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Effect ofDepth ofReinforcement onBearing Capacity ofCoir Mat Reinforced Sand

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ABSTRACT:

Very few literatures are available to assess performance of mat type of reinforcement which is extensively used as reinforcement in the soils. In the present study, load-settlement tests using model footing of 50mm diameter resting on coir mat of different opening size were conducted. The performance of reinforcement for various depths were analyzed by determining peak stress at failure and corresponding peak strain. The variation of BCR indicated that the depth of reinforcement has significant effect on bearing capacity of coir mat.

KEYWORDS: Bearing Capacity Ratio(BCR), Coir mat, model footing, settlement reduction factor(SRF), Peak stress at failure,Peak Strain,Load Settlement.

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I. INTRODUCTION

India is the largest producer (66% of world production) of coir fiber from the husk of coconut fruit. From one million coconut husks, 80 tons of fiber can be extracted. Though about 13000 million nuts are annually harvested in India, less than 25% are used industrially. The resultant mutilated husk either becomes garbage or are dried and burnt as fuel. This rather indiscriminate destruction of a potentially useful material owes much to the lack of alternate end uses of coir fibers.Many civil engineering problems in coastal areas in India need stabilization of soft soil. Some of these structures may be temporary for establishing roads and rail communication links and in some accessibility by itself possesses a major problem. To tackle such problems in civil engineering, geosynthetics emerged as a good solution. To improve the mechanical properties of soils, a variety of materials are used for reinforcement e.g. metallic elements, geosynthetics,and others. Majority of geosynthetics used in civil engineering application are polymeric in composition. These products generally have a long life and do not undergo biological degradation, but are liable to create environmental problem from its manufacture till the end use. In effecting this, the use of natural fibers is gaining popularity.

II. LITERATURE REVIEW

Initial investigations were concerned with subgrades reinforced horizontally with several members of thin strips [Binquet and Lee (1975), Sreekantaiah (1987, 1988), Mandal and Dixit (1986), Bergado, et.al (2001)]. Subsequently metal and coir rods [Milovic (1977, 1979),Zhenggui Wang &Richwein (2002)], ropes and strips made of natural fibres [Akinmusuru&Akinbolade (1981), Mandal& Dixit (1986), RamanathaIyer (1988), Shankaraiah&Narahari (1988)] Geosynthetics [Guido (1985, 1989), Singh &Bindumadhava (1986), Saran (1985), Dembiki&Jermolowicz (1988), Ramaswamy (1985), Hoe.I.Ling, et.al (2001)] were also used in investigations. In the above investigations optimization of the following variables such as Length of the reinforcing strips, Depth of the reinforcing layers, Numbers of strips,Effective distance among them [Horizontal and vertical spacing,Material& tensile strength of reinforcement,A great deal of literature focuses on the use of geosynthetics as a possible means of increasing the bearing capacity of soil have been tried and reported. The improvement in bearing capacity is commonly expressed as the ratio of the ultimate bearing pressure for the reinforced soil to that of the unreinforced soil and is referred to as the ultimate Bearing capacity Ratio or BCR.

Several investigations have been carried out [1-7] with regard to the bearing capacity of mat type of reinforcements and have indicated that both synthetic and natural materials when used as reinforcement in soils are beneficial in reducing the settlement of reinforced soil. In all these investigations, it has been observed that the layout and configuration of reinforcement play a vital role in bearing capacity improvement rather than the tensile strength of the material. In contrast to grid or mat form of reinforced soils exhibit some advantages. The objective present study thus is to understand the performance of mat type of reinforcement at various depths. For this study, the locally available coir based materials have been used as reinforcement.

III. MATERIALS

3.1 Sand

Sand a naturally occurring granular material composed of finely divided rock and mineral particles was used which was extracted from Bangalore. Properties of sand used in the present experimental study are as shown in Table 1.

Table1. Properties of Sand Used

Coefficient of uniformity, (C_u)	4.48
Coefficient of curvature, C_c	0.960
Specific gravity, G	2.66
Maximum density of sand, γ_d(max.), kN/m^3	16.7
Minimum density of sand, γ_d(min.), kN/m^3	14.0
Classification of Sand	SP

3.2 Coir Mat

Coir mat used in the present study were prepared from coir obtained from coir industry, Gubbi, Tumkur district, Karnataka, India. Typical properties of coir are as shown in Table 2.

Table 2.Typical Properties of Coir Fibers

Young's modulus	4000-5000Mpa
Tensile strength	140-150mpa
Elongation index	15-17.3%
Thermal conductivity	0.047W/m K
Density	1.15-1.33 Kg/m3
water absorption	10%
Total water soluble	26%
Pectin soluble in water	14.25%
Hemi celluloses	8.50%
Lignin	29.23%
Cellulose	23.81%

3.3 Model Footing and Test tank

The load tests on model footings resting on unreinforced sand and reinforced sand were conducted in a load frame that can apply load at a continuous rate of 1.25mm/minute. Sand beds were prepared in a cylindrical steel tank of diameter 300mm and height 350 mm. The model footing used for the tests was circular in shape and is of 50 mm diameter and is of sufficient thickness to withstand bending stress.Fig.1 shows the typical layout of the reinforced sand bed adopted in the model tests.

