Reed Mark of Fabric and Its Relation with Warp Tension at Beat-up with Different Loom Settings

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Reed mark of jute fabric with plain weave, expressed as reed mark percentage (RMP), has been studied with different loom parameters. Attempts have also been made to find out the relationships between RMP and (a) tension difference between two warp shed lines at beat-up and (b) seepage of the fabric. RMP at fell varies in the same manner as that at grey state of fabric with different loom settings and the relationship between them is linear with correlation coefficient of 0.96. RMP at grey state decreases with earlier shed timing, higher back rest position and change of leasing pattern of warp yarns from one-by-one to two-by-two. Beat-up tension difference varies inversely with RMP and the relationship between them is linear with correlation coefficients of −0.91 and −0.76 for different shed timings and back rest positions respectively. Seepage of the fabric is directly related with RMP with correlation coefficient of 0.64.

Keywords: Jute fabric, Loom setting, Reed mark, Warp tension

1 Introduction
Reed mark or Reediness of fabric is one of the major faults and, therefore, needs proper care during weaving. Since jute cloth is mostly used as sacks for carrying food grains, cement, etc., pore size or the cover of the cloth plays an important role in its practical uses. Methods to overcome reed mark on cloth are fairly known and have been discussed earlier,1 but no systematic analysis of the effects of different loom settings on reed mark has been made. Snowden2 made some studies with cotton fabrics and expressed the reed mark quantitatively but he too did not consider the effects of either different leasing patterns or the tension of warp yarns during weaving on the reed mark of the cloth.

The lack of sufficient information on these problems has initiated in undertaking a study, reported here, with plain jute fabrics which are generally of opener construction and, therefore, more prone to such defect.

The reed mark of the fabric has been expressed in percentage form as reed mark percentage (RMP) and calculated as \((A - B)/B \times 100\), where \(A\) is the distance between two warp ends separated by a reed wire; and \(B\), the distance between two successive warp ends in a dent.

2 Materials and Methods
Hessian fabric woven on a non-automatic shuttle loom in IJIRA laboratory was used for the study. The particulars of fabric and loom are given in Table 1.

### Table 1—Particulars of Loom and Fabric

<table>
<thead>
<tr>
<th>Make of loom</th>
<th>Utex (India)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loom speed</td>
<td>152 ppm</td>
</tr>
<tr>
<td>Reed space</td>
<td>112.1 cm</td>
</tr>
<tr>
<td>Warp width at reed</td>
<td>107.3 cm</td>
</tr>
<tr>
<td>Shed dwell</td>
<td>130°</td>
</tr>
<tr>
<td>No. of heald shaft</td>
<td>Two with sliding wire healds</td>
</tr>
<tr>
<td>Let-off motion</td>
<td>Negative friction type</td>
</tr>
<tr>
<td>Weave</td>
<td>Plain (1/1)</td>
</tr>
<tr>
<td>Ends/dm</td>
<td>39</td>
</tr>
<tr>
<td>Picks/dm</td>
<td>35.6</td>
</tr>
<tr>
<td>Warp count</td>
<td>275.6 tex</td>
</tr>
<tr>
<td>Weft count</td>
<td>292.8 tex</td>
</tr>
<tr>
<td>Denting pattern</td>
<td>2 in a dent for body and 4 in a dent for selvedge</td>
</tr>
<tr>
<td>Leasing pattern</td>
<td>1 up-1 down and 2 up-2 down</td>
</tr>
<tr>
<td>Reed dent/cm</td>
<td>1.81</td>
</tr>
<tr>
<td>Ratio of air space to reed wire, %</td>
<td>68.5:31.5</td>
</tr>
</tbody>
</table>
sured between the axes of two successive yarns with the help of an ordinary mm steel rule and a magnifying glass of power of 5.88 dioptres. To find out RMP at fell, inter-yarn spaces were measured between the second and third picks soon after stopping the loom with crank at back centre and front heald down, and to find out RMP at grey state, measurements were taken after the samples were relaxed for at least 48 h. RMPs at fell and grey state of each sample are the average of six values calculated at six different places along the width of the fabric, leaving about 7.5 cm from each selvedge and 45 cm from the start of a sample. The places were so selected that the same warp yarns were involved for calculating the corresponding values of RMP at fell and grey state of all the samples. At each place, twenty consecutive readings of A and B (section 1) were taken. Therefore, each value of RMP is the result of 120 readings of inter-yarn spaces.

