

**INFLUENCE OF STRUCTURAL CHARACTERISTICS OF
WOOLEN YARN ON PERFORMANCE PROPERTIES OF
HANDLOOM CARPET**

by

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CERTIFICATE

This is certify that the thesis entitled “**INFLUENCE OF STRUCTURAL CHARACTERISTICS OF WOOLEN ON PERFORMANCE PROPERTIES OF HANDLOOM CARPETS**” being submitted by **Mr. Ajay Kumar** to the Indian Institute of Technology Delhi, for the award of the degree of **Doctor of Philosophy** is a bonafide research work carried out by him. Mr. Ajay Kumar has worked under our guidance and supervision and fulfilled the requirements for submission of the thesis. The results contained in the thesis have not been submitted, in part or full, to any other university or institute for award of any degree or diploma.

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ABSTRACT

The changing market trend and desired performance and functional end uses of the carpets forced the researcher to develop and impart required characteristics in the carpets through different approaches. This may be achieved by modification the yarn structure or surface modification through chemical means; however, functional durability and adverse effects on strength and abrasion resistance are the cause of concern.

Different approaches are proposed to produce structurally different yarns to improve the performance and functional properties of carpets. Besides conventional homogeneous fibre blending, concept of strategic mixing by strategically positioning of different fibres across the cross-section of the yarn is proposed to exploit fully the advantages of individual fibre characteristics. Accordingly, firstly, wool spinning system, which is commercially adopted system, is used to produce carpet reference yarn. Secondly, to overcome fibre orientation issue of woolen spinning system, worsted spinning system is considered to produce single roving feed control yarn to improve the compactness of the yarn. Thirdly, due to well-known reasons double roving feed system is considered to further improve the compactness second control yarn. Further, it created a need to engineer the structurally different types of carpet pile yarns to exploit three different varieties of Indian wools in terms of fibre diameter, medullation and bending rigidity. Accordingly, fibres of different characteristics are strategically positioned in the yarn cross-section to develop multilayered yarn structure on ring spinning system. Three different approaches on SIRO spinning system with suitable modifications are proposed to produce multi-component engineered yarns. Control and multi-component engineered yarns spun on worsted spinning system provide higher bending rigidity in comparison to reference yarn spun on woolen spinning system. The recovery property of all multi-component engineered yarns is found to be better than reference and control yarns.

The cross-sectional study of structurally different researched yarns is also discussed to understand the mechanism of the fibre density distribution across the yarn cross-section. It is observed that the radial packing density of all researched yarns found to be neither uniform across the yarn cross-section nor maximum at core of the yarns. For all the considered yarns, the maximum packing density occurs at some different distances from the yarn axis and it sharply

decreases from that point towards yarn surface. It is observed from our results that in general the yarns are seen to have slight hollowness near their axis. Therefore, the present work has suggested different approaches to produce multi-component ring spun yarn structures and created possibilities to manipulate the radial packing density of yarns to favorably exploit its advantages in specific end uses.

A versatile automatic stress transducer based system has been designed and developed to measure the compressional behavior of carpet viz. compressibility and resiliency under static and dynamic conditions to overcome the issues related to conventional methods. The system also simulates the applied axial force, the displacement force and turning force while moving over the carpets. These forces are measured in terms of compressional force, traverse force and rotational torque under dynamic conditions. The newly developed carpet compression tester has significantly better capabilities to assess the repeatability and reproducibility in the products in comparison to conventional instrument.

Accordingly, handloom carpets were made by using structurally different yarns to study the carpet thickness loss, compressibility (%) and resiliency (%) under static and dynamic conditions. Further the dynamic response of carpet during carpet movement at constant load in terms of carpet traverse and rotational force and change in carpet thickness in different direction were also measured. The performance and functional properties like carpet durability factor, abrasion loss%, tuft withdrawal force, thermal insulation and flammability of handloom carpets made from structurally different yarns were also measured.

In order to further enhance the performance of the researched carpets, two more possibilities were considered. Firstly, an attempt is made to study the influence of carpet pile density on carpet performance by reducing the spacing between the piles and secondly to further improve the results through chemical processing.

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