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Comparative Study on Soil Stabilization Using Jute and Coir Geotextile

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Abstract - *The strength of the sub-grade soil has a greater impact on the performance of any type of pavement. A variety of stabilizing methods and components were employed to boost the strength of subgrade soil amid many natural and synthetic geotextile materials. Due to their biodegradability and environmental friendliness, jute and coir may almost always be replaced with a modern polymeric alternative. The development of technical textiles made from natural fibers, which include geotextile products for geotechnical alliances and agro textile products, is one of the growing alternatives in the current context, with relevance to growing environmental concern and carbon footprint generation.*

In general, Black Cotton soil is pricey and has one or more issues, including low shear strength, high compressibility, and low hydraulic conductivity, enlargement, and contraction. The goal of this research is to use these geo-textiles as stabilizers for black cotton soil. To look at the petrographic properties of geotextiles used in soil stabilization. Geotextile's impact on compressive strength is being studied Comparative research will be done on subgrade soil to use jute and coir to raise the CBR value. The main uses for Jute and Coir geotextile are to thin out pavement layers and when laid down on a road's subgrade, properly designed woven Jute and Coir improves the structure's carrying capacity (expressed as CBR percent)

Keywords: (**Black Cotton soil, geo-textiles, stabilization, Comparative research**)

1. INTRODUCTION

Transportation by road is the most crucial of the primary communication networks. An area or country benefits from it in terms of its economy, industry, society, and culture. Its main objective is to link the centers of consumption and industry. Raw materials and completed items are now used far from the places where they were initially produced. Pavements are a necessary component of daily living. They serve as driveways, parking lots, runways, and highways. Pavements are engineered constructions that are essential to daily life, trade, and defense. In resource-constrained nations like India, the significance of highways cannot be overstated. The ability of the pavement to endure the weight of a truck or other large, heavy vehicle without experiencing significant deformation is its primary purpose. It is necessary to enhance the soil when it is not rigid enough to withstand the relatively low stress. Black cotton soil expands when it's dry but contracts when it's moist. Over time, continual expansion and contraction erode the material's durability. These troublesome soils as Black cotton soil, may be deficient in one or more of the following characteristics, including low shear strength, high compressibility, low hydraulic conductivity, swelling and shrinkage, susceptibility to frost action, etc., and are consequently linked to issues like low bearing capacity, high settlement, high seepage loss, liquefaction during earthquakes, and instability of foundation excavation.

The term "ground enhancement" refers to the process of treating soil to improve its strength and other engineering properties. There are many techniques to make the ground better, including stabilizing the soil, compaction (both static and dynamic), using additives like cement and lime, etc. The best techniques among those mentioned above are stabilization and geosynthetics. Geotextiles are one of the major families of geosynthetics.

Geotextiles made of coir that have an Indian feel "Coir Bhoovastra" is the collective term for a member of the geosynthetic family that is made from coconut fiber that is extracted from the husks of coconut fruit. Coir fiber is natural and strong under compression. Engineers from all over the world have specified technical requirements, and it is available in a variety of thicknesses and tensile strengths that meet those standards. Weaved geotextile, nonwoven geotextile (sometimes called coir needle felt), and coir logs, or coir fiber logs, are the three various kinds of coir fiber that are available. This study's material is a Grade 2 - H2M5 (740gsm) coir geotextile.

As a natural fabric, jute geotextile is environmentally benign and biodegradable. It has both hydrophilic and hygroscopic characteristics The 1980s saw the beginning of the use of jute-geotextile (JGT). With the intention of building long-lasting roads and lowering maintenance costs, JGT has been employed effectively in numerous road projects. JGT has also been used to manage slopes, including hill slopes, protect river banks, stop surface soil erosion, stabilize embankments, stop reflection fractures

in bituminous pavements, consolidate soft soils, and more. Jute that is readily available locally is used to enhance the soils' engineering qualities. The weight and diameter of the jute fibers are used to calculate the jute's physical characteristics.

The benefits of Geo textiles include their low cost, low density, acceptable specific strength, strong thermal insulating capabilities, reduced tool wear, reduced cutaneous and respiratory irritation, and their ability to be recycled without causing environmental harm. They also offer a renewable resource. They commonly degrade by biodegradation as well.

1.1 NAOH treated Coir geotextile:

Coir geotextile of grade 2 – H2M5 has been taken In order to treat the coir geotextile NAOH solution of 6% concentration was prepared using NAOH pellets.

As a natural geotextile, the Grade 2 - H2M5 (740gsm) coir we're utilizing in this experiment needs to be treated to make it more durable. Consequently, it receives a 24-hour treatment with a 6-percentage concentration of NAOH solution to clean out the impurities and enhance its qualities. In order to make 4000 grams of 6 percentage NAOH solution, 240 grams of NAOH pellets were mixed with 3760 grams of water.

1.2 Jute geotextile:

About 7-9 percentage of the weight of the green plant is made up of jute fibres. Its multicellular structure aids in blending with the soil and fortifying it. The employed jute geotextile's characteristics are listed below.

2. CBR test Analysis:

In unsoaked California bearing test, the air-dried sample of 5kg is weighed and sieved through 475-micron sieve according to IS 2720 specification. The collar placed at bottom of the mould, the mould was compacted with 5 layers, each of with 55 blows with application of rammer of the weight 4.89 kg. Mould was removed and placed in CBR testing machine, the load in kg and the depth of penetration is noted and plotted graph of load versus penetration and noted the CBR value at 2.5mm and 5mm is calculated with the help of graph. Soaked California bearing test is similar to that of unsoaked California bearing test but before placing the specimen in the testing after the compaction the mould was kept for curing for 72 hours and removed after 72 hours and similar to unsoaked California bearing test, penetration will conduct.

