ISSN 2250-3153

# Effect of Natural Coir fibres on CBR Strength of Soil Subgrade

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***Abstract-*** This paper deals with an experimental study on the utilization of natural coir fibers on unpaved roads. Coir fibres provide a reinforcement action to the subgrade soil. Coir fibre is a natural material obtained from coconut husk which is commonly seen in India. Use of coir fibres improves the subgrade soil strength. Coir fibers of varying length from 0.5 to 3cm and varying percentage from 2 to 8 of total weight of soil were added with the soil and CBR test was conducted. From the test results, it was concluded that the CBR strength using coir fibre was improved and optimum fibre length obtained was 1.5cm and optimum fiber content was 5% of total weight of soil. CCM-400 Coir Geotextile which is a woven type coir mat was placed at ¼ th, ½ th, ¾ th and top positions of soil sample and CBR test were conducted. The results concluded that placing geotextiles at two third depth from bottom position was seems to be more effective.

## I. INTRODUCTION

FLEXIBLE pavements are the most common pavement structure. There are so many factors which affect the service life of roads and pavements. They include subgrade conditions, environmental factors, traffic loading, road widening etc. One of the prominent deterioration among pavement cracking is due to the poor subgrade soil. Due to repeated traffic loads subgrade leads to large deformations. This increases the maintenance cost and lead to interruptions of traffic service. The deformation occurs because there is no reinforcement action occurs in subgrade. The reinfocement action is necessary during initial stage and later reinforcement action is obtained by the consolidation of subgrade soil. The use of geotexliles in subgrade soil acts as a reinforcement and reduces the deformation. Studies proved that the use of geotextiles increases the service life of the pavement and also reduces the thickness of the pavement layer. This is more beneficial because the cost of geotextiles is less while comparing the cost of the reduced pavement layer thickness material.

In modern pavement design, geosynthetics play a significant role. They are the most cost effective tools for increasing the pavement life and reducing the maintenance of pavements. There are many applications of coir geotextiles in pavements. They include subgrade separation, subgrade stabilization, base reinforcement, overlay stress absorption etc.

The process of improving engineering properties of soil, and thus making it more stable is called soil stabilization. There are various methods for soil stabilization like mechanical stabilization, cement stabilization, lime stabilization, bituminous stabilization, chemical stabilization, thermal stabilization, electrical stabilization, stabilization by grouting etc. In the present work, detailed study on the effect of using a natural material such as coir on subgrade soil is being considered to improve properties. Soil stabilization is of great importance in road construction. Long term performance of pavement structures often depends on the stability of the underlying soils. Engineering design of these constructed facilities relies on the assumption that each layer in the pavement has the minimum specified structural quality to support and distribute the super imposed.

Rao and Balan (2000), in their study found the gaining importance of geotextiles like coir and jute because of their ecofriendliness and low cost with reasonable durability. Coir is the husk of coconut, a common waste material and subsequently processed. Coir fiber is strong and degrades slowly compared to other natural fibers due to high lignin content. The advantages of coir geotextiles are the initial strength, stiffness and hydraulic properties of coir reinforcement are almost comparable to those of similar products made from polymer materials. They are of very low raw material price. By chemical treatment and polymer coating, the life of coir products can be improved. It can be laid on any surface owing to its flexibility and hence it is useful for geotechnical purpose. Coir fibers are environmental friendly, biodegradable and aesthetically pleasing and easy to install and follows the contour the soil surface.

### *Need for the study*

The life time of pavement depends upon the subgrade soil strength. If subgrade strength is less, it may lead to the propagation of cracks on the pavement surface. The selected paving geosynthetics must have the ability to provide reinforcement action and thus increases the subgrade soil strength. Also the geotextiles improves the CBR value and thus reduces the pavement thickness. The paper highlights the improvement in CBR properties of coir geotextiles.

### *B. Objectives*

1. To find the improvement in CBR strength of subgrade soil using coir geotextiles.
2. To determine the optimum fiber percentage and fiber length using CBR test.
3. To locate the ideal position of coir geotextiles in subgrade soil.

## II. MATERIALS USED

### *Coir Geotextiles*

The Coir Geotextiles used for the study are procured from a local supplier. There are mainly two types of coir geotextiles; woven and non- woven type. The process for their production includes retting, spinning and weaving. For the present experimental work coir fibres of varying length and CCM 400 coir geotextiles which was a mat was used. The CCM 400 is a woven type coir geotextiles. The CCM 400 coir geotextiles are shown in Fig 1. Tensile properties are found out using tensile testing machine as per ASTM standards. The tensile tests were performed in both axial and lateral direction. The physical and engineering properties of the woven and non-woven coir geotextiles are presented in Table 1.

