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Application of Coir Geotextile in Subgrade For Improved Strength And Drainage Condition Of Flexible Pavement

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Abstract- *In areas where the subgrade soil has low bearing capacity, such as clay soils, the addition of a suitable granular material can enhance the road's ability to withstand traffic loads. However, when the subgrade soil has a California Bearing Ratio (CBR) value of less than 2%, issues like shear failure and excessive rutting are common. These problems require additional measures to improve the ground conditions.*

Traditionally, several methods have been employed to address poor ground conditions, including excavation and replacement of unsuitable material, deep compaction, chemical stabilization, preloading, and the use of polymeric geosynthetics. However, these procedures can be expensive, and their implementation in developing countries like India is limited due to cost constraints and the availability of virgin materials. In this context, natural fiber products like coir geotextiles offer a potential solution. Coir geotextiles can be placed within the soil layers to provide reinforcement and improve the overall performance of the road. The geotextiles act as a separator between the soft clay and the granular material, preventing intermixing and maintaining the stability of the road structure.

Studies have been conducted to evaluate the effectiveness of coir geotextiles in different soil conditions. These studies have shown positive results, indicating that coir geotextiles can enhance the bearing capacity and overall performance of rural roads built on soft clay. By using coir geotextiles, it may be possible to avoid or reduce the need for more expensive and resource-intensive methods of ground improvement. However, it is important to note that the use of coir geotextiles is just one of the potential solutions for addressing road infrastructure challenges in India.

Key Words- Coir geotextile, Bearing capacity, Subgrade, Rutting, pavement.

1.INTRODUCTION-

The Rural Roads Vision - 2025 aims to provide all-weather road access to all habitations by the year 2025. Engineers frequently encounter the issue of creating roadbeds on or with soils that lack adequate strength to handle wheel loads, either during the construction stage or throughout the life of the pavement. One of the primary challenges in road construction is dealing with weak or unstable soils that lack the necessary strength to support the weight of vehicles. When such soils are exposed to water, they can undergo volume changes, leading to road deterioration and increased maintenance costs. Geotextiles, including coir geotextiles, address these issues effectively. Coir geotextiles act as permeable fabrics that can separate, filter, reinforce, and drain when used in conjunction with soil. They distribute the load over a wider area, thereby enhancing the bearing capacity of the subgrade and reducing settlement. By reinforcing the subgrade, coir geotextiles allow for the reduction of pavement thickness and associated earthwork. They can also serve as a membrane between the subgrade and the granular subbase layer, providing stability and drainage. One of the advantages of coir geotextiles is their organic composition. Coir, derived from coconut husk, is a natural and renewable material composed of lignocellulose. It is resistant to rot, molds, and moisture, eliminating the need for chemical treatment. Coir geotextiles are considered environmentally friendly and have a lower cost compared to synthetic alternatives, making them well-suited for low-cost applications. The lifespan of coir geotextiles within the soil environment is typically four to six years, depending on soil conditions. During this period, they can share the load with the soil and increase the subgrade's load-bearing capacity. Coir geotextiles also serve as effective separators and drainage filters, contributing to improved subgrade strength over time. As the coir geotextiles degrade, the compressed organic skeleton remains in place, acting as a filter cake and maintaining a constant moisture content in the subgrade soil. This residual effect further contributes to the stability of the road.

In summary, the use of coir geotextiles in road construction offers several advantages, including reinforcement, separation, filtration, drainage, cost-effectiveness, and environmental compatibility. They can improve the performance of rural roads, enhance subgrade stability, and reduce the overall transportation cost.

2. LITERATURE REVIEW -

Evaluation of Coir Geotextile Mats to Enhance the Poor Subgrade Under Repeated Load for Low-Volume Roads D. Harinder,s. Shankar (2020)-The study concluded that the use of coir geotextile mats proved to be effective in reducing deformation, particularly in morrum soil. Additionally, the results indicated that incorporating coir geotextiles improved the performance and serviceability of

LVRs (Low Volume Roads). This suggests that the inclusion of coir geotextiles in road construction can enhance their durability and functionality. In this study the maximum rut depth was noticed as 37 mm without the reinforcement of the coir geotextile. It can reduce up to 8 mm with coir composite mats.

