UTILITY AND FUNCTIONAL CHARACTERISTICS OF BAMBOO/POLYESTER BLENDED WOVEN FABRICS FOR GARMENTS

KEDAR NATH DAS & INDRAMANI KANDI

Professor & Head, Department of Textile Engineering, College of Engineering and Technology, Odisha, India,
Assistant Professor, Department of Textile Engineering, College of Engineering and Technology, Odisha, India,

ABSTRACT

In this work, the utility & functional characteristics of garment made from woven fabrics of bamboo/ polyester yarns have been studied in relation to pick density, weave and % of component fibers in the blends. The objective of utility & functional characteristics was to determine the influence of fabric factors such as Pick density, weave and the constituent fibers characteristics on the fabric properties such as GSM, Tensile Strength, Tearing Strength, Abrasion Resistance & Pilling Propensity. The experimental results show that 2/30s bamboo in warp way of twill woven fabric exhibit Tensile Strength, Tearing Strength, Abrasion Resistance & Pilling Propensity when compared to other Samples.

KEY WORDS: Utility, Functional, Physical, Picks Per Inch, Weave Type, % Component Fibres, Tensile Strength, Tearing Strength, Abrasion Resistance, Pilling Propensity.

I. INTRODUCTION

Now a days, consumer education level is increasing, becoming more & more health conscious and they have become more careful towards their living conditions than they were previously. Bamboo fibre is a new material developed at the beginning of the 21st century. It has many characteristics that meet the current requirement of end uses. But today we still don’t know the actual performance behaviour of bamboo fibres in many application. Availability of bamboo fibres is sufficient due to the plant’s high growth rate. It is an eco friendly, biodegradable, natural antibacterial, anti-fungal product, having good soil release and ultra violet protection ability. Bamboo fibres having high modulus, softness, brightness as well as uv-protective characteristics with its high moisture absorption capacity, breathability & fast drying behaviour due to its unique microstructure. Bamboo is a naturally occurring composite material which grows abundantly in the
topical countries. It is considered a composite material because it consists of cellulose fibres imbedded in a lignin matrix which are aligned along the length of the bamboo providing maximum tensile strength, flexural rigidity in that direction. From application point of view, bamboo is also one of the oldest building materials used as, flooring, ceiling, walls, windows, doors, housing roofs, trusses, rafters & purlins. In Asian countries bamboo has been used for household utilities as containers, chop sticks, woven-mats, fishing-poles, cricket-boxes, handcrafts, chairs etc. It can also be used in construction purpose for bridges, water transportation facilities & skyscraper scaffolding. There are about 35 species now used as raw material for the pulp & paper industry. Bamboo fibres are commonly used as, bamboo intimate apparels, sweaters, bath suits, mats, blankets, towels, underwears, tight-t shirts, socks & bamboo non-woven products, sanitary material (bandage, mask, surgical cloth, nurse’s wear, mattress) & food packing bags. Bamboo fibre’s mechanical process (spinning) is same as viscose fibres. Other properties of bamboo fibres is superior to viscose. Bamboo fibre is very low strength fibre, which makes the spinning processes difficult due to fly generation in roving. Also the production cost of bamboo yarn is around 2.5 times that of the cotton yarn. Bamboo fibres low tensile strength decreases further when wet. In order to avail the positive attribute of the fibres at economical rate, the fibres have been blended with polyester. Modern day, living condition require clothing that are hygienic, comfortable, hardwearing & having easy care properties. No, single textile fibres have all these desirable attributes. Synthetic fibres like polyester have better wear & easy care properties but they lack many of the comfort & hygiene related properties. But regenerated fibres like bamboo have good moisture related properties leading to good comfort as well as good hygiene related properties but they lack wear & easy care properties. So, blended yarns composed of polyester/bamboo and fabrics produced from them can provide optimum desirable properties. So, an attempt has been made in this current research to study the different aspects of the B/P blended yarns and fabrics produced from these. Accordingly the objectives of this study are,

1-To prepare polyester/bamboo blended yarns of different blends & study their properties.
2-To study the properties of polyester & bamboo blended woven fabrics prepared from these yarns.

