# MECHANICS OF 1x1 RIB LOOP FORMATION ON A DIAL AND CYLINDER MACHINE

*by*

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**CERTIFICATE**

This is to certify that the thesis entitled "MECHANICS OF 1x1 RIB LOOP FORMATION ON A DIAL AND CYLINDER MACHINE" being submitted by Mr. Sadhan Chandra Ray, to the Indian Institute of Technology, Delhi, for the award of the degree of DOCTOR OF PHILOSOPHY in Textile Technology, is a record of bonafide research work carried out by him. Mr. Sadhan Chandra Ray has worked under my guidance and supervision and fulfilled the requirements for the 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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Sadhan Chandra Ray

(Sadhan Chandra Ray)

Dedicated

to

My Mother

## ABSTRACT

An investigation on the mechanics of 1x1 rib loop formation (movement of yarn and knitting elements as well as forces acting on them inside knitting zone) on a dial and cylinder machine is reported in this study.

The work methodology involved the following steps:

i) observation of yarn movement around knitting elements inside knitting zone (KZ) at ultra low speed under different timings of knitting

ii) identification of important factors affecting length of loop under different timings of knitting

iii) development of model (computer programme) on loop formation process under synchronised (SYN) and 2 needle delayed (2 ND) timings

iv) validation of the model by measuring loop length and needle butt-cam interaction force under actual conditions of knitting

v) analysis of the behaviour of the modelled system

The important findings of the investigation are:

i) Rib loop formation process is governed by the phenomenon called robbing back.

ii) Rib loop is formed in multiple planes and the configuration of the loop arms changes in dynamic KZ.

iii) The rate of yarn flow across knitting elements is lower in case of 2 ND timing than SYN timing. Moreover, the rate of change in length of loop arm is steadier in case of 2 ND timing as compared to SYN timing. This indicates a delicate treatment of yarn under 2 ND timing.

iv) The developed model can predict loop length and yarn tension profile inside KZ for various combinations of input variables. However, the model, in general, slightly underestimates loop length (upto 9%). The cam force also tends to be underestimated at the point one needle pitch beyond cylinder knitting point (CKP) (upto 28%) and overestimated at CKP (upto 32%).

v) Change in only relative position of the dial bed with respect to the cylinder bed (timing of knitting) can result in a wide range of loop length. Loop length varies in the range of 35 to 40% while timing is changed from SYN to 2 ND. Peak cam force also changes with change in timing.

vi) Increase in input tension causes drop in length of cylinder and dial loops as well as final length of rib loop. However, the extent of drop depends on the combination of cylinder and dial stitch cam settings and timing of knitting. Cam force increases with increase in input tension.

vii) Cylinder cam setting has direct effect on loop length and cam force irrespective of timing. However, the effect of dial cam setting on loop length and cam force is complex and depends on timing. The loop length may slightly increase, may remain same or even may decrease causing a tremendous rise in cam force as a result of increase in dial cam setting under 2 ND timing.

viii) Yarn properties and dial height have significant effect on loop length and cam force. However, take down load has only marginal effect on loop length and cam force.

ix) Under identical conditions of knitting, dial loop is smaller than cylinder loop under SYN timing whereas the reverse holds true under 2 ND timing.

x) For constant loop length from various combinations of input variables, the relationship between the forces acting on CN and DN is linear under both SYN & 2 ND timings.

xi) Sensitivity of the loop formation system falls with rising value of peak cam force inside KZ.

xii) Considering knitting under identical conditions, the sensitivity of the system is lower and cam forces are higher under 2 ND timing as compared to SYN timing.

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