SRI JAYACHAMARAJENDRA COLLEGE OF ENGINEERING
JSS SCIENCE AND TECHNOLOGY UNIVERSITY, MYSURU – 570006
DEPARTMENT OF CIVIL ENGINEERING
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"EXPERIMENTAL INVESTIGATION ON BEHAVIOUR OF CIRCULAR FOOTING RESTING ON SAND, REINFORCED WITH PLASTIC GEOCELL"

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IN

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BY,

BRUHATH RAJ :- 01JST20CV401
BHOOMIKA P :- 01JST19CV011
PRIYADARSHINI R :- 01JST19CV059
SAYAM S :- 01JST19CV077

Under the guidance of,

Prof. PRASAD PUJAR

Assistant Professor,
Department of Civil Engineering,
JSS STU, MYSURU-06

***KEY WORDS*:**

Circular footing, sand, plastic geocell, experimental investigation, load-settlement response, stress distribution, reinforcement strains, load-bearing capacity, shallow foundation, reinforcement, laboratory testing.

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INTRODUCTION

The quality of civil engineering has long been at the heart of social infrastructure, builders must prioritize this aspect of the field in order to produce results that live up to expectations. Since the start of the 21st century, the building industry has grown exponentially as science and technology advanced rapidly, the building industry has grown exponentially. Also in past few decades, it is observed that adding reinforcements to the soil improves its engineering properties. Soil reinforcement is utilised in many application like retaining walls, embankments, foundations, slopes, highway and airport pavements, and railway tracks. Geosynthetic reinforcement is used in shallow foundations shows cost-effectiveness, versatility, and reproducibility make fiber-reinforced soil an efficient ground improvement approach [1-5].

In this study, the focus is on the response of circular footings, which are commonly used in various civil engineering applications such as building foundations, transmission towers, and storage tanks. The circular footing is subjected to vertical loading, simulating the loads it would experience in practical scenarios.

In the current work, recycled plastic bottles that have been processed and arranged to form geocells are used to strengthen the soil. These made-in-house geocells are utilised to strengthen sand. In order to understand how a circular footing responds to loads both with and without sand reinforcement, as well as the effects of combined loads on sand footings with various densities and reinforced spacing, experimental research was conducted. This study's main objective is to investigate the load-bearing capacity and settlement of a circular foundation that is fortified with plastic geocells in a sand-based medium. Understanding the relationship between soil and the geocell made from waste plastic will be made easier, and the same can be used in field applications.

1.2 LITERATURE REVIEW

1) D.M. Dewaikar, H.S Chore, K.G. Gupta and G.S. Kame studied the behavior of a square footing on reinforced soil using geogrid reinforcement. The study aims to evaluate the bearing capacity, settlement, and failure mechanism of the reinforced soil under different loading conditions. The experimental investigation includes the preparation of soil samples with varying geogrid spacing and number of layers. The tests were conducted under different loading conditions, and the results were compared with unreinforced soil. The test results indicated that the addition of geogrid reinforcement significantly increased the bearing capacity, reduced the

settlement, and improved the overall performance of the soil. The study also analyzed the failure mechanism of the reinforced soil using digital image correlation (DIC) technique to observe the strain distribution in the soil. The analysis revealed that the geogrid reinforcement improved the tensile strength of the soil and reduced the shear strain at the soil-geogrid interface, leading to a more stable failure mechanism.

2) Mr. Kiran and Prof. Nagraj Bacha conducted research on the behavior of circular and square footings on reinforced sand bed stratified with lateritic soil. The study aims to evaluate the bearing capacity, settlement, and failure mechanism of the reinforced soil under different loading conditions. The experimental investigation includes the preparation of soil samples with varying lateritic soil content, geogrid spacing, and number of layers. The tests were conducted under different loading conditions, and the results were compared with unreinforced soil. The test results indicated that the addition of geogrid reinforcement significantly increased the bearing capacity and reduced the settlement of the soil.

3) Bandita Paikaray, Sarat Kumar Das AND Benu G. Mohapatra investigated the bearing capacity of a model footing on a reinforced foundation with crusher dust. The study aimed to evaluate the effectiveness of crusher dust as a reinforcement material for improving the bearing capacity of the foundation.

