USE OF PLASTIC BOTTLE AS GEOCELL FOR IMPROVING GROUND CHARACTERISTICS

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Introduction:

India's plastic waste management scenario presents a concerning challenge. Current statistics reveal that only 8% of the country's plastic waste is recycled, and projections suggest that by 2035, the recycling rate might only marginally increase to 11% if the present trend persists. Consequently, India's plastic consumption is anticipated to surge from 24.1 million tons to a staggering 70.5 million tons by 2035 (The Week magazine by Mohit Sharma). This alarming rise can be attributed to the global population growth, which fuels the demand for plastic-containing products. In the realm of geotechnical engineering, a class of materials known as geosynthetics, comprising natural or polymeric substances, is employed in conjunction with rock, soil, or other related materials. Geocells, a specific type of geosynthetic, are three-dimensional honeycomb-like polymeric structures extensively utilized in civil engineering applications.

However, this study explores an innovative approach by repurposing discarded plastic bottles as an alternative to conventional geocells, thereby contributing to sustainable development and environmental protection while addressing the plastic waste challenge. This study aims to investigate the behaviour of circular footing subjected to incremental loading when resting on both reinforced and unreinforced sand beds. The circular footing has dimensions of 10 cm diameter and
1.2 cm thickness. Geocells, serving as reinforcing materials, are positioned at varying depths beneath the footing. The sand beds are prepared using the rainfall technique to achieve different

densities. The experimental setup consists of a wooden box measuring 60cm x 60 cm x 60 cm, within which the tests are conducted. The key variables

under consideration include the number of geocell layers (N=0,1,2,3), the height of reinforcement placement (ranging from 1.5 cm to 3.0 cm), and the varying sand densities. By systematically altering these parameters, the study seeks to gain a comprehensive understanding of the influence of geocell reinforcement on the load-bearing capacity and settlement characteristics of circular footings supported by sand foundations.

Objectives:

The literature review undertaken for this study revealed a research gap, as limited scholarly investigations have explored the effects of varying sand densities and employing different numbers of geocell layers as reinforcement. Consequently, this project aims to bridge those gaps by conducting experiments that systematically evaluate the performance of circular footings on reinforced sand beds with diverse densities and utilizing multiple geocell layer configurations. Hence the objectives of this study are:

- To analyze the performance of circular footing on sand bed with and without reinforcement by varying parameters such as number of layers 0,1,2,3 and different densities of 18.96kN/m^3 and 19.32kN/m^3.
- To study the effect on load bearing capacity for different L/D ratios of 0.21,0.28,0.35,0.42.

Methodology:

The present investigation was carried out in the geotechnical engineering laboratory of civil engineering department, S. G. Balekundri Institute of Technology, Belagavi. The study commenced with the collection of river sand and waste plastic bottles as the primary materials. A test tank measuring 60cm x 60cm x 60cm was prepared to facilitate the experiments. The experimental setup was carefully assembled, comprising a 3-ton capacity screw jack, a proving ring, a dial gauge, the test tank, and a circular model footing with a 10cm diameter and 12mm thickness. Preliminary tests, including sieve analysis and direct shear tests, were conducted on the sand to characterize its properties. The core experiments involved performing load tests on sand beds with varying densities and different numbers of geocell layers (0, 1, 2, 3) constructed using the waste plastic bottles. The L/D (length to diameter ratios) ratios are 0.21,0.28,0.35,0.42. The load-carrying capacity of reinforced and unreinforced sand beds was compared to evaluate the reinforcing effects of the geocells. Additionally, the influence of the number of geocell layers on the load-bearing capacity was investigated. Furthermore, the depth of settlement for different L/D ratios

were analysed to gain insights into the deformation behaviour under loading conditions. Upon completion of the experiments, a comprehensive comparative analysis was conducted to evaluate the bearing capacities and settlement behaviors exhibited by the reinforced sand beds

