COMPARATIVE ANALYSIS OF JUTE AND COIR GEOTEXTILES FOR SOIL STABILIZATION

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Abstract

Each style of pavement will function differently depending on the strength of the sub-grade soil. In addition to several natural and synthetic geotextile materials, a number of stabilising techniques and materials were used to increase the subgrade soil's strength. Modern polymeric alternatives may almost always replace jute and coir because of their biodegradability and environmental friendliness. One of the expanding options in the contemporary context, with relevance to rising environmental concern and carbon footprint production, is the creation of technical textiles manufactured from natural fibres, such as geotextile goods for geotechnical alliances and agro textile products.

Black Cotton soil is often expensive and has one or more problems, such as low shear strength, high compressibility, low hydraulic conductivity, enlargement, and contraction. This study aims to stabilise soil made of black cotton using geotextiles. examine the petrographic characteristics of geotextiles used for soil stabilisation. The effect of geotextile on compressive strength is being investigated. To increase the CBR value of subgrade soil, comparative study will be conducted using jute and coir. The major applications for Jute and Coir geotextile are to thin down pavement layers and to increase a road's carrying capacity when placed down on the subgrade (expressed as CBR percent)

Keywords: Black Cotton soil, stability, comparative studies, and geotextiles

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1. Introduction

The principal network for road transportation is the most important one. An place or country gains from it in terms of its economics, industry, society, and culture. Its primary goal is to connect the industrial and consumer hubs. The locations where finished goods and raw materials were originally created are now far away from where they are consumed.(Pavani et al., 2016) A fundamental part of daily life is pavement. They function as runways, parking lots, driveways, and roads. Engineered structures called pavements are necessary for daily living, trade, and defence. The importance of highways in countries with limited resources, like India, cannot be emphasised. The principal function of pavement is to support the weight of a truck or other large, heavy vehicle without significantly deforming. When the soil is too flexible to bear the relatively mild tension, it has to be strengthened. The soil in black cotton grows when it is dry but shrinks when it is wet. Constant expansion and contraction wear down a material's durability over time. These problematic soils, such as Black Cotton Soil, may be lacking in one or more of the traits listed below, such as Low Shear Strength, High Compressibility, Low Hydraulic Conductivity, Swelling and Shrinkage, Susceptibility to Frost Action, etc.(Bordoloi et al., 2017) These traits are linked to problems like Low Bearing Capacity, High Settlement, High Seepage Loss, Liquefaction during Earthquakes, and Instability of Foundation Excavation.

The practise of treating soil to increase its tensile strength and other engineering attributes is referred to as "ground improvement". There are several methods for improving the ground, such as soil stabilisation, compaction (both static and dynamic), the addition of additives like cement and lime, etc. Of the methods listed above, stabilisation and geosynthetics perform the best. One of the main groups of geosynthetics is geotextiles.

Coir-based geotextiles with an Indian aesthetic The collective name for a geosynthetic product formed from coconut fibre that is removed from the husks of coconut fruit is "Coir Bhoovastra". Natural and robust under compression is coir fibre. It is available in a variety of thicknesses and tensile strengths that comply with the technical standards set by engineers from all over the world. Three different types of coir fibre are available: woven geotextile, nonwoven geotextile (also known as coir needle felt), and coir logs, or coir fibre logs. A Grade 2 - H2M5 (740gsm) coir geotextile was used for this investigation.(AL-Hameidawi et al., 2016; Arora et al., 2021)

Jute geotextile is a natural material that is safe for the environment and biodegradable. It possesses hygroscopic and hydrophilic properties. The first jute-geotextiles were used in the 1980s (JGT). JGT has been used successfully in many road projects with the goal of constructing durable roads and reducing maintenance costs. JGT has also been applied to manage slopes, including hill slopes, river banks, stabilise embankments, prevent reflection cracks in bituminous pavements, manage slopes, including managing slopes on hills, and more. Locally accessible jute is utilised to improve the engineering capabilities of the soils. The physical properties of jute are determined by weighing and measuring the fibres' diameter.

The advantages of Geo textiles include their affordability, low density, tolerable specific strength, effective thermal insulation, reduced tool wear, decreased cutaneous and respiratory irritation, and their capacity to be recycled without harming the environment. In addition, they supply a renewable resource. They frequently also disintegrate through biodegradation.(Meshram et al., 2013)

1.1 Coir geotextile with NAOH treatment:

Grade 2 - H2M5 coir geotextile was used. To treat the coir geotextile, a 6% concentration of NAOH solution was made using NAOH pellets.

