Soil Improvement by using Coconut Fronds As Reinforcement

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***Abstract*— Kerala is well known for coconut cultivation. The coir fibre obtained from coconut husk had been effectively utilized for ground improvement techniques. Coconut frond is one of the waste product obtained from coconut tree and now it is becoming a burden on farmlands. In this project, an attempt has been made to evaluate the load bearing capacity of this material under plate load test.**

Keywords—Coconut frond, Bearing capacity, Plate load test.

I. INTRODUCTION

Soil reinforcement is a technique used to enhance the stiffness and strength of soil using geoengineering ways. This technique is widely applicable for lands having the chance of erosion are high. It is mainly useful in areas were the soft soil cannot provide adequate support to any construction or building. Different engineering methods are used to enhance the soil strength using soil reinforcement. Geogrids are more widely used as soil reinforcement, which in turn are produced with extreme durablility and resistance. Soil reinforcement is performed by placing tensile elements in the soil to improve its natural stability and strength. This is done by placing reinforcement elements in contact with surfaces in the aggregate and sub-base of soil mass. Soil reinforcement are usually designed based on the soil texture and its load bearing capacity. Due to a wide variety of soil and load variations, engineers are facing a number of challenges during soil reinforcement. This paper focuses on reinforcing the soil layers with coconut fronds in grid pattern and evaluate the bearing capacity of grids with different aperture size.

II. LITERATURE REVIEW

Satyanarayan. K. G etal (1982), this study mainly examined the different structural parts of fibres from coconut palm tree such as density, size, ultimate tensile strength and percentage elongation. Internal structure and chemical composition has also been evaluated. The major chemical constituents of fibres obtained are cellulose 39 to 46% and lignin about 13 to 25%. The modulus, strength and percentage elongation values of rachis, rachilla, leaf sheath and spathe are obtained as 2 to 6 GNm-2, 48 to 104 MNm-2 and 5.6 to 8% respectively, since for bark of petiole and root are found to be in the range of 6 to 24.7GNm-2, 157 to 191.81 MNm-2 and 3 to 3.8 % respectively. It is observed that fibres from the bark of petiole have similar properties to coir.

Vijayan. A and D'cruz (2019), this study focuses on the effect of bamboo grid and geonet as soil reinforcement. Here they compare the behaviour of bamboo grid and geonet under plate load test. In this paper, they mainly investigated the effect of varying the depth and effect of placing multilayers. The optimum embedment depth was obtained as 30 mm from the base of footing and the optimum number of placing layers is obtained as 3.

Jose. A etal (2019), study mainly focused on increasing the load carrying capacity and reduce the settlement of weak soil using screw pine cells. In this study, three types of cell aperture size were adopted such as 125 mm x 105 mm, 125 mm x 85 mm to exhibit better performance. Inclusion of green reinforcement reduce the settlement about 49 % compared to unreinforced soil.

Kashap. A etal, (2019), this paper reviews the various studies conducted for evaluating the bearing capacity of foundation. It is observed that computing the bearing capacity of soil and settlement of footing is very important work in designing footing. In this paper, results were obtained parallel to their theoretical solutions.

Kolathayar. S etal (2020), this study showed the effect of using coir geocell as soil reinforcement. A series of model plate load test were performed to understand the bearing capacity of unreinforced and reinforced soil. Then a comparative study was done with the HDPE geocell. It is observed that a threefold increase in bearing capacity was obtained by the use of coir geocell compared to unreinforced soil. This study also demonstrates the analytical solution for bearing capacity.

III. MATERIALS USED

The materials used for the tests are clayey soil and coconut frond strips.The soil collected from Anad village in Thiruvanthapuram district was used for the foundation bed preparation. The soil were air dried and pulverised for carrying out laboratory tests. The properties of the soil are illustrated in table 1.

Table 1 Properties of soil

Properties	Values
Specific gravity	2.65
Percentage of silt	49.5%
Percentage of clay	60.5%
Plasticity index	10.42%
Optimum moisture content	20.75%
Maximum dry density (KN/m^3)	14.9
Soil classification	CL

The coconut fronds obtained from the farmlands were converted into grids of different aperture size. The fronds were converted into strips 10 mm width. The strips were arranged in the form of grids using resin adhesives, for keeping the strips in position and hence the aperture size could be maintained through out the test. The grids with different aperture size were given in fig 1. The arrangements of grids were given in table 2.