Effect of Natural Fibers Composites as Soil Stabilizer on Flexible Pavement Design P. Sribalaji, S. Banupriya, R.Ruthra (2020)- In this study it has been noted that the research area's pavement failure falls under the category of soil's swelling and shrinking features. It is required to increase the carrying capacity of subgrade soil in order to avoid this failure. In order to build flexible pavement, the Natural Fibre Composites (Coir & Sisal) were employed to increase the soil bearing capacity and were examined using the CBR test. This study so demonstrates the efficiency of natural fibre composites (Coir & Sisal) in enhancing pavement performance attributes. The CBR value for the composite material, which is kept at a height H above the soil, is 25.12. Similar CBR values of 25.26 and 25.5 with matching pavement thicknesses of 48.06 cm, 47.88 cm, and 47.57 cm are found at heights H/2 and H/3.

Pavement Evaluation And Application Of Geo Textiles In Pavements Naragani ,V V Gopala Rao , J.Sowjanya (2019) The cost of 25 exemplary low volume road design alternatives was calculated in this study using a thorough life cycle cost analysis framework that was created. The subgrade must be firm, stable, well-drained, and devoid of volume variations brought on by changes in moisture. Typically, structural, functional, material, or a combination of these failures cause pavement to fail. According to this paper the CBR value is comparatively least for sample in which Geotextile is not used and thus pavement thickness is higher and the CBR value recorded for sample in which Geotextile used is higher.

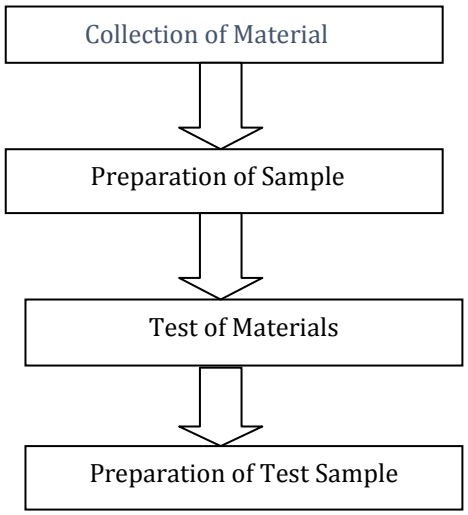
A Review on Improvement of Subgrade Soil Using Coir Geotextiles Sridhar Rajagopalaiah (2019) . In this study Natural fibre products show promise in this context for building rural roads over soft clay. The effectiveness of coir geotextile as a reinforcement in various soil conditions has been examined. According to this paper By using coir geotextiles as reinforcement, the bearing capacity was increased. When compared to unreinforced pavement, reinforced pavement has a 1.83- times increase in bearing capacity. When coir geotextiles are applied, the soaking CBR value improves as well. The use of Coir geotextile improves the carrying capacity of roadway sections while also providing separation and drainage between the subgrade and subbase layers.

3. OBJECTIVES-

The objectives of this research are:

- To prevent the penetration of sub-base materials into the sub-grade soil.
- To Increase the life span of the road
- For Less maintenance of the road.
- Add the coir geotextile(H2M2) at H/2, and H/3, and note down the CBR value.

4. METHODOLOGY-



Flow Chart

5. MATERIALS AND METHOD-

5.1 Coir Geo textiles - Coir geo textiles (Coir Bhoovastra) are permeable fabrics capable to control soil erosion. It protects the earth and promotes vegetation retaining precious top soil. It is available in woven and non-woven forms.

Coir Bhoovastra is-

- Made from natural fibre
- 100% organic and renewable
- Good durability
- Biodegradable
- Naturally resistant to rot, moulds and moisture
- Needs no chemical treatment
- High tensile strength and modulus
- Serves the purposes of Reinforcement, Separation, Filtration and Drainage – in road construction.

Functions of Geo textiles-

Geo textiles usually fulfill one or more of the following functions

1. Drainage (Fluid Transmission).
2. Filtration.
3. Separation.
4. Reinforcement (Protection)

The study was conducted on the soil sample using coir geotextiles (H2M2). California Bearing Ratio (CBR) Was conducted to evaluate the strength properties of the soil. The details of the testing programs are explained below.