The Grade 2 - H2M5 (740gsm) coir we're using in this experiment is a natural geotextile, thus it has to be treated to make it more durable.(Dabir et al., 2020; Ramzan et al., 2020) In order to remove the impurities and improve its properties, it is treated for 24 hours with a 6-percent concentration of NAOH solution. 240 grammes of NAOH pellets and 3760 grammes of water were combined to create 4000 grammes of a 6 % NAOH solution.(Büyükakın, 2020)

1.2 Jute geotextile

Jute fibres make up around 7-9% of the weight of the green plant. Its multicellular structure helps it blend in and reinforce the soil. The following is a list of the properties of the jute geotextile that was used. (Karthik & Chamberlain, 2021)

2. Test CBR Analysis

The air-dried sample of 5kg is weighed and sieved through a 475-micron sieve in accordance with IS 2720 specifications for the unsoaked California bearing test. The mould was compressed with 5 layers, each with 55 blows using a 4.89 kg rammer, with the collar put at the bottom of the mould. Mold was taken out and placed in a CBR testing machine.(Khan et al., 2014) The load in kg and the depth of penetration were documented, and a graph of the load versus penetration was created. With the aid of this graph, the CBR value at 2.5mm and 5mm was determined.(Shukla et al., 2019) The soaked California bearing test is similar to the unsoaked California bearing test, but before the

specimen is put through the test after being compacted, the mould is kept for 72 hours to cure before being removed, and like the unsoaked California bearing test, penetration is conducted after 72 hours.(Sayida et al., 2022)

Table 1: Values for CBR

Type of Soil	CBR(1layer)	CBR(2layers)
Black Cotton Soil (BCS)	2.09	2.09
BCS+ Jute Geotextile	3.08	3.79
BCS +Coir Geotextile	3.32	4.29

The results of the laboratory experiments show that the soil's bearing capacity is increased by the progressive addition of geotextile. A layer of coir is added, raising the CBR value by 1.23 percent. Whereas the CBR value of the black cotton soil was raised by 2.2 percent by the addition of two layers of treated coir geotextile. Coir is also used to improve the condition of the soil. Even when soils are wet, it enhances air permeability and helps retain moisture. Due to their resistance to being pulled out, the addition of a layer of jute enhances the CBR of the black cotton soil by 0.99 percentage, and the increment is 1.7 percentage with two layers of jute.(Sayida et al., 2022)

