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# STABILIZATION OF SOIL BY USING JUTE FIBRE

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**Abstract**
*The main objective of this study is to investigate the use of jute fibre materials in geotechnical applications and to evaluate the effects of jute fibres on shear strength of unsaturated soil by carrying out California Bearing Ratio Test, to check for settlement two different soil samples. The results obtained by this test are compared for the two samples and inferences are drawn towards the usability and effectiveness of fibres reinforcement as a replacement for deep foundation or raft foundation, as a cost effective approach. Geotextile, Natural and Synthetic, are helpful in improving the Geotechnical properties of soil. These fabrics are used for control on erosion, Drainage, Filtration, as separation layer, for vegetation support etc. Jute is also a Geotextile which is more ecofriendly and can be used in road works cost effectively. Because the structure of road consists of the formation or Subgrade and the pavement. The Structural element of the pavement is the foundation(soiling or bottoming) also called the sub-base of the base. Subgrade is an integral part of road pavement structure as it provides support to the pavement as its foundation, so it is necessary that it should be strong.Therefore introduction of reinforcing elements in a soil mass is necessary for increasing the shear resistance of the mix. So that the use of jute fibre as soil reinforcement material.*

***Index Terms:*** *Jute fibre, Shear strength, Fibre reinforcement, Shear test.*

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## 1. INTRODUCTION

### 1.1 General

For any land-based structure, the foundation is very important and should be strong to support the entire structure. so that for strong foundation, the soil around it plays a important role. So, to work with soil is necessary that we should have proper knowledge about their properties and factors which affect their behaviour. The process of soil stabilization helps to gain main properties which are important for construction work. From beginning of the construction work, the necessity of enhancing soil properties has come to the light. Various methods to improve soil strength were utilized by ancient civilizations of the Chinese, Romans and Incas, some of these methods were so effective that their buildings and roads still exist. In India, the modern era of soil stabilization began in early 1970's, with a general shortage of petroleum and aggregates, engineers to look at means became necessary for the to improvement of soil other than replacing the poor soil at the building site.

### 1.2 Need of study

Soil stabilization was used but due to the absence of proper technique, favour was lost by soil stabilization In recent times, with the increase in the demand for infrastructure, fuel and raw materials, soil stabilization started to take a new shape. With the availability of better research, materials and equipment, it is rising as a popular and cost-effective method for improvement of soil. In this present study, an attempt is made by them to stabilize Peat soil and Black cotton soil (BCS) with the use of jute geo-textile (JGT). The geo-textile was 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 fibre 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 fibres which includes geo-textile products for geotechnical.

### 1.3 Objectives of Study

The main aim of the present investigation is to assess the usefulness of jute geotextile as soil investigates the use of jute fibre as soil reinforcement material. Present investigation has been limited to the following. Studies,

1. To study the nature of the soil with and without jute geotextiles.
2. To study the strengthening of soil of low bearing capacity.

3. To study the effect of geotextile as a arrests migrating of soil particle and allows water to permit across it.
4. To study the influence of jute geotextile on California bearing ratio.

## 2. SOIL STABILIZATION

Soil stabilization is the process of changing some soil properties by using different methods to increase the strength and durability or for preventing erosion and dust formation in soils, soils are generally stabilized. The main aim is the creation of a soil material or system that will hold under the design conditions and for the designed life of the engineering project. The properties of soil vary a great deal at different places or in certain cases even at one place; the success of soil stabilization depends on testing of soil samples. Various methods are employed for soil stabilization and the method should be verified in the lab with the soil material before it applying on the field.

### 2.1 Principles of Soil Stabilization:

1. Evaluating the soil properties of the area under consideration.
2. Deciding the property of soil which needs to be change to get the design value and choose the effective and economical method for stabilization.
3. Designing the Stabilized soil mix sample and testing it in the lab for finding stability and durability values.

### 2.2 Needs & Advantages

Properties ofsoil vary a great deal and construction of structures depends upon the bearing capacity of the soil. Hence, we need to stabilize the soil which makes it easier to predict the load bearing capacity of the soil and improve the load bearing capacity. The gradation of the soil is also a very important property that should keep in mind while working with soils. The soils may be said ass well-graded which is desirable as it has less number of voids or uniformly graded which though sounds stable but has more voids. Thus, it is better to mix different types of soils together to improve the soil strength properties. It is very much expensive to replace the inferior soil by entirely different soil and so that, soil stabilization is the thing to look for in these cases.