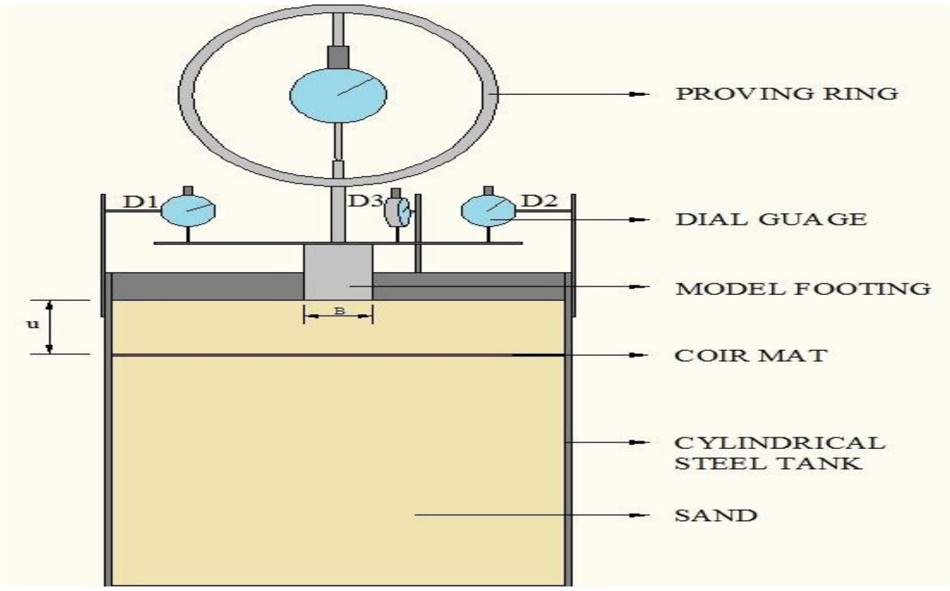

Figure.1 Typical layout of the reinforced sand bed.

IV. METHODOLOGY

Sandbed was prepared up to the height of 30cm by compaction in three layers and a relative density of 80% was maintained for all the tests. Coir mats of opening 10x10 mm, 20x20 mm and 30x 30 mm and of diameter slightly less than the inner diameter of tank, to avoid side friction, were used and placed at specific depths while preparing the sand bed for each model test. The depth of layer of reinforcement of coir mat from the bottom of the footing is measured as u, and model footing tests for various depth of reinforcement to width of footing ratio(u/B) 0.6, 0.3, 1.0 and 2.0 were conducted.

Tests with reinforced sand beds were carried out by placing the coir mat at the predetermined depths while preparing the sand beds. After preparing the bed, surface was leveled and the footing was placed exactly at the center to avoid eccentric loading. The footing was loaded and the load was applied at the rate of 1.25mm/min, measuring the corresponding footing settlements through the dial gauges D1, D2 and D3.Average of the three readings were considered as final settlement for a given load intensity. Model footings resting on unreinforced sand bed were conducted to compare the results in terms of Bearing Capacity Ratio (BCR). Experiments were repeated with unreinforced sand for comparison purpose.Table.3 shows the different parameters considered in this experimental study.

Table 3 Parameters Considered in the Experimental Study

Type of reinforcement	**u/B ratio**	**Depth of reinforcement, u(mm)**
Unreinforced	-	-
10mmx10mm mat	0.3,0.6,1	15,30,50
20mmx20mm mat	0.3,0.6,1	15,30,50
30mmx30mm mat	0.3,0.6,1	15,30,50

V. RESULTS AND DISCUSSIONS

In order to assess extent of improvement in BCR with increase in strain, BCR for reinforced sand corresponding to different %strain was obtained from plot of load intensity versus %strain. Figures 2, 3 and 4 shows such a variation for BCR with u/B corresponding to strains of 2.5%, 5%, peak strain and beyond peak strain(approximately at 15% strain).