II. MATERIALS AND METHODS

2.1. Some Precaution in Bamboo Yarn Production Process

It is similar to traditional viscose yarn production process. But some minor adjustments should be required for bamboo yarn production process.

Bamboo fiber producing flyings in Draw frame & Speed frame, so we should adopt a high humidity (65%-70%) and a low temperature (25°C) in Industry.

High coefficient of twist should be adopted due to weak cohesion between bamboo fiber. Card web tension and roving tension should be kept low for this weak cohesion of fibres.

2.2. Some Precaution in Bamboo Fabric Weaving

Twist coefficient in the range from 350 to 410 turns per meter should be required for requirement of higher tensile strength of pure bamboo yarn for weaving in high speed modern looms. Relatively low and even tension should be maintained during warping and sizing process of bamboo yarn, because of moisture regain rate and elongation is relatively high in case of bamboo yarn. It is better to choose starch as main component of sizing agent due to hydrophilic nature of bamboo fibres. Sometimes it is better by choosing some acrylic acid as part of sizing agent rather than PVA to improve yarn softness and makes it easy to dividing the yarns and also to decreasing yarn hairiness. The moisture regain rate should be kept 8-9%, because bamboo fibers are breakable when moisture regain is too low & also bamboo fibers tensile strength decreases dramatically when
moisture regain rate is too high. Weaving should be maintained in lower tensions and carried out at relative humidity of 65-75%.

2.3. Experimental Plan
The present study was performed in following steps.

2.3.1. Yarn Preparation
Yarns of five different blends along with a 100% bamboo yarn were produced on ring spinning system after proper mixing and blending. The various yarn samples prepared were of blends, 30/70, 40/60, 50/50, 60/40 and 70/30 bamboo/polyester. The yarns produced were then wound to form cones. All the six yarns were then tested for strength and elongation, uneven-ness and hairiness.

2.3.2. Fabric Preparation
The yarns were woven in an automatic dobby sample loom with 100% bamboo yarn as warp. Two types of fabric (plain & 2/2 twill) were produced from each of the six weft yarns with different pick density as 64 ppi, 62ppi & 60ppi. All the fabric samples were then washed with 2 gpl soda solution & 2gpl soda ash at boil for 30 mins. Subsequently they were hot washed twice and finally cold washed. The pH was maintained at 7. The sample were then dried & ironed for testing purpose.

2.3.3. Preparation of Samples
The yarns used in the study were made from blends of regenerated bamboo and polyester fibres. 18 kgs of bamboo fibre and 18 kgs of polyester fibres was available as raw material, taken for spinning. A predetermined quantity of the fibres according to the blend percentage was hand opened and sandwiched well to produce a homogenous blend. The fibre mix was then processed in Blowroom line followed by MMC card and then two passages of Lakshmi Rieter Drawframe (DO/2S). The drawn slivers were converted into rove of 0.40/gm and then to yarns on a Lakshmi Rieter Ringframe (G-5/1). The spindle speed being constant at 14500 rpm. Then the yarn was fed to the laxmi automatic sample loom having reed width of 20 inch.

2.4. Process Parameters for Fabric Preparation
Make:- Laxmi automatic power loom
Type:- Dobby, Width:-20 inches, Reed no.:-64, Reed space:-20 inch, Ends per inch:-72

Picks per inch:- 64, 62, 60  Weft yarn:-6 types of blends of bamboo & polyester as 30/70, 40/60, 50/50, 60/40, 70/30, 100/0: Warp yarn:- 2/30'(15') count of 100% bamboo yarn

Types of Fabric Prepared:- Plain & 2/2twill

Blend % of Bamboo & Polyester in the Woven Garments as bp1(67/33), bp2(72/28), bp3(76/24), bp4(81/19), bp5(86/14), bp6(100/0)

III. TESTING

3.1. Tensile Strength
The tensile strength of the fabric sample was tested on Digital Tensile Strength Tester according to A.S.T.M. Standard D5035-95.
3.2. Tearing Strengths

Tearing strength of fabric samples was determined on a Elemendorf Tearing Tester in accordance with ASTM test method D 1424. Fabric strip of dimension 100 ± 2 mm long and 63 ± 0.15 mm wide were taken.

