SOIL REINFORCED WITH COCONUT COIR FIBRE

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ABSTRACT

Safe and Economic disposal of agricultural wastes and development of economically feasible ground improvement techniques are among the important challenge being faced by the engineering community.

In this investigation, an attempt has been made to study the possibility of utilizing coconut coir fibre these are the agricultural waste for stabilization of soil, since bulk utilization of rice coconut coir fibre is feasible in the case of geotechnical applications like construction of embankments, earth dams, and highway and air field pavements.

In this project we use one of the natural fibre i.e. coconut coir fibre it is a natural biodegradable material that is abundantly available in India. Due to high lignin content (about 46%) it is stronger than other natural materials such as jute or cotton. Coir fibres are extracted from the husks surrounding the coconut. It was used as an additive material to improve the strength properties such as maximum dry density and CBR.

Soil stabilization is the process of improving the engineering properties of the soil and thus making it more stable. It is required when the soil available for construction is not suitable for the intended purpose. In its broadest senses, stabilization includes compaction, pre consolidation, drainage and much other such process. However, the term stabilization is generally restricted to the process which alters the soil material itself for improvement of its properties. A cementing material or a chemical is added to a natural soil for the purpose of stabilization.

Soil stabilization is used to reduce the permeability and compressibility of the soil mass in earth structures and to increase its shear strength. Soil stabilization is required to increase the bearing capacity of foundation soils. However, the main use of stabilization is to improve the natural soils for the construction of highways and airfields. The principles of soil stabilization are used to controlling the grading of soils and aggregates in the construction of bases and sub bases of the highways and airfields.

Keywords: coconut coir, fibre, CBR, OMC, UCS, soil stabilization.

I. INTRODUCTION

In India, the modern era of soil stabilization began in early 1970. It became necessary for the engineers to look at means to improve soil other than replacing the poor soil at the building site. Soil stabilization was used but due to the use of obsolete methods and also due to the absence of proper technique, soil stabilization lost favor. In recent times, with the increase in the demand for infrastructure, raw materials and fuel, soil stabilization has started to take a new shape. With the availability of better research, materials and equipment, it is emerging as a popular and cost-effective method for soil improvement.

For any land-based structure, the foundation is very important and has to be strong to support the entire structure. In order for the foundation to be strong, the soil around it plays a very critical role. So, to work with soils, we need to have proper knowledge about their properties and factors which affect their behavior. The process of soil stabilization helps to achieve the required properties in a soil needed for the construction work. From the beginning of construction work, the necessity of enhancing soil properties has come to the light. Ancient civilizations of the Chinese, Romans and Germany have utilized various methods to improve soil strength etc., some of these methods were so effective that their buildings and roads still exist.

II. COCONUT COIR FIBRE

Coconut fibre is a natural fibre extracted from the husk of coconut and used in products such as floor mats, doormats, brushes and mattresses. Coir is the fibrous material found between the hard, internal shell and the outer coat of a coconut. Other uses of brown coir (made from ripe coconut) are in upholstery padding, sacking and horticulture. White coir, harvested from unripe coconuts, is used for making finer brushes, string, rope and fishing nets. Being a good absorbent, dry coco peat can be used as an oil absorbent on slippery floors. Coco peat is also used as bedding in animal farms and pet houses to absorb animal waste so the farm is kept clean and dry. Coco fibre is hydrophilic unlike sphagnum moss and can quickly reabsorb water even when completely dry. Coco peat is porous and cannot be overwatered easily.

Coir fibers are found between the hard, internal shell and the outer coat of a coconut. The individual fibre cells are narrow and hollow, with thick walls made of cellulose. They are pale when immature, but later become hardened and yellowed as a layer of lignin s deposited on their walls. Each cell is about 1 mm (0.04 in) long and 10 to 20 µm (0.0004 to 0.0008 in) in diameter. Fibres are typically 10 to 30 centimeters (4 to 12 in) long. The two varieties of coir are brown and white. Brown coir harvested from fully ripened coconuts is thick, strong and has high abrasion resistance. It is typically used in mats, brushes and sacking. Mature brown coir fibres contain more lignin and less cellulose than fibers such as flax and cotton so are stronger but less flexible.

