North Asian International Research Journal of Sciences, Engineering & I.T.

IRJIF. I.F. : 3.821

ISSN: 2454-7514 Vol. 8, Issue-6 June-2022

Index Copernicus Value: 52.88 Indian Citation Index Thomson Reuters ID: S-8304-2016

NAIRJC

A Peer Reviewed Refereed Journal

DOI: 10.5949/NAIRJC_joe_00007.53

STRENGTH PROPERTIES OF TREATED AND UNTREATED COIR GEOTEXTILES REINFORCED IN SUBGRADE SOILS

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ABSTRACT

The growing speed of construction activity around the world puts a strain on available land space. The search for a new and competent site frequently leads to the necessity to improve old sites that are judged inappropriate for traditional foundations. This is performed through the use of ground improvement techniques, which are used to improve the quality of soil that is ineffective in its natural state. A well-connected road network is one of the basic infrastructure requirements for the fast and pleasant movement of inter-regional traffic in nations like India, and it is one of the construction operations.

Geo synthetics, which comprise geo fabrics, geo membranes, geo grids, and other products, are one of the most inventive ground improvement approaches used around the world. Because of its core qualities, such as tensile strength, filtering, and water permeability, they provide benefits such as space savings, environmental sensitivity, material availability, technical superiority, higher cost savings, shorter construction time, and so on. Although polymeric geo textiles are widely utilized, natural geo textiles (such as coir, jute, and other natural fibers) have yet to gain traction. This is primarily owing to a scarcity of research on natural geo-textiles for ground improvement, particularly in unpaved areas. Because coir geo textiles are less expensive than synthetic alternatives, they are ideally suited for low-cost applications. The goal of this research is to see if coir geo textiles can be used as a sub-grade for unpaved roads.

California Bearing Ratio (CBR) tests are used to investigate the performance of coir geo textiles reinforced

sub-grade. Coir geo textiles were used in the experiments, which were placed at various levels and in numerous layers. The coir geo textile improves the sub-grade strength, according to the findings. The qualities of coir geo textile reinforced sub-grade soil as a function of soil parameters, coir geo textile properties, and reinforcing installation depth.

***KEYWORDS*: Coir Geo textiles, Treated and Un- Treated, CBR Test.**

INTRODUCTION

Various forms of geosynthetics are widely used for reinforcement and separation functions in highway construction. Natural geo-textiles made of coir, jute, etc., are more preferred to synthetic fibres on account of the fact that the material is environmental friendly and ecologically compatible as it gets degraded with the soil. Moreover, natural fibres are less costly which make it a better choice compared to synthetic fibres. Experimental studies have proved that while cotton and jute degrade within the six months, coir geotextiles provide good support for about 5 years. It is resistant to saline water also. Reinforcing the subgrade using coir geotextiles helps to achieve pavements with longer service life.

Geosynthetics is the collective term applied to thin, flexible, sheets of material incorporated in or about soil to enhance its engineering performance. Applications of geosynthetics fall mainly within the discipline of civil engineering and the design of these applications, due to the use of geosynthetics with soils, is closely associated with geotechnical engineering.

