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Performance of Soft Soil Reinforced With Bamboo and Geonet

Alida Mathew[1], Aswathy Sasikumar[2]

[1]M.Tech Student, Marian Engineering College, Kazhakootam, Trivandrum, Kerala
[2]Assistant Professor, Marian Engineering College, Kazhakootam, Trivandrum, Kerala

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Abstract - *The naturally available bamboo can be used as soil reinforcement, which proves to be economical than commercially available geosynthetics. The comparison of performance of bamboo grid reinforced soil with geonet reinforced soil was studied in this paper. Bamboo grid reinforcement has better performance than geonet reinforcement. Maximum bearing capacity was obtained when 3 layers of bamboo grids placed at a spacing of 50 mm between the successive layers. The depth of first reinforcement layer from the base of the model footing was kept constant in this study.*

Key Words: **Bamboo grid, Bearing capacity, Bearing Capacity Ratio, Settlement, 400 GSM coir geonet**

1. INTRODUCTION

The existing soil at a construction site may not have sufficient strength to bear the load coming on it. In such cases, soil improvement or ground improvement is needed. Improvement of soil can be done in many ways. The soil improvement techniques are used for the following:

- ✓ Reduce the settlement of structures
- ✓ Improve the shear strength of soil and thus increases the bearing capacity of shallow foundations
- ✓ Increase the factor of safety against possible slope failure of embankments and earth dams
- ✓ Reduce the swelling and shrinkage of soil

Any soil which is susceptible to failure or cause excessive settlement when superstructure is built over it is referred to as soft soil. The methods which are capable of improving certain characteristics of soft ground are considered as ground improvement techniques. Soft soils have poor strength and they are compressible. Various ground improvement techniques are largely available now- a -days. The different methods of ground improvements are over excavations or replacement method, densification & compaction (mechanical modification), hydraulic modification, admixture stabilization, reinforcement method, electrical modification method, thermal modification method, etc.

Soil reinforcement method is one of the most popular ground improvement techniques. One of the major reasons for increase in the use of soil reinforcement is the availability of different materials and techniques for reinforcement. The reinforcement method can be in the form of vertical reinforcement like piles, stone column etc. or horizontal reinforcement like soil nailing, geosynthetic products, etc. Sometimes they may be expensive. Research is being carried out to develop new ground improvement techniques which are affordable. Ground improvement is mainly carried out to improve the bearing capacity and to reduce the settlement. This paper focuses on reinforcing the soil wirh naturally available bamboo in the grid pattern and then compares it with the performance of 400 GSM coir geonet.

2. EXPERIMENTAL SETUP

A series of laboratory plate load tests were conducted. The dimension of the tank used in the test was 500mm x 500mm x 500mm. A square shaped steel plate of 100mm size with 12mm thickness was taken as the model square footing. The load was applied to the footing via a centrally placed hydraulic jack. The load applied was measured through a pre-calibrated proving ring. Test setup is shown in fig.1.

Fig -1: Test setup

2.1 Materials Used

The materials used for the tests are Kuttanadu soil, bamboo grid and 400 GSM coir geonet.

The soil collected from Kuttanadu region in Alappuzha district was used for the preparation of foundation bed. The soil was air dried and pulverised for the laboratory tests to carry out. The properties of the soil are tabulated in table I. The grain size distribution is shown in chart 1.

The naturally available bamboo was made in the form of a grid of aperture size similar to the aperture size of 400 GSM coir geonet. The width of each strip was 10mm. The bamboo grid is shown in fig.2.

The coir geonet of 400 GSM was collected from Geonet Enviroslutions Pvt Ltd, Ernakulam. The 400 GSM coir geonet is shown in fig.3 and the properties are given in table II.

