International Journal of Innovative Research in Engineering & Management (IJIREM)
ISSN: 2350-0557, Volume-9, Issue-5, October 2022
https://doi.org/10.55524/ijirem.2022.9.5.40
Article ID IJIR-1279, Pages 278-281
www.ijirem.org

Study of Impact of the Coir Geo-Textile Usage on the Unpaved Roads

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ABSTRACT- Transportation infrastructure development is crucial to a country's overall growth. Roads are one of the most essential routes of transportation in the world, and they play a crucial part in a country's economic and social development. Unpaved roads are typically utilised for low traffic flow and serve as access roads; they are also known as village roads. Unpaved roads serve a critical role in the rural region economy and the resource sectors of agricultural and resource-rich countries. a method is required that either removes the requirement for good-quality aggregate or needs the use of only a small amount of the such material while still providing adequate road performance. Geosynthetics have been utilised to improve unpaved roads on basis of soft subgrades and to lengthen their service life. By adding reinforcement, the aggregate layer thickness required for a given traffic volume can be reduced, or the traffic volume can be raised for a given aggregate layer thickness. Due to its high lignin concentration, coir fibre is robust and degrades slowly when compared to other natural fibres (Rao and Balan, 2000). When embedded in the fill material, coir geotextile creates good interface friction with granular fill, which can cause tensile stress in the reinforcement.

KEYWORDS- Coir Geo-Textile, Unpaved Roads. Coir fibre, Geotextiles

I. INTRODUCTION

In recent years, the development of geosynthetics has contributed new dimensions to the solution of a number of tough geotechnical engineering challenges. Polymeric materials are employed in geotextiles, geonets, geomembranes, geogrids, geopipes, geocomposites, geosynthetic clay liners and geofoams while natural materials can also be used. Geosynthetics are made from polymeric materials such as polypropylene, polyethylene, polyester, and polyamide[1-5]. They are created from petroleum by-products, a raw resource that might become limited over time. These items have a lengthy shelf life and do not disintegrate biologically, yet they are likely to cause long-term environmental problems. However, because of ecological and environmental engineering issues, the general application of geosynthetics is limited. Alternatives to polymeric geosynthetic materials have included natural materials such as coir, bamboo, and jute[5-10].

Kaniraj et al [11] investigated the present trends in geotextile and associated product utilisation in civil engineering. Manufacturing, property and testing equipment, requirements, applications and research, and the usage of natural fibre geotextiles have all been reviewed in order to emphasise the potential for the development of geotextiles in India. Ranganathan has elaborated on the evolution and possibilities of jute geotextiles[12]. Geotextiles, whether polymeric or natural, provide the same tasks as separators, reinforcement, and drainage/filtration in most circumstances. This study investigates reinforcement functions in relation to the unpaved embankments and roads, as well as the utilisation of coir geotextiles.

II. MATERIALS

A. Natural Geotextiles

Natural fibres are those that are derived from living things, such as plants, animals, or minerals, and huge numbers of these natural fibres may be found in many parts of the world. Natural fibres have a low elasticity, a high breaking extension, a high modulus, and a low breaking extension[13].

B. Synthetic Geotextiles

The main raw materials for the creation of all forms of geotextiles are synthetic or man-made fibres. Polypropylene, polyamide, polyester, and polyethylene are the four major polymer families used as raw materials in geosynthetics[14].

C. Coir Fibre

Coir fibres may be extracted from husks that are found on the outside of coconuts. White coir and brown coir are the two forms of coir fibre that may be obtained when coconut husks are extracted in different ways[15].

D. Composition of Coir Fibre

Fruit (for example, coir), seed (for example, cotton), stem (for example, sisal), leaf (for example, banana and pineapple), and so on all include cellulose fibres. Coir, sometimes known as *golden fibre* is completely organic fibre. It has a strong cellulose fibre with the high content of lignin[16-18]. It is a multicellular fibre with a polygonal and spherical cross section that comprises 30-300 or more cells. The main wall, the outer secondary wall, the middle secondary wall, and the inner secondary wall are all concentric layers in each cell[19]. The non-crystalline intercellular cementing material, composed of lignin, pectines, and hemicellulose, is found between the main cell walls and keeps the cells together reported in[20]. Coir fibre is strong and long-lasting, with lengths ranging from 150mm to 280mm and diameters ranging from 0.1mm to 0.5mm. It is most durable natural fibres due to its high lignin concentration (CSIR, 1960 report)[21-24].