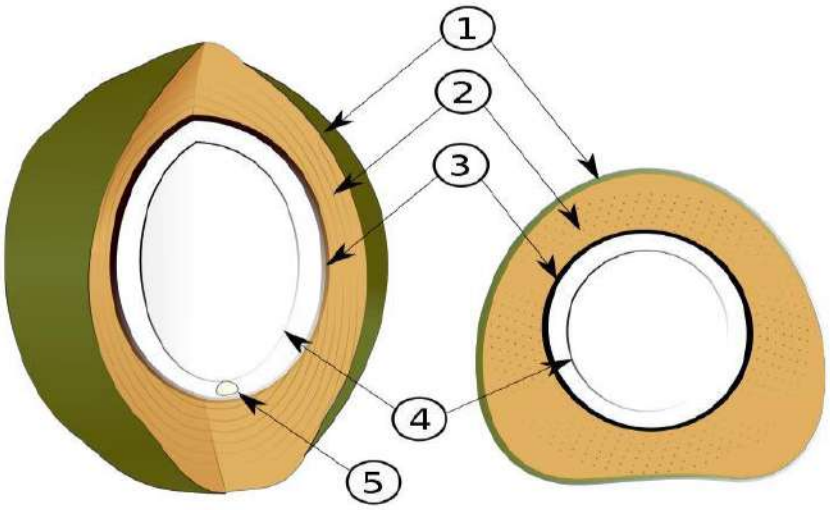
India is the first largest country (66% of world production), producing coir fibre from the husk of coconut fruit at the rate of around 200,000 tonnes/annum. Coir industry in India is concentrated in south India with Kerala occupying the major position. Kerala is followed by Tamil Nadu, Karnataka and Andhra Pradesh as centre of coir industry. The basic difference between Kerala coir and that from the other states is that Kerala coir is produced from rutted husks (white coir) and the others from non-rutted husks (brown coir). Coir yarns obtained from husks is much superior in quality. Coir Geotextiles are manufactured by a series of processes viz. netting, spinning and weaving. They are Woven and Non-woven types. Non-woven coir geotextiles are made directly from the fiber without being spun into yarn. Other various coir geotextiles are H2M8, H2M9, H2M5 and H2M6.

LITERATURE REVIEW

The previous chapter provides a detailed discussion on the different types of geosynthetics, their functions, the application in pavements and the corresponding properties and also scope, use and applications of coir geotextiles. The main focus of this chapter will be on coir specifications and various studies on coir applications in highway in India and around the world.

COIR

Coir may be defined as the fibre obtained from the husk of the fruit of the coconut palm tree. The coconut has a thin smooth outer skin called “exocarp”. It is generally pale green in color, but in some varieties it may be light red or pale grayish green. The space between the nut and the exocarp is filled with a spongy fibrous material, called “mesocarp”. The “husk” is made up of mesocarp and the exocarp. The mesocarp part of the coconut husk has great importance in the coir industry. Coir fibre is one of the strongest among the natural fibers. Figure 2.1 shows the various layers of coconut.



1. Exocarp 2.Mesocarp 3.Endocarp 4.Solid Endosperm 5.Embryo
Figure 2.1 Layers of coconut

TYPES OF COIR GEOTEXTILES

Coir Geotextiles are manufactured by a series of processes viz. netting, spinning and weaving. They are Woven and Non-woven types. Non-woven coir geotextiles are made directly from the fibre without being spun into yarn.

Coir itself can be broadly classified into 3 categories

- Fine Yarn Fibre: This is obtained from carefully retted husks. It finds use in making fine yarns, woven baskets and mats etc.
- Coarse Fibre: This is got from dry coconut husks and is useful for making brushes, brooms etc. It is something referred to as bristle coir fibre.
- Mattress Fibre: This is extracted from fully ripened and dried husks and is used a filling material in coir – based mattresses and upholstery manufacture.

Below figures show the many types of coir geo-textiles that are available on the market.

H2M2

H2M3

H2M5

H2M6

H2M8

H2M9

NA1

NA2

METHODOLOGY

3.1.1 Guiding Parameter for Chemical Treatment

The concentration of phenol solution and the period of soaking the coir in phenol solution must be explored in order to chemically treat the coir geo-textile. To estimate the length of soaking of coir in phenol solution for a particular concentration of phenol solution, a guiding parameter must be determined. As a result, the chemical oxygen demand (COD) has been chosen as a parameter.

A trial concentration of 1 percent (by volume) phenol was added to water to form a 500 ml diluted solution, and the coir specimen of 5cmx5cm was soaked in 500 ml solution for 24 hours to assess the COD as a guiding parameter. After every 2 hours, a sample of 2.5 ml was taken in test tubes, and the COD test was performed as per normal procedure.

3.1.2 Method Selection

The open reflux approach (B) is appropriate for a wide range of wastes that require a high sample size. Closed reflux procedures (C and D) employ less metallic salt reagents and produce less hazardous waste, but they need homogenization of samples containing suspended particulates in order to yield repea results. Commercially available ampules and culture tubes with premeasured chemicals are available. Sample volumes, as well as reagent volumes and concentrations, must all be measured. As a result, before using premixed reagents, get manufacturer requirements for error limitations.