The critical dimension i.e. the distance to be torn was taken to be 43 ± 0.15 mm. The sample curing was done with a template. The tearing strength was calculated by using formula: -

\[
\text{Tearing strength (gm)} = 64 \times \text{scale reading}. \]

10 observations were taken in each sample.

3.3. Measurement of Abrasion resistance

Abrasion resistance was measured on C.S.I. Abrasion Tester. The size of sample was 8 inch×1 inch for both warp & weft direction. The samples were rubbed until broken. The number of cycles required to break the specimen due to flex abrasion were noted. The speed of the machine was 108 cycles/min. Numbers of samples tested were 10 warp wise & 10 weft wise according to A.S.T.M. standard D3885-99.

Tension load to the flex weight carriage: 4 lb

Spigot loads: 1 lb

3.4. Measurement of Pilling

Pilling propensity of the sample was tested on I.C.I. Pillbox Tester (Make: Innolab) according to A.S.T.M. standard D3512.99. Sample size was 5 × 5 inches and sewn by ½ inch from both sides, mounted on polyurethane tubules & were tumbled by rotating the box at 60 rpm. The number of pills generated were counted in each sample and expressed as number of pill per sq. inch of the fabric. The no of pills formed after 18,000 revolutions (5 hour time) was counted for all the samples & rated according to ATIRA standard as given in table for each sample. 10 observations were taken for each sample.

<table>
<thead>
<tr>
<th>Pill rating</th>
<th>No. of pill per square inch</th>
<th>Remarks</th>
</tr>
</thead>
</table>
IV. RESULT AND DISCUSSION

The above tables 4.1. show that the fabric tensile strength decreases with increasing bamboo content in the blend s in both in warp & weft directions. The strength of the bamboo fibres is lower than that of polyester. Accordingly, the tenacity of the yarn samples decreases with the bamboo content increases in the blends. Therefore, the tensile strength of the fabric decreases with increasing bamboo content in the blend\(^{(1)}\). The fabric tensile strength in the warp direction is more than the tensile strength in the weft direction. This may be due to doubling of bamboo yarn in warp direction\(^{(2)}\). Twill weave fabrics shows more tensile strength than plain woven fabrics due to higher no. of intersection/repeat in case of twill weave than plain weave which gives higher tensile strength with a consequent lowering of extension\% and vice versa\(^{(7)}\). More floats, thicker, heavier, More diagonal effect, lateral stress imposed in fabric is more in case of twill weave structure than plain weave structure which increases the strength of the former. For this causes the twill weave fabric to exhibit higher tensile strength than plain weave fabric\(^{(8)}\). The tensile strength increases with increase of pick density due to more cover factor of fabrics in both directions.

It is evident from the table 4.2. that warp & weft way tearing strength increases with increase in polyester percentage in fabrics due to higher strength of constituent yarns\(^{(3)}\). Doubling in warp direction increases the yarn strength & produces compact yarn structure and therefore, the freedom of warp thread to slide over the weft increases. The flexibility & mobility of yarn in warp direction is also more than in weft direction. This may be the reason for higher tearing strength in warp direction than in weft direction. Due to tighter structure, chances of yarn slippage is less in weft direction showing lesser tearing strength in weft direction. Twill fabrics shows higher tearing strength than
plain fabrics. The greater extent of length of warp & weft floats make structure of twill fabrics looser than the plain fabrics which may be the reason for lower tearing strength of twill fabrics\(^3\). Tearing strength decreases with increase of pick density of fabrics due to tighter structure of fabrics increase to increasing the pick density, as a result the chance of yarn slippage is less in any direction showing less tearing strength.