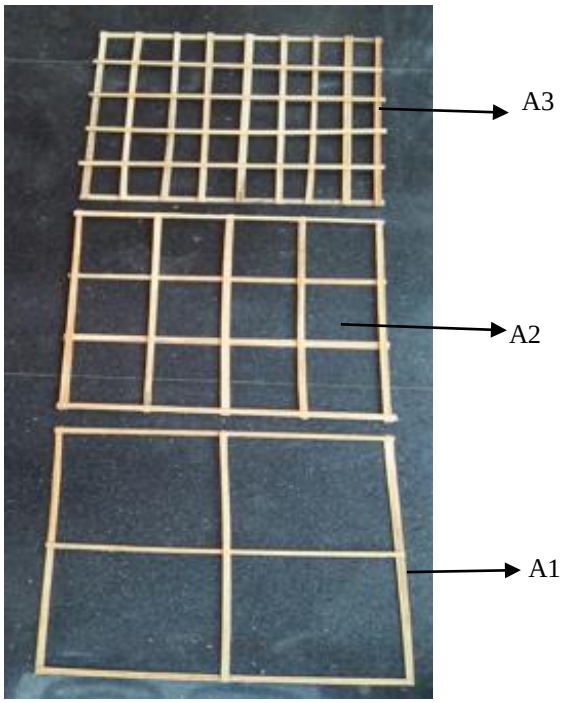

Fig 1 Grids with different aperture size.

Table 2. Arrangements of grids

Sl.No.	Type	No. of transverse ribs	No. of longitudinal ribs	Size of aperture, mm
1.	A1	3	3	178 X 176
2.	A2	5	4	114 X 86
3.	A3	9	6	65 43

IV. EXPERIMENTAL SETUP AND METHODOLOGY

A series of laboratory plate load test were carried out. A test tank of dimension 400mm x 400mm x 400mm. A square shaped steel plate of size 80mm was taken as model footing. The load was applied using hydraulic jack. Test setup is shown in fig.2.

Fig 2 Setup for plate load test

The soil required for the test was air dried and then pulverized. Then it is mixed in optimum moisture content and fills in tank in 4 layers with uniform compaction. Inorder to reduce side friction, the sides of tank were coated with oil. After the preparation of clay bed, plate load test were carried out and settlements corresponding to each loading were measured using dial gauges.

V. RESULTS AND DISCUSSIONS

Load settlement graphs for different aperture size were given in fig 3 . Bearing capacity obtained for different aperture size were given in table 3. Here the maximum bearing capacity was obtained for A3 type. For unreinforced soil, the bearing capacity obtained as 48.67KN/m^2. By the inclusion of frond strips, bearing capacity increases. The optimum value obtained as 97.33KN/m^2 and the corresponding percentage increase was obtained as 99.98%.

Table 3. Bearing capacity of grids

Types	Bearing capacity (KN/m^2)	% increase
Unreinforced	48.67	-
A1 Type	68.13	39.98
A2 Type	87.60	79.99
A3 Type	97.33	99.98

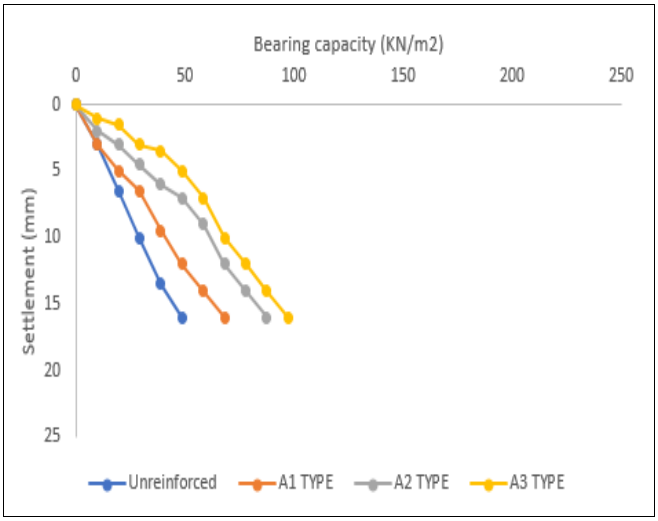

Fig 3 Load settlement graph for different aperture size

VI. CONCLUSION

Inclusion of coconut frond strips showed an improvement in bearing capacity. The optimum value was obtained for A3 type. The percentage improvement in bearing capacity compared to unreinforced soil is obtained as 99.98%. The increase was obtained due to the inclusion of more number strips, hence impart more load carrying capacity.

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