seen that the bearing capacity of soil increases with increase in the number of anchored geotextiles. From the Figure, it is clear that increasing the number from 1 to 4, the bearing capacity of soil improved by 1.4 times.

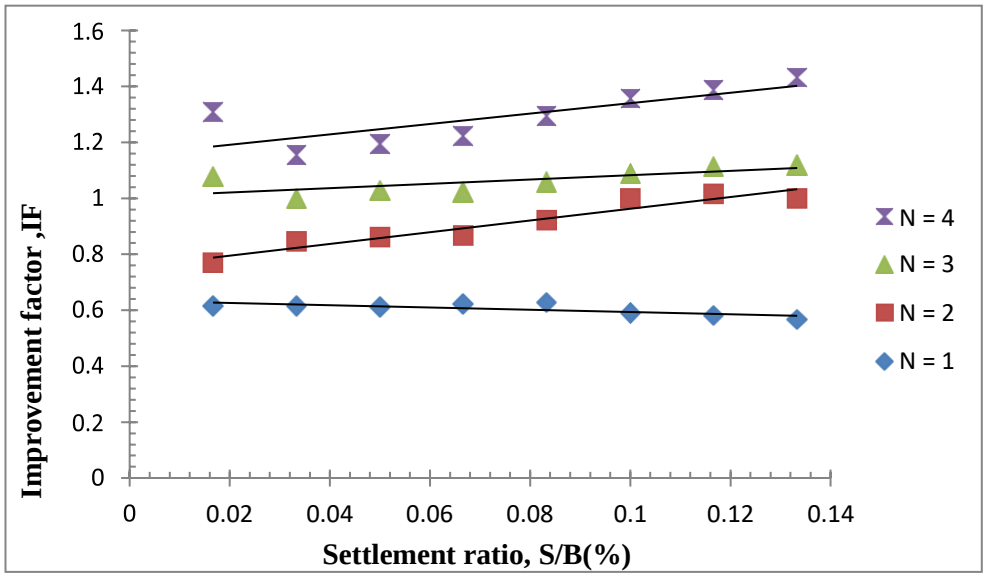

Figure 5. Variation of IF with footing settlement for different layers

3.2 *Effect of width of anchored coir geotextile*

The width of the anchored geotextile is non-dimensionalised as a ratio termed as width ratio, b/B where b is the width of the geotextile and B is the width of the plate. Experiments were conducted for b/B = 4.2 and 5. The bearing capacity improvement factor for anchored geotextile reinforced soil by varying width of geotextile for various settlements with respect to the sand bed is presented in Figure 6. From figure, it is clear that for a width ratio is increased from 4.2 to 5, the bearing capacity of soil is improved.

