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Experiment on soil properties made with geocell-shredded tyres reinforced sand

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ABSTRACT

Soil reinforcement is one of the most popular ground improvement techniques. Availability of different material and techniques for reinforcement is one of the major reasons for the continuous increase in the application of the soil reinforcement. Rapid industrialization is full filling the need of the present time and it is also producing a huge amount of waste under the present investigation, a detailed parametric study through a series of triaxial experiments has been carried out to develop an understanding of the behavior of geocell-shredded tyres reinforced sand under triaxial loading. The influence of various parameters pertaining to geocell- shredded tyres reinforced soil such as relative densities (i.e., 30%, 50%, 70%), confining pressures (i.e., 50kPa, 100kPa, 200kPa), types of geocells (i.e., M=4.79, 3.23), and shredded tyres content (i.e., 10%, 20%, 30%, 40%) have been studied extensively in a systematic manner. The results of the triaxial tests show that the stiffness and the load carrying capacity of the soil improve substantially with the provision of shredded tyres reinforcement in content 10% and 20% respectively while results of tyre content 30% and 40% show less stiffness and the load carrying capacity of the soil. The stiffness and load carrying capacity of the soil also improves with the provision of reinforcement of soil using geocells and also improves with the provision of reinforcement of soil using geocell-shredded tyres. When geocells are used with shredded tyres for reinforcement of soil then improved results have been seen in 10%, 20%, and 30% tyre content as compare to geocell reinforcement of soil without shredded tyres. While 40% of tyre content shows less load carrying capacity as compare to lesser contents of shredded tyres.

Keywords— *Sand, Geocell, Shredded tyres, Specific gravity, Triaxial compressive test, Shear test*

1. INTRODUCTION

The behaviour of soil is the most important parameter which we have to consider before the construction of any type of civil engineering structure. Problems regarding construction on soils arise from their lack of strength which manifests itself in their deformation, which beneath foundations takes the form of settlement, or in some exceptional circumstances gives rise to ground failure. Problems are also associated with water in the soil. Leaning Tower of Pisa is also an example of failure due to excessive settlement (Fig. 1.1). Construction of embankments over weak, relatively thin foundation soils often poses problems for designers and contractors. Failure due to the inadequacy of properties of soft soil, due to swelling and shrinkage of soft soils and due to differential settlement of buildings are some of the failures associated with the construction of structures on soft soils. There are several problems like scarcity of suitable construction sites, inadequate mechanical properties of soil, collapsible soils etc. forces engineers to become more innovative and to utilize new products for improving the soil properties. To mitigate these problems related to soft soil several techniques were introduced like provision of piled foundation, excavation and replacement with good quality soil, preloading with vertical drains, stone columns etc. The engineering treatment of soils involves improving their geotechnical character for construction purposes. Hence soil treatment is primarily concerned with enhancing its Strength. The ground can be improved by several methods like compaction, dewatering, reinforcement, and admixture or grouting. All these methods are used as per site requirement by considering the economy and feasibility of the method. Soil reinforcing technique is widely gaining acceptance as a viable alternative to other ground improvement techniques. Economical and Simple construction process are major advantages of reinforcement technique.

2. MATERIALS USED

2.1 Sand

The sand used in the study is locally available river sand whose particle size distribution [ASTM D 6913-04]. The coefficient of uniformity (C_u) and coefficient of curvature (C_c) are found to be 2.05 and 0.95 respectively. The soil can thus be classified as poorly

graded sand (SP) as per the Unified Soil Classification System (USCS) [ASTM D 2487-06]. The physical properties of sand such as specific gravity [ASTM D 0854-06], maximum dry density [ASTM D 4253- 00] and minimum dry density [ASTM D 4254-00] are reported in Table 3.1. Direct shear tests as per ASTM D 6528-07 were performed on samples prepared at relative densities (ID) of 30%, 50% and 70% and the variation of normal stress with peak shear stress is presented in figure 2.

2.2 Shredded Tyres

The tyres used in the study are recycled tyres manufactured in a recycling plant whose particle size distribution [ASTM D 6913-04] is shown in figure 3. The coefficient of uniformity (C_u) and coefficient of curvature (C_c) was found to be 3.74 and 0.86 respectively.