III. SOIL REINFORCED WITH COCONUT COIR

As the quality of a soil layer is increased, the ability of that layer to distribute the load over a greater area is generally increased so that a reduction in the required thickness of the soil and surface layers may be permitted. The most common improvements achieved through stabilization include better soil gradation, reduction of plasticity index or swelling potential, and increases in durability and strength. In wet weather, stabilization may also be used to provide a working platform for construction operations. These types of soil quality improvement are referred to as soil modification or soil stabilization.

Figure 3.1 coconut coir

3.1 STABILIZATION

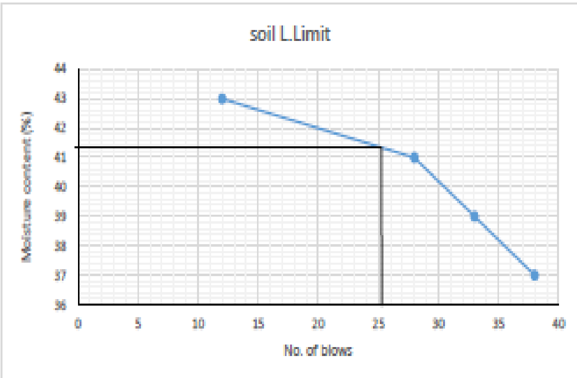
Stabilization can increase the shear strength of a soil and/or control the shrink's well properties of a soil, thus improving the load bearing capacity of a sub grade to support pavements and foundations. The most common improvements achieved through stabilization include better soil gradation, reduction of plasticity index or swelling potential, and increases in durability and strength. In wet weather, stabilization may also be used to provide a working platform for construction operations. These types of soil quality improvement are referred to as soil modification. Benefits of soil stabilization are higher resistance values, reduction in plasticity, lower permeability, reduction of pavement thickness, elimination of excavation, material hauling and handling, and base importation, aids compaction, provides all-weather access onto and within projects sites.

The determining factors associated with soil stabilization may be the existing moisture content, the end use of the soil structure and ultimately the cost benefit provided. As good soil becomes scarcer and their location becomes more difficult and costly, the need to improve quality of soil using soil stabilization is becoming more important.

Soil stabilization using raw plastic bottles is an alternative method for the improvement of sub grade soil of pavement. It can significantly enhance the properties of the soil used in the construction of road infrastructure.

IV. RESULTS AND DISCUSSION

4.1 LIQUID LIMIT



Water Content (%)