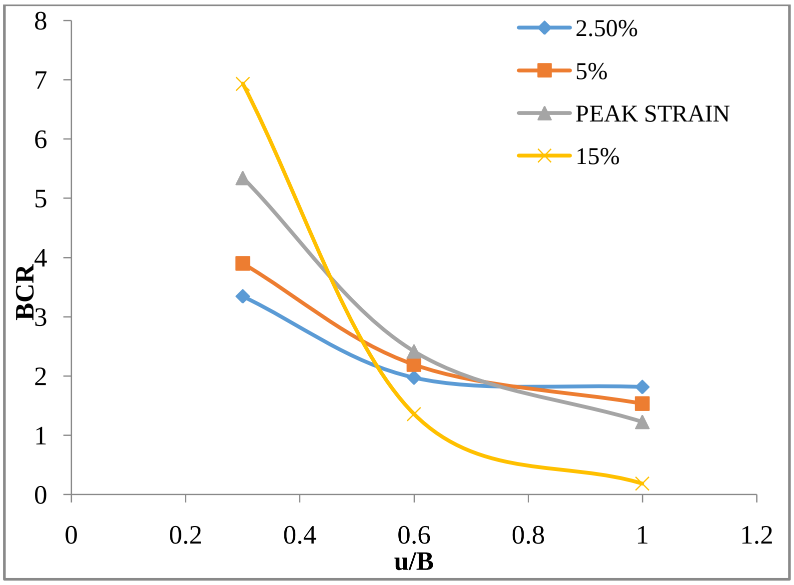

Figure 2. BCR versus u/B ratio for 10x10mm opening coir mat

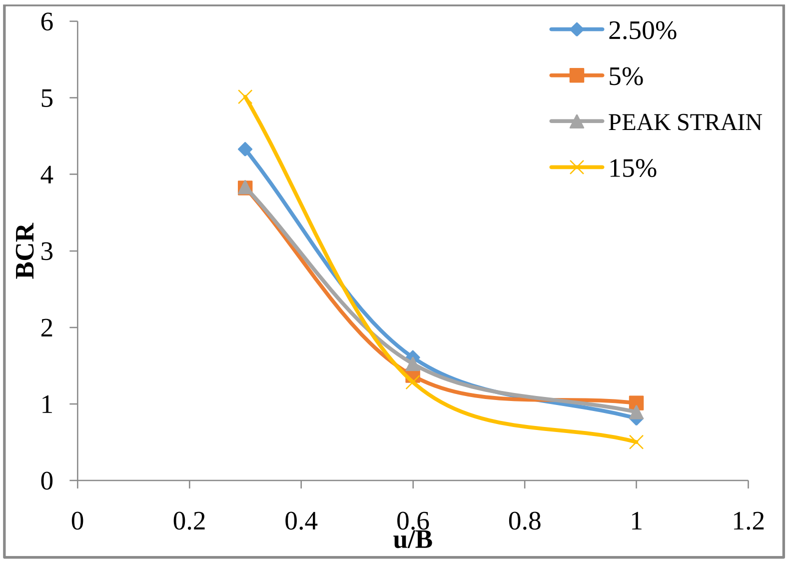

Figure.3 BCR versus u/B ratio for 20x20mm opening coir mat

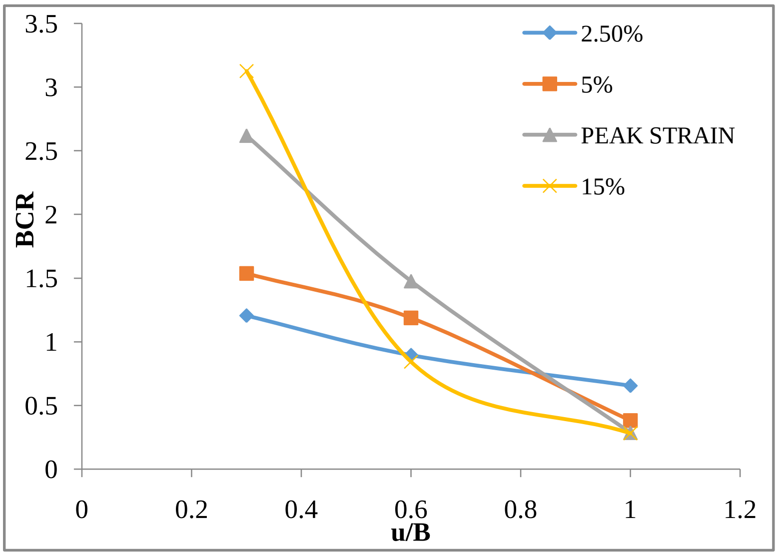

Figure 4. BCR vs u/B ratio for 30x30mm opening coir mat

As it can be seen in figures 2, 3 and 4, with increase in u/B ratio, BCR value decreases. Decrease in BCR is significant between u/B=0.3 to 0.6. Further at a given u/B ratio lower the rate of strain lower is the BCR. This is because of lower overburden pressure over the reinforcement at smaller settlement. With increase in strain BCR value increases as the overburden pressure increases. The decrease in the BCR with the increase in u/B ratio can be attributed to the fact that peak stress measured decreases with increase in u/B ratio.

VI. CONCLUSIONS

On the basis of present experimental investigation, the following conclusion are drawn.

1. Bearing capacity of sand reinforced with coir mat is greater than that obtained for unreinforced sand. The optimum location for mat form of reinforcement corresponds to u/B=0.3.
2. For a coir mat form of reinforcement, the peak strain reduced with increase in u/B ratio. This indicates introduction of fiber form of reinforcement increases ductile characteristics of reinforced sand.
3. BCR for coir mat decreases with increase in u/B ratio which can be attributed to the fact that peak stress decreases with increase in u/B ratio.
4. Coir mats exhibited variations wherein it increases ductility of the reinforced sand which is required in many civil engineering applications.

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