Table -1: CBR values

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 findings of the laboratory tests demonstrate that the gradual addition of geotextile increases the soil's bearing capacity. The addition of a layer of coir increases the CBR value by 1.23 percentage. Whereas the addition of two layers of treated coir geotextile increased the black cotton soil's CBR value by 2.2 percent. As a soil conditioner, coir is also employed. It aids in moisture retention and increases the air porosity of soils, even when they are wet.The addition of layer of jute increases the CBR of the black cotton soil by 0.99 percentage and the increment is 1.7 percentage with two layers of jute, this is due to their resistance to pulling out.

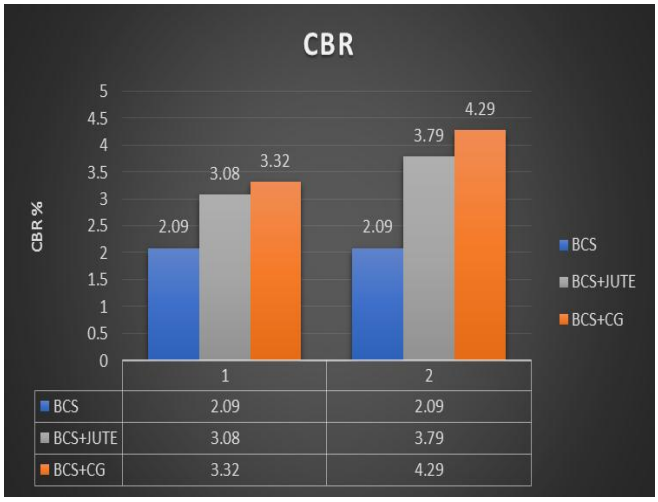

Chart -1: CBR Analysis

3.Compaction test Analysis:

The IS 2720 compaction test was carried out. A 3.5-kilogram sample of dried soil that had been sieved through a 475-micron sieve was poured in three equal layers in a mould and compacted using a 2.6 kg rammer that had a 30.5 cm drop height between each layer. The ideal moisture content and maximum dry density were established after soil samples were taken from the mould's extremities and the intermediate area. By comparing a graph of dry density vs the percentage of water content, it was possible to determine the relationship among moisture density and dry density.

Table -2: Compaction values

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 results of the laboratory tests show that gradually adding geotextile increases the MDD of the soil. When treated coir geotextile was added in two layers, the soil's MDD increased by 5.1 percent; when added in single layers, the increment was 0.6 which was numerically low on grounds The woven NAOH treated coir increases the bonding strength of soil increasing the MDD of the soil reducing the OMC.The addition of jute also had considerable changes on MDD of black cotton with 3.8percentage increment on adding 2layers and 0.9percentage with single layer of jute. This is because of increase in the plasticity of soil with layers of jute.

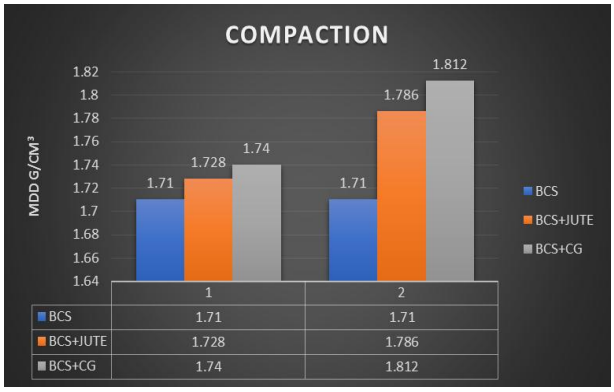

Chart -2: Compaction Analysis

3.Cost Analysis:

Chart -3: Cost Analysis

According to the cost analysis, the cost of construction of Conventional Flexible Pavement is Rs 1,69,97,800, and the cost of construction of Flexible Pavement with Double Layered NAOH Treated Coir Geotextile is Rs 1,82,37,800, which is 7.038 percent higher than the cost of construction of Conventional Flexible Pavement. The cost of constructing Flexible Pavement with Doubled Layered Jute Geotextile is Rs 1,97,17,800, which is 14.816 percent more expensive than conventional Flexible Pavement. Even in terms of cost, coir is a more viable option than jute for constructing a more cost-effective and low-maintenance flexible pavement on black cotton soil. Despite a modest price rise, we would recommend building a pavement with reinforcing coir as a geotextile because it has been proven to increase soil strength, which in turn increases pavement life and aids in low-cost pavement maintenance.

4. CONCLUSIONS

Based on the current study's findings, it is clear that using treated coir geotextile for soil stabilization could be a successful strategy for enhancing soil. Because treated coir geotextile has a high strength-to-weight ratio and is a low-cost material, it gives the construction its strength and sturdiness. Black cotton soils were used for the check. The stabilization of the soil increases its bearing capacity, allowing for the construction of any foundation within the soil. Because coir is a sufficiently eco-friendly product, its use won't ever cause environmental harm and will therefore be completely free of resentments. In actuality, coconut coir can't really be considered a by-product of the coconut industry. For the entire above mentioned test results, the addition of geotextile met the traditional pavement building soil specifications. The inclusion of geotextile achieved the conventional pavement construction soil standards across the entire above mentioned test findings. Even in terms of cost, coir is a more viable option than jute for constructing a more cost-effective and low-maintenance flexible pavement on black cotton soil. Despite a modest price rise, we would recommend building a pavement with reinforcing coir as a geotextile because it has been proven to increase soil strength, which in turn increases pavement life and aids in low-cost pavement maintenance.

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