2.2 Loom Setting and Leasing Pattern of Warp Yarn

Loom settings studied to observe their effects were timing of shedding motion and position of back rest. As shown in Fig. 1, three different positions of shed level and heights of back rest with respect to front rest were arranged. For each shed timing and back rest height, three types of leasing pattern, one-by-one (invariably adopted for weaving jute fabrics with plain weave), two-by-two type 1 (i.e. conventional for cotton weaving) and two-by-two type 2 (i.e. type 1 with rearranged denting), as shown in Fig. 2, were used. Therefore, a total of 27 samples with various combinations of loom setting and leasing pattern were woven. As shown in Fig. 1, the back rest could not be set at a level with or below the height of front rest because of the mechanical limitations of the loom and hence the effects of loom setting with top shed tighter than the bottom could not be compared with those studied by Snowden9. The maximum height of back rest with two-by-two leasing could not be set as high as that with one-by-one as any attempt to go beyond the height of 11.5 cm caused the top shed line getting too slack to permit satisfactory weaving. Distances between the back heald and front lease rod and between the lease rods were kept unaltered throughout the

![Fig. 1—Loom setting and timing diagram](image)

![Warp Ends](image)

![Lease Rods](image)

![Back Heald](image)

![Front Heald](image)

![Read Dent](image)

![1/1 Leasing Pattern](image)

![1st Dent: A-B = Maximum - Minimum = High](image)

![2nd Dent: C-D = Maximum (-) - Minimum (+) = Low](image)

![2/2, Type 1 Leasing Pattern](image)

![1st Dent: A-D = Maximum - Minimum (+) = Medium](image)

![2nd Dent: C-B = Maximum (-) - Minimum = Medium](image)

![2/2, Type 2 Leasing Pattern](image)

![1st Dent: A-D = Maximum - Minimum (+) = Medium](image)

![2nd Dent: C-B = Maximum (-) - Minimum = Medium](image)

![Fig. 2—Leasing pattern of warp yarns studied](image)
study. When the height of back rest was changed the
distances of lease rods from the heald shafts were
readjusted.

2.3 Measurement of Warp Tension

For all the 27 cloth samples, tensions of single
warp yarn of both front and back heald shafts pass-
ing through the same dent of reed were measured
during weaving at four different places along the
width of the warp sheet (about 7.5 cm away from the
selvedge) between warp beam and back rest with the
help of Rothschild electronic tensiometer and Hel-
coscriptor recorder. The chart speed of the recor-
der was 50 mm/s. Tension recording was done after
at least fifty picks were inserted. From the tension
chart, ten consecutive peaks (i.e. the maximum ten-
sion) at the instance of beat-up were noted for each
yarn for calculating mean beat-up tension. Basic
tension of warp yarns was kept as far as possible
same throughout the study.

2.4 Seepage

Seepage is the extent of percolation of granules of
a given size, shape and weight through the inter-
stices of a fabric in a given time. Therefore, the high-
er the reediness of a cloth the greater is the pore size
between the groups of yarns separated by the reed
wires and higher should be the seepage. To correlate
RMP of the cloths with seepage, each cloth sample
was tested for seepage in IJIRA laboratory by plac-
ing 1 kg of mustard on the sample of effective area
of 324 cm² and shaking it for 5 min by Sinex electric
vibrator, UK. Mustard was selected because of its
smooth and round surface, reusability and its being
one of the food materials transported in jute bags.
From the weight of mustard passed through the
sample after the stipulated period of time the per-
centage seepage was calculated.

3 Results and Discussion

3.1 RMP at Fell and Grey State

Table 2 shows the values of RMP at fell and grey
state of the samples with different loom settings and
leasing patterns. It is observed that RMP of the fab-
rics under any weaving condition changes from fell
to grey state and is generally higher at the former.
Changes in RMP are possibly due to the changes in
yarn spacings and crimp amplitudes of both sets of
yarns while passing from fell to grey state. It is also
observed that RMP at fell varies more or less in the
same manner as at grey state and the relationship
between the RMPs at these two stages is linear (Fig.
3) with the equation, RMP at grey state = 22.70 +
0.68 × RMP at fell and correlation coefficient (r) of
0.96, which is statistically highly significant. There-
fore, with the type of fabric studied, a fairly accurate
idea of resultant reed mark of the fabric with a given
condition of weaving can be obtained from the ob-
served value of reed mark at fell and, if necessary,
corrective measure can be taken well before the de-
fective fabric has already been produced.