Tested Quality Parameters of Coir Bhoovastra (Coir geotextiles)

Table 1

Parameter	H2M2 Coir
Unit Area(gm/mm^2)	717.52
Thickness(mm)	6.77
Puncture Resistance(mm)	26
CBR Push Through Resist. (kN)	1.47
Wide Width Tensile Test Dry(kN/m)	8.76
Wide Width Tensile Test Wet (kN/m)	7.66
Tearing Strength(kN)	0.45
Shear Stress(kg/cm^2)	0.32
Permeability (lit/m^3/min	11940

6. EXPERIMENTAL STUDIES AND RESULTS -

6.1 Subgrade soil: The study was conducted with subgrade soil borrowed from the site. The basic tests on BC soil are done in the laboratory and are detailed below.

6.1.1. Sieve Analysis-

D60=259 mic
D30=179.84 mic
D10=60.26 mic
C_C = 2. 07
Cu= 4.29
Hence soil is Poorly Graded Sand (SP) .

6.1.2 .Liquid limit-

Table 2

Determination Number	1	2
Number of blows	25	25
Container number	1	2
Weight of container(W)	22.5	25.28
Weight of container +wet soil(W1)	38	41.2
Weight of container +Oven dry soil (W2)	34.5	37.3
Weight of water (W1-W2)	3.5	3.9
Weight of oven -Dry soil (W2-W)	12	11.5
Water Content W= (w1-w2)/w2-w) *100%	29.16	33.9

Hence Liquid limit=31.53%.

6.1.3 Plastic limit:

Table 3

Determination Number	1	2
Container number	1	2
Weight of container(W)	26.10	21.5
Weight of container +wet soil(W1)	32.29	34
Weight of container +Oven dry soil (W2)	31.20	32.75
Weight of water (W1-W2)	1.09	2.75
Weight of oven -Dry soil (W2-W)	5.10	11.25
Water Content W= (w1-w2)/w2-w) *100%	21.37	24.44

Hence Plastic limit is 22.9%

6.1.4 Maximum dry density-

Table -4

Determination No.	1	2	3
Volume of mould V(cm^3)	1000	1000	1000
Wt. of mould W1(g)	4800	4800	4800
Wt. of mould + Compacted soil W2(g)	6798	6930	6925
Wt. of compacted soil W =W2-W1(g)	1998	2130	2125
Bulk Density=W/V(g/cm^3)	1.998	2.13	2.125
Water content w (%)	9.3	10.5	12.5
Dry density (Y_d=Yb/ 1+w) (g/cm3)	1.83	1.93	1.88

Hence Maximum dry density is 1.94.

6.1.5 Specific gravity-

Specific gravity of the soil is 2.5.

6.2 CBR TEST-

CBR Value in Soil

Table -5

CBR	Value	Unit
2.5mm	6.74	%
5.0	7.43	%

CBR Value in H/2 Coir Geotextile

CBR	Value	Unit
2.5mm	6.84	%
5.0	7.54	%

CBR Value in H/3 Coir Geotextile

CBR	Value	Unit
2.5mm	7	%
5.0	7.72	%

6.3 PERMEABILITY TEST OF SOIL:-

Table-6

Test	Result	unit
Soil Permeability	1.19x10^-2	m/sec
Soil Permeability H/2	1.38x10^-2	m/sec
Soil Permeability H/3	1.55x10^-2	m/sec

7. Conclusion:

The use of coir geotextile composite in soil reinforcement has yielded positive results in terms of California Bearing Ratio (CBR) values. CBR is a measure of the load-bearing capacity of a soil relative to that of a well-graded crushed stone. The composite material, when placed at heights H/2 and H/3, showed CBR values of 6.84, 7.54, and 7,7.72 at 2.5 mm and 5 mm penetrations, respectively. On the other hand, the CBR values without the use of coir geotextile were 6.74 and 7.43 at 2.5 mm and 5 mm penetrations, respectively. Comparing these findings, it is evident that the inclusion of coir fiber reinforcement at a height of H/3 resulted in higher CBR values compared to both the absence of coir and the use of coir at H/2. Therefore, implementing coir fiber reinforcement at a lower height proved to be an effective measure in improving the engineering properties of the soil.

Overall, the utilization of natural fiber reinforcement techniques, such as coir geotextile, provides a cost-effective and efficient solution for enhancing the properties of black cotton soil, leading to improved pavement construction

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