Influence of tuft constitution on performance properties of hand-woven carpets

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The influence of tuft constitution on the functional and aesthetic properties of hand-woven carpets has been studied. It is observed that the tuft composed of plied yarn provides better handle but diminishes the surface appearance of carpet. The carpet piles having single-ply yarn exhibit better look because the spread of pile all over the carpet is more uniform. To obtain both virtues, i.e. appearance and handle, two-ply yarn instead of single-ply or three-ply yarn may be used. It is also observed that in carpets prepared from plied yarns, more force is needed to withdraw a tuft. Abrasion loss in the carpet samples of all the compositions has been found within the acceptable limit.

Keywords: Abrasion loss, Compressibility, Hand-woven carpets, Resiliency, Tuft constitution

1 Introduction
The effect of fibre characteristics and constructional parameters on the performance properties of hand knotted and woven carpets has been reported. It has been observed that fibre characteristics don't influence as much the performance characteristics of a carpet as the constructional parameters. Tuft constitution defines the number of threads assembled together to form a tuft whether single or plied. The number of ends passing through each heald eye determine the pile density i.e. distribution of tufts per unit area, which, in turn, affects the performance characteristics of the carpet. This communication deals with the study undertaken to determine the effect of different tuft structures on the performance characteristics and aesthetic appeal of hand-woven carpets.

2 Materials and Methods
Nineteen handloom woven carpet samples of different tuft constitutions were collected from the local carpet industry of Bikaner. The carpet samples were properly conditioned and brushed before testing.

Fibre diameter and medullation per cent of fibre samples, drawn by shaving the carpet pile, were determined with the help of a projection microscope following the standard procedures. Pile height, pile density and pile weight were determined as reported elsewhere.

The abrasion loss at 1000 cycles was determined using a carpet abrasion tester manufactured by M/s Prolific Engineers Ltd, Noida. The loss was calculated by weighing the carpet samples before and after 1000 abrasions against a standard abradant.

Tuft withdrawal force was observed on tuft withdrawal tester made by Salter India Ltd. The force required to withdraw the tuft from the sample is denoted by the pointer on dial which automatically stops after the tuft is withdrawn. The observation is directly read from the dial.

According to their tuft constitution, the samples were grouped into seven groups, viz. 1/3, 1/4, 1/5, 2/1, 2/2, 2/3 and 3/2 (numerator and denominator represent the pile and fold respectively). From each group, a representative sample was taken and the seven samples thus obtained were evaluated subjectively by five different judges for assessing visual appeal and handle separately. The judges evaluated the sample independently and ranked them in order of preference. The statistical analysis of the ranking was done as mentioned elsewhere.

3 Results and Discussion
The physical characteristics of wool samples (Table 1) show that the fibre fineness ranges from 27.5 µ to 41 µ. The various fibre types are 34-93% non-medullated, 6-41% partially medullated, 0-18% coarsely medullated and 0-14% kemp. The constructional details of the various carpet samples are given in Table 2. It is observed that by varying the tuft constitution, pile density and pile height, the carpets having variable weight per unit area are obtained.
3.1 Statistical Analysis

The performance characteristics of carpet samples are presented in Table 3. It is observed that by increasing the number of folds in the yarn, the pile density increases, which, in turn, increases the resiliency and decreases the compressibility. Weight loss is below 70 mg per 1000 abrasion cycles in all the samples which is within the acceptable limits. The increase in the number of piles and folds in yarn increases the force required to withdraw the tuft. This is due to the increased cohesion between the constituent yarns.

The correlations between tuft constitution and performance characteristics of carpet samples are presented in Table 4. ANOVA to see the effect of tuft constitution on the performance characteristics of carpet samples is presented in Table 5. On the application of Duncan's multiple regression test, it is observed that with regard to tuft withdrawal force, the tufts made of single-ply yarn form one group whereas the tufts made of plied yarns form another group with significantly higher values. Also, the two groups are significantly different from each other.