4) Hegde investigated that the effect of geocell type on load-carrying mechanisms of geocell-reinforced sand foundations was studied to evaluate the performance of different geocell designs in enhancing the bearing capacity of sandy soils. The study found that the load-carrying mechanisms of geocell-reinforced sand foundations are significantly influenced by the type of geocell used. The depth and width of the geocell and the junction type between cells also play a critical role in determining the behavior of the reinforced soil system. The results suggest that hexagonal geocells with a large width-to- height aspect ratio provide the highest bearing capacity and deformation resistance. Additionally, geocells with a greater depth have been found to increase the confinement effect and improve the soil's load-carrying capacity

OBJECTIVES

The primary goal of this research is to examine the load bearing capability and settling of a circular foundation which is reinforced by plastic geocells in sand base. Sand is the primary medium used in the present study. Recycled plastic bottles are used in creating in miniature of geocells are placed within sand to strengthen them.

The main objectives of this experimental study are as follows:

- To evaluate the load-settlement behavior of circular footings on unreinforced sand.
- To investigate the influence of plastic geocell reinforcement on the load-settlement characteristics of circular footings.
- To determine the optimal geocell configuration (number of reinforcement layers) for maximizing the footing performance.

MATERIALS AND METHODOLOGY

1. MATERIALS

1.1 Sand: The locally available sand will be used for the present study.

Description	Result
Specific Gravity	2.527
Sieve Analysis	
D10	0.09mm
D30	0.23mm
D60	1.2mm
Cc	0.49
Cu	13.33

Classification of soil: **Poorly graded soil (SP)**

For sand, the particle size range typically falls between 0.075mm to 4.75mm. Based on the sieve analysis conducted, the conclusion can be made that the material being analyzed is graded as sand.

1.2 Reinforcement: In the present work reinforcement will consists of recycled plastic bottles procured locally.

Figure 1: **Reinforcement model**

1.3 Experimental Setup: In the present study the experiment will be carried out on miniature models are described herein. The following section provides specifics on the testing, materials, technique, and analysis of data for model studies.

1.4 Funnel: The sand is evenly distributed throughout the tank and its density is maintained throughout the tank's depth during the filling process. After determining the maximum and minimum densities of the sand, the desired density can be achieved by pouring the sand from a fixed height by using different height pipes under the funnel. The PVC pipe was secured to the base of the funnel to ensure a constant height of fall.

Figure 2: Funnel

2. METHODOLOGY

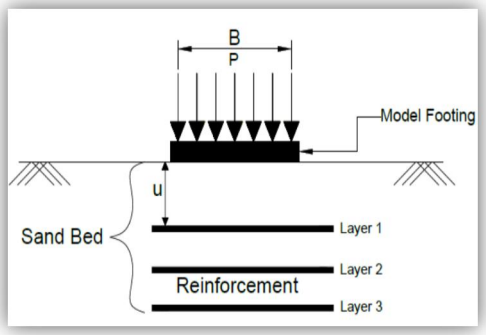
As presented in this section, the experimental setup is used to study the behavior of footing on sand which reinforced with plastic geocells reinforcements as follows.

2.1 Sand Raining Technique: In the study the density of sand will have different effect on the behavior on footing. To have uniform density sand raining technique is adopted. Sand of varying densities are tested in present study accomplish with the sand pouring approach by adjusting the height of the sand's fall. Sand will be poured into the funnel to a predetermined height.

A wooden box will be placed on top of a concrete bed to create an experimental setting. The sand will then pour into the box using the sand raining technique.

To reach the desired density, sand is poured into the box using the funnel from a predetermined height of fall. Here, a PVC pipe is fastened to the funnel's base, keeping the drop at a constant height.

2.2 Reinforcement placement: Reinforcements will be employed as defined in the previous section. It is to be noted that Fig. 4, provides the cellular structure of the reinforcement arrangements in the wooden box at a specific level, with a varying number of layers. Reinforcement is placed by adjusting the u/B ratio, where u is the height from the footing's bottom surface to the top surface of the first reinforcement and B is the footing's diameter. The number of



reinforcement layers will vary as the u/B ratio is adjusted.

