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Effect of Jute Fiber Reinforcement Layers on Unconfined Compressive Strength of Black Cotton Soil

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Abstract: ***Improvement of soil in foundation is a major challenge in civil engineering. Structures built on black cotton soil may be damaged due to high swelling and shrinkage characteristics of this soil with variation of water content. Black cotton soil is an expansive soil which loses its strength in presence of water. On the other hand, it has behavior of shrinkage when loss of moisture is there. About 20 % of land area in India is covered by black cotton soil. Because of its swelling & shrinkage properties, it is also called expansive soil. The present paper is an attempt to study the effectiveness of jute fiber (reinforcement) in layers to control its strength characteristics and dry density by unconfined compressive strength test. The test results show that the soil when reinforced with 2-layers attained maximum dry density and at 4-layer reinforcement attained maximum unconfined compressive strength.***
Keywords: Jute Geotextile Sheet, Geotextile Reinforcement, Expansive soil, Stabilization, UCS, geo-synthetic reinforcement, Strength of soil.

I. INTRODUCTION

Soil has been used as a construction material from time immortal. Being poor in mechanical properties, it has been putting challenges to civil engineers to improve its properties depending upon the requirement which varies from site to site. During last 25 years, much work has been done on strength deformation behaviour of fiber reinforced soil and it has been established beyond doubt that addition of fibre in soil improves the overall engineering performance of soil. Among the notable properties that improved are greater extensibility, small loss of post peak strength, isotropy in strength and absence of planes of weakness. Fiber reinforced soil has been used in many countries in the recent past and further research is in progress for many hidden aspects of it. Fiber reinforced soil is effective in all types of soils (i.e. sand, silt and clay). Use of natural material such as Jute, coir, sisal and bamboo, as reinforcing materials in soil is prevalent for a long time and they are abundantly used in many countries like India, Philippines, and Bangladesh etc. The main advantages of these materials are they are locally available and are very cheap. They are biodegradable and hence do not create disposal problem in environment. Processing of these materials into a usable form is an employment generation activity in rural areas of these countries. If these materials are used effectively, the rural economy can get uplift and also the cost of construction can be reduced, if the material use leads to beneficial effects in engineering construction. The use of Jute geotextile is a new and innovative solution, in which a geotextile material is used in expansive soil to stabilize it.

II. LITERATURE REVIEW

Bairagi, 2014 studied the Effect of jute fibers on engineering characteristics of black cotton soil and gave result that CBR and UCS values of soil is increased when mixed with jute fiber from 0% to 5%. Choudhary et al, 2012 researched the improvement in CBR of expansive soil with a single Jute reinforcement layer and gave results that reinforcement in layer controls swelling and enhances CBR value. Das and Singh, 2014 researched on Deformation and strength Characteristics of jute geotextile in reinforced soil concluded that jute layer reinforcement is very effective in stabilizing and protecting of weak soil. Gill and singh, 2012 studied CBR improvement of clayey soil and concluded that CBR was improved by 9.4% with different positions of layer. Jagan, 2016 gave a case study on a critical review on applications of natural jute fibers and concluded that the cbr value of soil was increased after mixing the jute fiber in soil. Singh, 2013 researched on strength and stiffness of soil reinforced with jute geotextile sheets and concluded that there is increase in shear strength of soil with inclusion of jute in soil.

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III. OBJECTIVE

A. To Study The Strengthening Of Soil Of Low Bearing Capacity.
B. To study the effect of jute fiber reinforcement on expansive soil.
C. To study the change in UCS value of soil due to jute layer reinforcement.

IV. MATERIALS

In this study, materials used are black cotton soil which is very much expansive in nature due to the montmorrilonite mineral present in it. Black cotton soil due to its swelling and shrinkage properties can cause deformation of subgrades, foundations etc and Jute fiber geotextile layer which is easily available in local market.