Table -1: Properties of Soil

Properties	Value
Natural moisture content	115 %
Specific Gravity	2.6
Clay Fraction (IS 2720 PART 4)	18 %
Silt Fraction (IS 2720 PART 4)	72.52 %
Sand Fraction (IS 2720 PART 4)	9.48 %
Liquid Limit (IS 2720 PART 5)	79 %
Plastic Limit (IS 2720 PART 5)	49.8 %
Shrinkage Limit	19.92 %
Plasticity Index (IS 2720 PART 5)	29.2 %
Optimum Moisture Content (IS 2720 PART 7)	31.29 %
Maximum Dry Density (IS 2720 PART 7)	1.35 g/cc
IS classification	MH
Free Swell Index	3.92 %
UCC Strength (IS 2720 PART 10)	0.49 kg/cm²

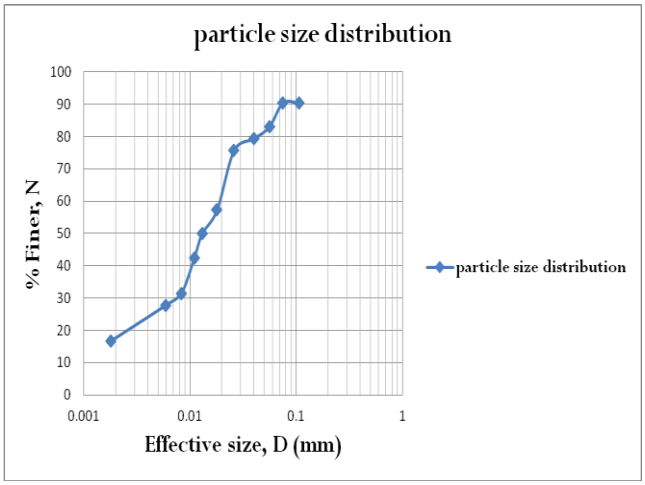

Chart -1: Particle Size Distribution of Soil

Fig -2: Bamboo Grid

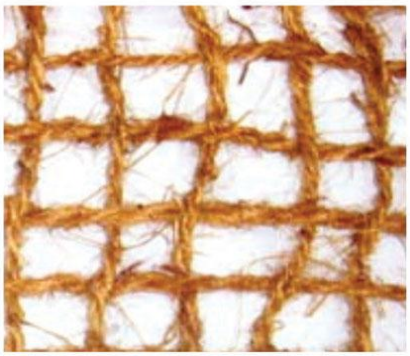

Fig -3: 400GSM Coir Geonet

Table -2: Properties of 400 GSM Geonet

Characteristics	400GSM
Mass/unit area, g/m² Min	400
Width, cm, Min	100 or as required
Length, m	50 or as required
Thickness at 20 kPa, mm, Min	6.5
Ends (wrap)	180
Pcks (weft)	160
Break Load, Dry (kN/m), Min Machine direction Cross machine direction	7.0 4.0
Break Load, Wet (kN/m), Min Machine direction Cross machine direction	3.0 2.0
Peak Load, Dry (kN/m), Min Machine direction Cross machine direction	 7.5 4.0
Peak Load, Wet) (kN/m), Min Machine direction Cross machine direction	3.0 2.0
Trapezoidal Tearing Strength (kN) at 25mm gauge length, Min Machine direction Cross machine direction	0.18 0.15
Mesh size, mm, Max	20.0 x 16.75

2.2 Laboratory Plate Load Test

a) Preparation of soft soil bed:

The soft soil bed for the test was air dried and then pulverized. It is then mixed in optimum moisture content and fills it in the tank in 5 layers and compacted. The sides of the tank were coated with oil to reduce side friction. After the preparation of test bed, plate load tests were conducted and settlements corresponding to each loading were measured using two dial gauges placed exactly opposite to each other.

b) Test Procedures:

The reinforcements were placed in each layer of the test bed. The test was carried out by varying the number of reinforcement layers. It was done for finding the effective depth of reinforcement for the development of maximum bearing capacity.
The square foundation supporting the prepared test bed is shown in the fig 4.