Figure 4.1 liquid limit for soil

4.2 OPTIMUM MOISTURE CONTENT

4.2.1 soil without reinforcement

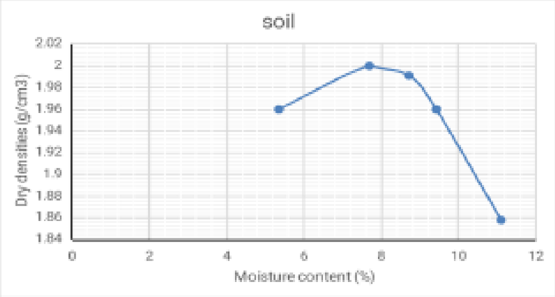


Figure 4.2 soil without reinforcement

4.2.2 Soil + 0.5% coconut coir fibre

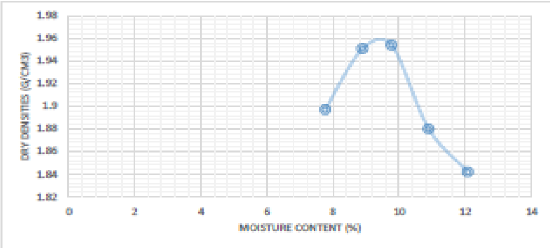


Figure 4.3 Soil + 0.5% coconut coir fibre

4.2.3 Soil + 0.75% coconut coir fibre

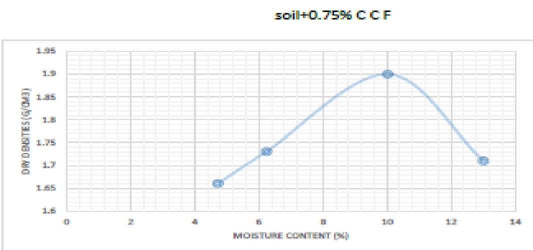


Figure 4.4 Soil + 0.75% coconut coir fibre

4.2.4 Soil + 1% coconut coir fibre

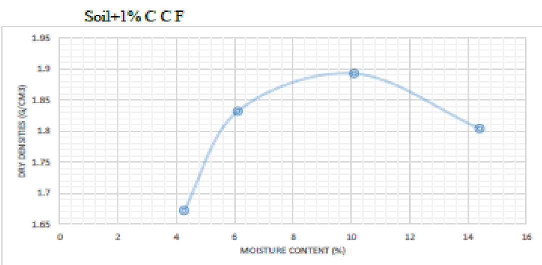


Figure 4.5 Soil + 1% coconut coir fibre

4.2.5 Soil + 1.25% coconut coir fibre

Soil+1.25% C C F

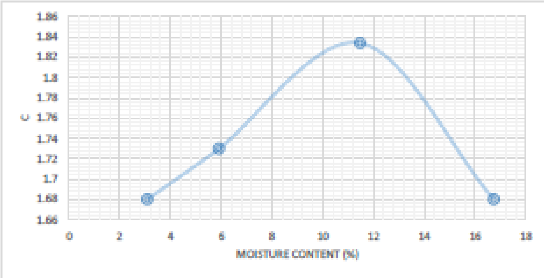


Figure 4.6 Soil + 1.25% coconut coir fibre

4.3 DIRECT SHEAR TEST OF SOIL

4.3.1 Soil without reinforced

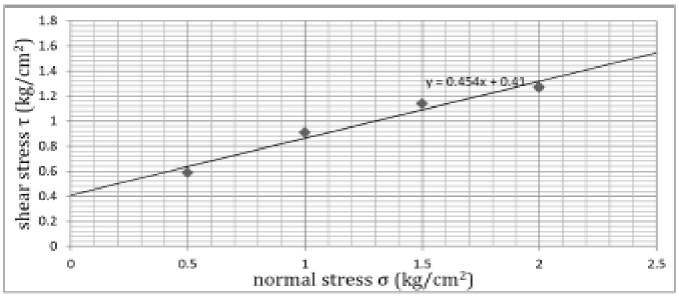


Figure 4.7 soil without reinforced

