Strain Rate Sensitivity of Jute Geotextile in Uniaxial Tension

S. Islam, A. J. Khan

***Abstract:** Use of synthetic geotextile for embankment stabilization, reinforcement of soil, grade separation of road layers is a common practice for many years. Woven Synthetic geotextiles are not environmental friendly and as imported these are often found to be costly. Jute geotextiles (JGT) are indigenous and have got enough potential for use as initial reinforcement and moisture absorption accelerator in road subgrades, for river bank protection via facilitating establishment of inverted filter formation and for top soil erosion control of exposed slope surfaces. By employing different modification techniques, JGTs may be converted into designed biodegradable material without changing its environmental friendly properties. In the present study two types of JGTs (untreated 627gsm and untreated 724gsm) have been used. The samples are supplied by Bangladesh Jute Mills Corporation (BJMC) and Bangladesh Jute Research Institute (BJRI). The most important properties of JGT, i.e., tensile strength and strain at maximum load have been evaluated for both types of samples at different strain rate. This paper presents the rate sensitivity of JGT through the test results of these two types (untreated, 627gsm and untreated 724gsm) of JGTs.*

***Keywords:** Jute geotextiles (JGT), uniaxial tensile strength, strain, strain rate sensitivity.*

I. INTRODUCTION

Versatility and distinctive physical characteristics of jute fibers coupled with its high spinnability, make it an ideal material for new technical applications beyond the existing conventional end-uses (Sanyal, 2008). For some areas of civil engineering applications, JGT has emerged as a strong alternative to synthetic geotextiles. Laboratory studies on the physical and engineering properties of different varieties of geotextiles as well as some field studies have been carried out by BUET, LGED, RHD, BWDB and SRDI. Synthetic geotextiles being made from non-biodegradable polymer based constituents such as polypropylene, polyester or polyethylene, have inherent advantage over natural fibre based biodegradable JGT for long-term applications. Recently, Bangladesh Jute Research Institute (BJRI) have developed some treatment techniques for JGTs which may enhance their life (Abdullah, 1999). Development of such durable JGT materials is likely to allow them to be used in short-term to medium-term soil reinforcement applications, e.g. rural roads, construction of access roads, flood and road embankments etc. (Khan, 2008).

Jute is a biodegradable and eco-friendly natural product with low cost, which can be used for producing many types of geotextiles. With growing awareness about preserving the environment against the long suffering effects of using synthetic (polymeric) materials, the use of jute-based geotextiles works is gaining importance. In absence of any recognized testing standard, the ASTM, BS, DIN or ISO methods of testing usually employed for synthetic geotextiles are most commonly adopted for the determination of the properties of JGTs (Khan, 2008). For example, the test method ASTM 4595 is usually used for determine the wide width tensile strength of JGTs. It should be noted that this ASTM method is particularly applicable for synthetic geotextiles which specifies a strain rate of 10 ± 2%. This strain rate suggested by ASTM 4595 for synthetic geotextiles is based on the fact that synthetic geotextiles are elasto-visco-plastic in nature and hence strain rate sensitive, with visco-pastic component being dominant. Jute geotextiles are elasto-pastic material (Mohy, 2003) and mostly dominated by the elastic component. Hence, it may be envisaged that JGTs may not be as sensitive to strain rate as synthetic geotextiles. With this background in mind, two types of JGT samples (untreated 627gsm and untreated 724gsm) have beed adopted to identify their sensitivity to different strain rate.

II. METHODOLOGY

Two basic types of Jute geotextiles (JGT) are now commonly used named by their mass per unit area 724gsm and 627gsm respectively in both treated and untreated condition. The sample and apparatus for wide width tensile strength of Jute Geotextile have been prepared accordance with ASTM D4595. 200mm wide three samples of each type JGT have been stressed at three different strain rate (10±3)%, (50±5)%, (100±10)%, to evaluate the stress strain characteristics of jute geotextiles. The samples were tested on both the machine direction (MD) and cross machine direction (XMD).

III. TEST RESULT

Data obtained from the tests are being plotted in the graph. Fig 1, 2 and 3 shows the stress strain characteristics of untreated 627gsm JGT stressed at strain rate (10±3)%, (50±5)%, (100±10)% respectively. According to ASTM D4595 stress unit is presented in KN/m.

The obtained data from the tests are being plotted in the graph. Fig 4, 5 and 6 shows the stress strain characteristics of untreated 724gsm JGT stressed at strain rate (10±3)%, (50±5)%, (100±10)% respectively. For both type of sample (624gsm and 724gsm) the average wide width tensile strength and the average strain at breaking point of the samples in machine direction as well as cross machine direction is summarized in the Table 1.

