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ANALYSIS OF PHYSIO-MECHANICAL PROPERTIES OF JUTE-PALF UNION FABRICS

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ABSTRACT

This experiment was done on jute-PALF union fabric produced from twill weave structures. The aim of this attempt is to find out how physico-mechanical properties like tensile strength, abrasion resistance, drape co-efficient, bending length and flexural rigidity of the produced fabric is influenced by the fabric design in order to increase the uses of natural fibers instead of manmade fibers. Two fabric samples; 3/1 twill and 2/2 twill were produced by local hand loom from same ends/inch and picks/inch in value. Jute yarn of 241 Tex (7 lb/spy) was used in warp direction and PALF yarn of 345 Tex (5 lb/spy-2ply) was used in weft direction. From the experiment, the comparative results of both samples on tensile strength, abrasion resistance, drape co-efficient, bending length and flexural rigidity are investigated to exhibit the effect of twill structures to perform the task for diversified use and domestic and industrial purposes.

KEYWORDS: Jute Yarn, Lb/Spy, PALF Yarn, Physio-Mechanical Properties, Tex, Twill Structure

INTRODUCTION

Materials science and engineering is concerned with the generation and application of knowledge relating the composition, structure and processing of materials to their properties and uses (Van Vlack, 1980). It deals with the synthesis and use of both fundamental empirical knowledge in order to develop, modify and prepare materials to meet desired needs. It is convenient to group into three main types of materials; metals, polymers and ceramics. Polymers play an important role to materials scientists. There are two types of polymers; natural and synthetic. Jute, wood, kenaf, cane etc are natural organic polymers. Early in the history of the use of organic materials, attempts have been made to improve their engineering properties. Materials must be processed to meet the specifications that the engineer requires for the product being designed. In Bangladesh jute is the most versatile natural fiber gifted to man by nature. Today jute can therefore be defined as an eco-friendly natural fiber with versatile application prospects ranging from low value geo-textiles to high value products such as utility/fancy bags, carpets, home furnishings, composites, papers, particle boards, car components, fashion accessories and gift articles.

There are mainly two kinds of jute in use; these are White Jute (*Corchoruscapsularies*) and Tossa Jute (*Corchorusolitorius*). The former variety is more than four hundred years old and has been used for spinning and manufacturing ropes, twines and cloth. The golden colored tossa was developed by the British as an individual fiber for the manufacture of cheap reusable packaging material. Jute cloth is known as 'hessian cloth' and jute bags are called 'gunny bags' (derived from Hindi word meaning cheap). In North American 'hessian cloth' is commonly known as 'burlap' (IJSG, 2010). Jute plays a significant role in the socio-economic development in some Asian countries. In Bangladesh, jute and its subsequent conversion to many value added products, play an important role in the country's economy and provide considerable employment opportunities to the country's work force. The traditional uses of jute have declined. Therefore, it is important to develop new products from jute to regain the economic importance of jute (Jahan et al, 2011). Therefore scientists and engineers adapt jute fiber energy into useful products. In doing so, they endeavor to select fibers with optimum properties.

Bangladesh is the largest producer of jute fiber in the world. But now a day it is facing tough competition with synthetic fibers. For the survival of jute, it is necessary to diversify the uses of jute and developed new products by blending jute with cotton, viscose, acrylic, PALF and banana fibers. It is now common practice to blend two or more fibers together in order to produce yarns or fabrics with required properties and end uses. Blending of jute with other fibers may be considered as an alternative and possible diversified uses of jute yarns and fabrics. Jute fiber can be blended with PALF and blended fabrics could be used as shirting, suiting, curtains, bed cover, sofa cover, fine quality shopping bag, furnishing fabrics and for other upholstery purposes. Because of its great abundance and shortage of cotton, jute is blended with PALF and jute-PALF blended yarns are manufactured mainly to take advantages of the lower price of PALF fiber. Because this fiber can be obtained for industrial purposes without any additional cost. Pineapple leave fiber is an agro-waste which is rich in cellulose, relatively inexpensive and has a potential for polymer reinforcement (Mishra et al, 2001). Most of the pineapple fibers are used to make traditional dresses. But recently the pina fabric has been re-introduced by the top fashion houses that are always in search for something new and innovative. Now consumers have to come forward to support this natural fabric. A polymer is a versatile material. In the present era of science is the most promising and comprehensive field. Development of polymer is a continuous process for achieving polymer in a specific application under certain environmental condition (Kamal et al.1996). The bombardment of the invention of different polymer field is increased day by day. The natural polymer is biodegradable, abundantly available, and easily decomposable in the environment and eco-friendly. The polymer materials that are biodegradable are now enjoying considerable popularity, especially from the standpoint of environmental protection (Piekiena and Muchaa, 1999). Bangladesh earns about 70% of its foreign currency by exporting ready-made garments. But the lion's share of earned foreign currency is spent for importing 95% of required fabrics for garments. Only 5% of required fabrics are produced locally for ready-made garments. To overcome this high competition, it is necessary to produce different types of new fabrics, which may substitute of foreign fabrics. Through this new type of fabrics it may possible to take places of all furnishing fabrics which can be used for diversification of pineapple such as furnishing fabric, decorative fabrics, finer fabrics etc. As a result this type of pineapple fabrics may be used in the production of furnishing fabric that may further enhance its uses in various fields of textiles.