i. **Soil reinforced with 0.5% of coir**

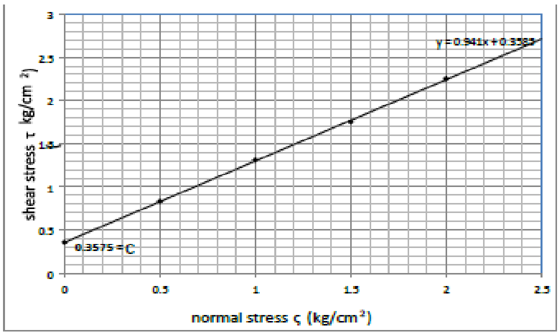


Figure 4.8 soil reinforced with 0.5 % coir

4.3.3 Soil reinforced with 0.75% of coir

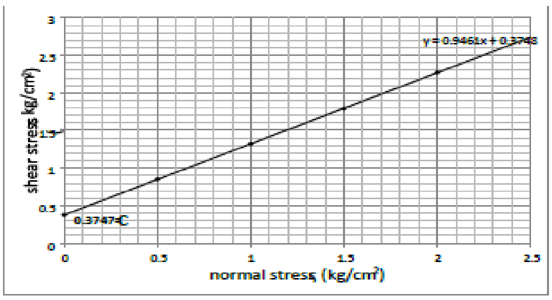


Figure 4.9 soil reinforced with 0.75 % coir

ii. **Soil reinforced with 1% of coir**

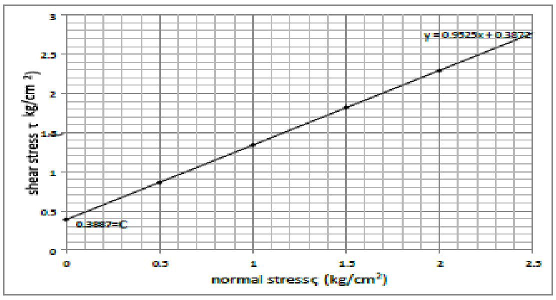


Figure 4.10: Soil reinforced with 1% of coir

4.3.4 Soil reinforced with 1.25% of coir

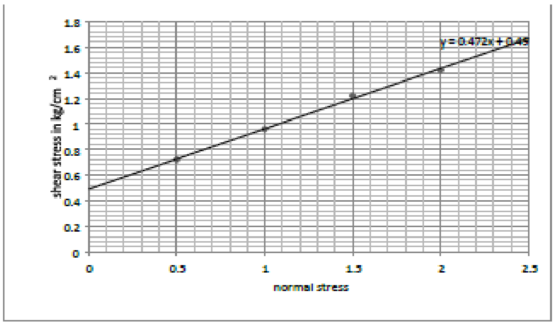


Figure 4.11: Soil reinforced with 1.25% of coir

Inferences from Direct Shear Test

Soil sample

- Cohesion value increases from 0.325 kg/cm2 to 0.3887 kg/cm2, a net 19.6%
- The increment graph shows a gradual decline in slope.
- The angle of internal friction increases from 47.72 to 48.483 degrees, a net 1.59%
- The increment in shear strength of soil due to reinforcement is marginal