Fig.1. CCM 400 coir geotextiles

Fig.2. Coir fibre

Table 1.
Properties of Coir geotextiles

| **Properties** | **Values** |
|---|---|
| Mass/unit area for CCM 400 | **400 GSM** |
| Mass/unit area for coir fibre | 250 GSM |
| Thickness for CCM 400& coir fibre | 6.46, 2.46 |
| Tensile strength | 37kN/m |
| Failure strain | 25% |

*Soil Sample*

Lateritic soil is collected from Manvela region of Trivandrum district, Kerala. It is the widely occurring type of soil in Kerala. It is reddish in colour and well graded soil developed from weathering. It is characterized by deep weathered layer in which silica has been leached out and a layer of aluminium and iron oxides have been accumulated. Liquid limit, plastic limit and shrinkage limit of soil sample were determined as per IS: 2720 (Part 5)-1985 [10]. Modified Proctor compaction were carried out to determine the optimum moisture content and maximum dry density of the sample as per IS: 2720 (Part 8)-1983 [11]. Summary of the geotechnical properties of the soil used are given in Table-2.

**Table 2.**
**Properties of Soil sample**

| **Properties** | **Values** |
|---|---|
| Specific gravity | 2.633 |
| Liquid Limit (%) | 38 |
| Plastic Limit (%) | 26 |
| Plasticity Index (%) | 16 |
| Field density (g/cc) | 1.12 |
| Optimum moisture content | 16 |

## III. TEST PROCEDURE

CBR method of pavement design is the most popular method of pavement design. In this method, the thickness of pavement above a certain layer is based on CBR of that layer. There are charts connecting CBR and thickness of pavement required given by IRC 37-2001. As the CBR of the material increases, the thickness of pavement required reduces. The stabilization of the soil increases its CBR value tremendously and thus helps in reducing the pavement thickness. The experimental study involved performing laboratory CBR tests using coir fibers and coir geotextiles mate of CCM 400 for three samples each. The subgrade was prepared in the CBR mould of internal diameter 150mm and height (H) 175mm, by compacting up to 0.8H, to its Modified Proctor density and optimum moisture content. The control specimen is the soil sample without coir geotextiles and reinforced sample is the sample with coir geotextiles. The CCM 400 coir geotextiles was placed at ¼ th, ½ th, ¾ th and top position from bottom of the soil sample.

## IV. RESULTS AND DISCUSSIONS

The improvement in load carrying capacity of the subgrade soil was identified by using the CBR test. The coir fibre length varies from 0.5cm to 3cm and the optimum fibre length obtained was 1.5cm. The coir fibre percentage varies from 1% to 8% and optimum fibre percentage obtained was 5%.