2.3 Geocell

Geocells are fabricated by stitching the textiles into cylindrical shapes whose diameter and height are the same as that of diameter and height of the sample i.e. (38 mm diameter and 76 mm height). Two different types of geosynthetics G1 and G2 were used in this study. The materials are basically geotextiles. For stitching the geocells nylon threads have been used throughout the experiment. Single stitching was used and the numbers of stitches were also kept constant throughout the experiment.

3. RESULT AND DISCUSSION ON EXPERIMENTAL TESTS

To evaluate the behaviour of geocell-tire crumbs reinforced sand a series of triaxial tests are conducted in this study. Four different series of tests A, B, C, D were conducted. Tests were conducted on Unreinforced, geocell reinforced; tire crumbs reinforced and geocell-tire crumbs reinforced soil. Tests on the unreinforced sand were performed to evaluate the reinforcing potential of a different form of the reinforcement. Variable parameters considered in this study are types of reinforcement, stiffness of geocell membrane, the relative density of soil, tire content and confining pressure. In this study, all the tests were performed under unconsolidated undrained conditions. Size of the triaxial test specimen in this study is considered of diameter 38 mm and of height 76 mm. All tests were conducted on the confining pressure of the 50 kPa, 100 kPa, and 200 kpa To understand the effect of the stiffness of geocell membrane two types of geotextile having different stiffness will be used for the preparation of the geocell. To evaluate the effect of density of soil on the performance of geocell-tire crumbs reinforcement three different relative densities 30 %, 50% and 70% which represents the loose, medium dense and dense condition of the soil is considered. Four different 15%, 30%, 60% and 100% content of tire crumbs are considered to understand the effect of tire crumbs content.

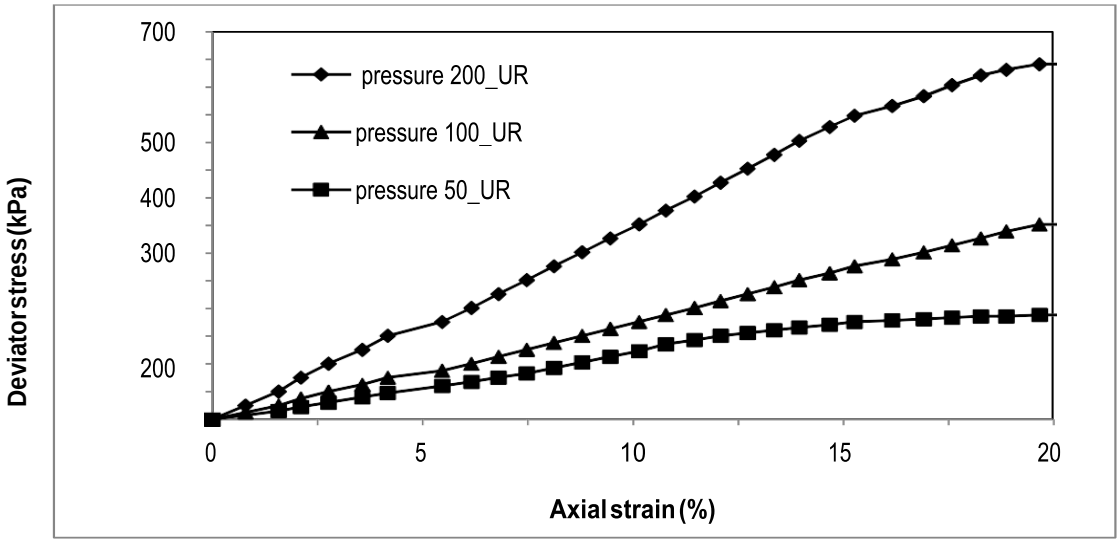

Fig. 1: Stress-strain behaviour of sand under triaxial compression test (relative density = 30 %)