Figure 3: **Layout and configuration of reinforcement layers in the test**

2.3 Experimental Setup: After the sand bed, either reinforced or unreinforced, has been prepared, the footing can be laid in the middle above the sand. The necessary capacity proving ring is fastened to the screw jack installed at the top of the frame. To ensure that loading is performed vertically, this proving ring is brought into touch with the footing. The LVDT will be used to measure the settlement or displacement of the footing.

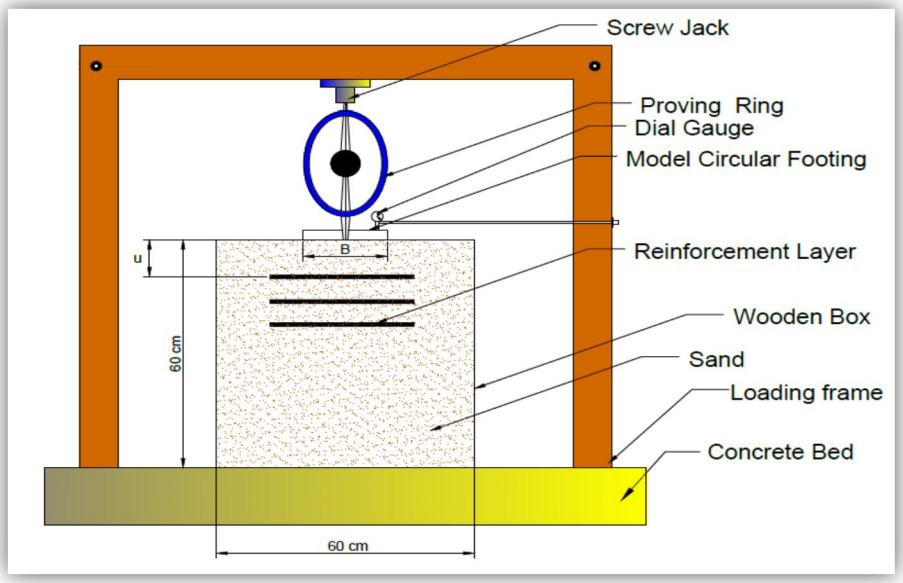


Figure 4: **Schematic View of Experimental Setup**

Figure 5: **Photograph of Prepared Experimental Setup**

Figure 6: **Methodology**

Testing Procedure

- Apply incremental vertical loads
- Record settlement, deformation, and stress data
- Monitor response of footing and geocell layer
- Repeat loading procedure for multiple trials

Data Analysis

- Analyze recorded data
- Plotting of load-settlement graphs

Conclusion and Report

- Summarize findings and observations
- Draw conclusions on footing behavior
- Prepare comprehensive report

3. Expected Outcome of the project:

Utilization of waste plastic bottles as reinforcement to improve the bearing capacity. The behaviour of footing reinforced with the plastic bottles will provide us with insights on the nature of load settlement and to provide optimum u/B ratio and optimum number of reinforced layers. In this regard effective disposal of plastic bottles can be well organised.

4. Innovation in the Project and Scope for the future work:

This project will have the scope for the usage of waste plastic bottles to improve the bearing capacity of soil, and further plastic waste blending with any other materials to improve the reinforcement property (tensile strength of reinforcement) can be consider for the further study. If time permits will include the second scope too.

REFRENCES

1) D.M. Dewaikar, H.S. Chore, K.G. Gupta and G.S. Kame, Behaviour of a square footing on reinforced soil an experimental study, Geotide, IGC 2009, Guntur, India.

2) Mr. Kiran and Prof.Nagraj Bacha, An Experimental Study on Behaviour of Bearing Capacity and Settlement of Circular and Square footing resting on sand bed stratified with lateritic soil, International Journal of Engineering and Technical Research 04(2278-0181):1033-1042, November 2015.

3) Bandita Paikaray, Sarat Kumar Das and Benu G. Mohapatra, Bearing capacity of model footing on reinforced foundation with crusher dust, Arabian Journal of Geosciences, 2021.

4) Amarnath Hegede, Geocell reinforced foundation beds, Construction and Building Materials, 2017.

5) Danny Useche and Gonzalo Martin, Experimental study of Behaviour of circular footing on geogrid-reinforced sand, Geomechanics and Geoengineering, 2019.

6) P.K.Basudhar, Santanu Saha and Kousik Deb, Circular footings resting on geotextile-reinforced sand bed, Geotextiles and Geomembranes, 2006.