ISSN 2250-3153

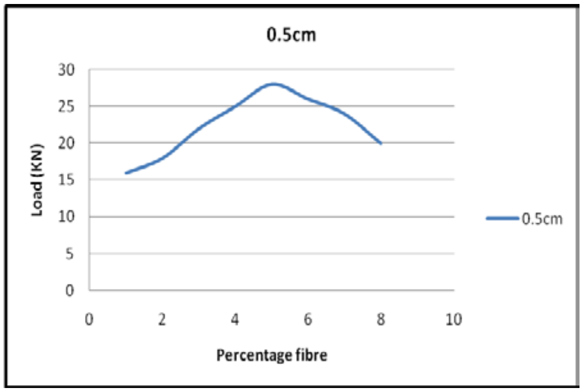


**Fig.3. Load vs Percentage fibre for 0.5cm fibre length**

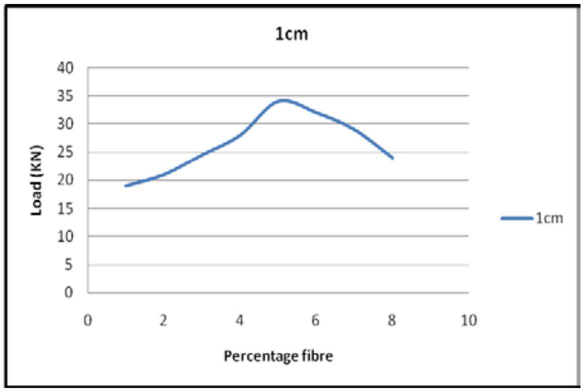


**Fig.4. Load vs Percentage fibre for 1cm fibre length**

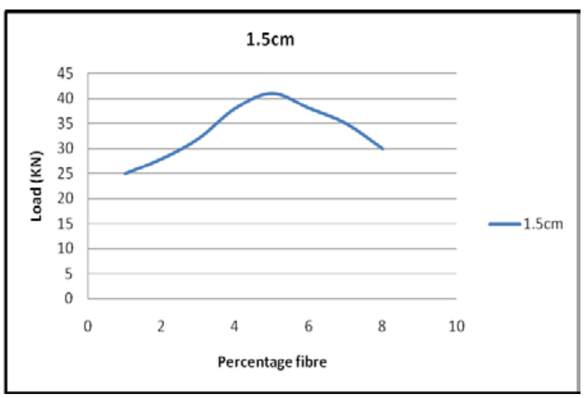


**Fig.5. Load vs Percentage fibre for 1.5cm fibre length**

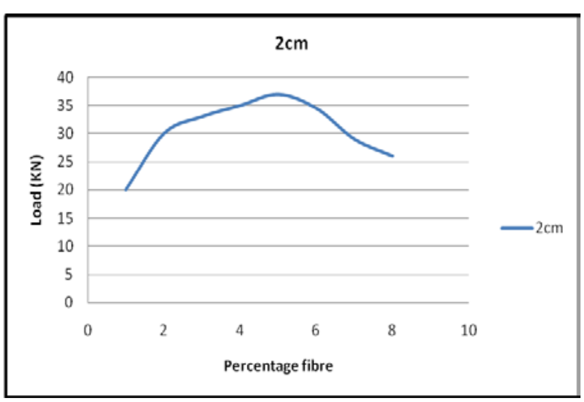


**Fig.6. Load vs Percentage fibre for 2cm fibre length**

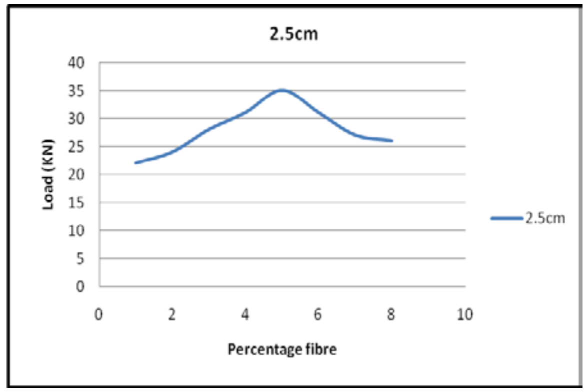


**Fig.7. Load vs Percentage fibre for 2.5cm fibre length**

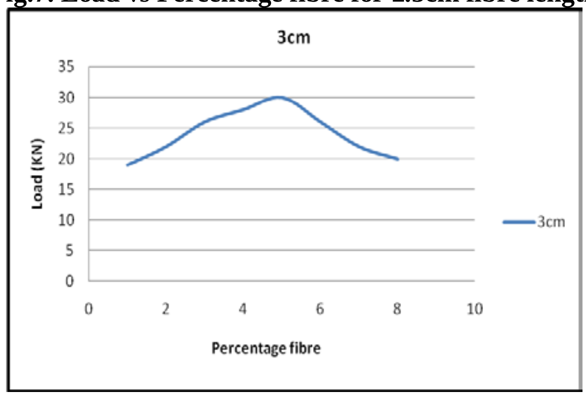


**Fig.8. Load vs Percentage fibre for 3cm fibre length**

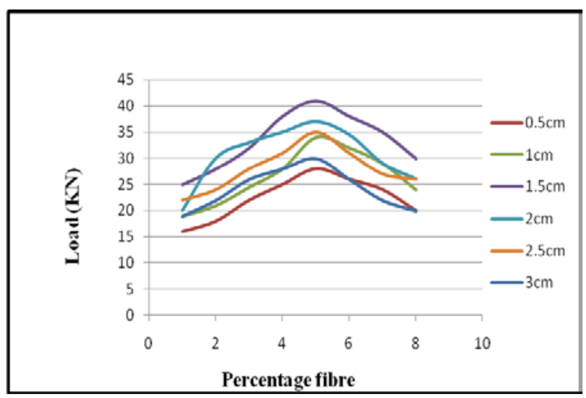


**Fig.9.Combined diagram for Load vs Percentage fibre**

The influence of varying fibre length of coir was studied. It was found that the test was sensitive to the fibre length variation. For 5% fibre content the maximum value of load obtained was 41kN for 1.5cm fibre length.

Also coir mates of CCM400 coir geotextiles was placed as a layer at ¼ th, ½ th, ¾ th and top position of the soil sample and the CBR test was conducted.

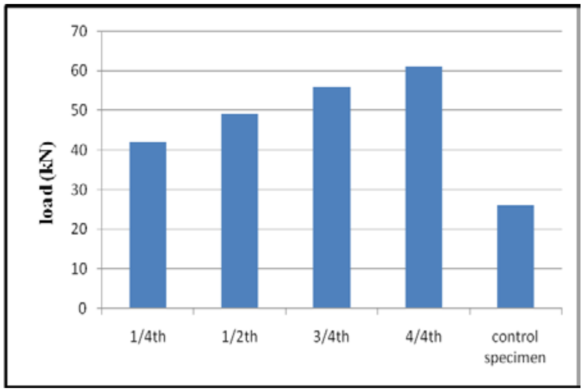


**Fig.10. Load Comparison graph**

From the test it was clear that the load was maximum while placing the geotextiles at top position of the subgrade and the least value was obtained at bottom most position. But the load was more for all samples placing the geotextiles at different positions while comparing with the control specimen.

## V. CONCLUSIONS

This investigation was conducted to assess the effect of coir geotextiles on the performance of subgrade soil. Based on the results obtained in this investigation, the following conclusions could be drawn.

- The optimum fibre percentage obtained was 5% of total weight of sample.
- The optimum fibre length obtained was 1.5cm.
- The ideal position for placing the coir geotextiles was at top position of the subgrade and the least value was obtained at bottom most position.
- The use of coir geotextiles increases the subgrade strength and thus improves pavement life.

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