LABORATORY EVALUATION OF BLENDED COTTON/LOW-MELT SYNTHETIC FIBER CARPET

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Abstract

An attempt has been made to determine the properties of cotton/synthetic fiber blend carpets which are important from a consumer's viewpoint. Being a natural fiber it is well suited for indoor applications and is known to improve indoor air quality. Even though cotton fiber is much finer than the normal carpet denier synthetic fibers, blending with small amounts of synthetic fiber and increasing the tuft density has given floor coverings of desirable characteristics. We have evaluated three properties which are considered as important to floor coverings by the consumer; i.e.; flammability, durability and " body". TRI/Carpet Walker has been used to evaluate durability. The changes in appearance of the carpet as a result of " trafficking " was evaluated by the image analysis method.

Introduction

As a natural fiber popularity of cotton has been steadily increasing in the apparel segment of the textile industry. It is used both as 100% cotton as well as blends with synthetic fibers, especially, polyester (PET). Absorptive and water transmission characteristics are responsible for the high comfort of these fabrics. The same properties can also contribute to improvements in indoor air quality when these fabrics are used as home furnishings. One of these possibiities is the use of cotton carpets as floor coverings. Although the fiber by itself is too fine for this application blending with proper synthetic fiber it has been possible to make carpets of considerable aesthetic value by proper construction of the tuft and the carpet itself. In this communication we have investigated three properties of cotton carpets which are considered to be important from consumer's viewpoint.

Materials and Methods

The carpet samples used in this study were supplied by Cotton Incorporated and are listed in Tables 1 and 2. Table 1 lists carpet constructions based on Kodel 410 polyester as the blend fiber. Table 2 lists carpets based on a variety of synthetic fibers. Details of the construction and the heat setting conditions are also given.

Reprinted from the *Proceedings of the Beltwide Cotton Conference*
Volume 2:1507-1510 (1996)
National Cotton Council, Memphis TN

Flammability : The standarad ASTM test method (D2829) was adopted for evaluating carpet flammability. The method involves igniting a methanamine tablet on the carpet and examining the area of the char formed during combustion. The set up used for this purpose is shown in Figure 1. The carpet sample is placed in a test chamber on a steel plate. A methanamine tablet is ignited in the center and the entire experiment was videotaped. The top view of the set up is shown in Figure 2. A set of thermocouples were placed in the center of the sample to record the temperature, if necessary.

Durabilit : This is an "in use " characteristic of the carpet. It represents the ability of a carpet to retain its appearance when it is being used over extended periods of time. In the synthetic carpet industry this is achieved by asking people to walk on the carpet and evaluating the appearance by experts after several thousand steps. To avoid this laborious procedure TRI has developed a mechanical Carpet Walker which is shown schematically in Figure 3. It consists of a turntable on which the carpet samples are placed. A motorized conical cylinder represents the "foot ". When the turntable rotates the cylinder will rotate in the same direction, shearing the tufts. However, there is provision to impose an additional shear by rotating the cylinder in the same or in the opposite direction. In these experiments the linear velocity of the cylinder was 20% higher than that of the turntable, imposing an additional shear on the tufts. The direction of rotation of the turntable and the cylider change every 7.5 min to simulate walking back and forth on the carpet. The appearance of the carpet was evaluated by image analysis using ImagePro Plus® software.

Carpet Body : This is a term used by experts to characterize the " hand " of a carpet. It involves both reasonable resistance to compression as well as good recovery. The latter can be termed as resilience. Basic mechanical properties of the fiber such as bending modulus and interfiber friction contribte to this property. In this preliminary investigation we have developed a compressibility test which measures the resistance of a carpet to compressive loads. Aspects of recovery will be cosidered subsequently. The compressibility apparatus used in these measurements is shown in Figure 4. The cylinder of appropriate weight is mounted on the load cell of the Instron machine and the carpet sample is placed on the crosshead. The cylinder is made to land on the carpet sample to give a definite loading rate. The results are expressed as percent change in the pile height of the carpet.

Results and Discussion

Flammability : In this ASTM test procedure the sample is judged to have failed if the resultant char extends more than 7.5 cm from the point of ignition. Every bicomponent fiber carpet tested in this work passed the ASTM test. The portion of the charred carpet yarn was so small that the temperature measurements were not very useful. This is rather unusual for cotton. We feel that the reason for the flame retardant behavior is the dense construction of the carpet tuft as well as the carpet. Combustion is retarded because of the nonavailability of air at the site. The work is being continued to understand the exact cause of the flame retardant behavior.