![Fig. 3—Relationship between RMPs at fell and grey state of fabric](image-url)

<table>
<thead>
<tr>
<th>Shed level position (0°)</th>
<th>Back rest height with respect to front rest (cm)</th>
<th>Leasing pattern</th>
<th>1/1</th>
<th>2/2 Type 1</th>
<th>2/2 Type 2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Fell</td>
<td>Grey state</td>
<td>Fell</td>
</tr>
<tr>
<td>0/360</td>
<td>3.5</td>
<td></td>
<td>156.4</td>
<td>129.9</td>
<td>145.1</td>
</tr>
<tr>
<td></td>
<td>8.5</td>
<td></td>
<td>156.1</td>
<td>127.0</td>
<td>113.8</td>
</tr>
<tr>
<td>13.5'/11.5</td>
<td>3.5</td>
<td></td>
<td>123.2</td>
<td>101.6</td>
<td>116.0</td>
</tr>
<tr>
<td></td>
<td>164.7</td>
<td></td>
<td>125.3</td>
<td>129.3</td>
<td>124.4</td>
</tr>
<tr>
<td>315</td>
<td>8.5</td>
<td></td>
<td>136.3</td>
<td>109.7</td>
<td>124.4</td>
</tr>
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<td></td>
<td>124.7</td>
<td></td>
<td>100.7</td>
<td>99.7</td>
<td>122.2</td>
</tr>
<tr>
<td>270</td>
<td>3.5</td>
<td></td>
<td>145.0</td>
<td>117.2</td>
<td>116.4</td>
</tr>
<tr>
<td></td>
<td>120.9</td>
<td></td>
<td>117.2</td>
<td>114.6</td>
<td>105.5</td>
</tr>
<tr>
<td>13.5'/11.5</td>
<td>8.5</td>
<td></td>
<td>90.7</td>
<td>80.1</td>
<td>61.7</td>
</tr>
<tr>
<td></td>
<td>120.9</td>
<td></td>
<td>80.1</td>
<td>75.9</td>
<td>53.8</td>
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</table>

*13.5 cm with 1 up-1 down leasing pattern.*
The behaviour of warp yarns at fell while producing the highest and lowest degree of reed mark in a fabric is shown in Fig. 4. In Fig. 4A, warp yarns with loom settings and leasing pattern not suitable for better cover of the fabric are seen to run in pair in the fabric in the same manner as they have passed through the dents. There is hardly any evidence of side-wise movement of either of the yarns in a pair to cover the spaces left wide open by the reed wires. In Fig. 4B, with appropriate loom settings and leasing pattern every alternate warp yarn is seen to have moved away from its partner and thereby reduces the gap created by the reed wire. This side-wise movement is observed to have taken place while the yarn was at the top and, therefore, slack. This clearly proves the general belief that slackness and tightness of a warp yarn during weaving created by proper loom settings play the key role in achieving good cover of a fabric.

3.2 Effect of Loom Setting and Leasing Pattern of Warp Yarns

3.2.1 Shed Timing

Table 2 and Fig. 5, show that irrespective of the back rest height and leasing pattern RMP at grey state generally decreases as the shed level position is set further away from beat-up. Fig. 5 shows that the rate of decrease in RMP increases as the shed level position approaches 270° on crank cycle. Therefore, within the allowable limit the greater the opening of shed at beat-up the lower will be the tendency for reed mark. Setting the shed level position beyond 270° is, however, not always possible because of the likelihood of shuttle trapping while it is leaving the shed. The results of percentage reduction in reed mark with different loom parameters (Table 3) show that with a given back rest position and leasing pattern the timing of shedding motion has a significant effect on reed mark and in the case of two-by-two (type 2) leasing, reed mark with the highest position of back rest has reduced by about 44%. Snowden observed marginal improvement in reed mark with shed level at 40° before beat-up. The results of the present study with shed level at 45° before beat-up are in agreement with those of Snowden.

