Fibre Shredding in Needle-Punched Jute Non-Wovens

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A new method for measuring fibre shredding in needle-punched jute non-wovens, where shredding is high, is reported. The method is simple, fast and reasonably accurate. By using this method, the effects of fibre treatments, web weights and needling parameters on the shredding of fibres were also studied.

Keywords: Fibre shredding, Jute, Needle-punched fabrics, Non-wovens

For use as floor covering and in filtration applications it is important to know the amount of fibres loosely held by the fabric, as these are likely to come out easily from the fabric during use. As a majority of these fibres comprise fibres broken or shredded from the batt during needling, it is necessary to know the effect of material and process variables on shredding of fibres so that fibre shredding can be kept to a minimum. Also important is finding a suitable method for estimating fibre shredding. The method most frequently quoted is the one suggested by Hearle and Purdy, in which the change in length distribution of fibres after needling is taken as a criterion for fibre shredding. While the method may be highly suitable for fibres with a reasonably uniform length distribution it cannot be applied on jute non-wovens. Not only do the jute fibres, after opening, exhibit extreme variations in length but their low extensibility causes fragmentation of many fibres into extremely small lengths. As no reliable estimation of fibre shredding was possible using the pattern of fibre length distribution, the method had to be abandoned; instead, a new, extremely simple method involving vigorous mechanical shaking of fabric samples and collection of the resulting debris was used.

Materials and Methods
The specifications and the methods of production of the fabric samples used in this study were reported earlier.2

Measurement of fibre shredding — The test was performed with a laboratory flask shaker (Toshniwal). Needle-punched non-woven fabric specimens (15 × 7 cm) were suspended from the clamps of the shaker. A shaking rate of 260/min was used for a duration of 2 min, this duration being experimentally arrived at after several samples were tested. No further liberation of debris took place after 2 min. The shredded fibres thrown out from each sample were collected in a tray and weighed in an electronic balance. The shredding results are expressed as milligrams of fibres shredded per square metre of fabric.

Results and Discussion
Factors responsible for influencing the shredding of fibres in needle-punched jute non-wovens are discussed below.

Treatment with batching oil emulsion — An alteration in fibre friction through treatment with an oil emulsion reduces the shredding of fibres appreciably (Table I). The treatment with oil emulsion not only reduces the fibre friction but also the flexural rigidity of fibres from 4.0 × 10⁻³ to 2.4 × 10⁻³ g cm⁻². Both these factors are responsible for reducing fibre breakage during web and fabric formation.

Effect of woollenization — The process of woollenization reduces modulus and increases extensibility owing to the formation of crimps in jute fibres. The lowering of stiffness of jute fibres through

<table>
<thead>
<tr>
<th>Type of fibre in fabric</th>
<th>Fibre shredding mg m⁻²</th>
</tr>
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<tbody>
<tr>
<td>Jute fibre untreated</td>
<td>1380</td>
</tr>
<tr>
<td>Jute fibre treated with batching oil emulsion</td>
<td>952</td>
</tr>
</tbody>
</table>
woollenization reduces rupture and shredding of fibres drastically (Figs. 1-3).

**Effect of needling density** — Increase in the needling density increases fibre shredding (Fig. 1). The results are similar for both jute and woollenized jute; only in the latter is the extent of shredding substantially lower. Once the two ends of a fibre are pegged in the web, further needling would increase the number of punches per fibre, which would result in its being chopped into pieces. The damage would be more severe if the fibres are stiff.

![Fig. 1](image1.png)

**Fig. 1** — Effect of needling density on fibre shredding [Needle-punched jute fabric wt, 590 g/m² and needle-punched woollenized jute fabric wt, 560 g/m² — both including reinforcing jute hessian, 300 g/m²]

**Effect of needle penetration** — Fig. 2 shows the effect of needle penetration on fibre shredding. At low penetration the shredding is relatively high. This may be because fibres are not locked properly within the web matrix as well as with the reinforcing material. As the needle penetration is increased, shredding reduces considerably, signifying better anchorage of fibres. Increasing the needle penetration beyond an optimum value results in breakage of fibres owing to an increase in the number of barbs. Fibre shredding also, as a consequence, increases. Thus, there is an optimum level of needle penetration below or above which shredding of fibres is likely to increase. The trends are similar for both jute and woollenized jute fabrics.

**Effect of reinforcing material weight/web weight ratio** — As the weight of the reinforcing material was kept constant, an increase in the ratio signifies a decrease in web weight. Fig. 3 shows that a decrease in web weight decreases the amount of fibres shredded per unit area of the fabric. The trends are similar for jute and woollenized jute; only the magnitudes are different. This is, however, the only experiment where comparison is made between fabrics of widely varying weights. A more realistic assessment of fibre rupture and hence fibre shredding may be obtained if a comparison is made on the basis of percentage of fibres shredded per unit weight of the fabric. Such a comparison is shown in Table 2. It is interesting to note that here the trend reverses; that is, a decrease in web weight results in an increase in the percentage of fibres shredded, the corresponding percentage for woollenized jute fibres being always lower than that for the jute fibres owing to causes assigned earlier. A decrease
Table 2 – Effect of Reinforcing Material Weight/Web Weight Ratio on Shredding of Fibres

<table>
<thead>
<tr>
<th>Reinforcing material wt/web wt ratio</th>
<th>Web wt, g/m²</th>
<th>Fibre shredding, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jute Woollenized jute</td>
<td>Jute Woollenized jute</td>
<td>Jute Woollenized jute</td>
</tr>
<tr>
<td>0.62 0.62</td>
<td>482 482</td>
<td>0.30 0.11</td>
</tr>
<tr>
<td>0.87 0.74</td>
<td>346 404</td>
<td>0.38 0.12</td>
</tr>
<tr>
<td>1.17 1.06</td>
<td>256 282</td>
<td>0.45 0.13</td>
</tr>
<tr>
<td>1.82 3.30</td>
<td>165 91</td>
<td>0.67 0.24</td>
</tr>
</tbody>
</table>

in web weight for a constant needling density would effectively mean an increase in the amount of needling per unit weight of fabric and this would result in a more extensive fibre rupture and in increased shredding. However, with the decrease in web weight, the amount of fibres shredded, in absolute terms, would be less though the percentage would be higher. This is the reason why Fig. 3 shows a decrease in shredding with a decrease in web weight.

References