Durability and Appearance retention : Carpet samples from Table 1 were subjected to simulated trafficking on the TRI/Carpet Walker for various lengths of time and the change in appearance was evaluated by image analysis. Generally, under these conditions carpets look lighter in color, giving a higher value for the mean intensity. For example, the mean intensity for samples 3A and 4A are shown in Figure 5 as a function of time. Sample 3A seems to have better appearance retention. Both these are loop pile carpets with good reflective properties. The difference seems to be in the heat setting conditions. In 3A the tuft was heat set before cable twisting whereas in 4A it was done after cable twisting. The results indicate that the former is better than the latter. This may be due to improved heat penetration of the single tuft as compared to the doubled and twisted tuft. This is also observed in the tuft size as a function of time on the TRI walker. This was determined by image analysis and is shown in Figure 6. 3A seems to have a lower tuft area initially. This may be the reason for its improved appearance retention.

Compressibility : The deformation of carpet tuft in the compressibility measurement is shown schematically in Figure 7. The results are expressed as percent change in pile height. Absolute value of this parameter is probably ambiguous. However, when compared for the untrafficked and the trafiicked carpet, the effect of different synthetic fibers shows up. The data for samples from Tables 1and 2 are shown in Figures 8 and 9, respectively. Samples 1A and 3A seem to retain pile height better than 2A and 4A after trafficking. Figure 9 shows the effect of different synthetic fibers.The effect of trafficking is most pronounced in carpets containing polypropylene. 100% cotton carpets seem to do better. Both nylon and polyester containing carpets show good pile height retention characteristics after trafficking. This is a desirable property. We are in the process of developing a better method of evaluating carpet "body".

Tuft compaction : The overall result of trafficking on a carpet is the compaction of the tuft which limits the flow of air through the carpet. The TRI developed Air Resistance Tester is ideally suited for this purpose. The apparatus is schematically shown in Figure 10. Air from a computor controlled piston pump is forced through the carpet.pile. Air resistance is measured as a function of flow rate. Because of compaction, trafficked carpets will show higher resistances. We are in the process of evaluating the usefulness of this device for measurement of carpet "body" and its change as a result of trafficking.

Acknowledgements

We want to thank Cotton Incorporated for the technical and finacial assistance for this investigation.

Table 1	Carpet Test Samples
CI-100-1A	5/32 Cut 3/8" Pile Height Ne 3/2/2 80/20 Cotton/Kodel 410 Suessen heat-set in 3/2's condition
CI-100-2A	5/32 Cut 3/8" Pile Height Ne 3/2/2 80/20 Cotton/Kodel 410 Suessen heat-set in 3/2/2's condition
CI-100-3A	1/8 High/Low 5/8"-3/8" Pile Height Ne 3/2/2 80/20 Cotton/Kodel 410 Suessen heat-set in 3/2's condition.
CI-100-4A	1/8 High/Low 5/8"-3/8" Pile Height Ne 3/2/2 80/20 Cotton/Kodel 410 Suessen heat-set in 3/2/2's condition.

Table 2	Carpet Test Samples
CI-101-1B	100% Cotton 5/32nd gauge-cut pile-3/8" pile height
CI-101-2B	80% Cotton/20% Nylon 5/32nd gauge-cut pile
CI-101-3B	80% Cotton/20% K-54-5/32nd gauge-cut pile
CI-101-4B	70% Cotton/20% Nylon/10% K-54-5/32nd gauge-cut pile
CI-101-5B	80% Cotton/20% Type 171 Polyester-5/32nd gauge-cut pile
CI-101-6B	80% Cotton/20% Type"A" Polypropylene-5/32nd gauge- cut pile
CI-101-7B	80% Cotton/20% Type"B" Polypropylene-5/32nd gauge-cut pile

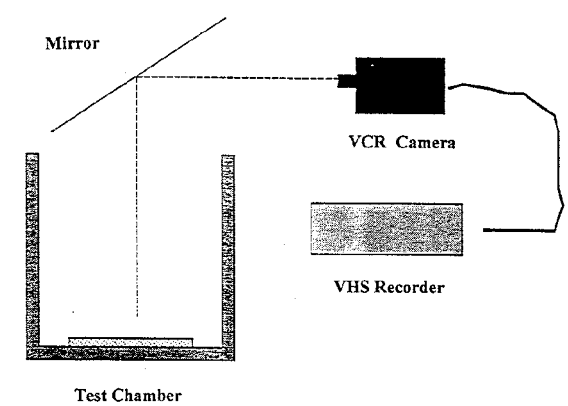

Fig. 1 Pill Test Apparatus for Flammability- Video Documentation (Side view)