A. Soil

The soil sample is collected from Jasuja City, near Dhanwantri Nagar, Jabalpur (MP). The sample was collected and tested in lab and the following characteristics of soil were observed:

Table-1

Sno.	Property	Notation	Value
1	Specific Gravity	G	2.40
2	Soil classification	CH	-
3	Liquid Limit	LL	68.34%
4	Plastic Limit	PL	30.05%
5	Plasticity Index	PI	38.30%
6	Differential free Swelling	DFS	60%
7	Optimum Moisture Content	OMC	19.54%
8	Maximum Dry Density	MDD	1.698 g/cc
9	California Bearing Ratio	CBR	2.67%
10	% Passing 75 micron sieve	-	98.54%
11	Unconfined compressive strength	UCS	162.15 KN/m^2

B. Jute

Jute is economical and easily available in the market. Jute bags are locally available in the market. Jute bags were cut in desired shape with an average overall thickness of 2mm and about 0.4% and 0.8% by weight of soil for 2-layer and 4-layer jute reinforcement as shown below:

V. METHODOLOGY

The soil sample is tested for different tests listed below:

A. Sieve Analysis
B. Specific Gravity Test

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C. Liquid Limit
D. Plastic Limit
E. DFS
F. Modified Proctor Test
G. CBR
H. UCS

The sample was tested as listed above and values obtained are shown in table-1. After the tests on Natural Soil Specimen Unconfined compressive strength test was again conducted on soil specimen reinforced with jute fibers in 2-Layer and 4-Layers respectively as shown below:

Figure 1- Compacted soil layers with no reinforcement

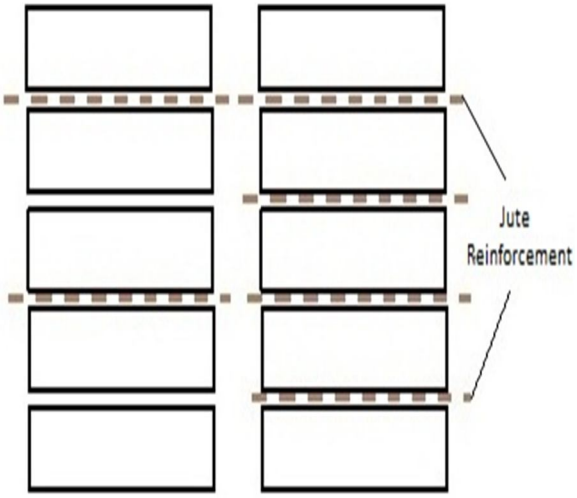

Figure 2- Compacted soil with 2-layer and 4-layer Jute reinforcement

Above shown figure gives the locations of reinforcement in soil specimen. Figure-1 shows the soil specimen without reinforcement and Figure-2 Shows the position of 2-layers and 4-layers of jute reinforcement in the soil specimen. Samples are tested for UCS.

1) *Unconfined Compressive Strength Test:* The Soil Sample was prepared by using UCS sampler having diameter 3.8 cm and length 7.62 cm. Soil was compacted in 5-layers in between layers 3 samples of 2-layer reinforcement and 3-samples of 4-layer reinforcement were prepared and the sample was tested for unconfined compressive strength the average values of stress is obtained and taken as UCS of sample.

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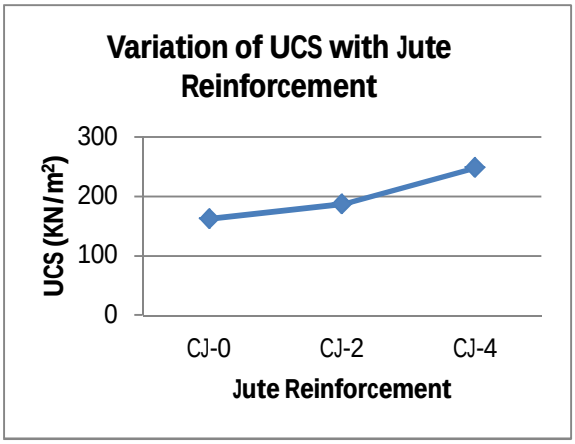
VI. RESULTS AND DISCUSSIONS

The Unconfined compressive strength of soil is improved. The maximum improvement is seen in 4-layers of reinforcement. The results are tabulated below:



Reinforcement	Notation	UCS Value (KN/m^2)
Soil with No Reinforcement	CJ-0	162.15
Soil with 2-layer Reinforcement	CJ-2	187.0
Soil with 4-layer Reinforcement	CJ-4	248.4

CJ-0 - Soil sample with no Reinforcement

CJ-2 - Soil sample with 2-layer Reinforcement

CJ-4-Soil sample with 4-layer Reinforcement

The above results indicate that the UCS (Unconfined Compressive Strength) of the soil is maximum in 4-Layer reinforcement and there is improvement in UCS of soil after reinforcement of jute layers as the UCS is improved from 162.15 KN/m^2 to 248.4 KN/m^2.