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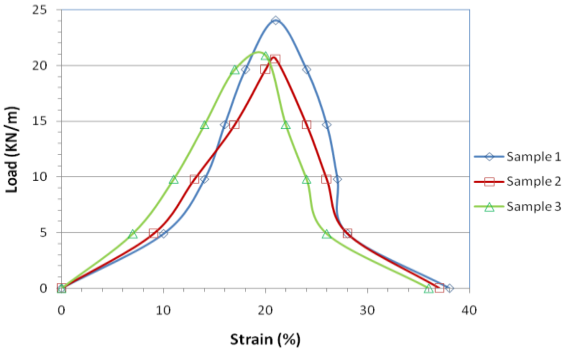
The variation of tensile strength of the test samples 627gsm and 724gsm due to different strain rates are plotted in the figure 7 and 8 respectively. The variation of strain at breaking point of the test samples 627gsm and 724gsm due to different strain rates are plotted in the Figure 9 and 10 respectively. Figure 11 represents the tested JGT specimen.



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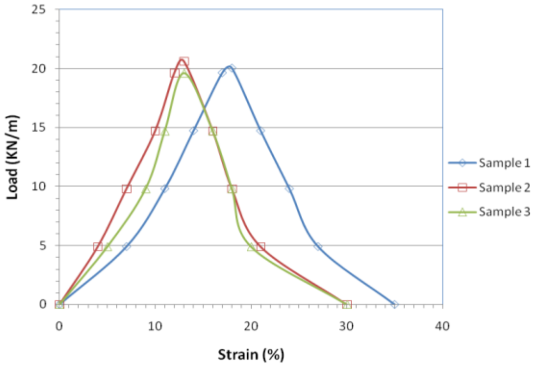

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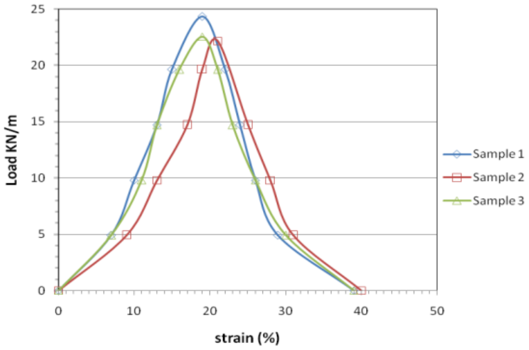
Fig 1: Load-strain curve of JGT (untreated, 627gsm) at strain rate (10±3)%. a) MD b) XMD



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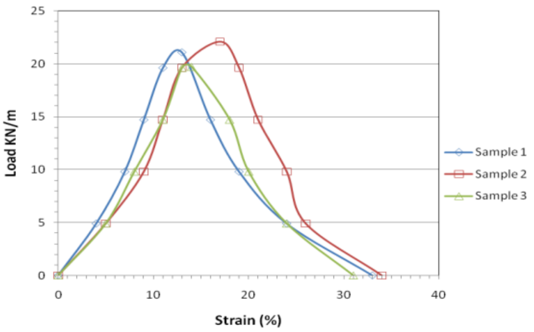

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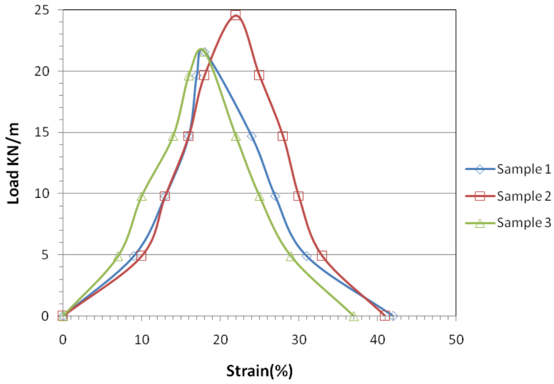
Fig 2: Load-strain curve of JGT (untreated, 627gsm) at strain rate (50±5)%. a) MD b) XMD



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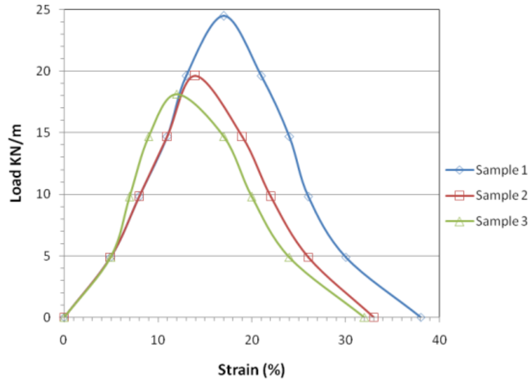