3.1.3 Sampling and Storage

Collect samples in glass vials if possible. Uns samples should be tested as soon as possible. Acidify the sample to pH 2 using concentrated H2SO4 if a delay before analysis is necessary. Before analyzing any samples containing suspended solids, blend (homogenize) them all together. If COD is to be linked to BOD, TOC, or other parameters, be sure that all tests are pretreated the same way. To limit the inaccuracy inherent in measuring small sample quantities, make preparatory dilutions for wastes with a high COD.

The following are the methods used to conduct the COD test:

- **The Method of Open Reflux**
- **Method of Closed Reflux**

3.2 Method of Open Reflux

3.2.1 Principle

A boiling mixture of chromic and sulphuric acids oxidizes most types of organic materials. In a strongly acidic solution with a known excess of potassium dichromate, a sample is refluxed (K2Cr2O7). The amount of K2Cr2O7 consumed is determined by titrating the residual unreduced K2Cr2O7 with ferrous ammonium sulphate, and the oxidizable matter is measured in terms of oxygen equivalent. When using sample volumes other than 50 ml, keep the reagent weights, volumes, and strengths consistent. If it has been proven that a shorter duration produces the same outcomes, the conventional 2-hour reflux time may be decreased. To obtain the most trustworthy data, some samples with very low COD or highly heterogeneous solids content may need to be examined in duplicate. The results are improved even further by reacting the highest amount of dichromate possible, as long as some residual

dichromate exists. The test equipment for the open reflux approach is shown in 3.2.

3.2 Open reflux test equipment

3.2.2 Apparatus

- Reflux equipment consisting of 500 or 250 ml measuring flasks with 24/40 ground-glass neck and 300-mm jacket Liebig, West, or equivalent condenser with 24/40 ground-glass joint, and a hot plate capable of producing at least 1.4 W/cm2 of heating area, or equivalent.
- Blender.
- Pipettes, Class A and wide-bore.

3.3 Method of Closed Reflux

COD values between 40 and 400 mg/l are sui for this technique. Dilution can be used to obtain higher COD values. To determine higher COD values, utilize higher concentrations of dichromate digestion solution. Using a more dilute dichromate digestion solution or a more dilute FAS titrant, COD values of 100 mg/l or less can be produced. Using a FAS titrant that is smaller than the 0.10M solution suggested below can enhance overall accuracy. Because of the amounts of titrant required, higher dichromate concentrations or reduced FAS concentrations will almost certainly necessitate titrations in a separate vessel rather than in the digesting tank. The test equipment for the closed reflux approach is shown in Figure.

Equipment of Closed Reflex Test

Sample Calculation

3.1 Calculation of COD

Samples	Volume of sample	Initial	Final	Reagent in ml
Sample 1	6.5	0	0.4	0.4
Sample 2	6.5	0.4	0.6	0.2
Distilled water	6.5	0.7	1.2	0.5

$$\text{COD as mg } O_2/L = \frac{(A - B) \text{ X } M \text{ X } 8000}{\text{ml sample}}$$

$$\text{COD} = 6400 \text{ mg/l}$$

Where;

A = ml FAS used for distilled water (0.5),

B = ml FAS used for sample (0.3),

M = molarity of FAS (0.1), and

8000 = milli-equivalent weight of oxygen × 1000 ml/l.

TESTS TO BE PERFORMED

The following tests were conducted to determine the physical properties of the soil sample as per BIS specifications.

The following tests conducted for identification and classification of soil.