VII. CONCLUSIONS

The Expansive soil when attempted to stabilize with Jute layer reinforcement the remarkable changes was observed as the UCS was seen to be increased from 162.15 KN/m^2 to 187 KN/m^2 in the 2-layer jute reinforcement and 248.4 KN/m^2 in 4-layers of jute reinforcement. Jute was found out to be very effective in improving Unconfined Compressive Strength of the expansive soil.

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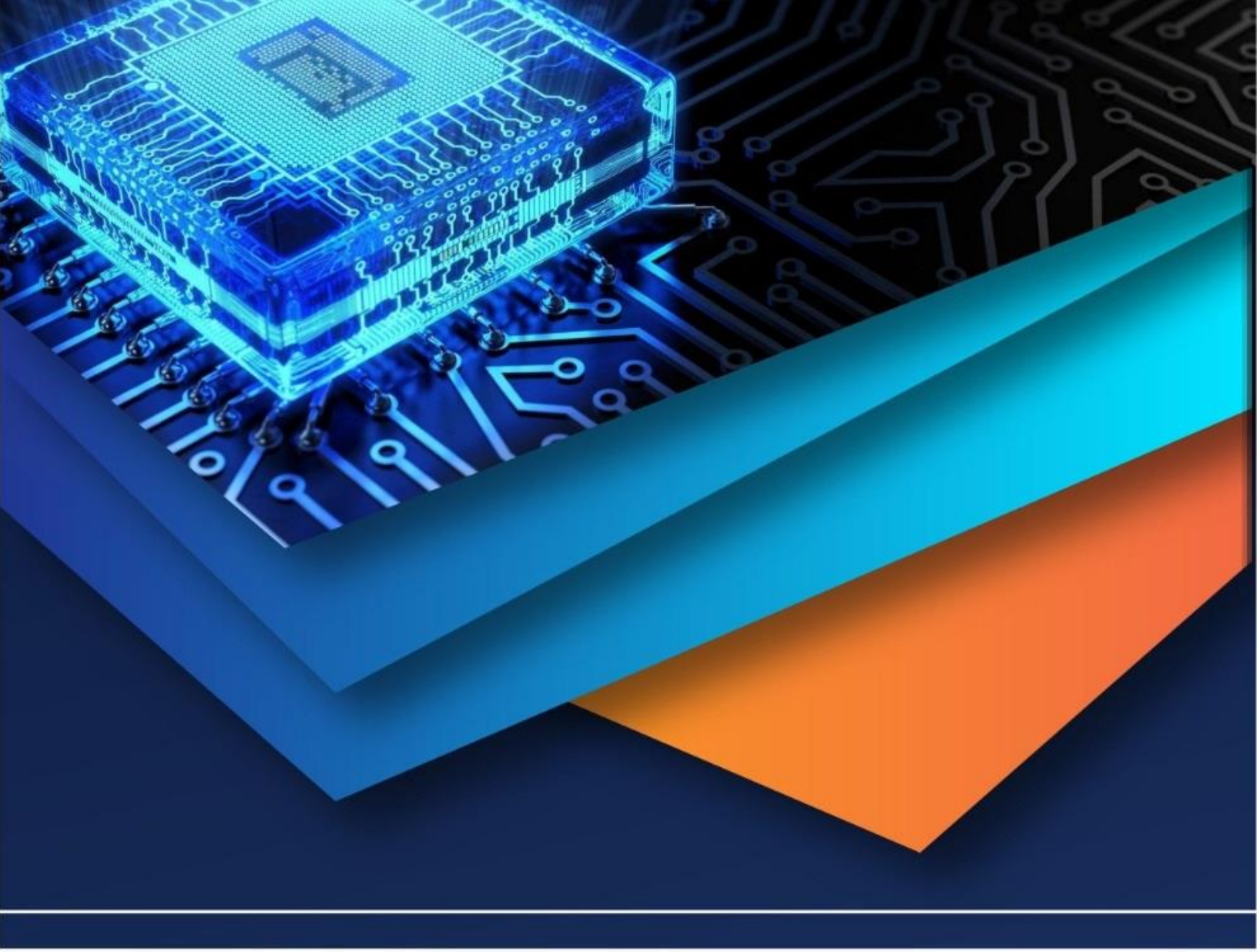

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