MATERIALS AND METHODS

Materials

Two samples of twill fabric 2/2 and 3/1 were woven from the hand loom by local weavers of Tangail. The 2/2 twill sample is 24 yards and 3/1 twill sample is 25 yards in length. The loom conditions for producing samples are given in Table 1.

Fabric Preparation

Two samples of fabric were woven from the hand loom by local weavers of Tangail. The 2/2 twill sample fabric is noted by "A" and 3/1 twill sample fabric is noted by "B". Samples "A" and "B" were woven without sizing using jute yarn as warp and PALF ply yarn as weft. Both samples were tested at controlled temperature and relative humidity.

Measurement of Tensile Strength

The most commonly used mode is the CRE mode and is often required by the test standards. The main factors that need to be considered are the size and accuracy of the load cell (0.5–25 kN), the distance of cross-head travel (0.1–2 m) and the rate of cross-head travel (0.1–500 mm/min) (Jinlian, 2008). BS 2576 method is used for determination of breaking strength and elongation (strip method) of woven fabrics.

Five fabric samples are extended in a direction parallel to the warp and five parallel to the weft, no two samples to contain the same longitudinal threads (Saville, 1999).

Measurement of Abrasion Resistance

Martindale Abrasion Resistance (ASTM D4966) is used to measure the abrasion resistance and weight loss % is recorded on 3000 revolution (MacMillan, 1957).

Measurement of Drape Co-efficient

Drape is a critical textile characteristic in determining how clothing conforms to the shape of the human silhouette (Kenkare and May-Plumlee, 2005). The drape was measured as the drape co-efficient F which is the ratio of the projected area of the draped specimen to its undraped area, after deduction of the area of the supporting disk. Drape of the produced fabric is measured by using the CUSICK Drape meter (IS 8357/1977).

$F = \frac{A_s - A_d}{A_D - A_d}$ Where, A_D= the area of the specimen, Ad= the area of the supporting disk and A_s= the actual projected area of the specimen. In the actual test, the light beam casts a shadow of the draped fabric onto a ring of highly uniform translucent paper supported on a glass screen. The surface drape pattern area on the paper ring is directly proportional to the mass of that area. So the drape coefficient can be calculated by the following formula:

$$F= \frac{\text{Mass of shaded area}}{\text{Total mass of paper ring}} \times 100\%$$

Bending Length

The bending length of the fabric is measured by cantilever test according to ASTM D1388-2007.

Measurement of Flexural Rigidity

The flexural rigidity (stiffness) of a fiber is defined as the couple required bending the fiber to unit curvature. Curvature is the reciprocal of radius of curvature. By this definition, the direct effect of the length of the specimen is eliminated. The flexural rigidity may be calculated in terms of other fiber properties (Hearle and Morton, 2008 and Kaswell, 1953).

$G = WC^3 \times 10^3$ mg/cm ; Where, C = Bending length, W = Cloth weight (gm) per square cm.

Results and Discussion

All the tests are performed in the standard testing atmosphere i.e. 65±2 % R.H and 20±2º C (Booth, J.E, 1968)

Table 1: Loom Features for Producing Jute-PALF Union Fabric

Fabric Sample	A	B
Nature of Weave	Twill 2/2	Twill 3/1
Warp Yarn	Jute	Jute
Weft Yarn	PALF	PALF
Count of Warp Yarn	241tex (7 lb/spy)	241 tex (7 lb/spy)
Count of Weft Yarn	345 tex (5lb/spy, 2 ply)	345 tex (5 lb/spy, 2 ply)
Reed Count	20	20
No. of Heald Eye	680	680
No. of Heald Frame	4	4
Name of the Loom	Hand Loom	Hand Loom