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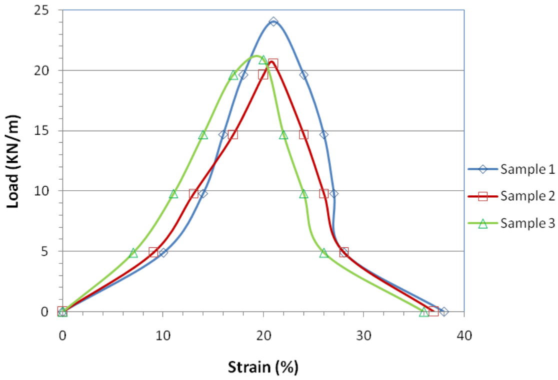
Fig 3: Load-strain curve of JGT (untreated, 627gsm) at strain rate (100±10)%. a)MD b) XMD



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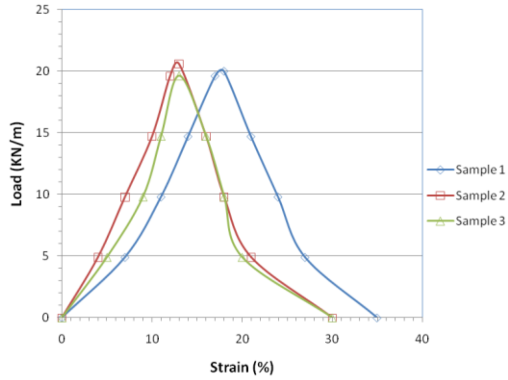

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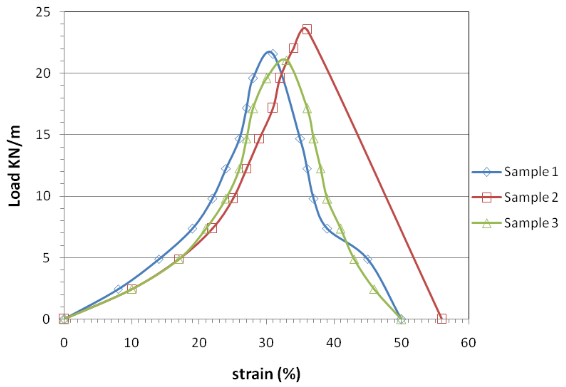
Fig 4: Load-strain curve of JGT (untreated, 724gsm) at strain rate (10±3)%. a) MD b) XMD



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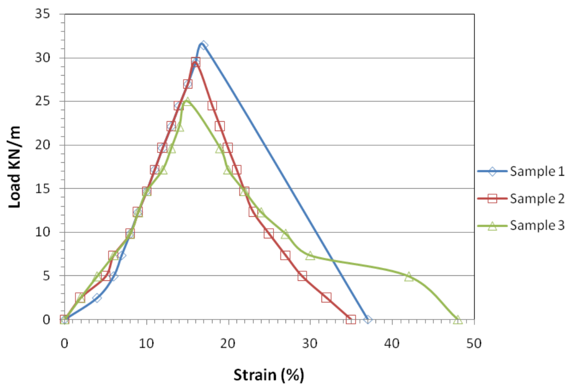

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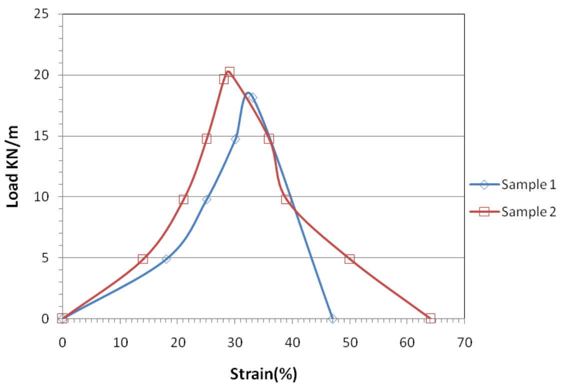
Fig 5: Load-strain curve of JGT (untreated, 724gsm) at strain rate (50±5)%. a) MD b) XMD



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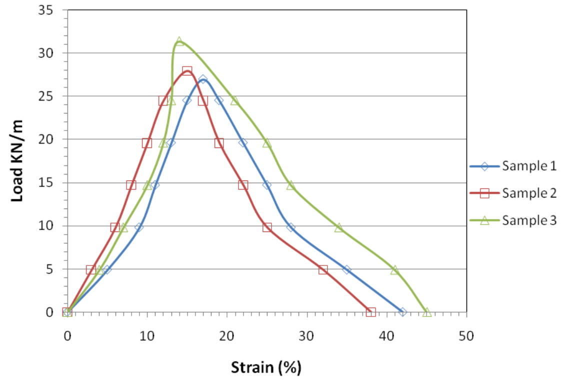

