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# EFFECT OF NEEDLE PUNCHED NONWOVEN COIR AND JUTE GEOTEXTILES ON CBR STRENGTH OF SOFT SUBGRADE

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**ABSTRACT**

This paper deals with an experimental study on the utilization of the needle punched nonwoven geotextiles made of coir and jute fibers, for unpaved roads over soft subgrade, otherwise undergoes large deformation. Since the CBR reinforcement ratio is used for the design of unpaved road, the CBR reinforcement ratio value of the geotextile-sub grade is obtained by conducting CBR test with the geotextile, to study the effect of the natural geotextiles on the soft sub grade. The CBR strength using both the nonwoven geotextiles is improved, whereas jute geotextile performs better.

**Keywords:** coir geotextile, jute geotextile, subgrade, CBR test, CBR reinforcement ratio.

## INTRODUCTION

Development of unpaved roads for low volume traffic is not only economical but important as it provides access to the rural areas for improvement especially in an agricultural country. Problems in unpaved roads arise when laid on soft subgrade because of large deformations. Though the use of geosynthetics in roads works well [1-4], however it may not be a viable option when it comes to rural places. In such situation, there is a possibility of utilizing the natural geotextiles instead of geosynthetics, as an economical alternative to overcome the problem.

It is well known that the natural materials will decompose over time, which limits its use to short term applications only. Since an unpaved road on soft subgrade gets stabilized due to repeated traffic load [5], till the time, natural geotextiles supports it. Hence, the natural geotextile complements the unpaved road on soft subgrade as it gains strength in the long-term.

Of all the natural fibrous materials for making geotextiles, Coir and jute fibers are strong and degrade slowly since it contains high lignin content [6]. The use of geosynthetics increases the CBR strength of the soil [7-8]. The application of natural woven coir geotextile for unpaved roads on soft subgrade performs satisfactorily [9]. However, the study on the use of needle punched nonwoven coir geotextile and jute geotextile is limited. Hence, the aim of the present study is to investigate the application of nonwoven needle punched coir and jute geotextile for soft subgrade.

## MATERIALS AND METHODS

### Soil samples

Soft clay representative soil samples were collected locally from Sowripalayam, Coimbatore. 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-1.

**Table-1.** Properties of soil.

| Properties | Value |
|---|---|
| Specific gravity | 2.89 |
| Liquid limit (%) | 49 |
| Plastic limit (%) | 24 |
| Plasticity index (%) | 25 |
| Shrinkage limit (%) | 16 |
| BIS soil classification | CI |
| Free swell (%) | 61 |
| UCC strength (kPa) | 358 |
| Optimum moisture content (%) | 18 |
| Maximum dry density (g/cm$^3$) | 1.74 |

### Coir and jute geotextiles

Coir fibers are procured from Pollachi near Coimbatore and jute fibers available at PSG Textile Department obtained from West Bengal, is used for the present study. The natural geotextiles of nonwoven fabric were prepared using DILO Needle punching machine, Germany available at PSG Textile Jute Division, Neelmabur, Coimbatore. The properties of geotextiles are presented in Table-2.

**Table-2.** Properties of geotextiles.

| Type of geotextile | Mass per unit area (g/m$^2$) | Thickness (mm) | Strip tensile strength (kN/m) |
|---|---|---|---|
| Coir geotextile | 1214.56 | 8.14 | 1.9 |
| Jute geotextile | 1086.50 | 5.21 | 1.4 |

### Experimental methods

The experimental study involved performing laboratory CBR tests using coir geotextile and jute geotextile for three samples each. The clay 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. Then, the natural geotextile was placed and base course aggregates were filled over the mould, which was soaked for not less than four days before testing.

## RESULTS AND DISCUSSIONS

The results of soaked CBR tests on soil sample, coir geotextile and jute geotextile interfaced soil samples are presented in Table-3, in which the loads are corresponding to the average of three tested samples.

**Table-3.** CBR test results.

| **Penetration** (mm) | **Load** (kg) | | |
|---|---|---|---|
| | **Soil** | **Coir geotextile** | **Jute geotextile** |
| 0 | 0 | 0 | 0 |
| 0.5 | 4.9 | 8.9 | 21.3 |
| 1.0 | 14.1 | 24.6 | 31.7 |
| 1.5 | 21.3 | 34.6 | 59.1 |
| 2.0 | 30.4 | 43.7 | 78.6 |
| 2.5 | 38.7 | 58.1 | 104.3 |
| 3.0 | 45.8 | 74.1 | 115.4 |
| 4.0 | 61.2 | 89.8 | 147.1 |
| 5.0 | 84.9 | 104.2 | 173.8 |
| 7.5 | 140.9 | 144.1 | 233.1 |
| 10.0 | 198.3 | 194.2 | 279.1 |
| 12.5 | 263.8 | 264.8 | 312.9 |

Based on the test results the reinforcement ratio is obtained, which can be used as a multiplier to the CBR strength of the soil for design of aggregate thickness [12].

The reinforcement ratio at a particular penetration is obtained by

$$Reinforcement\ ratio = \frac{Soil\ with\ geotextile}{Soil\ without\ geotextile}$$

The reinforcement ratio with coir geotextile as well as jute geotextile for soft clay subgrade is presented in Table-4.

**Table-4.** Comparison of reinforcement ratios.

| **Type of geotextile** | **Reinforcement ratio at** | | | |
|---|---|---|---|---|
| | **2.5mm** | **5.0mm** | **7.5mm** | **12.5mm** |
| Coir geotextile | 1.5 | 1.2 | 1.0 | 1.0 |
| Jute geotextile | 2.7 | 2.0 | 1.7 | 1.2 |

Based on the observations from Table-4, the reinforcement ratio at 2.5mm penetration was higher than at 5.0mm penetration, which is similar to routine CBR test results. The reinforcement ratio of both the coir geotextile as well as jute geotextile is equal to or more than one indicates that the equivalent CBR strength of the soil - geotextile increases due to separation alone. Apart from that the soft clay subgrade gain strength with time because of consolidation and also, due to the membrane support offered in the field.

## CONCLUSIONS

The use of the needle punched non-woven coir geotextile and jute geotextile in the soft clay subgrade increases the CBR strength overall. Though the natural geotextile is low strength and biodegradable material, it improves the performance of the unpaved road as the soft subgrade attains strength over the time.

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