The correlations between tuft constitution and performance characteristics of carpets are presented in Table 6. It is observed that compressibility is negatively correlated, whereas resiliency is positively correlated to the tuft constitution which is obviously...
Table 4—Means and standard errors of performance characteristics of carpet samples

<table>
<thead>
<tr>
<th>Code</th>
<th>Compressibility %</th>
<th>Resiliency %</th>
<th>Weight loss at 1000 abrasion cycles mg</th>
<th>Tuft withdrawal force g</th>
</tr>
</thead>
<tbody>
<tr>
<td>T₁</td>
<td>51.5±0.5</td>
<td>40.0±2.0</td>
<td>52.0±3.0</td>
<td>275.0±45.0</td>
</tr>
<tr>
<td>T₂</td>
<td>51.3±2.6</td>
<td>42.3±4.5</td>
<td>51.7±9.3</td>
<td>333.3±3.3</td>
</tr>
<tr>
<td>T₃</td>
<td>46.7±4.3</td>
<td>46.0±5.1</td>
<td>46.7±1.2</td>
<td>256.7±75.3</td>
</tr>
<tr>
<td>T₄</td>
<td>52.0±1.0</td>
<td>42.5±3.5</td>
<td>47.5±2.5</td>
<td>710.0±10.0</td>
</tr>
<tr>
<td>T₅</td>
<td>47.0±2.1</td>
<td>44.0±2.3</td>
<td>52.3±1.4</td>
<td>853.3±178.0</td>
</tr>
<tr>
<td>T₆</td>
<td>46.0±1.2</td>
<td>46.0±3.1</td>
<td>50.1±0.7</td>
<td>915.0±99.3</td>
</tr>
<tr>
<td>T₇</td>
<td>44.3±2.3</td>
<td>46.0±2.1</td>
<td>59.3±0.7</td>
<td>970.0±45.8</td>
</tr>
</tbody>
</table>

*There were two samples each in groups T₁ and T₄, and three samples each in remaining groups.

Table 5—ANOVA to see the effect of tuft constitution on performance characteristics of carpet samples

<table>
<thead>
<tr>
<th>Source of variation</th>
<th>Degrees of freedom</th>
<th>Compressibility</th>
<th>Resiliency</th>
<th>Weight loss at 1000 abrasion cycles</th>
<th>Tuft withdrawal force</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment</td>
<td>6</td>
<td>25.0745</td>
<td>11.3319</td>
<td>48.4313</td>
<td>248141.670</td>
</tr>
<tr>
<td>Error</td>
<td>12</td>
<td>18.5417</td>
<td>35.4306</td>
<td>47.6528</td>
<td>25016.667</td>
</tr>
</tbody>
</table>

Results of Duncan's multiple regression test

(T₁, T₄, T₅, T₆, T₇) (T₁, T₄, T₅, T₆, T₇) (T₁, T₄, T₅, T₆, T₇)

*P<0.01

Any two means coming in the same parentheses are not significantly different.

Any two means not coming in the same parentheses are significantly different.

Table 6—Correlation of tuft constitution with performance characteristics of carpet samples

<table>
<thead>
<tr>
<th></th>
<th>Compressibility</th>
<th>Resiliency</th>
<th>Weight loss at 1000 abrasion cycles</th>
<th>Tuft withdrawal force</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single ply</td>
<td>-0.4086</td>
<td>0.3690</td>
<td>-0.2580</td>
<td>0.4049</td>
</tr>
<tr>
<td>Double ply</td>
<td>-0.6903</td>
<td>0.1420</td>
<td>0.3934</td>
<td>0.4001</td>
</tr>
</tbody>
</table>

due to the increase in pile density. The weight loss at 1000 abrasion cycles shows a negative correlation when single-ply yarn is used and positive correlation when two-ply yarn is used. However, it is non-significant in both the cases. This may be due to the fact that when single-ply yarn is used, the pile surface of the carpet remains more uniform than when plied yarn is used. The abrasion on a more uniform surface causes less loss as compared to that on a less uniform surface.

The tuft withdrawal force shows a positive trend with the increase in the number of ends in an individual tuft.

The ranks awarded by the judges on the basis of visual appraisal and handle are presented in Table 7. The measure of degree of agreement among the
judges is 0.865 and 0.853 for visual and handle assessment respectively which is highly significant. Therefore, it may be concluded that the judges are really in close agreement, the closeness being not by chance. The perusal of rank total and final rank indicates that the judges could distinctly differentiate between the different carpets having different tuft constitution. The appearance of carpet samples prepared from a single-ply yarn is judged to be better, but from handle point of view, the plied yarn carpet samples are preferred.

References
5. Indian standard specifications IS: 2899 (Bureau of Indian Standards, New Delhi), 1965.