Table 1: Chemical composition of coir (Sarma, 1997)

Content	Percentage
Lignin	45.84
Cellulose	43.44
Hemi cellulose	0.25
Pectin	3.00
Ash	2.22
Water soluble	5.25

Table 2: Properties of coir fibre (Ayyar et aI., 2002)

Property	Value
Length (mm)	15-280
Density	1.15-1.40
Tenacity (g/tex)	10
Breaking elongation (%)	30
Diameter (mm)	0.1-1.5
Rigidity modulus (dynes/cm^2)	1.8924
Specific gravity	1.15
Young's modulus (GN/m^2)	0.27

III. OBJECTIVES

The research was carried out in order to analyse the effect of coir geotextile as reinforcement and to look into the feasibility of using them in the construction of unpaved roads.

- Analyse the effect of plate load test on coir reinforced subgrade, study the role of coir geotextile in enhancing bearing capacity of soil.
- Study the effect on permanent deformation of reinforced subgrade using cyclic tri-axial testing.

IV. METHODOLOGY

A. Introduction

The subgrade of the soil and other related materials used in road and embankment construction have a considerable impact on the design and construction strategy. It is usually recommended to use materials if their strength and hydraulic qualities allow. Geotextiles are a tried-and-true technique that allows for the use of local materials to some extent, even if the available materials aren't up to standard in terms of design issues. This is only feasible at a greater cost, therefore the price-performance connection is critical in material selection. A structure's mechanical and/or hydraulic behaviour can be improved by using a geotextile if the geotextile is able to perform one or more of the duties that are required of it. This research investigates the usage of coir geotextiles to perform diverse tasks in order to enhance the engineering behaviour of soil and the structure as a whole.

B. Materials Used

The materials used for this study are soil and coir geotextile. The soil was obtained locally in NIT Srinagar (India) and the coir geotextile used was H_2M_8.

C. Soil

The soil obtained was classified as silty soils and the property of soil is mentioned in table 3.

Table 3: Engineering Properties of soil collected

Property	Value
Type	Silty soil
Specific gravity	2.72
Liquid limit %	33
Plastic Index %	17
Shrinking limit %	18
OMC %	23
Max dry density	15.7

D. Tests Conducted

1)California Bearing Ratio Test

CBR tests with coir geotextiles were carried out at depths of H/2, H/3, and H/4 from the top surface of the soil, where H is the depth of the CBR specimen. The results of these tests were analysed to determine the soil's ability to withstand compression. Experiments were also carried out using a number of layers of coir geotextile and an aggregate layer that was placed on top of the coir geotextile layer. A mathematical model for modified CBR was established using multiple linear regression analysis in terms of the original CBR of the subgrade soil, as well as the features and depth of installation of coir geotextile.

Figure 1: California Bearing Ratio Test

2)Plate Load Test

The fill surface considered was levelled, and then the coir geotextile was put once the tank was filled to the proper height for the coir geotextile. To attain the complete height, more sand was added in layers. The loading jack's loads were transferred concentrically to the model footing by placing the footing on a specified alignment. LVDTs were positioned at four corners of the testing plate to measure footing settlements. The settlement for each load increase was determined using the average settlement corresponding to the four LVDT measurements. The footing was loaded at a consistent pace until it reached its ultimate state. It is important to keep in mind that the tests were conducted out in an untense environment, and there was no documentation of any post-failure behaviour. Before commencing a new test, all of the sand left in the tank from that of the previous test was emptied out and replenished with new sand in 100mm lifts. This was done before beginning the test.

Figure 2: Plate Load Test

V. RESULTS AND DISCUSSIONS

The experimental findings revealed that the presence of the coir based geotextiles affects the CBR of the soil. As a result of their deployment, coir geotextiles interact with the soil and improve soil strength. There was interaction between the soil and the coir geotextile under unsoaked circumstances.

Figure 1 depicts the CBR variation in unsoaked conditions of the three coir geotextiles which are placed in three different locations for silty soil. The geotextile depth ratio was defined as H/y, where y is the depth of reinforcement and H is the value of total depth CBR mould sample, with the unreinforced case depth ratio set to zero for comparison reasons. The graph clearly illustrates that coir geotextile location has an effect. The CBR value increases regardless of the deployment depth of the coir geotextile. It has been noticed. However, in all situations, the CBR values were increased. The increase in the percentage was significantly larger when coir geotextile was used in the upper one-third zone.