3.2.2 Back Rest Position

Table 2 and Fig. 6 show that with the given shed...
timings and leasing pattern RMP reduces as the back rest is set higher with respect to front rest which is in agreement with the findings of Snowden\(^9\) and the rate of decrease increases with the higher positions of back rest. The maximum reduction in reed mark, of about 50\%, is achieved when the back rest, in combination with shed level at 270°, is at the highest position with two-by-two (type 2) leasing pattern (Table 3).

### 3.2.3 Leasing Pattern

Table 2 and Figs 5 and 6 show that at each combination of shed timing and back rest height RMP reduces when the leasing pattern of warp yarns is changed from one-by-one to two-by-two (type 1), possibly due to the greater variation of beat-up tension associated with the latter type of leasing pattern. Fig. 2 shows that in the case of one-by-one leasing all the warp yarns of either front or back heald shaft pass through the lease rods in the same manner, and, therefore, experience similar level of tension at the time of beat-up (i.e. during the formation of the cloth). On the other hand, in the case of two-by-two leasing the yarns of the same heald shaft pass through the leasing zone in the different manners and, therefore, are under different levels of tension at the time of beat-up. The magnitude of reduction in reed mark due to change in leasing pattern is more significant with earlier timing of shedding motion and higher position of back rest (Figs 5 and 6).

When the denting of warp yarns with two-by-two (type 1) leasing pattern is modified to type 2, as shown in Fig. 2, RMP of the fabric at each shed timing and back rest height is reduced further (Tables 2 and 3), possibly for the reasons discussed below. Fig. 7 shows the gradual improvement in cover, i.e. reduction in reed mark, of the fabrics due to change in leasing pattern for a given shed timing and back rest position.

#### 3.2.3.1 Reasons for Improved Cloth Cover with Two-by-Two, Type 2 Leasing of Warp Yarns Compared to Two-by-Two, Type 1 Leasing

Considering two-by-two (type 1) leasing pattern in Fig. 2, analysis of shed geometry with back rest at higher level and shed nearly full open at the time of beat-up, e.g. shed level at 270°, reveals that at beat-up the half of the total warp yarns ‘A’ of the heald forming bottom shed are diverted from the front lease rod and have the maximum beat-up tensions and the half of the total yarns ‘B’ of the heald at top passing through the same dents as ‘A’ are diverted from the back lease rod and have the minimum beat-up tensions. In other dents, at the same time the rest of the yarns ‘C’ of the bottom shed are diverted from the back lease rod located further away and experience the beat-up tensions lower than the maximum [indicated in Fig. 2 by maximum (−)] and rest of the warp yarns ‘D’ of the top shed are diverted from the front lease rod located nearer and experience the beat-up tensions higher than the minimum [indicated in Fig. 2 by minimum (+)]. As a result, while the differences in beat-up tensions between the warp yarns ‘A’ and ‘B’ in half of the total dents of reed are fairly high, those between the yarns ‘C’ and ‘D’ in other half are much lower in the same pick cycle. Owing to this unbalanced nature of beat-up tension difference with two-by-two (type 1) leasing pattern, it is assumed that the effects of high differences in beat-up tensions are to a good extent subdued by the low differences and the resultant effects on the reed mark of the fabric are much reduced. On the basis of the above assumption if the yarns with two-by-two (type 1) leasing are so arranged at the reed dents that while maintaining the same leasing pattern warp yarns ‘A’ of one heald are denté along with the yarns ‘D’ of the other and yarns ‘C’ of the former heald are denté with yarns ‘B’ of the latter heald, the difference in beat-up ten-