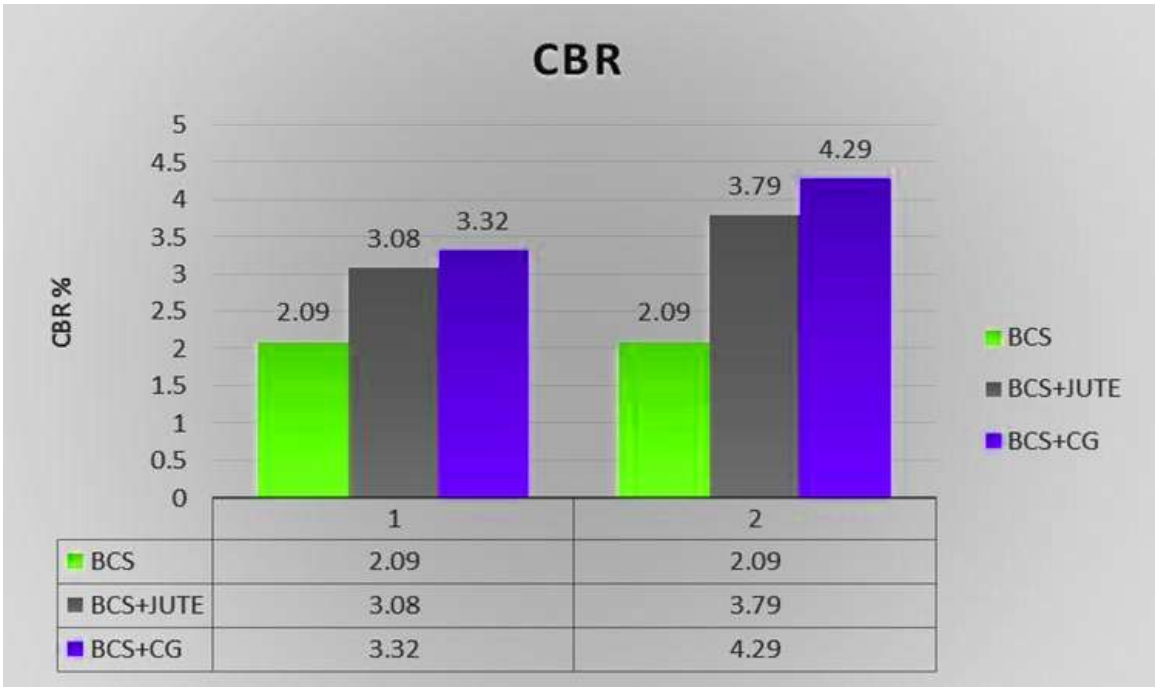

Chart 1: Study of CBR

3. Analyses of compaction tests

It was put through the IS 2720 compaction test. Three equal layers of a 3.5 kilogramme sample of dry soil that had been sieved through a 475 micron sieve were added to a mould. Each layer was then crushed using a 2.6 kilogramme rammer that had a 30.5 centimetre drop height. When soil samples from the mould's extremities and the middle region were collected, the optimal moisture level and the maximum dry density were determined. The correlation between moisture density and dry density might be found by comparing a graph of dry density vs. the percentage of water content.

Table 2: Values for compaction

Type of Soil	MDD(1layer)	MDD(2layers)
Black Cotton Soil (BCS)	1.71	1.71
BCS+ Jute Geotextile	1.728	1.786
BCS +Coir Geotextile	1.74	1.812

The findings of the laboratory studies reveal that progressively adding geotextile enhances the MDD of the soil. The soil's MDD rose by 5.1 percent when treated coir geotextile was applied in two layers; when it was added in one layer, the increment was 0.6, which was numerically low for technical reasons. The soil's MDD and OMC are both increased by the woven NAOH-treated coir, strengthening the soil's connection. Jute addition resulted in significant alterations to the MDD of black cotton, increasing by 3.8 percentage points with 2 layers and by 0.9 percentage points with 1 layer. This occurs as a result of the soil's increased flexibility as a result of the jute layers.

