

# Experimental Study on Improvement of Soil Subgrade Reinforced with Banana and Coir Fibers

Finu John<sup>1</sup>, Elsa Maria Jose<sup>2</sup>, Manu Varghese<sup>2</sup>, Megha Antu<sup>2</sup>, Megha Joy<sup>2</sup>

<sup>1</sup>Ast.Professor, Dept.of Civil Engineering, Viswajyothi college of Engineering and Technology, Kerala, India

<sup>2</sup>B-Tech Student, Dept.of Civil Engineering, Viswajyothi College of Engineering and Technology, Kerala, India

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**Abstract** - For pavement construction and design, behaviour of subgrade soil is an important factor. If the subgrade soil is too weak, large deformations may occur which may lead to cracking, differential settlement, potholes, wheel path rutting. Natural fibers are used for soil improvement as they are cheap, locally available, bio degradable and eco-friendly. Geosynthetics and other additives are not eco-friendly. The aim of this paper is to study the effectiveness of natural fibers (coir and banana fibers) on soil subgrade strengthening. CBR tests were conducted on soil sample before and after addition of fibers. Fibers were randomly oriented. Fibers were added at 0.25%, 0.5%, 0.75%, 1%, 1.25%. Length of fibers were taken as 20mm. The increase of CBR value leads in decreasing thickness of pavement.

**Key Words:** Soil Reinforcement, Subgrade soil, Banana Fiber, Coir Fiber, CBR Value

## 1. INTRODUCTION

The road consists of layers of subgrade, sub base, base course and wearing course. The primary factor for the construction and design of highway projects is the availability of good subgrade soil. Soil as being poor in mechanical properties is to be improved depending on its requirement which varies. Soil reinforcement is one of the common techniques used for subgrade soil for its modification and is applicable to all types of soils. Soil reinforcement can be done in defined manner or in discrete pattern. Randomly distributed method is commonly adopted. Natural fibers are attractive as they are cheap, eco-friendly and locally available. Hence study on naturally reinforced soil is needed and beneficial. Pavement design is based on subgrade soil properties and hence it is to be improved. In this work, coir and banana fibers are used for reinforcing soil. Soil properties are studied. CBR test was conducted to analyse subgrade soil. Natural fibers were added in various percentages (0.25%, 0.5%, 0.75%, 1%) to investigate the improvement in properties of soil. Fiber reinforced soil act as a composite material. Obtained results were compared.

## 2. LITERATURE REVIEW

H.P Singh, M. Bagra (2013) did a study on improvement in CBR value of soil reinforced with jute fiber and they found that with increase in fiber content CBR value also increases and this is upto 1%. Preparation of soil samples for CBR test beyond 1% is not possible.

Amit Kumar Singh, R.K Yadav (2016) did a study on improvement of expansive soil with jute fiber reinforcement and concluded that jute fiber is very effective as CBR value increases. Jute fiber also increases unconfined compressive strength.

Prajisha J.P, Ajisha A.R (2016) did a study on strength and durability study on banana fiber and found that unconfined compressive strength of soil reinforced with 0.5% fiber shows 1.59 and 1.86 times increase in value respect to unreinforced soil.

Shukla Devdatt, Rajan Shikha, Saxena A.K, Jha A.K (2015) did a study on soil stabilization using coconut coir fiber and found that addition of fibers changes compaction parameters. OMC decreased and maximum dry density increased with addition of fiber.

## 3. MATERIALS

In this work silty clay is used. Because of the presence of clay content, it can cause deformations of subgrades. Coir and banana fibers are easily available.

### 3.1 Soil

Soil sample was collected from Nadukkara, Ernakulam, Kerala. Sample was collected and tested for its basic properties and following were obtained.

**Table-1**

Sl no.	Property	Value
1	Specific Gravity	2.7
2	Liquid Limit	50
3	Plastic Limit	33.33
4	Optimum Moisture Content	23%
5	Maximum Dry density	1.58
6	% Passing 75 micron sieve	9%

### 3.2 Fibers

Banana and Coir fibers were used. They are economical and are easily available. Fibers were cut at 20mm and are added in discrete manner. They were added at various percentages of dry density of soil.

#### 4. METHODOLOGY

The soil sample is tested for its basic properties by conducting:

- Atterberg limits
- Pycnometer test for Specific gravity
- Sieve analysis for grain size distribution
- Proctor test for OMC and maximum dry density

The values obtained from these tests are shown in table-1. After this CBR test was conducted at both reinforced and non reinforced soil sample at different fiber percentage contents.

##### A. California Bearing Test

The test shows bearing resistance of soil .Water is mixed at optimum moisture content to the soil sample and is mixed. Compaction is given in 5 layers with 56 blows on each layer. Soil sample is tested in the CBR machine in which penetration and load is noted down. Loads corresponding to 2.5mm and 5mm penetration are found out and CBR values are obtained. Same procedure was repeated at different percentage of fiber contents and changes in values were noted down.

#### 5. RESULTS AND DISCUSSIONS

CBR values of soil and soil reinforced with banana and coir fiber with varying percentage of fiber content are shown in Table 2 and Table 3 respectively. It is clear from the results that CBR value increases with increase in fiber content. Result from Table 2 show that maximum CBR value of coir reinforced soil is 3.3 times(519%) that of plain soil at a fiber content of 1%.The minimum CBR value of coir reinforced soil is obtained as 1.4 times (43%)that of plain soil at a fiber content of 0.25%.In case of soil reinforced with banana fiber(Table3),CBR value is 4.6 times(361%)that of plain soil at a fiber content of 1%.It also show that soil reinforced with banana fiber is 1.6 times(67%)that of plain soil at a fiber content of 0%.

**Table-2 CBR value of coir fiber reinforced soil**

Fiber content(%)	CBR value(%)	Increase in CBR value	(%)increase in CBR value
0	5.4		
0.25	7.7	2.3	43
0.50	9.4	19.4	359
0.75	13.1	23.1	428
1	18	28	519

Increase in strength in soil is due to the interaction of fiber with the soil particle through surface friction and interlocking. It transfers the stress from the soil to the fiber by its tensile strength.

**Table-3 CBR value of banana fiber reinforced soil**

Fiber content(%)	CBR value(%)	Increase in CBR value	(%)increase in CBR value
0	5.4		
0.25	9.0	3.6	67
0.5	15.2	9.8	181
0.75	21.1	15.7	290
1	24.9	19.5	361

#### 6.CONCLUSION

Based on test results it was founded that CBR value increases with increase in fiber content at different percentages. With increase in fiber content CBR value also increases further and are substantial at 1% fiber content. Preparation of soil sample with more than 1% fiber content is difficult. It was also found that banana fiber has more CBR value with same fiber content as that of coir fiber and thus banana fiber is more suitable than coir fiber.

#### 7. REFERENCES

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