Improvement of Soil Characteristics Using Jute Geo-Textile

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ABSTRACT: Analysis and comparison of properties of two different clayey soils is carried out with and without reinforcement. Jute geo-textile (grade TD-5) was used as reinforcing material to stabilize both peat and black cotton soil. Almost all the standard laboratory tests as well as field tests were conducted. Finally study of the contribution of jute geo-textile on the properties of clayey soils and its feasibility for various civil engineering applications is evaluated. The results show the increment of soil properties like shear strength, dry density and CBR(California Bearing ratio) while permeability and settlement decreased on introduction of jute geo-textile, indicating significant improvement in the engineering behavior.

Index Terms— Jute geo-textile, reinforcement, shear strength, dry density , CBR , permeability ,settlement

I. INTRODUCTION:

Soil is considered by the civil engineer as a complex material. Apart from the testing and classification of various types of soil, in order to determine the stability and physical properties, the knowledge of problems related to foundation design and construction, pavement design, design of embankments and excavation, design of earth dams are necessary.

In this present study, an attempt is made to stabilize Peat soil and Black cotton soil (BCS)with the use of jute geo-textile (JGT). The geo-textile selected for the project was Tossa Jute (corchorus olitarus)-TD5.It is non-woven jute which is mechanically bonded using heat, pressure or resin bond.
From the very inception of the Indian Jute Industry, jute fiber has proved its superiority over other fibres in terms of its functionality and reusability due to its considerable tensile strength, low extensibility and good dimensional stability. One of the growing alternatives in today's context is the emergence of technical textiles made out of natural fibers which includes geo-textile products for geotechnical applications, agriculture and in other such relevant areas. Jute geo-textile (JGT) can certainly be considered as a potential aspirant replacing majority of today's popular synthetic products which are posing severe threats to our environment thereby adversely affecting the eco-congruity. Several exhaustive studies and research works related to the design

and engineering of JGTs with end-use requirements have been carried out over the years by several research organizations of national and international status to establish the potentiality of JGTs in mitigating the geotechnical problems.

Peat soil is a type of soft soil composed of high contents of fibrous organic matters and is produced by the partial decomposition and disintegration of mosses, sedges, trees, and other plants that grow in marshes and other wet place in the condition of lack of oxygen. Peat soil is often referred as problematic soil due to its low shear strength, high compressibility and high water content. These soils which are highly compressible and permeable containing high organic content ≥75% and liquid limit greater than 50%.

Fig.1 Tossa Jute (corchorus olitarus)-TD5

BCS is igneous rock (basalt) formed by rapid cooling of basaltic lava. Black color of BCS is due to titanium oxide present in small concentration. It is inorganic clay of medium to high compressibility with high shrinkage and swelling properties, very hard when dry but lose its strength completely in wet condition. The high content of montmorillonite makes it expansive. The property of

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volumetric changes with the change in atmospheric condition makes BCS dangerous to be used in building construction foundation.

Peat soil and BCS is considered as problematic soils in the view of design parameter by the geotechnical engineers because its engineering characteristic are inferior to those of the other soft soils which make it unsuitable for construction in its natural stage. Peat soil and BCS are generally associated with poor strength characteristics, large deformation, high compressibility, and high magnitude and rates of creep.

They are subjected to problems of instability such as local sinking and development of slip failure. They are also subjected to very large primary and long term settlement under an even moderate increase in load. A large variation in material properties coupled with difficulty in sampling of both these soils.

G.Venkatappa and P.K.Banerjee, Indian institute of technology, New Delhi (1997), from various observation concluded that before the geotextiles can be put to effective use, their characterisation is utmost importance. From the design and engineering point of view of Singh (2011), Yachang (2012), Ghosh Swapan Kumar (2014) Department of Jute and Fibre Technology, University of Calcutta, West Bengal, India, the JGT fabric samples ensured themselves as a suitable and potential geotextile fabric as per end-use requirements. In 2011, Surendra. P. Jadhav and R. M. Damgir (Government College of Engineering Aurangabad Maharashtra, India) successfully used jute geotextile (JGT) for reinforcement of soil to improve bearing capacity.

II. EXPERIMENTAL STUDIES:

A number of laboratory tests were done for the physical properties as well as the engineering properties of peat and black cotton soil. Properties were compared without reinforcement and after providing the reinforcement. Sp Gravity, Liquid limit, Plastic limit were found out. Soil is classified as per Indian Standard Classification System ISCS (IS 1498-1970). For peat soil $I_P = W_L - W_P$

$= 58\% - 40.95\%$

$= 17.05\%$

A_{Line} Equation, $I_P = 0.73 (W_L - 20)$

Soil is classified as OH

This soil is highly organic soil with high compressibility. This can be readily identified by colour, odour, spongy feel and fibrous texture. The Liquid Limit is > 50%.

For Black Cotton Soil: $I_P = W_L - W_P = 63\% - 40.2\% = 22.8\%$

A_{Line} Equation, $I_P = 0.73 (W_L - 20)$

Soil is classified as MH

This soil is Inorganic Silts of high compressibility, micaceous, diatomaceous fine sandy or silty and elastic. The Liquid Limit is > 50%.

Particle size distribution through sieve analysis was done and for peat soil Uniformity coefficient = $D_{60}/D_{10} = 8$ and Coefficient of curvature = $D_{30}^2/(D_{60}-D_{10}) = 0.98$. For black cotton soil the uniformity coefficient was found to be 9.643 and the curvature coefficient was 7.619.