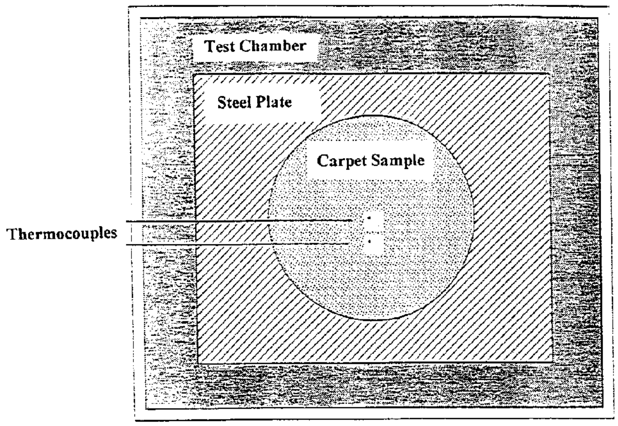

Fig. 2 Pill Test Apparatus for Flammability (Top view)

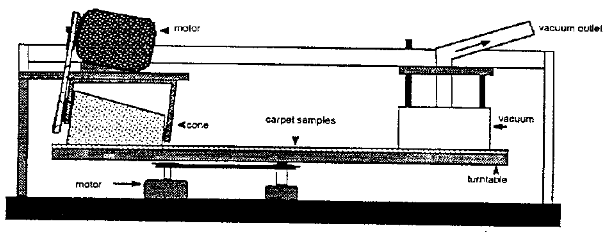

Fig. 3 TRI turntable carpet walker (schematic)