(b)

Fig 6: Load-strain curve of JGT (untreated, 724gsm) at strain rate (100±10)%. a)MD b) XMD

Table 1: Tensile strength test results

JGT Sample	Strain rate	Avg. wide width tensile strength (KN/m)		Avg. strain maximum load (%)	
		MD	XMD	MD	XMD
627 gsm	(10±3)%	21.84	20.01	20.7	14.7
	(50±5)%	23.02	20.1	19.7	14.7
	(100±10)%	22.56	20.76	19.3	14.3
724 gsm	(10±3)%	21	26	33.3	14.7
	(50±5)%	22.07	28.6	33.3	16
	(100±10)%	19.2	28.8	31	15.3

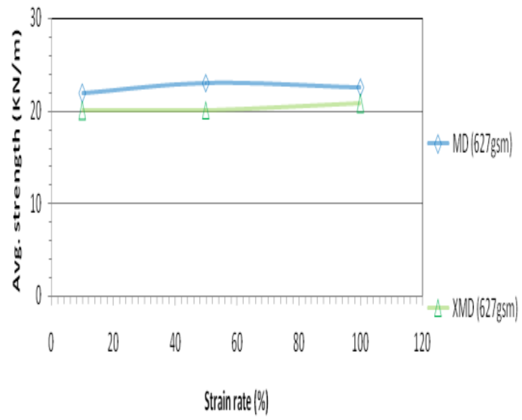

Fig 7: Strength of JGT (627gsm) at different strain rate.

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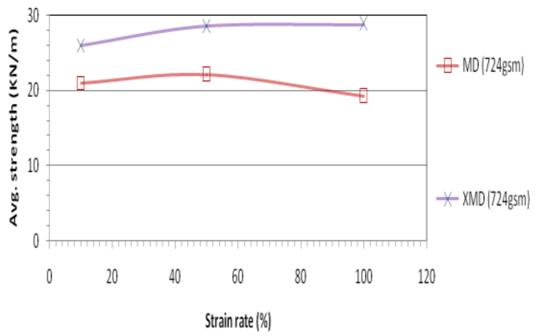

Fig 8: Strength of JGT (724gsm) at different strain rate.

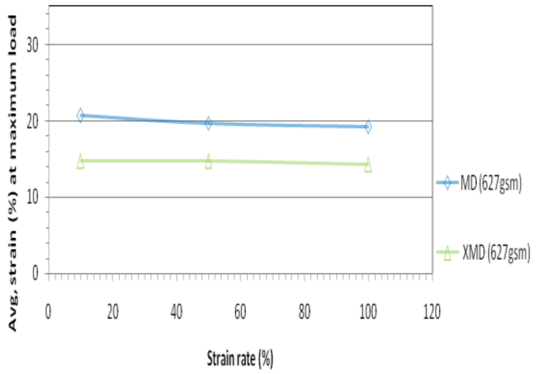

Fig 9: Strain of JGT (627gsm) at different strain rate.

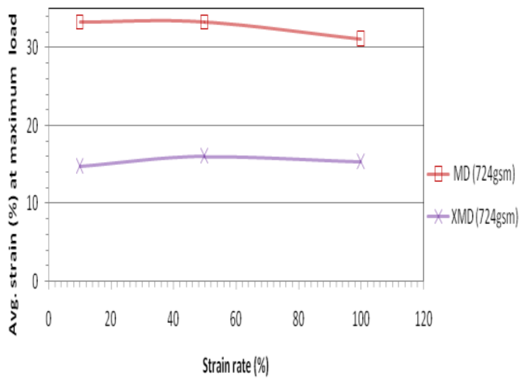

Fig 10: Strain of JGT (724gsm) at different strain rate.

(a)

(b)

Fig 11: Tested sample of JGT (a) strain rate (50±5)% (b) strain rate (100±10)%.

IV. CONCLUSION

The test result shows that naturally fibered geotextile JGT has sufficient tensile strength to use it as reinforcing and stabilizing element for soil. The effect of strain rate is insignificant on strength of both type JGT 627gsm and 724gsm in machine direction as well as in cross machine direction. This means that instead of using low strain rate 10±2% as specified in ASTM 4595 for synthetic geotextiles, higher strain rate may be adopted for determining wide width tensile strength of jute geotextiles. This may be considered as an important issue to be considered while formulating standards for testing jute geotextiles.

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