b. UNCONFINED COMPRESSIVE STRENGTH OF SOIL

4.4.1 Soil without reinforced

SOIL WITHOUT REINFORCED

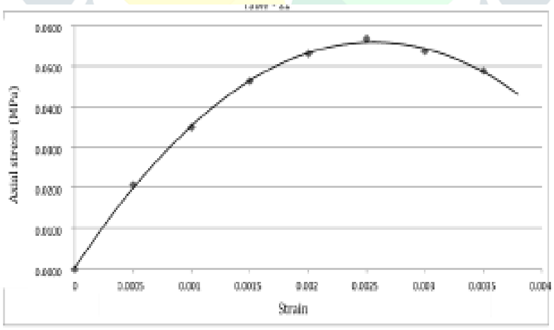


Figure 4.12 soil without reinforced

i. Soil reinforced with 0.5% of coir

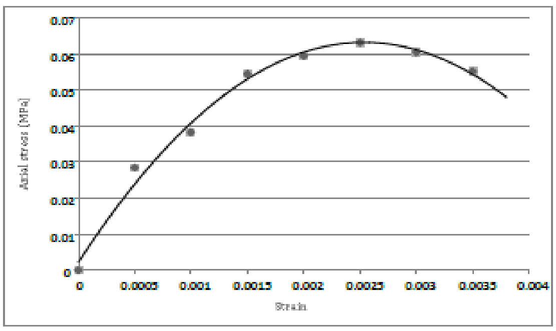


Figure 4.13 soil reinforced with 0.5 % coir

4.4.3 Soil reinforced with 0.75% of coir

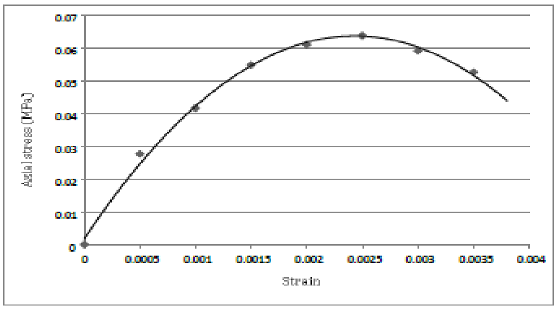


Figure 4.14 soil reinforced with 0.75 % coir

4.4.4 Soil reinforced with 1% of coir

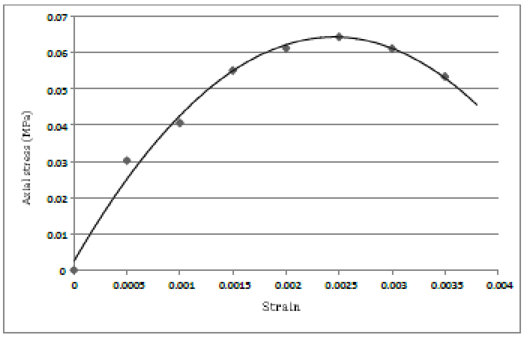


Figure 4.15: Soil reinforced with 1% of coir

4.4.4 Soil reinforced with 1.25% of coir

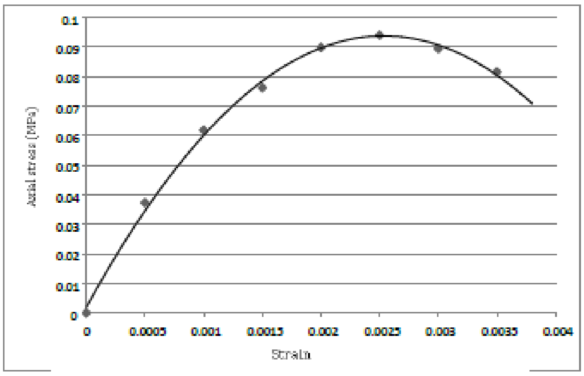


Figure 4.16: Soil reinforced with 1.25% of coir

4.5 CALIFORNIA BEARING RATIO TEST

4.5.1 Soil without reinforcement

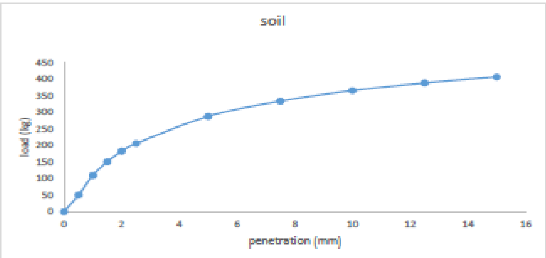


Figure 4.17 soil without reinforced

4.5.2 Soil reinforced with 0.5% of coir

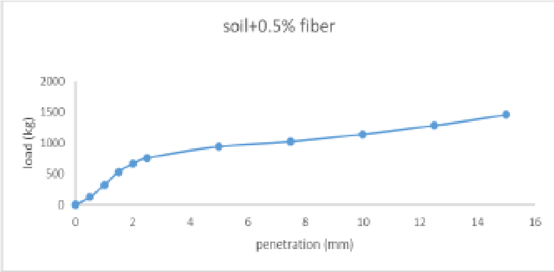


Figure 4.18 soil reinforced with 0.5 % coir

4.5.3 Soil reinforced with 0.75% of coir

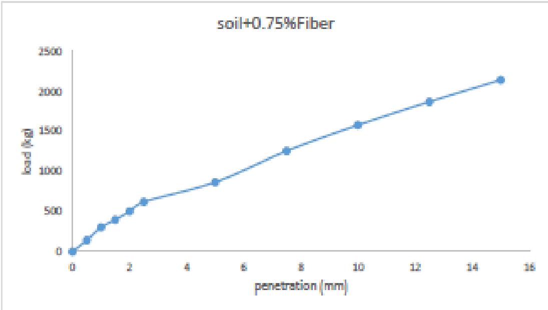


Figure 4.19 soil reinforced with 0.75 % coir

4.5.4 Soil reinforced with 1% of coir

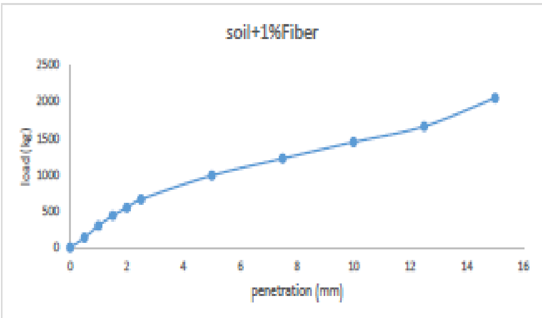


Figure 4.20: Soil reinforced with 1% of coir

4.5.5 Soil reinforced with 1.25% of coir

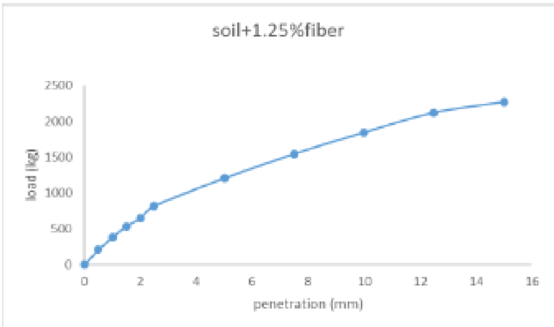


Figure 4.21: Soil reinforced with 1.25% of coir

V. CONCLUSION

On the basis of present experimental study, the following conclusions are drawn:

1. Based on direct shear test on soil sample, with fibre reinforcement of 0.5%, 0.75% and 1.0%,1.25% the increase in cohesion was found to be 11.2%,10%, 4.8% and 3.73% respectively

2. The increase in the internal angle of friction (φ) was found to be 0.98%,0.8%, 0.31% and 0. 47% respectively.

