GEOTECHNICAL CHARACTERIZATION OF JUTE GEOTEXTILE

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ABSTRACT: Nowadays the application of Jute geotextiles in the field of civil engineering is quite popular, as it is ecofriendly. Jute geotextiles can be used for construction of rural roads, embankments and also for erosion controls of hill slopes and river banks. In this paper an attempt has been made to present the results of experimental studies on some common engineering properties of jute geotextiles, such as tensile strength (wide width, narrow width), CBR Push through, thickness, apparent opening size, Permittivity, Transmissivity to evaluate the suitability in the field of geotechnical engineering. From experimental results, it is found that with time the value of tensile strength (wide width, narrow width) and also puncture breaking force decrease irrespective of types of jute geotextiles.

INTRODUCTION
Over the last two decades jute geotextiles are being increasingly used in different civil engineering activities and especially in geotechnical engineering field. Jute geotextiles have some distinctive character like its use as a separator in case of road construction; it has an excellent character to suck out water from soil, high initial tensile strength, and high moisture absorbing capacity. A number of studies on application of jute geotextiles in construction of road, stabilization of hill slope, and also riverbank protection have been documented [1 - 11]. However, detailed study on engineering properties of jute geotextiles is scarce. In the present investigation, an attempt has been made to study the geotechnical properties of jute geotextiles.

MATERIALS
In the present study six varieties of woven jute geotextiles has been collected from Kolkata, west Bengal, India. The above six varieties of jute geotextiles may be designated as JG1, JG2, JG3, JG4, JG5 and JG6. To study the degradation properties of jute geotextiles, soil has been collected from BESUS Campus, West Bengal India.

Engineering Properties of Soil
Engineering properties of soil has been determined in accordance with IS: 2720. The engineering properties of soil are presented in Table 1. In accordance with ASTM D 2487 (1992), the soil may be classified as CL.

Geotechnical Properties of Jute Geotextiles
Jute geotextiles are used in wide range of areas. Nowadays with increasing environmental awareness engineers are trying to use natural product in their project work. The important geotechnical properties of jute geotextiles are mass per unit area, thickness, apparent opening size, permittivity, Transmissivity, tensile strength, and puncture strength. The mass per unit area of geotextile samples has been determined in accordance with ASTM D 5261. Value of mass per unit area for JG1, JG2, JG3, JG4, JG5 and JG6 are 670-, 560-, 235-, 800-, 750-, and 500 gsm respectively. Thickness of jute geotextile samples has been determined in accordance with ASTM D 5199. The values of thickness of JG1, JG2, JG3, JG4, JG5 and JG6 are 1.43-, 1.21-, 0.85-, 1.72-, 1.70-, and 1.20 mm respectively.

Apparent Opening Size of Jute Geotextiles
Jute geotextile soil filtration capability can be determined through apparent opening size tests. In the present paper the apparent opening size of jute geotextile samples has been determined in accordance with ASTM D 4751. The test is carried out with different sizes of glass beads. The apparent opening size (O95) is the pore size at which 95% of the glass beads are retained on and within the fabric. The values of O95 as obtained in the present investigation for JG1, JG2, JG3,
JG4, JG5 and JG6 are 0.150-, 0.075-, 0.850-, 0.425-, 0.425-, and 0.850 mm respectively.

Permittivity and Transmissivity of Jute Geotextils
One of the major functions that jute geotextiles performs is that of filtration. The fabric permeability must be quantified in cross plane (permittivity) and in plane (transmissivity). In the present study permittivity and transmissivity of jute geotextiles have been determined in accordance with ASTM D4491 and ASTM D4716 respectively. The values of transmissivity for JG1, JG2, JG3, JG4, JG5 and JG6 are \(5.4 \times 10^{-6}\), \(16.0 \times 10^{-6}\), \(21.1 \times 10^{-6}\), \(6.9 \times 10^{-6}\), \(5.68 \times 10^{-6}\), and \(9.11 \times 10^{-6}\) m\(^2\)/s respectively. Whereas, the respective values of permittivity as obtained in the present investigation for JG1, JG2, JG3, JG4, JG5 and JG6 are \(10.1 \times 10^{-3}\), \(6.9 \times 10^{-3}\), \(11.0 \times 10^{-3}\), \(10.2 \times 10^{-3}\), \(9.5 \times 10^{-3}\), and \(16.1 \times 10^{-3}\) s\(^{-1}\) respectively. From the results it is observed that with increase apparent opening size the permittivity of jute geotextiles increases.

