

**ROLE OF LOOP GEOMETRY ON PROPERTIES AND
PERFORMANCE OF WOVEN TERRY FABRICS**

by

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Certificate

I am satisfied that the thesis entitled “**Role of Loop Geometry on properties and Performance of Terry Fabrics**” presented by Mr. Jitendra Pratap Singh is worthy of consideration for the award of the Degree of **Doctor of Philosophy** and is a record of the original bonafide research work carried out by him under my guidance and supervision and that the results contained in it have not been submitted in part or full to any other University or Institute for award of any degree/diploma.

I certify that he has pursued the prescribed course of research.

Date: October 2013

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Abstract

This research work is focused on the critical investigation of the effect of a crucial parameter of pile loop known as loop shape factor on properties and performance of woven terry fabrics. Keeping in mind the services required from woven terry fabrics, their properties and performance are studied in the descending order of their importance. Loop geometry is considered as the most important attribute to characterize overall performance of the terry fabrics.

Water absorbency which is the most important property required from woven terry fabrics, has been studied on the priority basis. In this research work, both dynamic and static water absorption has been accounted for good water absorbent woven terry fabrics. Effect of fibre quality, pile yarn count, pile yarn twist, yarn structure, loop length, loop density, loop shape factor, combed yarn, yarn spinning system (ring and rotor) and wrap yarn quality have been studied for their effect on water absorbency. It has been found that terry fabrics produced by using long staple cotton, low twist multiplier, finer yarn count, high loop density, moderate loop length and high loop shape factor give better performance in terms of water absorbency. Using Box-Behnken design of experiments loop density, loop shape factor, pile yarn twist, and loop length were also optimized for the better absorbency performance of terry fabrics.

Mechanical comfort takes the second important place in the characterization of good quality terry fabric in this research work. Fabric hand is a measure of the mechanical comfort of the fabrics. The strongest point of the subjective hand evaluation is that it takes into account the human sensitivity but at the same time it has the weakness of unreliability and non-reproducibility of the results under certain circumstances. Because of its weaknesses,

objective hand evaluation came into existence and numerous hand equations have been developed for different apparel grade fabrics but this investigation for terry fabrics continued to remain a grey area for about four decades after development of a systematic hand evaluation instrument and method. So in this research work, primary hand equations BJ-101, BJ-102, BJ-103, BJ-104 and total hand equation BJ-105 have been successfully developed for terry fabric with high accuracy and small error by using their low stress mechanical properties. Different yarn and fabric parameters were also studied for their effect on the compression and surface properties of terry fabric as these properties were the major contributors in the hand of terry fabrics. Using Box-Behnken design of experiments loop density, loop length, and loop shape factor were also optimized for the better compression properties of terry fabrics.

Excellent aesthetic characteristics add more value to the products like terry fabrics. The appearance of terry fabric is normally evaluated by subjective method by experienced personnel. To impart excellent aesthetic characteristics to the terry fabrics, subjective evaluation of aesthetics has to be replaced by an objective evaluation. Therefore, an objective evaluation of surface texture based on the digital image processing technique has been suggested in this research work. Energy, entropy, inertia, fractal dimension, and uniformity index have been calculated using well established standard statistical methods. It is found that these parameters are very well correlated with the subjective surface ratings of the terry fabrics. Different yarn and fabric parameters were also studied for their effect on the different texture descriptors and found that terry fabrics produced by using long staple cotton, low twist multiplier, finer yarn count, high loop density, moderate loop length, and high loop shape factor exhibits better aesthetic characteristics.

During the course of research time, it has been found that the loop geometry is a crucial parameter that governs most of the properties of the terry fabrics. Therefore, exclusive research focus is directed on this to study the science involved in the geometry of loop. Formation of loop on terry fabric surface is affected by buckling of yarn which is highly non-linear in its behaviour. Geometric non-linearity and bending non-linearity both govern the yarn buckling process and consequently the shape of the loop. As mentioned in earlier research, geometric non-linearity is important for modeling large deformation like buckling and non-linear bending rigidity is important to get the real fabric behaviour from the model. Considering these two non-linearities, mathematical modeling and finite element modeling were carried out. Results of FEM model was very well supported by the results of the numerical analysis and actual experiments.

Life of any product plays a crucial role in its costing and market value. A customer may declare a fabric unusable if it loses its aesthetic appeal. A fabric may be uglified out soon rather than worn out. Therefore, the research has also been directed towards the investigation of effect of home laundering on all the properties of terry fabric so that manufacturer may come to know key structural and material parameters which should be altered to improve their performance. Number of washing cycles has a very little influence on the rate of water absorption of terry fabric. The total amount of water absorbed increases with increasing number of wash but after certain washes it starts reducing. Loop density and loop length are the two important fabric parameters that were studied here to see their impact on the life of the product. It is found that maximum loop density and moderate loop length can increase the life of terry fabrics.

The complete experiment as regard to fabric development, post weaving treatments and some subjective evaluation of this research were conducted under industrial manufacturing conditions. Therefore, it is expected that the findings and the recommendations would be useful for actual applications in the industry. The newly developed hand equations would also be used by many researchers in future years.

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