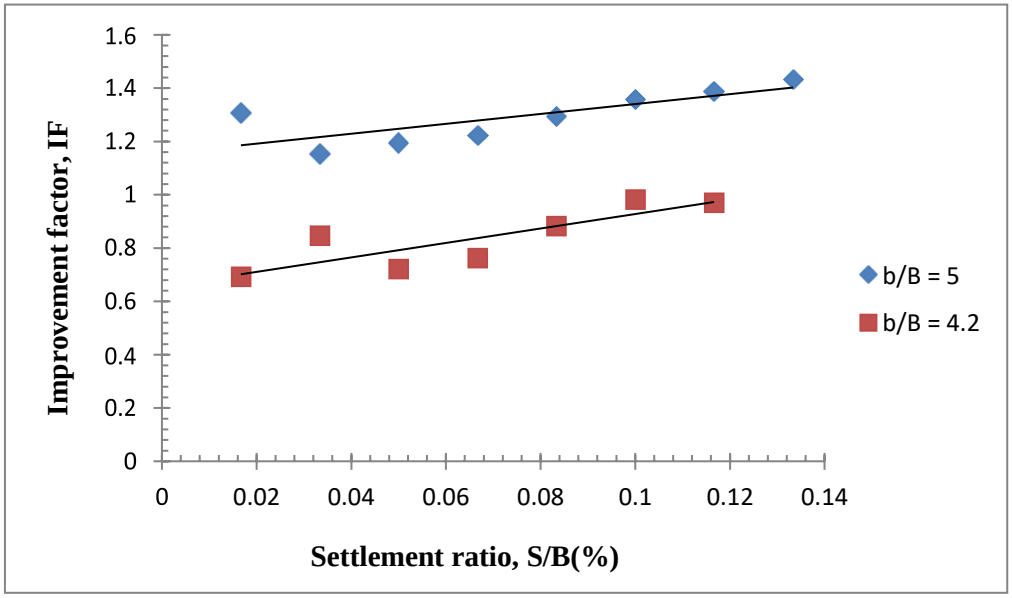

Figure 6. Variation of IF with footing settlement for different width of geotextiles

3.3 *Effect of distance between anchored layers*

The bearing capacity improvement factor by varying the distance between the anchored layers with respect to width of foundation is presented in Figure 7. From figure, it is clear that as h/B reduces, the bearing capacity of soil improves. The improvement is nearly 1.4 times at smaller spacing between the layers.

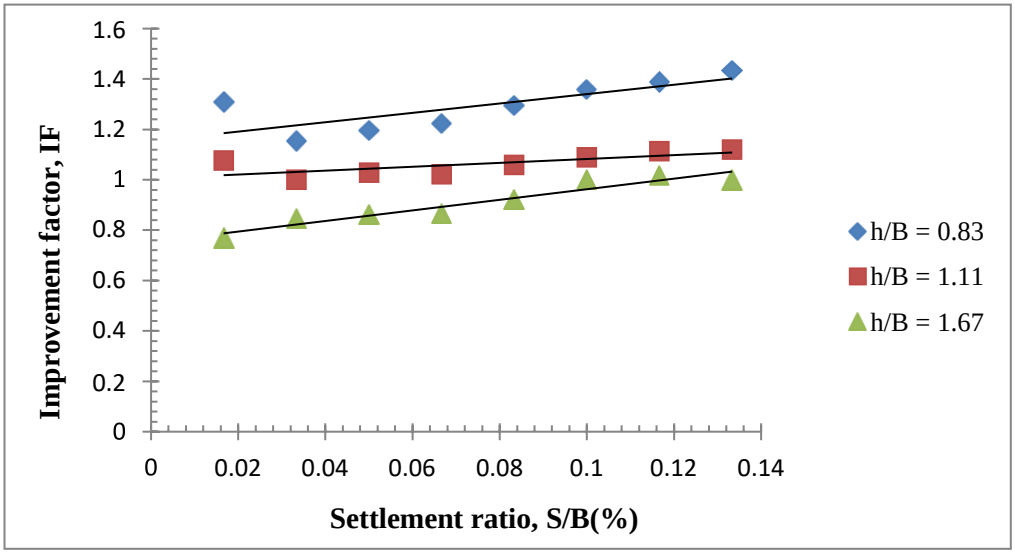

Figure 7. Variation of improvement factor with footing settlement for varying spacing of geotextile with anchors

4 CONCLUSION

It has been seen that anchoring coir geotextile with nail and washer helps in improving the bearing capacity. A series of tests were conducted by varying different parameters such as distance between the layers (h), width of geotextile (b) and number of geotextile layer (N). The bearing capacity increases with the addition of coir geotextiles with anchor system on soil than that of unreinforced soil. The bearing capacity of soil increased with increase in the number of geotextiles with anchor. As the number of geotextile layers increases from 1 to 4, the bearing capacity of soil improved by 1.4 times. The bearing capacity is improved for anchored geotextile reinforced soil for a width ratio equal to 5. As the spacing between the layers decreases from 1.67B to 0.83B, the bearing capacity increases and the improvement is nearly 1.4 times at smaller spacing between the layers. Also the settlement reduces with increase in number of layers, width and distance between geotextile layers.

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