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REVIEW ON THE UTILIZATION OF WASTE PLASTIC BOTTLES AS GEOCELLS FOR IMPROVING GROUND CHARACTERISTICS

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ABSTRACT
The plastic waste crisis in India necessitates innovative solutions for effective waste management and sustainable development. This study investigates the potential of repurposing discarded plastic bottles as an alternative to conventional geocells in geotechnical applications. Specifically, the performance of circular footings subjected to incremental loading on reinforced and unreinforced sand beds is examined. The study aims to analyze the influence of varying parameters, including the number of geocell layers (0, 1, 2, 3), sand densities and length-to-diameter (L/D) ratios on the load-bearing capacity and settlement characteristics of the circular footings. The experimental setup involves a wooden test tank 60 cm x 60 cm x 60 cm with a circular model footing 10 cm diameter, 1.2 cm thickness resting on sand beds reinforced with geocells made from waste plastic bottles. Load tests are conducted, and the performance of reinforced sand beds is compared with unreinforced beds to evaluate the reinforcing effects of the plastic bottle geocells. The study aims to bridge the research gap by systematically investigating the influence of sand densities and multiple geocell layer configurations on the load-bearing capacity and deformation behavior of circular footings supported by sand foundations. The findings of this study contribute to sustainable waste management practices by repurposing plastic waste and exploring its potential in geotechnical engineering applications, while also providing insights into the performance of reinforced sand foundations for circular footings under various loading conditions.

Keywords:
Waste Plastic Bottles, Geocells, Circular footing, Load Bearing Capacity

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.

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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 60 cm 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, 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 for different L/D ratios. 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.
- To study the effect on load bearing capacity for different L/D ratios.

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 number of layers and different densities with plastic bottle geocells are placed in 3 layers within the soil beds: The first layer at a depth of 0.33 times the diameter of the footing, the second layer at 82.5mm below the first layer, and the third layer at a constant 55mm thickness below the second layer. After the tests the comparison will be made between the load carrying capacities and settlements of the reinforced sand bed and the unreinforced one after conducting the tests. Once everything is set up, the dial gauge's initial reading should be recorded and the plate should be subjected to the first load increment. This load will be kept constant for a certain amount of time, or until either no further settlement happens or the rate of settlement decreases to almost nothing (less than 0.02mm/hour). It is necessary to record the dial gauge's final readings. The dial gauge's readings should be recorded once more when there is no more rebound or when the rate of rebound is minimal. The load will then be steadily increased until it reaches the suggested next higher loading stage. During this time, it will be kept constant, and the final dial gauge readings should be recorded as previously indicated. When the rate of rebound is minimal, the entire load should be decreased to zero, and the final dial gauge readings should be noted. Until the projected ultimate load is attained, the cycle of reinforced and unreinforced is

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continued, and each time the final dial gauge reading values being documented. 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 against their unreinforced counterparts. This comparison aimed to quantify the reinforcing effects imparted by the plastic bottle geocells on the load-bearing performance and deformation characteristics of the sand foundations under the applied loading conditions.

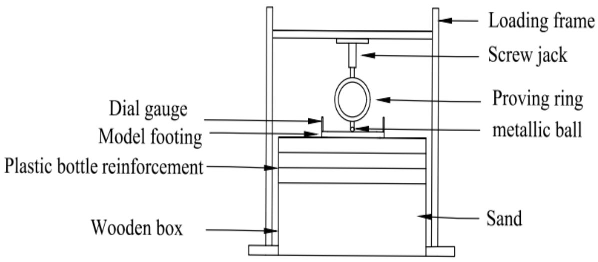

Figure 1 Line diagram of experimental setup

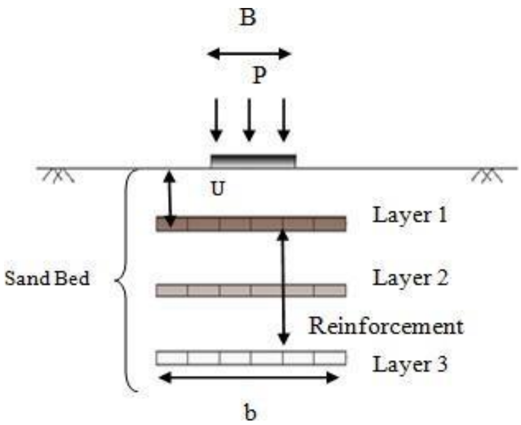

Figure 2 Layout and configuration of three-dimensional reinforcement layers in the test

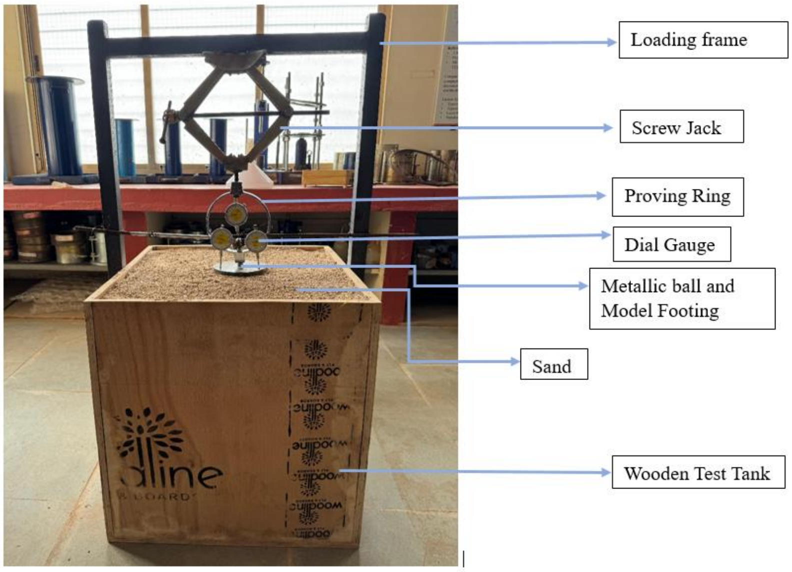

Figure 3 Laboratory setup of experiment

Figure 4 Different L/D ratio waste plastic bottles

RESULTS AND DISCUSSION

1. It is observed that as density increases 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.
3. As L/D ratio increases load carrying capacity increases and settlement decreases.

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CONCLUSION

The study concluded that as densities, number of layers and L/D ratios increase the load bearing capacity also increases and settlement value decreases.

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