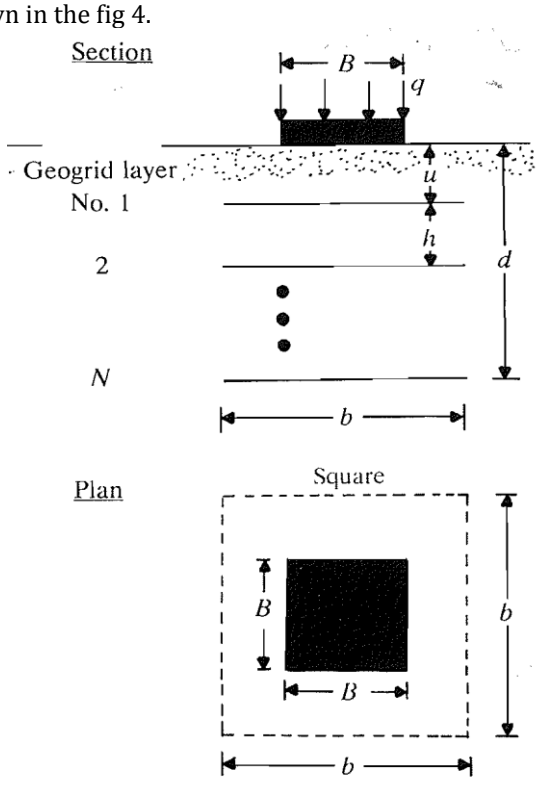

Fig -4: Square Foundation Supporting the Prepared Test Bed

The parameters shown in the figure are described below.

B = Width of the model square footing

u = Spacing between the base of footing and first reinforcement layer

h = Spacing between two successive reinforcement layers

d = Depth of the last reinforcement layer from the base of model footing

b = Width of geogrid

N = Number of geogrid layers.

Here the geogrid is placed full width of the tank. The parameters u, h and B are kept constant throughout the test. u and h were taken as 50mm. Here N is the varying parameter i.e; d/B becomes varied.

The test was carried out for both bamboo grid and geonet of 400 GSM and the performance of both the reinforcements were compared.

2.3 Results and Discussions

Chart 2 shows the load settlement behaviour of unreinforced soil bed and soil bed reinforced with bamboo grid in different layers.

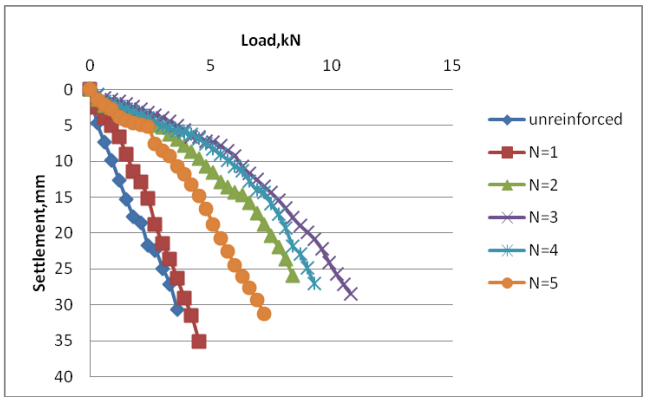

Chart -2: Load – settlement behaviour of soil when reinforced with bamboo grid

From the test result the bamboo grid reinforced soil bed has better performance than the unreinforced soil bed. Also the bearing capacity increases with increase in number of layers upto N = 3, after that it decreases. i.e; the optimum number of layers for maximum bearing capacity was found as 3.

Chart 3 shows the load - settlement behaviour of unreinforced soil bed and soil bed reinforced with 400 GSM coir Geonet in different layers.

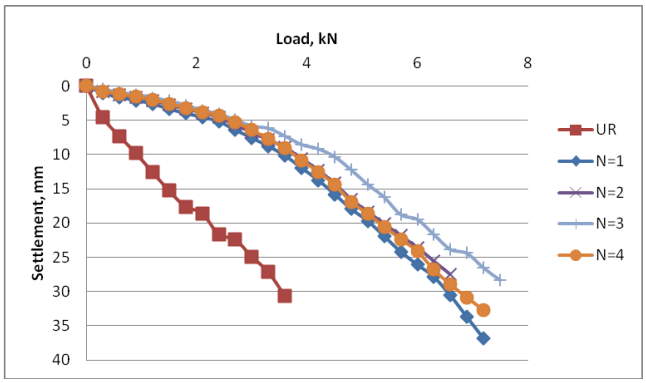

Chart -3: Load – settlement behaviour of soil when reinforced with 400 GSM Coir Geonet

From the test result the geonet reinforced soil bed has better performance than the unreinforced soil bed. Also the bearing capacity increases with increase in number of layers upto N = 3, after that it decreases. i.e; the optimum number of layers for maximum bearing capacity was found as 3.