California Bearing Ratio Test:

The load values to cause penetration of 2.5mm and 5mm are recorded .These loads are expressed as percentages of standard load values 1370 and 2055 kg respectively at 2.5 and 5mm penetration respectively.

Check for settlement:

Four pits were dug; two for soil without Geotextile and another two for soil reinforced with geotextile. The reinforcement was given at every one third depth.

Fig.2 pit dug for the test

Diameter of the pit = 0.3m

Depth of the pit = 0.6m

Load applied on each pit = 212.2kN/m^2

Water content for peat and black cotton soil= 10%

Settlement was checked after 14 days and 24 days. It is seen that after the application of geotexties the settlement reduced significantly for both peat and black cotton soil.

Proctor compaction test was done and relation was found between optimum moisture content and maximum dry density. Unconfined compression test also was done with and without geo-textiles and comparison is done for the shear parameters.

III. FORMULATION OF EXPERIMENTS:

Table:1 Physical Properties of Soil:

Properties	Peat Soil	Black Cotton Soil
Specific gravity	3.03	2.56
Liquid Limit	58%	63%
Plastic Limit	40.95%	40.2%

Table:2Comparison of different test results for Peat Soil

Particulars	Without Jute	With Jute
Maximum Dry Density, Y_d	1.486	1.51

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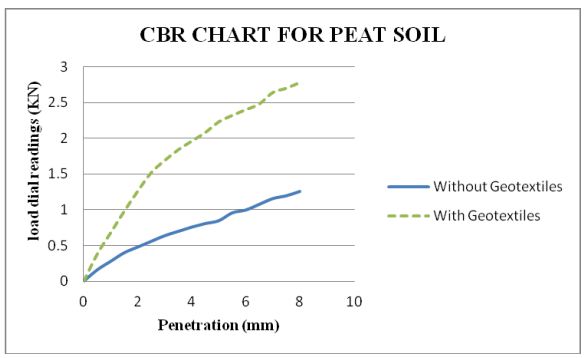
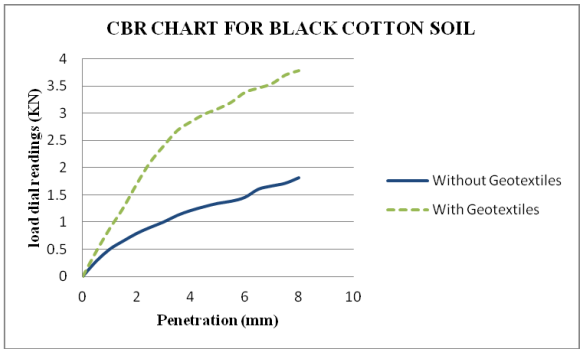
Optimum Moisture, W, %	20	25
Unconfined Compressive	0.441	0.667
Cohesive Strength, C, kg/cm^2	0.11	0.243
Angle of internal friction, Ø,	36^o	18^o
Coefficient of Permeability, K, cm/s	9.13*10^{-4}	6.05*10^{-4}
California Bearing Ratio, CBR, %	4.2	11.3

Table :3 Comparison of different test results for Black Cotton Soil

Particulars	Without Jute	With Jute
Maximum Dry Density, Yd	1.54	1.482
Optimum Moisture, W, %	18	23
Unconfined Compressive	0.772	1.084
Cohesive Strength, C, kg/cm2	0.313	0.74
Angle of internal friction, Ø,	12^o	20^o
Coefficient of Permeability,K, cm/s	0.0232	0.0175
California Bearing Ratio, CBR, %	6.695	15.62



Graph1 : CBR of Peat Soil



Graph2 : CBR of Black Cotton Soil

Table :4 Settlement for Peat Soil

Peat Soil	14 days Settlement	24 days Settlement
Without Jute	0.8 cm	1.1cm
With Jute	0.6 cm	0.7 cm

Table :5 Settlement for Black Cotton Soil

Black cotton Soil	14 days settlement	24 days Settlement
Without Jute	0.90 cm	1.0 cm
With Jute	0.75 cm	0.8 cm

IV. CONCLUDING REMARKS:

Based on the observations and the results obtained, it can be concluded that the jute geotextile used in the project has a significant influence on the soil properties. Shear strength, dry density, permeability and CBR have been compared before and after laying of the jute geo-textile. While shear strength, dry density and CBR increased, permeability and penetration (check for settlement) decreased on introduction of jute geo-textiles, indicating significant improvement in the engineering behavior. Hence, jute geo-textile plays very effective role in the improvement of soil properties by reducing their compressibility and increasing their strength. The project was done on two types of clayey soils and TD-5 Jute geo-textile. There is substantial scope for carrying out further work in this area as the future of Jute geo-textile is very dynamic and it is be driven by various factors such as cost, performance and availability of resources. In the area of geo-textile utilization, there are several competing ideologies today. On one hand we have a growing need to create eco-friendly geo-textile and on the other hand there is a constant need to utilize the resources given by nature. The possible research ideas for future work are summarized below.

The present work can be extended considering more varieties of jute geo-textiles and soils. In the studies concerned with reinforcement of soft soil more advanced technology, precise application methods and maintenance, can be adopted. Field tests can be carried out to get more practical results. Studies related to degradation aspects and their effects can be studied.

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