Table 2: Physical Properties of Jute and PALF Single Yarn

Yarn type	Nominal count tex (lb/spy)	Actual count tex (lb/spy)	Twist tpm	Tensile Strength Kg (lbs)				Quality ratio %
				Mean	SD	CV%	Extension at break %	
Jute	241(7)	242 (7.02)	354	3.06 (6.75)	0.275	8.65	1.31	96.12
PALF	173 (5)	175 (5.08)	314	2.05 (4.51)	0.391	10.03	2.75	88.25

Table 3: Comparative Test Results of Fabric "A" and Fabric "B"

			Tensile Strength (kg)												
Name of Fabrics	Construction of Fabrics		Mean		SD		CV%		Abrasion Resistance		Drape Co-efficient (%)	Bending Length (cm)		Flexural Rigidity (mg/cm)	
	Ends/ inch	Picks/ inch	Warp	Weft	Warp	Weft	Warp	Weft	Revs	Wt. loss (%)		Warp	Weft	Warp	Weft
A	30	25	83.91	154.99	2.22	3.63	2.65	2.34	3000	2.22	52.45	3.38	7.52	3457.16	41600.86
B	30	25	78.56	147.46	0.40	0.46	0.50	0.31	3000	2.16	68.68	2.43	5.46	1087.05	14337.34

The average tensile strength of sample A is higher than the sample B both in warp and weft direction. This is because sample A has a balanced or tight structure than the sample B; hence the yarn mobility of sample A is least. It is evident from table 3 that there is a little difference between the abrasion resistance of sample A and B. The weight loss percentage (on 3000 rev) of sample A is 2.22 which is 1.85% higher than the sample B. The sample B draped very elegantly over a circular support. Table 3 also shows that the drape co-efficient of sample B is 68.68% which is 30.94% higher than that of sample A. Tight constructions have little mobility and does not drape as well as looser constructions. Hence drape of sample B is well than the sample A. Bending length of sample A is higher than the sample B both in warp and weft direction. From the test result, sample B which exhibits lower flexural rigidity when compared to sample A. Extensibility is affected by the crimp present in the fabric structure. The higher the number of interlacing per area the greater the crimp. In general, the longer the floats in construction the fabric will be less extensible. In table 2 extension% of the PALF yarn is more than the jute yarn but quality ratio% of PALF yarn is less than that of jute yarn.

Cost Factor

As mention earlier, jute-PALF union fabric can easily be prepared in conventional (hand loom) loom. So, manufacturing of jute-PALF union fabric does not require any new or extra machine. Thus capital investment for making the fabric is much less. The raw material cost is also very low. Considering the price of jute-PALF union colored fabric in the range of TK.300 to 500 per meter and that of 100% cotton fabric in the range of TK.500 to 800 per meter. It may be stated that manufacturing of jute-PALF union fabric in existing conventional loom would be highly cost effective as this value added high performing fabric may be marketed at a much higher price.

Applications

This new type of union fabric opened up some new areas of use for jute and PALF fiber for which jute and PALF have never been thought off. Disposable decorative and fancy carry bags with different color effects for i) school bag ii) shopping bag iii) ladies purse iv) traveling luggage bag v) curtains vi) placement sheet vii) table cloth viii) cushions fabric etc. can be made from this fabric. Presently, these items are made from 100% synthetic material.

The findings will help jute industry and may be able to produce better quality of union fabric by adopting the method suggested. The output of this experiment would be the rebirth of jute industry of Bangladesh and jute sector will get back its past glory.

CONCLUSIONS

- The findings will have a direct impact on the jute industry and may be able to produce better quality fabrics by adopting the method suggested.
- Consequently the use of jute fabric and PALF fabric will be increased, which is to bio-degradable and therefore environment friendly.
- Valuable foreign currency can be saved by encouraging the use of jute-PALF fabric in place of synthetic fabric.
- Interlacement of jute yarn with PALF yarn to weave fabric did not cause any notable change in color strength of the produce fabric. So, natural color of the yarn mix could almost be retained.
- Price of the 100% cotton fabric is higher than that of jute-PALF union fabric. That’s why union fabric may be replacement of 100% cotton and jute fabric.
- Pineapple Leaf Fiber can be obtained for industrial purposes without any additional cost. So, capital investment is low.
- Pineapple leave fiber is an agro-waste which is rich in cellulose, relatively inexpensive. So, use this fiber we could reach the zero waste management.

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