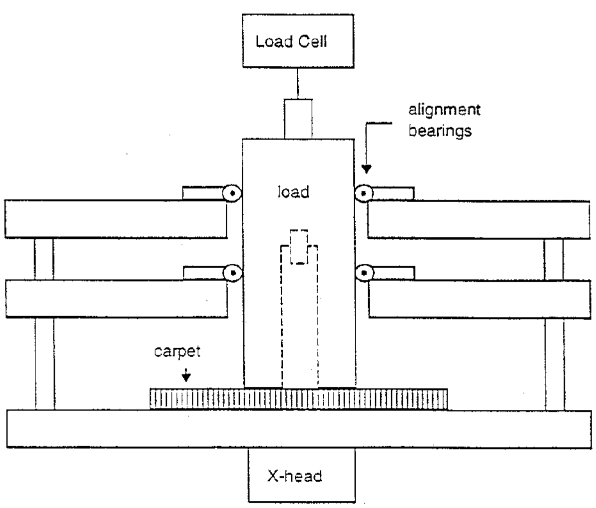

Fig. 4 Carpet Compressibility Apparatus

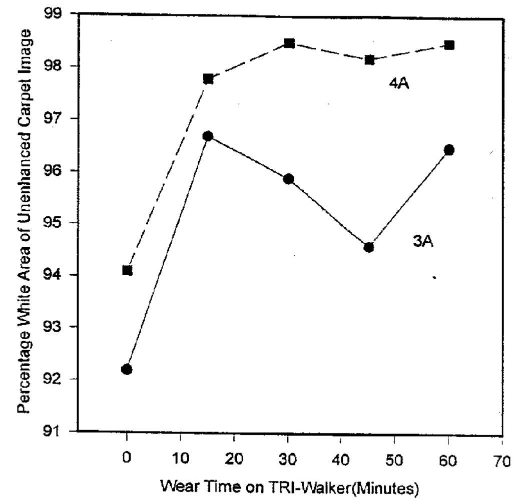

Fig. 5 Change in % White Area Vs. Wear Time for Samples 3A and 4A

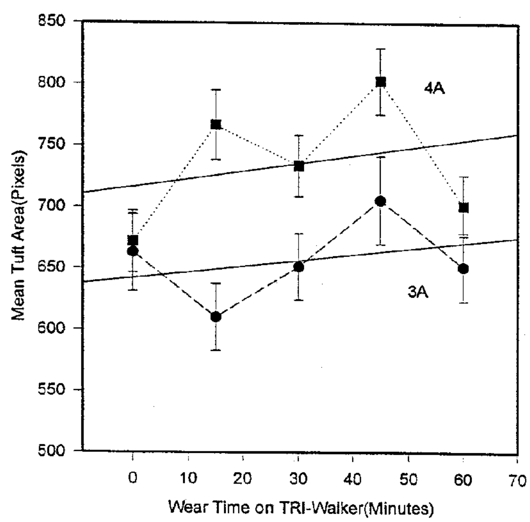

Fig. 6 Change in Tuft Area with Wear Time for Samples 3A and 4A

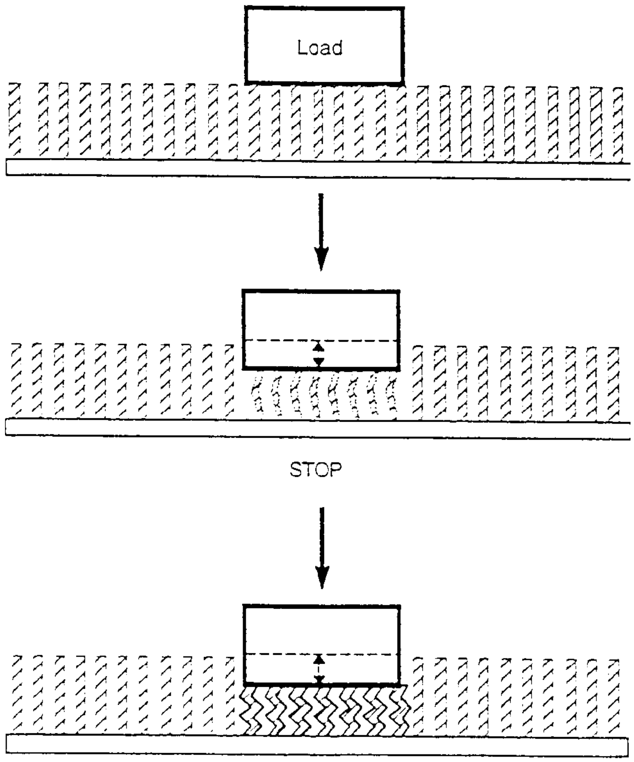

Fig. 7 Tuft compression in dynamic loading test.

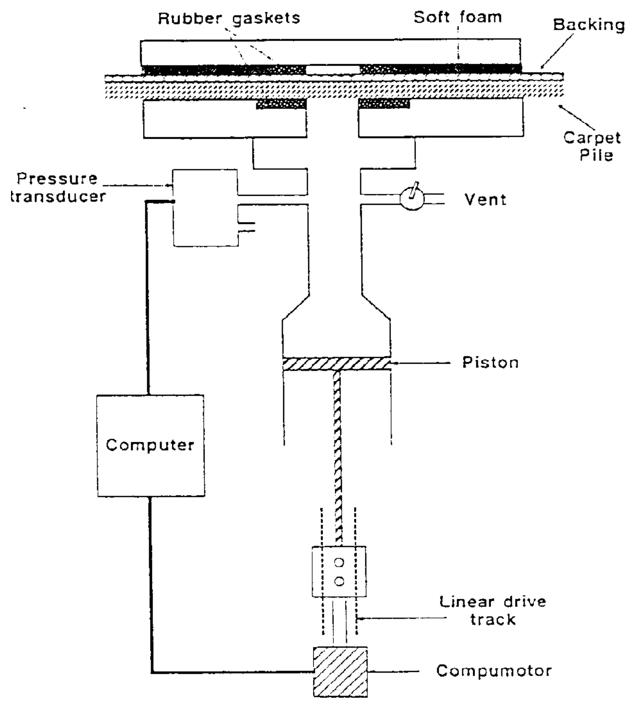

Fig. 10 TRI Air Flow Resistance Apparatus

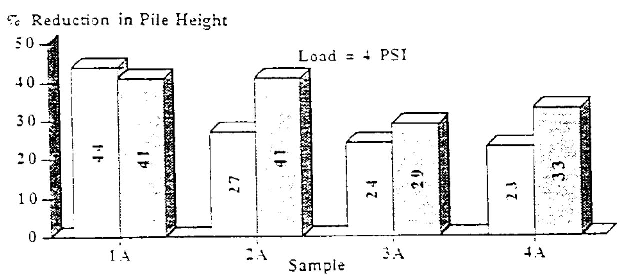

Fig. 8 Reduction in pile height in compression
Cotton/Kodel polyester blends.

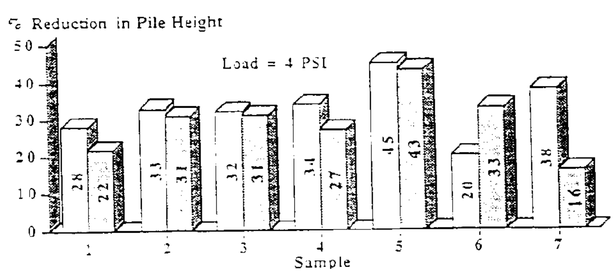

Fig. 9 Reduction in pile height in compression.
Different synthetic fiber blend carpets.