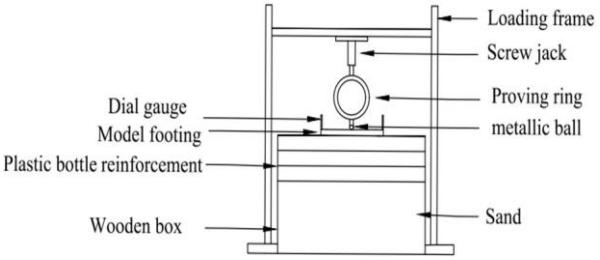

Fig.1 Experimental setup line diagram

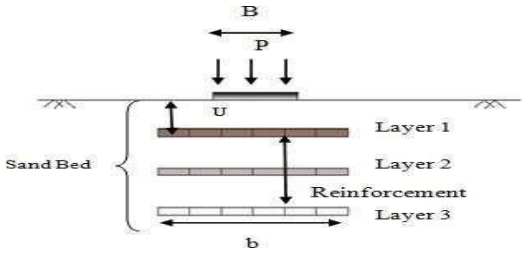

Fig.2 Layout and configuration three dimensional reinforcement layers in the test.

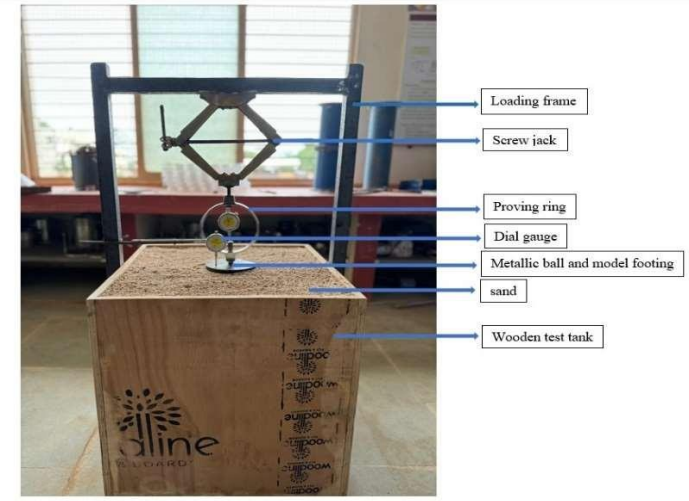

Fig.3 Test tank (60 X 60 X 60 cm)

Result:

1. It is observed that as density increases from 18.96kN/m^3 to 19.32kN/m^3 load carrying capacity also increases and there is decrease in settlement.
2. As number of layers increases from 0 to 3, the load carrying capacity increases and settlement decreases.

As L/D ratio increases from 0.21 to 0.42 load carrying capacity increases and settlement decrease

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Following conclusions can be drawn based on the experimental results:

1. Load carrying capacity of unreinforced sand bed for varying densities is 6.67kN and 7.35kN.
2. Whereas load carrying capacity for plastic bottle reinforced sand beds will be 40.99kN and
   41.87kN and corresponding settlement values noted are 16.6mm and 16.2mm respectively.

Innovation in the project:

1. Waste plastic bottles are used as geocells for determination of load carrying capacity and settlement.

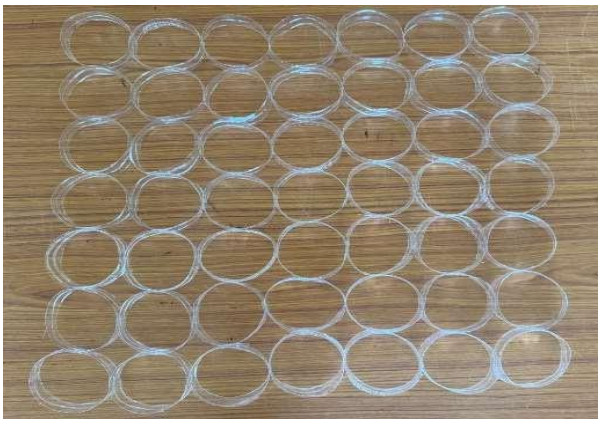

Fig.4 Waste plastic bottle as geocell reinforcement

Scope for future work:

Following works can be taken up in future:

1. This experiment can be tried on different types of footing.
2. Instead of sand, work can be carried out on soil.