3. Since the net increase in the values of c and φ were observed to be 19.6%, from 0.325 kg/cm2 to 0.3887 kg/cm2 and 1.59%, from 47.72 to 48.483 degrees respectively, for such a soil, randomly distributed coconut coir fibre reinforcement is not recommended.

4. The results from the UCS test for soil sample are also similar, for reinforcements of 0.5%, 0.75%, 1.0% and 1.25% the increase in unconfined compressive strength from the initial value are 12.04%,11.68%, 1.26% and 0.62% respectively

5. This increment is not substantial and applying it for soils similar to soil sample is not effective.

6. The shear strength parameters of soil sample were determined by direct shear test. illustrates that the increase in the value of cohesion for fibre reinforcement of 0.05%, 0.15% and 0.25% are 34.7%, 6.09% and 7.07% respectively. illustrates that the increase in the internal angle of friction (φ) was found to be 0.8%, 0.31% and 0. 47% respectively.

7. Thus, a net increase in the values of c and φ were observed to be 53%, from 0.3513 kg/cm2 to 0.5375 kg/cm2 and 15.02%, from 27.82 to 32 degrees. Therefore, the use of coconut coir fibre as reinforcement for soils like soil sample is recommended.

8. On comparing the results from UCS test of soil sample, it is found that the values of unconfined compressive strength show a net increment of 49.8% from 0.0692 MPa to 0.1037 MPa. This also supports the previous conclusion that use of polypropylene fibres for reinforcing soils like soil sample is recommended.

9. Overall it can be concluded that fibre reinforced soil can be considered to be good ground improvement technique specially in engineering projects on weak soils where it can act as a substitute to deep/raft foundations, reducing the cost as well as energy.

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