Confinement Effect of Coir Geocells on Sand Samples Under Triaxial Compression

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***Abstract*—Use of natural geotextiles in geotechnical engineering purpose is advantageous as they are cheap and locally available. This paper studies the effects of coir reinforcement on the strength improvement of geosynthetic-reinforced sand through triaxial compression tests. Shear strength of the soil sample is vastly improved with the provision of geocells. This is mainly due to the confinement effect provided by the geocells. To understand the mechanism behind this, triaxial compression tests were conducted on 100 mm x 200 mm samples. From the results, it has been observed that friction angle improved for all the reinforced samples. The post-peak value of strength is also higher compared to the unreinforced samples. The results show that stiffness characteristics were significantly improved with the provision of reinforcement.**

Keywords*—Natural geotextiles; coir reinforcement; triaxial compression tests; geocells; friction angle.

I. INTRODUCTION

Reinforced soil has been widely used in geotechnical applications due to its cost-saving, ease of construction and better visual appearance compared to other ground improvement methods. Natural geotextiles such as jute, coir, and bamboo, as reinforcing materials in soil is gaining widespread acceptance and they are abundantly used in many developing countries like India, Srilanka, etc. These material offer the advantages such as biodegradability, availability etc. They are biodegradable and hence do not create disposal problems in the environment. Of all the natural fibers, coir has the greatest tearing strength and retains this property even in wet conditions. The rate of decomposition of coir fiber is generally known to be less than that of any other natural fibers, such as jute, cotton, and others, due to the high lignin content. Coir retains 20% of its strength even after one year. Numerous researchers have examined the effect of coir reinforcement on soil [1-6]

Geocells are three-dimensional, polymeric, honey-comb like structure of cells interconnected by joints. They are used as reinforcement materials for embankments, on steep slopes and in applications where the soil should withstand high tensile stresses. Various studies were reported on the use of geocells [7, 8].

This paper reports the results from a series of triaxial compression tests carried out on sand confined with single coir geocell. The main aim of the experimental program is to determine the improvement in the strength and stiffness characteristics of soil reinforced with geocell.

II. TEST MATERIALS

Uniform, clean sand near NIT Calicut was used for the study. It is seen that the particle sizes of the sand mainly ranged between 0.25–1 mm. The sand has a relatively uniform grain-size distribution with median grain size (D50) of 0.78 mm and coefficients of uniformity (Cu) and curvature (Cc) of 3.1 and 0.92, respectively. The coir geotextiles used in the study were obtained from Alappuzha. Photograph of coir geocell is shown in Fig. 1.

Fig. 1. Photograph of coir geocell

III. RESULTS AND DISCUSSIONS

Triaxial compression tests were carried out on sand confined with single geocell. Fig. 2 shows the stress-strain plot of unreinforced sand and sand reinforced with coir geocell at 100 kPa. In the case of sand reinforced with geocell, failure started at mid-height of the sample by the bursting of the seam and progressed to the full-height along the joint. This bursting of the seam was audible for most of the tests. It is evident that the strength improvement in sand due to geocell depends on the properties of reinforcement. It is clear from the figure that the

geocell has exhibited stronger and stiffer response compared to the unreinforced sand. Failure strain also increased with the provision of reinforcement. The post-peak loss of strength is also far less in the case of geocell reinforcement when compared to unreinforced sand. In addition to the increase in the strength of soil, there was a corresponding increase in the stiffness of the soil, which is indicated by steeper stress-strain curve in Fig. 2. Because of the additional confining pressure on the soil due to the membrane stresses, the peak stresses occurred at larger strains. This is similar to the unreinforced soils developing peak stress at higher strains at higher confining pressures.

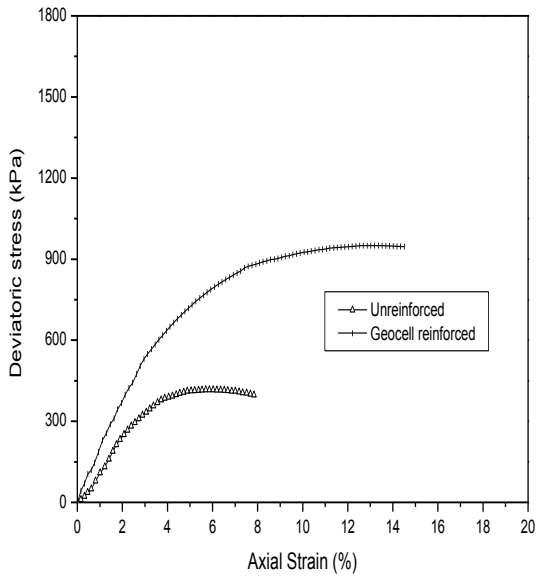

Fig. 2. Stress-strain behavior of unreinforced and reinforced sand at 100 kpa

IV. CONCLUSIONS

This study has employed tests on geocell-reinforced sand subjected to triaxial compression to examine the confinement effect of geocells. It was found that the confinement effect provided by geocells related mainly to the mobilization of the tensile strength in the geocells, which varies with the volumetric strain induced. The findings are summarized as follows.

a) Reinforced samples showed improvement in peak deviatoric stress.
b) Reinforced samples showed an increase in stiffness and strength properties.
c) An increase in the failure strain was observed in the case of reinforced samples.
d) Reinforced samples imparted cohesive strength to the sample.
e) The post-peak value of strength is higher than the unreinforced samples.

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REFERENCES

[1] P. Vinod, A. B. Bhaskar, and S. Sreehari, "Behaviour of a square model footing on loose sand reinforced with braided coir rope," *Geotext. Geomembr*., 27(6), 464–474 (2009).

[2] B. Ajitha, and T. Jayadeep, "Interfacial frictional properties of geotextiles and bio-mats," *Proceedings of Indian Geotechnical Conference*, Vadodara, 287-290 (1997).

[3] E. A. Subaida, S. Chandrakaran, and N. Sankar, "Laboratory performance of unpaved roads reinforced with woven coir geotextiles," *Geotext. Geomembr*., 27(3), 204–210 (2009).

[4] G. V. Rao, and K. Balan, Coir Geotextiles—Emerging Trends, The Kerala State Coir Corporation Ltd, Alappuzha, Kerala (2000).

[5] E. A. Subaida, S. Chandrakaran, and N. Sankar, "Experimental investigations on tensile and pullout behaviour of woven coir geotextiles," *Geotext. Geomembr.*, 26(5), 384–392 (2008).

[6] G. L. Sivakumar Babu, and A. K. Vasudevan, "Strength and stiffness response of coir fiber-reinforced tropical soil," *J. Mater. Civ. Eng*., 20(9), 571–577 (2008).

[7] R. J. Bathurst, and R. Karpurapu, "Large-scale triaxial compression testing of geocell reinforced granular soils," *Geotech. Test. J.*, ASTM 16 (3), 296–303 (1993).

[8] K. Rajagopal, N. R. Krishnaswamy, and G. M Latha, "Behavior of sand confined with single and multiple geocells," *Geotext. Geomembr*. 17, 171–184 (1999).