3.1 Effect of the stiffness of the membrane

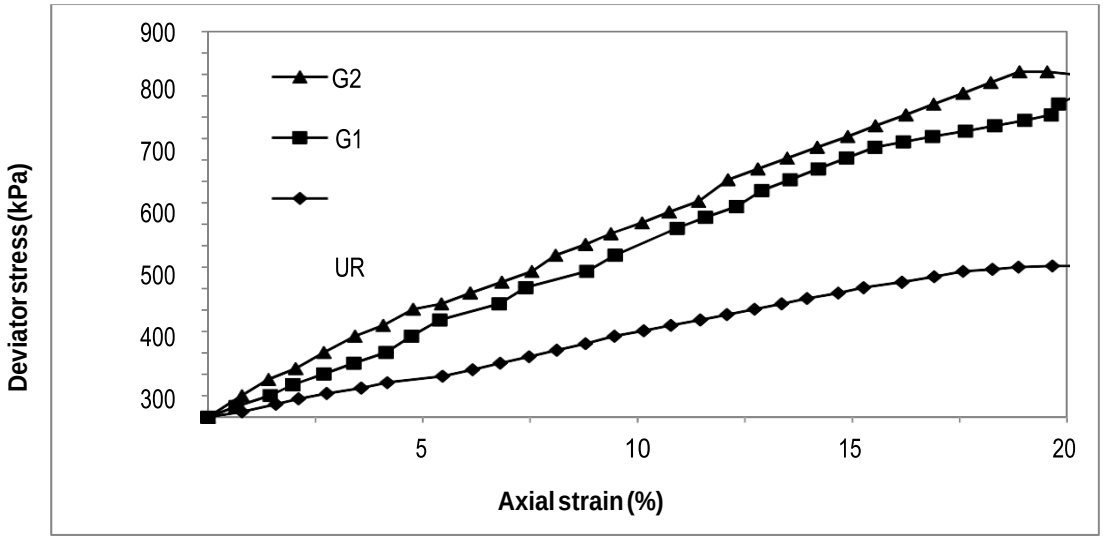

Fig. 2: Stress-Strain behaviour of sand using different Geocells (relative density 30%, confining pressure =100kPa).

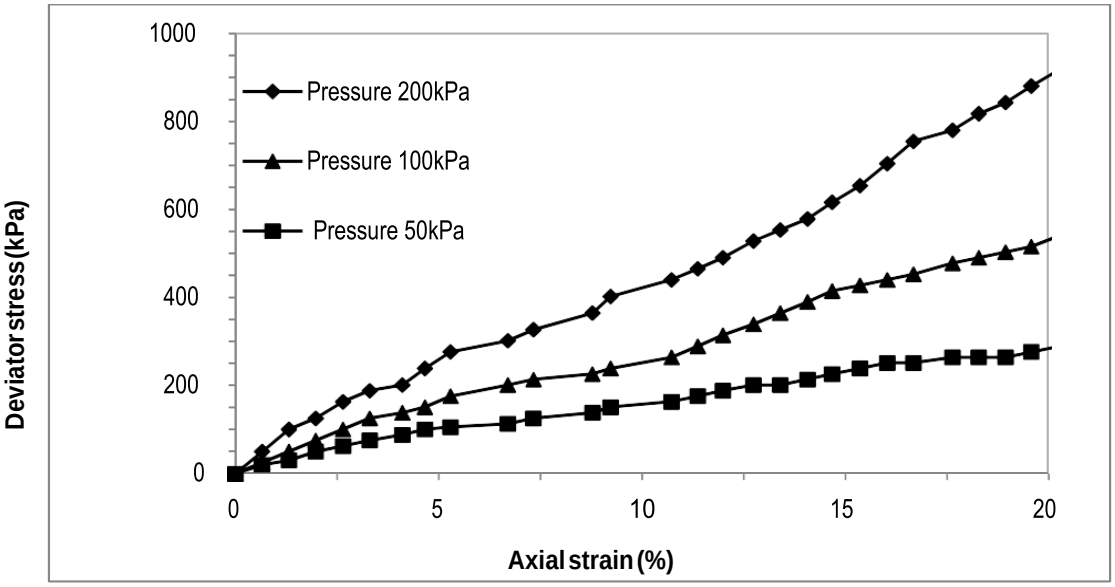

Fig. 3: Stress-strain behaviour of sand mixed with different confining pressure under triaxial compression test at 20% tyre content (Relative density = 30 %

In this chapter result of geocell-shredded tyres, reinforced soil is presented and discussed. The parameters considered are stiffness of geocell membrane, the relative density of soil and confining pressure. Geocell-shredded tyres improve the soil through cohesion. The angle of friction doesn't change much.