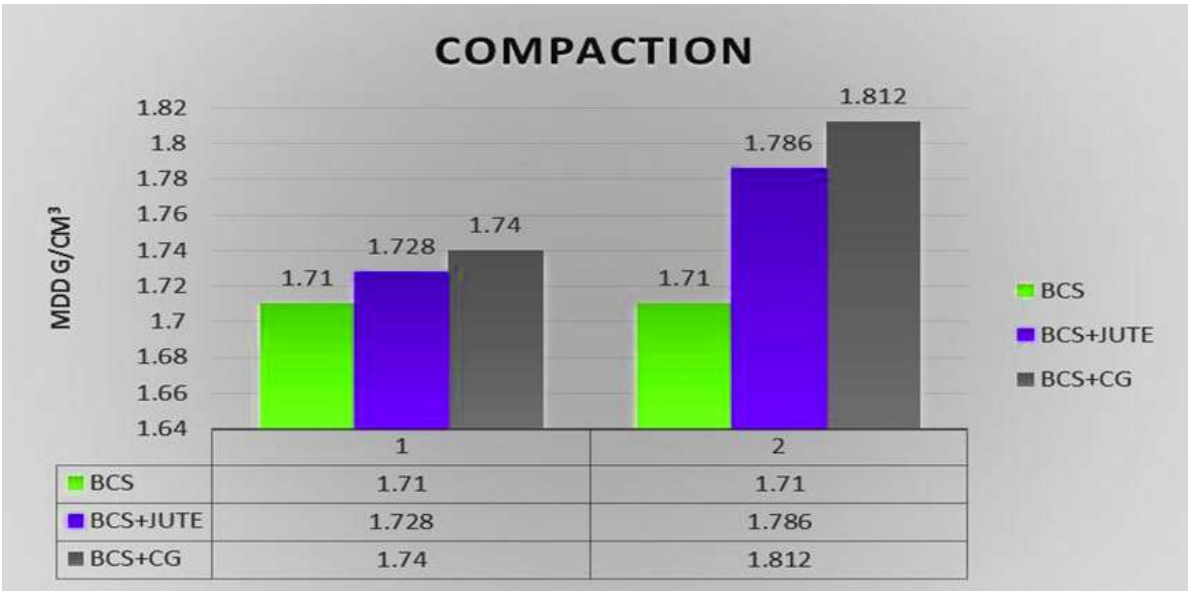

Chart 2: Study of Compaction

3. Cost Evaluation

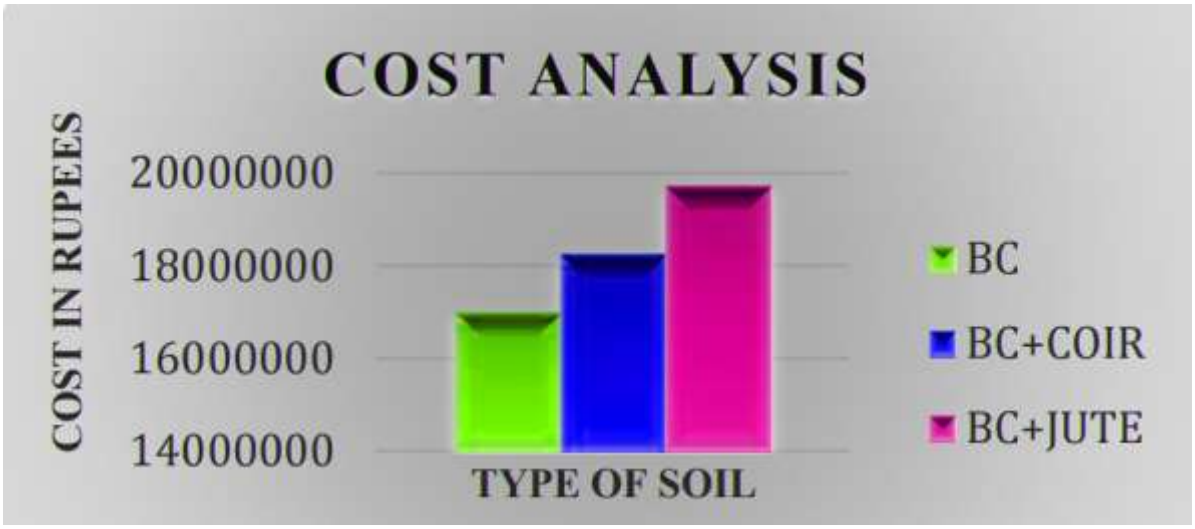

Chart 3: Cost Analysis

The cost study shows that the price to build conventional flexible pavement is Rs. 1,69,97,800, whereas the price to build flexible pavement with double-layered NAOH-treated coir geotextile is Rs. 1,82,37,800, or 7.038% more. Flexible Pavement with Double Layered Jute Geotextile construction costs Rs 1,97,17,800, or 14.816 percent more than regular Flexible Pavement. Coir is a more practical solution than jute, even in terms of price, for building a more affordable and low-maintenance flexible pavement over black cotton soil. We would advise using reinforcing coir as a geotextile when constructing a pavement despite the little price increase because it has been shown to boost soil strength, which extends pavement life and enables low-cost pavement maintenance.

4. Conclusion

The results of the current study make it evident that stabilising soil with treated coir geotextile might be a viable method of improving soil. The construction's strength and sturdiness are provided by the treated coir geotextile since it is a low-cost material with a good strength-to-weight ratio. For the check, black cotton soils were utilised. Any foundation may be built inside the stabilised soil due to the improvement in the soil's bearing capacity. Coir is a suitably environmentally friendly substance, thus using it won't ever hurt the earth and will be absolutely free of grudges. Actually, it isn't possible to classify coconut coir as a by-product of the coconut business. The inclusion of geotextile complied with the typical pavement building soil criteria for all of the aforementioned test findings. The use of geotextile allowed the typical pavement construction soil criteria to be met across the whole set of test results indicated above. When it comes to price, coir is a better material than jute to use for building a flexible, low-maintenance pavement over black cotton soil. We would advise using reinforcing coir as a geotextile when constructing a pavement despite the little price increase because it has been shown to boost soil strength, which extends pavement life and enables low-cost pavement maintenance.

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