A STUDY ON THE ROLE OF YARN PROPERTIES IN DOUBLE JERSEY LOOPS

by

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Dedicated to

My Father

Who wished me to be a doctorate

CERTIFICATE

This is to certify that the thesis entitled, "**A Study on the Role of Yarn Properties in Double Jersey Loops**" being submitted by **Mr. Prabhakar Bhat** to the Indian Institute of Technology, Delhi, for the award of the degree of **Doctor of Philosophy** in the department of Textile Technology, is a bonafide research work carried out by him. Mr. Prabhakar Bhat worked under our joint guidance and supervision and fulfilled the requirements for submission of the thesis.

The results contained in this thesis have not been submitted, in part or in full, to any other University or Institute for the award of any degree or diploma.

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(PRABHAKAR BHAT)

ABSTRACT

The formation of loop in knitting and stabilization of its dimension during relaxing involves bending, twisting and stretching of yarn. The present study has been designed to investigate the role of three yarn rigidities namely flexural, tensile and torsional rigidities as also thickness and coefficient of friction of cotton hosiery yarns in knitting process and in the dimensions of relaxed loop.

The methodology adopted for the work is as follows.

- Improvement of Torsiometer: There being no instrument commercially available for testing torsional properties of spun yarns, improvement of an instrument earlier developed at the laboratory of IIT Delhi to the satisfactory level.
- Measurement of torsional properties of cotton hosiery yarns considered in the study.
- Characterization of cotton hosiery yarns for torsional rigidity by a parameter that associates best with relevant fibre and yarn variables.
- Knitting samples of rib, half cardigan & interlock structures as also recording the respective cam forces with the help of a measuring device and stabilizing the fabric samples by suitable relaxation process.
- Measurement of loop dimensions namely, loop length, wale spacing and course spacing of the samples as also two more variables namely loop height and crown width to be measured additionally for exploring their importance in the loop dimensions.
- Statistical treatment of experimental data for establishing the role of yarn properties on cam force and loop dimensions by employing General Linear Model.

Based on the experimental work performed and the analysis of data the important findings are listed below.

1. Among the different parameters characterizing the torsional properties of cotton hosiery yarn, the mean torsional rigidity in twisting and detwisting exhibits the strongest correlation of 0.98 with certain fibre and yarn properties. The increase in fibre span length and maturity leads to rise in mean torsional rigidity while an increase in fibre count (tex) (for the type of yarns used in this study) lowers rigidity. The increase in yarn count (tex) and twist factor raises rigidity while the increase of yarn tensile modulus lowers rigidity.

2. The cam force profile is structure specific and varies considerably in terms of number of peaks, their locations as also amplitudes. In case of rib the cam force profile exhibits four peaks. A close observation indicates that the casting-off loops from previous course influences peaks other than that of maximum peak. On the other hand half cardigan shows less variation in force followed by only one peak while interlock exhibits one sharp peak in association with many small peaks on either side of the maximum peak, indicating the interaction of loops formed by short and long needles of the cylinder.

3. The position of maximum peak is closest to the feeder, among the three structures studied, for interlock structure and this is followed by that of rib structure. The position of peak for half cardigan structure is closest to knitting point.

4. The interlock structure shows highest cam force followed by that of rib and half cardigans structures.

5. Yarns of higher thickness, relative rigidity in tension, torsional rigidity and flexural rigidity lead to higher cam force in all the three structures. Incidentally the effect of the torsional rigidity is the strongest.

6. The loop length exhibits a very good negative correlation with yarn variables in all the three structures indicating that coarser and more rigid yarns produce shorter loops. The remaining dimensions are structure specific. It is observed that only the wale spacing of interlock increases with rise in thickness and rigidities of the experimental hosiery yarns and all other dimensions namely the loop length of all three structures, wale spacing of rib structure and course spacing of half cardigan and interlock structures show a declining trend.

7. The crown width has a good positive correlation with yarn variables in half cardigan and interlock while it has no correlation in rib. The loop height, which could not be measured in half cardigan and interlock due to structural limitations, has a positive correlation in case of rib.

8. The verification of the role played by yarn variables on loop dimensions by using regression equations was found to be excellent for loop length of interlock structure (error $< \pm 2\%$). Followed by rib structure (error $\cong< \pm 3\%$). In case of half cardigan the loop length was always overestimated (upto 8%) while the course spacing was underestimated (upto –3.6%). Higher error was recorded (+5 to – 6%) for the wale and course spacing of interlock.

9. The torsional rigidity of yarn has a strong influence on loop dimensions on all three structures followed by that of flexural rigidity and relative (tensile) rigidity. However, the yarn thickness has the maximum importance. It is important to point out that the

rigidities of the experimental yarns are not collinear with yarn thickness as the exact nature of the cotton fibres constituting the yarns as also their manner of assembly in the body of yarns varied considerably.

10. It has been observed that the values of coefficient of friction have a very narrow range of distribution and as a result their influence on the loop dimensions could not be statistically determined.

Finally, this study does reveal the importance of yarn rigidities – the mean torsional rigidity being the most important of the three – and hence the necessity to measure and standardize them for hosiery yarns.

CONTENTS

CHAPTER 6 RELATION BETWEEN LOOP DOMENSIONS AND YARN PROPERTIES