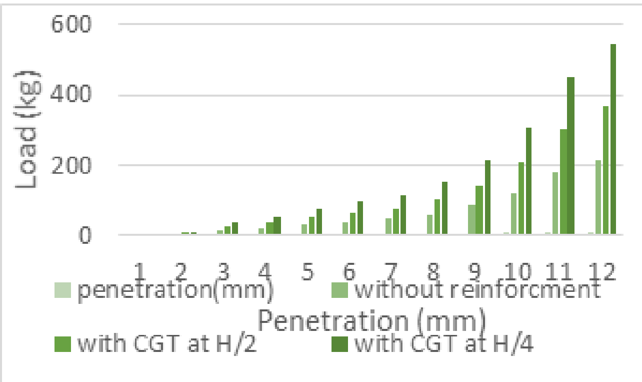

Figure 3: Effect of Placement of Coir Geotextile at H/2 & H/4

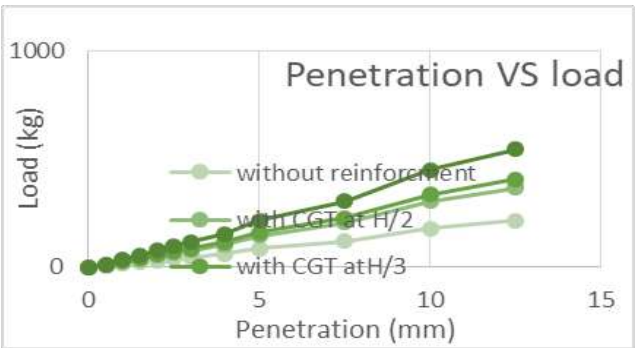

Figure 4: Effect of placement of Coir geotextile at depths H/2, H/3 & H/4 from top

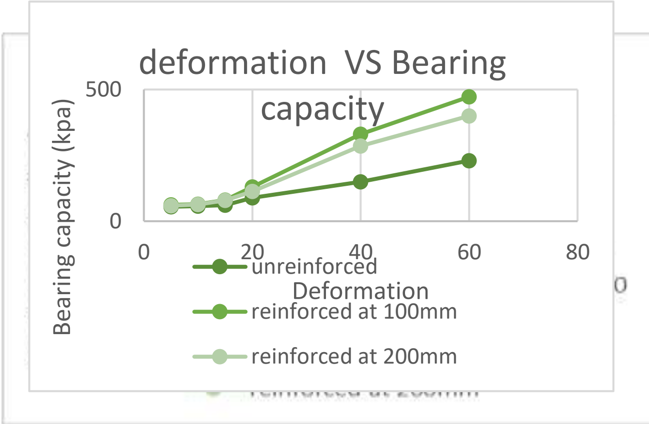

Figure 5: Effect on bearing capacity, when coir geotextile is placed at different z/B ratios

A. Plate Load Test Variation of Bearing Capacity with z/B

Figure 3 shows how the applied pressure changes as the footing settles for different values of z/B, which were found by testing a model in a lab on a coir geotextile-reinforced sand foundation when it was dry.

As can be seen in Figure 3, there was an increase of 36% and 30%, respectively, in the load bearing capacity of sand when it was reinforced with coir geotextile and put 100mm and 200mm from the top (z/B = 0.5 and z/B = 1.0). This occurred for a settlement of 10mm. Experiments conducted on unreinforced sand and reinforced sand with z/B > I revealed that the magnitudes of settlement in reinforced and unreinforced settings were quite similar to one another. This was evident from the graphs. On the other hand, foundation settlement under the ultimate load was reduced for the z/B 1 design by a factor of 1.5 to 2.0 times less than the unreinforced soil test.

VI. CONCLUSION

The use of woven coir geotextile can increase the bearing capacity of narrow unpaved road sections. When coir geotextile was put at a depth in the base course, it resulted in considerable improvements in ultimate bearing capacity and bearing capacity at any settlement. The use of coir geotextile improved bearing capacity just somewhat for thicker parts. The data clearly indicate that natural coir geotextiles may greatly increase the value of bearing capacity of a shallow square foundation on sand. Because of the high interfacial value of friction between the geotextile and the soil, the improved performance can be attributed to an increase in shear strength in reinforced soil mass due to the presence of coir geotextile reinforcement. As the z/B value decreases, the capacity augmentation factor increases. A z/B ratio of around 0.5 can be considered ideal for coir geotextile reinforced soil. The CBR results also indicate that the incorporation of coir geotextile lowered the penetration values to a greater extent. The optimal coir geotextile location is H/2. To achieve satisfactory reinforced system performance, woven coir geotextiles may be placed within the base course of unpaved roads with sufficient fill thickness above the geotextile layer to mobilise frictional resistance at the interface of reinforcement and fill, thereby avoiding traffic damage to the geotextile.

The coir geotextile is sustainable alternative for the subgrade reinforcement and also does not affect the environment in long run. Therefore, more extensive research should be conducted in this field and research should be extended to different types of coir and soils. The tests should also be conducted for the long run to understand the real behaviour of coir for reinforcement. In order to avoid early degradation of coirs, we can use treated coir's with different minerals, and it will also enhance the application of coir's to different soils such as marine and could be used effectively in more environmental conditions.

CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest.

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