4. CONCLUSIONS

Based on the results obtained from the present investigation, the following major conclusions can be made on the behaviour of reinforcement of soil using different materials i.e. geocell and shredded tyres.

- Soil sample having a relative density 70% shows more stiff behaviour and shows more strength than the sample having a relative density of 30% and 50%. But soil sample having relative density 70% shows sudden failure or brittle failure at less axial strain because of fewer voids, while sample having relative density 30% and 50% show ductile failure.
- The shredded tyres reinforced soil at tyre content 10% and 20% exhibit a much stronger and stiffer behaviour compared to the unreinforced cases. Results show that tyre content below 20% gives about 1.2 times more strength than unreinforced sand. While tyre content more than 20% shows less strength carrying capacity.
- Friction angle of soil-shredded tyre mixture is less as compared to soil alone but the overall strength of the reinforced soil is more because of more cohesion between the particles.
- When soil is reinforced with shredded tyres failure will occur at more axial strain than unreinforced soil.
- As we increase the tyre content in soil tyre mix than axial strain at failure increases about 1.3 times as compared to soil only.
- Geocells reinforced soil exhibits a much stronger and stiffer behaviour as compared to unreinforced soil. Results show that with the inclusion of geocell for reinforcement of soil gives about 2.75 times more strength than unreinforced sand. With the inclusion of geocells as reinforcement material, the friction angle does not change.
- The geocell encasement is found to induce an apparent cohesion to the sand leading to improved load carrying capacity. This apparent cohesion is found to increase with the increase in relative density of soil and strength of geocell material.
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5. REFERENCES

[1] A Nakhaei,S.M.Marandi , S.SaniKermani and M.H.Bagheripour(2012)." Dynamic properties of granular soils mixed with granulated rubber." Soil Dynamics and Earthquake Engineering 43 (2012) 124–132.

[2] Priyadarshee and S. K., Dash(2013)."Behaviour of geocell reinforced granular soil." Proceedings of Indian Geotechnical Conference December 22- 24,2013, Roorkee.

[3] Aminaton Marto, Mohsen Oghabi and Amin Eisazadeh(2013)." Effect of Geocell Reinforcement in Sand and Its Effect on the Bearing Capacity with Experimental Test; A Review."EJGE Vol. 18 [2013] 3501-3516.

[4] Asha M Nair and G. Madhavi Latha(2011)." Bearing resistance of reinforced soil–aggregate systems." Proceedings of the Institution of Civil Engineers Ground Improvement 164 May 2011 Issue GI2 Pages 83–95.

[5] Ayse Edincliler, Ali Firat Cabalar, Ahmet Cagatay and Abdulkadir Cevik(2012)." Triaxial compression behavior of sand and tire wastes using neural networks." Neural Comput & Applic (2012) 21:441–452.

[6] Bathurst, R.J., and Jarrett, P.M. (1993). "Large-scale triaxial compression testing of geocell-reinforced granular soils." Geotechnical testing journal, 16(3), 296-303.

[7] Ben A. Leshchinsky(2011)."Enhancing Ballast Performance using Geocell Confinement." Geo-Frontiers 2011 © ASCE 2011, 4693-4702.

[8] Bush, D.I., Jenner, C.G., and Bassett, R.H. (1990). "The design and construction of geocell foundation mattress supporting embankments over soft ground." Geotextiles and Geomembranes, 9(1), 83-98.

[9] Carroll, Jr, R.G., and Curtis, V.C. (1990). "Geogrid connections." Geotextiles and Geomembranes, 9(4-6), 515-530.

[10] Chandan Basu and Jitendra Kumar Soni(2013).”Design approach for geocell reinforced flexible pavements.” highway research journal, July – December 2013.

[11] Chen Yun-min, Cao Wei-ping and Chen Ren-peng(2008).” An experimental investigation of soil arching within basal reinforced and unreinforced piled embankments.” Geotextiles and Geomembranes 26 (2008) 164–174.