### Table 3—Percentage Reduction in RMP with Different Loom Settings

<table>
<thead>
<tr>
<th>Back-rest height cm</th>
<th>Shed level (°)</th>
<th>Leasing pattern</th>
<th>1/1 (Type 1)</th>
<th>2/2 (Type 2)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0/360</td>
<td>21.8</td>
<td>20.7</td>
<td>21.4</td>
</tr>
<tr>
<td>315</td>
<td>19.6</td>
<td>24.0</td>
<td>24.4</td>
<td></td>
</tr>
<tr>
<td>270</td>
<td>31.7</td>
<td>48.4</td>
<td>49.9</td>
<td></td>
</tr>
<tr>
<td>3.5</td>
<td>9.8</td>
<td>9.8</td>
<td>12.0</td>
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<td>8.5</td>
<td>19.9</td>
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<td>25.2</td>
<td></td>
</tr>
<tr>
<td>11.5</td>
<td>41.4</td>
<td>43.9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13.5</td>
<td>21.2</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Fig. 6—Variation of average RMP with back rest height
sions between the yarns of two shed lines will be more uniform (Fig. 2) but significant in each dent in a pick cycle, possibly to have better effects on reed mark of the fabric. With this arrangement, the mean beat-up tension difference of the warp sheet will remain the same. To verify this, study was carried out with rearranged denting of warp yarns in the manner mentioned above and expected results were obtained, as discussed in 3.2.3. This leasing pattern of warp yarns with rearranged denting, which in fact is the combination of one-by-one and two-by-two (type 1) leasings, has been designated as two-by-two, type 2 leasing (Fig. 2).

3.3 Relationship between Beat-up Tension and RMP

To study the nature of variation of warp tension difference at beat-up with RMP at grey state of the fabric, the mean differences of peak tensions at beat-up between the bottom and top shed lines have been plotted against the corresponding values of RMP in Fig. 8 for different shed timings and in Fig. 9 for different back rest positions. The figures show that the tension difference at beat-up varies inversely with RMP. The reason is that earlier timing of shedding motion and higher position of back rest while improve the cover of the fabric, as described in 3.2.1 and 3.2.2, cause greater difference in beat-up tension between the two shed lines as the yarns of bottom shed line get increasingly tighter and those of the top shed line slacker. The relationship between the tension difference and RMP is linear in both the cases with the equations, $RMP = 115.63 - 0.23 \times$ beat-up tension difference for change in shed timing and $RMP = 142.96 - 0.68 \times$ beat-up tension difference for change in back rest position. The respective correlation coefficients of the two equations are $-0.91$ (statistically highly significant) and $-0.76$ (statistically significant at 5% level).

A comparison of Figs 8 and 9 show that the gra-

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Fig. 7—Effect of leasing pattern on cloth cover (magnification, 1.5×) [(A) Shed timing—shed level at 270°, back rest height 13.5 cm, leasing pattern 1/1; (B) Shed timing—shed level at 270°, back rest height 11.5 cm, leasing pattern 2/2 type 1; (C) Shed timing—shed level at 270°, back rest height 11.5 cm, leasing pattern 2/2 type 2]

Fig. 8—Relationship between beat-up tension difference and RMP with different shed timings
increase in RMP at grey state (Fig. 10). These two factors are related linearly with the equation, Seepage = 0.39 × RMP − 2.03 with correlation coefficient of 0.64, which is statistically highly significant. This finding agrees with the observation made by Snowden\(^9\) on the air permeability of the fabric.

4 Conclusions

4.1 Reediness of plain jute fabric of opener construction, expressed quantitatively as reed mark percentage (RMP), is generally higher at fell of cloth (i.e. at loom state) than at grey state for any loom setting and leasing pattern of warp yarns studied. RMPs at these two stages are related linearly with correlation coefficient of 0.96, which is statistically highly significant.

4.2 RMP at grey state decreases with (a) earlier rimming of shedding motion, (b) increasing height of back rest, and (c) changing of leasing pattern of warp yarns from one-by-one to two-by-two. Of these, the effect of back rest height is more pronounced.

4.3 RMP at grey state is related linearly with warp tension difference at beat-up between the two warp shed lines with the correlation coefficients of −0.91 and −0.76 for changes in shed timing and back rest height respectively and the results are statistically significant.

4.4 When the conventional two-by-two leasing pattern is so arranged that the warp ends of both the front and back heald shafts passing through the pair of lease rods in the same manner pass through two consecutive dents of reed (instead of the same dent), RMP at grey state is further reduced for the given shed timing and back rest height.

4.5 Seepage of the fabric varies linearly with RMP at grey state with correlation coefficient of 0.64, which is statistically highly significant.

References

2 Caldwell S A G, Fibres, 10 (1949) 159.
8 Marks R and Robinson A T C, Principles of weaving (The Textile Institute, Manchester), 1976, 42.
9 Snowden D C, Text Asia, 7 (1976) 51.