### Table 4.3. Tearing strength of bamboo/polyester blended woven fabrics

<table>
<thead>
<tr>
<th>Blend</th>
<th>60ppi</th>
<th>62ppi</th>
<th>64ppi</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>plain</td>
<td>twill</td>
<td>plain</td>
</tr>
<tr>
<td></td>
<td>warp</td>
<td>weft</td>
<td>warp</td>
</tr>
<tr>
<td>Bp1</td>
<td>5835</td>
<td>7410</td>
<td>5845</td>
</tr>
<tr>
<td>Bp2</td>
<td>5055</td>
<td>7300</td>
<td>5065</td>
</tr>
<tr>
<td>Bp3</td>
<td>4650</td>
<td>7330</td>
<td>4670</td>
</tr>
<tr>
<td>Bp4</td>
<td>4042</td>
<td>7222</td>
<td>4062</td>
</tr>
<tr>
<td>Bp5</td>
<td>2456</td>
<td>6815</td>
<td>2476</td>
</tr>
<tr>
<td>Bp6</td>
<td>4108</td>
<td>7245</td>
<td>4128</td>
</tr>
</tbody>
</table>

Tables 4.3. evident that the abrasion resistance increases with increase in polyester content. i.e. polyester rich blends have higher tenacity resulting in higher tensile strength of the fabrics\(^1,5\). Polyester fabric shows higher abrasion resistance than bamboo due to inherently higher strength and elongation at break of polyester fibre\(^9\). The abrasion resistance of twill fabrics is more than plain woven fabrics due to loose structure, thicker fabric, longer floats & diagonal structure of twill weave which impose lateral stresses at the time of abrasion\(^2\). The abrasion resistance increases with increasing pick density of woven fabrics from 60 ppi to 64ppi due to increasing of thicker fabric structure with increasing pick density which impose lateral stresses at the time of abrasion\(^2\).

### Table 4.4. Tearing strength of bamboo/polyester blended woven fabrics

<table>
<thead>
<tr>
<th>Blend</th>
<th>60ppi</th>
<th>62ppi</th>
<th>64ppi</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>plain</td>
<td>twill</td>
<td>plain</td>
</tr>
<tr>
<td>Bp1</td>
<td>34</td>
<td>32</td>
<td>30</td>
</tr>
<tr>
<td>Bp2</td>
<td>29</td>
<td>27</td>
<td>25</td>
</tr>
<tr>
<td>Bp3</td>
<td>25</td>
<td>23</td>
<td>21</td>
</tr>
<tr>
<td>Bp4</td>
<td>22</td>
<td>20</td>
<td>18</td>
</tr>
<tr>
<td>Bp5</td>
<td>19</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bp6</td>
<td>14</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Tables of 4.4. show that The pilling tendency decreases with the decrease in polyester content in the blended woven fabric. Due to Higher tenacity of polyester fibres prevents pill wear off during the pilling test & Also the longer length of polyester fibres as compared to the bamboo fibres increases the pill formation tendency\(^1\). Pilling tendency is more in case of twill fabrics than plain fabrics due to open structure, more floats & less interlacing points in the twill structure than plain woven structures\(^6\). The pilling tendency decreases with the increasing of pick density from 60 ppi to 64 ppi due to increasing tightness factor with increase of cover factors in the woven fabric.
CONCLUSION

The fabric tensile strength decreases with increasing bamboo content in the blend both in warp & weft direction of the fabric. The fabric tensile strength in the warp direction is more than that in the weft direction. Twill fabric shows more tensile strength than plain woven fabric. Tensile strength increases with increasing the pick density in the fabric.

Tearing strength increases with increase in polyester percentage in the fabric. Tearing strength in the fabric warp direction is higher than that in the weft direction. Twill fabric shows higher tearing strength than plain woven fabric. Tearing strength decreases with increasing the pick density in the fabric.

Abrasion resistance increases with increase in polyester content in the fabric. The abrasion resistance of twill fabric is more than plain fabric. Abrasion resistance is more in the weft direction than in the warp direction in the fabric. Abrasion resistance increases with increasing the pick density in the fabric.

Pilling tendency decreases with decrease in polyester content in the fabric. Pilling tendency is more in case of twill fabric than the plain woven fabric. Pilling tendency decreases with increasing the pick density from 60ppi to 64ppi in the fabric.

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