1. By increasing the soil bearing capacityit improves the strength of the soil.
2. Soil stabilization is more economical both in terms of cost and energy to increase the bearing capacity of the soil rather than going for deep foundation.
3. It provides more stability to the soil in slopes or other such places.
4. Sometimes soil stabilization is also used to prevent soil formation of dust.
5. Stabilization is also done for soil water-proofing; this prevents the entry of water into the soil and hence helps the soil from losing its strength.
6. Due to change in temperature or moisture contentit helps in reducing the soil volume change.

## 3. JUTE GEOTEXTILE

Jute plant is woody type growing to about 3m high and under its bark bundles of fibres run longitudinally down the stem held together by sticky resin. When harvested, the cut stems are tied into bundles and kept submerged in water for between20 to 30 days. This process is known as retting. The tissues of the stems are broken down under bacterial action. The resulting soggy mass consists of strands of overlapping fibres. The fibres are then stripped off from the stem manually, washed in water and dried under the sun. The earth reinforcement is an ancient technique and demonstrated abundantly by the nature in the action of tree roots. This concept is used for the improvement of certain desired properties of soil like bearing capacity, shear strength, and permeability characteristics etc. The concept of soil reinforcement was first developed by vidal (1969), by which he demonstrated that the introduction of reinforcing elements in a soil mass increases the shear resistance of the mix. This work investigates the use of jute fibre as soil reinforcement material.

**Fig-1: Jute Fibre**

## 4. 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 IP = WL – WP
= 58% - 40.95%
= 17.05%

A line Equation, IP = 0.73 (WL – 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: IP = WL - WP
= 63% - 40.2%
= 22.8%

A line Equation, IP = 0.73 (WL – 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.

**4.1 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.

**4.2Check 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 = 0.6

Load applied on each pit = 212.2kN/m2

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 geotextiles 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 properties.

## 5. FROMULATION OF EXPERIMENT

**Table 1: Physical Properties of Soil**

| Properties | Peat Soil | Black Cotton Soil |
|---|---|---|
| Specific gravity | 3.03 | 2.56 |
| Liquid limit | 58% | 63% |
| Plastic Limit | 40.59% | 40.2% |

**Table 2: Comparison of Different Test Results for Peat Soil**

| Particulars | Without Jute | With Jute |
|---|---|---|
| Maximum Dry Density, $\gamma_d$ | 1.486 | 1.51 |
| Optimum Moisture W % | 20 | 25 |
| Unconfined Compressive | 0.441 | 0.667 |
| Cohesive Strength, kg/cm$^2$ | 0.11 | 0.243 |
| Angle of internal friction | 36 | 18 |
| Coefficient of Permeability, cm/s | 9.13 x 10$^{-4}$ | 6.05 x 10$^{-4}$ |
| California Bearing Ration CBR, % | 4.2 | 11.3 |

**Table 3: Comparison of Different Test Results for Black Cotton Soil**

| Particulars | Without Jute | With Jute |
|---|---|---|
| Maximum Dry Density, $\gamma_d$ | 1.54 | 1.482 |
| Optimum Moisture W % | 18 | 23 |
| Unconfined Compressive | 0.772 | 1.084 |
| Cohesive Strength, kg/cm$^2$ | 0.313 | 0.74 |
| Angle of internal friction | 12 | 20 |
| Coefficient of Permeability, cm/s | 0.0232 | 0.0175 |
| California Bearing Ration CBR, % | 6.695 | 15.62 |

**Table 4: Settlement for Peat Soil**

| Peat Soil | 14 Days Settlement | 24 Days Settlement |
|---|---|---|
| Without Jute | 0.8 cm | 1.1 cm |
| With Jute | 0.6 cm | 0.7 cm |

**Table 5: Settlement for Black Cotton Soil**

| Peat Soil | 14 Days Settlement | 24 Days Settlement |
|---|---|---|
| Without Jute | 0.9 cm | 1.0 cm |
| With Jute | 0.75 cm | 0.8 cm |

## 6. ADVANTAGES OF JUTE GEOTEXTILE

Following are the advantages of Jute Geotextile

1. Abundant availability.
2. Superior drapability, jute geotextile can perfectly shape itself to ground contours.
3. High moisture / water absorbing capacity. Jute geotextile can absorb moisture / water up to about 5times its dry weight.
4. High initial strength.

## 7. CIVIL ENGINEERING APPLICATIONS OF JUTE FIBER

1. Strengthening of road by improving CBR.
2. Slope management.
3. Protection of river bank against erosion.
4. Stabilizing embankments.
5. Prevention of railway track settlement.
6. Consolidation of soft soil.
7. Control of surface soil detachment.

## 8. CONCLUSION

Based on the observations and the results obtained from the experiments which I have studied, 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 lying 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 behaviour. 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.

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