The variation of bearing capacity ratio (BCR) with d/B for bamboo grid reinforced soil and geonet reinforced soil are shown in the chart 3 and 4 respectively.

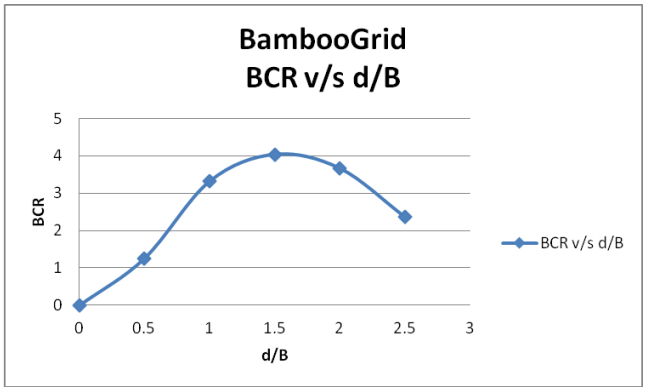

Chart -3: BCR v/s d/B for bamboo grid reinforced soil

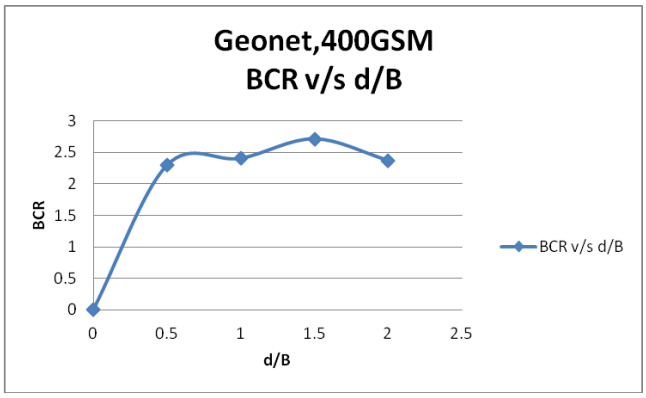

Chart -5: BCR v/s d/B for geonet reinforced soil

It is found from the chart 5 that the performance of bamboo grid reinforced soil is better than geonet reinforced soil.

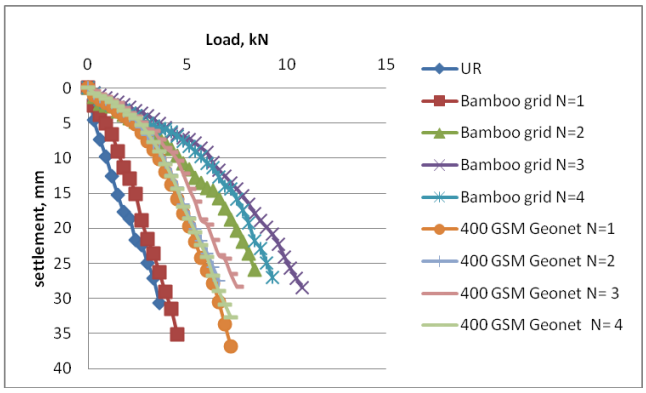

Chart -5: Comparison of load settlement behaviour of bamboo grid reinforced soil and geonet reinforced soil.

3. CONCLUSIONS

Reinforcing the soft soil with any material can improve it. Here the study focused on reinforcing the soil with bamboo grid and coir geonet of 400 GSM. The conclusions arrived are:

- ✓ Soil reinforced with bamboo grid has better performance than that reinforced with geonet.
- ✓ In both cases the bearing capacity increases with d/B ratio up to N= 3 then it decreases, i.e; the optimum number of layers for the development of maximum bearing capacity is 3.
- ✓ The bearing capacity becomes increased and the settlement gets reduced for reinforced soil.

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