Tensile Strength of Jute Geotextiles
In the present investigation narrow width tensile strength test and wide width tensile strength test have been performed to evaluate the stress strain characteristics of jute geotextiles. Wide width tensile strength tests have been conducted on jute geotextile specimens of 200 mm wide and keeping aspect ratio (width of the specimen to the gauge length) as 0.5. In case of narrow width tensile tests the width of the specimen and aspect ratio are taken as 25 mm and 4 respectively. Data obtained from the experiments are plotted in the graph. Fig 1 shows the plots of typical tensile stress versus strain curves for wide width tensile tests and narrow width tensile strength for both the directions machine (M) and cross machine (XM) of jute geotextile (JG2). From the curves it is found that tensile strength of jute geotextiles obtained from wide width tensile strength exhibits higher value than tensile strength of jute geotextile obtained from narrow width tensile strength test for both the directions machine direction and cross machine direction. From the curves (Fig.1), the breaking toughness of jute geotextile has been determined in accordance with ASTM D4595. Fig.2 shows breaking toughness from narrow width tensile strength test versus breaking toughness from wide width tensile strength test plot. From the figure (Fig.2) it is found that the breaking toughness obtained from narrow width tensile strength test is about 77% of the breaking toughness obtained from wide width tensile strength test.

Puncture Strength of Jute Geotextiles
In the present study CBR puncture strength test of jute geotextile samples has been determined in accordance with German standard DIN 54307. Fig.3 shows the plots of CBR puncture breaking force versus vertical displacement curve for JG4. From the curve the peak values of puncture breaking force obtained are called as CBR puncture strength. Values of CBR puncture strength obtained from the present investigation are 1.314-, 1.422-, 0.671-, 2.850-, 2.644-, and 1.286 kN for JG1, JG2, JG3, JG4, JG5, and JG6 respectively.

Wide width tensile strength has been calculated based on the equation proposed by Cazzuffi and Venesia [12] of the same jute geotextiles that were tested in CBR puncture strength test. It appears that strength predictions are quite reasonable for jute geotextiles. Fig.4 shows the values of wide width tensile strength from experiment and also values of wide width tensile strength and those calculated based on the equation proposed by Cazzuffi and Venesia [12] of the same jute geotextiles that were tested in CBR puncture strength test. From the figure it is found that the value of calculated wide with tensile strength is close to the wide with tensile strength obtained from experiment.
### Degradation Properties of Jute Geotextiles

To know the degradation properties of jute geotextiles, jute geotextile sheets are cut with suitable sizes based on relevant tests and then all the samples have been buried into the saturated soil in different layers for entire tests period. In the entire tests period care has been taken, and to ensure that the samples do get dry. Water has been poured in to the soil time to time. Samples are collected from the saturated soil and wash thoroughly. All the types of tests (wide tensile tests and also CBR push through tests) have been performed after the sample buried in the soil for 7-, 14-, 21-, 28-, 45 days. Figs. 5 and 6 shows the plots of typical wide width tensile stress versus strain curves with varying time for JG6 (XD) and Typical puncture breaking force versus vertical displacement curve with varying time for JG6 respectively. From both the curves it is found that with time the strength of jute geotextiles decreases. From the figure (Fig. 5) it is also found that the rate of decrease of strength is very slow. In case of jute geotextile the decrease of wide width tensile strength only 10% after 45 days of degradation of jute geotextile. Ramaswami & Aziz [1] reported that the sufficient strength of jute geotextile remains up to one year. Ranganathan [3] opined that incase of road, once the road has been fully constructed and in use, the geotextile becomes superfluous and hence the biodegradability of jute does not pose problems for this end use.
CONCLUSION
Based on the experimental results presented and discussions are made in the previous sections the following conclusions may be drawn:

- The values of the breaking toughness of jute geotextile for narrow width tensile strength test are almost 0.77 times of the values of the breaking toughness of jute geotextile obtained from wide width tensile strength.
- With increase in apparent opening size of jute geotextiles the permittivity of jute geotextile increases.
- With time values of tensile strength of geotextiles decrease slowly. In case of jute geotextiles (JG6), the decrease of wide width tensile strength is only 10% after 45 days of degradation of jute geotextiles.

REFERENCES
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