- Wet sieve analysis for Particle Size Distribution
- Proctor compaction test
- Consistency Limits
- Free swell index
- Differential Free swell index

TEST RESULTS

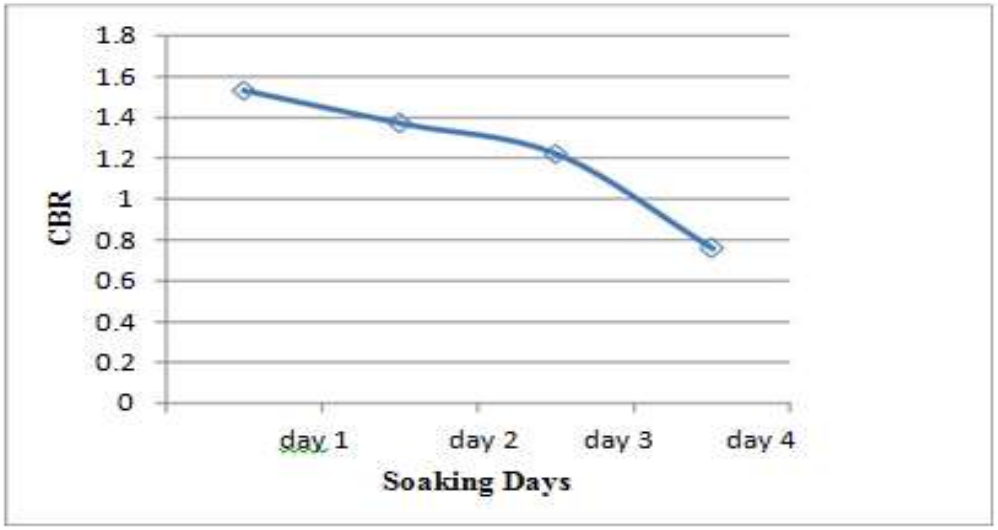
Effect of Chemical Treatment on Coir Geo-textile

Applying the chemical treatment to coir geo-textiles, it can be deduced that a COD of 6400 mg/l is obtained after 2 hours with a 1 percent phenol solution, as indicated in 4.1. The sample with the lowest COD value is considered the optimum dosage, indicating that maximum phenol adsorption occurs at this dosage. As a result, this is the best time to soak the coir in phenol for a 1 percent phenol solution. The COD of the remaining samples varies, which could be attributed to the coir's affinity for phenol and the water's fluctuation. A throw examination must be conducted in order to accurately comprehend the fluctuations in COD values over time.

4.1 Values of COD for 1% phenol solution

Time of collecting sample, h	COD (mg/l)
2	6400
4	20700
6	22300
8	19100
10	25700
12	28500
14	25500
16	32100
18	27400
20	22300

Fig illustrates the CBR values of unreinforced sections after 1, 2, 3, and 4 days of soaking.



Weights of two types of coir geo-textile

Coir grade	Weight (g)	
	Before treatment	After treatment
H2M8	10.6	18.1
H2M9	11.2	18.5

CONCLUSIONS

- The following conclusions were reached as a result of the investigation:
- One of the germicides that can be used to treat coir is phenol. Based on COD results, phenol at 1% (by weight of water) in water and a 2-hour soaking time are the best conditions for treating the coir.
- The Black Cotton soil used in this dissertation has a swelling index of 15 to 20 percent. For BC soils, the maximum dry density is 1480 kg/m3 and the OMC is 17%.
- Treated coir has a higher breaking load in the range of 1.8 to 1.9 times that of untreated coir, with H2M8 having a higher combined machine and cross direction breaking load than H2M9.
- Due to the swelling property of BC soils, the sub-grade strength decreases as the soaking duration lengthens. This pattern can be seen in cases that are unreinforced, untreated, and treated.
- In comparison to soils reinforced with untreated and treated H2M9 coir mats, BC soils reinforced with untreated and treated H2M8 coir geo-textile have greater strength values.

ACKNOWLEDGEMENT

First and foremost, praises and thanks to the God, the Almighty, for His showers of blessings throughout my research work to complete the thesis successfully.

I would like to express my gratitude to my beloved guide **Er. Shakshi Chalotra**, Assistant Professor of Civil Engineering, RIMT UNIVERSITY for her timely and valuable suggestions. I am thankful for her guidance and active supervision at every stage of the thesis work. She has been constant driving force, source of inspiration and encouraging me throughout this work. It is her immense patience and co-operation that has helped for the successful completion of this work.

I express my deepest thanks to our **H.O.D DR.SANDEEP SINGLA** for helping us and giving necessary advices and guidance and arranged all facilities to make this easier. I am very much thankful to my parents, friends and also to my family who have supported me greatly during the course of this work

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