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Evaluation of Physico-Mechanical Properties of 1×1 Interlock Cotton Knitted Fabric Due to Variation of Loop Length

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Abstract*— The Physico-Mechanical properties of knitted fabric can be changed due to use of various count of yarn, type of yarn (ring, rotor, and compact), quality of yarn, Loop length / Stitch length, structural geometry, fibre composition of yarn etc. This study focused on the various Loop length effect of grey interlock knit structure. With an increase in Loop length, the dimensional properties like CPI, WPI, GSM, thickness & tightness factor will be decreased; while comfort properties like air permeability & water absorbency will be increased. Again shrinkage & spirality will be decreased with increased Loop length at grey stage. Other properties such as bursting strength, abrasion resistance & pilling resistance improved with increased Loop length. Though all the tests for fabric properties were carried out for grey stage, there properties can considerably vary after further finishing of the fabrics. As finishing is mandatory for fabric production, so now-a-days, these kinds of tests are carried out after finishing stage & proper controlling is done according desired quality. Sometimes, controlling of some properties of finished fabrics are beyond our trial. In that case, analysis of fabric properties at grey stage can help us to take various control & corrective actions when necessary.

Keywords*— Loop Length, Physical Properties, Mechanical Properties, Interlock Fabric, Knitted Fabric.

I. INTRODUCTION

Knitting is a method by which thread or yarn is turned into cloth or other fine crafts. Knitted fabric consists of consecutive rows of loops, called Loops. As each row progresses, a new loop is pulled through an existing loop. The active Loops are held on a needle until another loop can be passed through them. This process eventually results in a final product, often a garment [1].

Knitted loop is a kink of yarn that is intermeshed at its base i.e. when intermeshed two kink of yarn is called a knitted loop. A knitted loop is a basic part of knitted fabric [2]. Technically a knitted loop consists of a needle loop & a sinker loop. The length of yarn knitted into one Loop in a weft knitted fabric. Loop length is theoretically a single length of yarn which includes one needle loop & half the length if yarn (half a sinker loop) between that needle loop & the adjacent needle loops on either side of it. Generally larger the Loop length more elastic & lighter the fabric & poorer its cover opacity & bursting strength. Generally Loop length is expressed in mm (millimetre). In the fabrics, loop lengths combine in the form of course lengths & it is there that influences fabric dimensions & other properties like weight, density, shrinkage, spirality etc. Variations in course length between one garment & another can produce horizontal bareness & impair the appearance of the fabric. In the modern knitting machine, it needs to maintain a constant loop length at one feed & another on same machine is mandatory for continuing the constant loop length. Although a machine may be set to knit a specific Loop length, fluctuations in yarn or machine variable can affect yarn surface friction or yarn tension at the knitting point.

As a result, the ratio of ‘robbed back’ to newly-drown yarn changes & alters the size of the knitted loop [3].

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Effect of Loop length on knit fabric structure plays a vital role on its properties. What kind of properties of interlock knit structure will be regulated by various Loop length is the measurement of our research.

II. Materials and Methods

A. Materials

100% cotton fibre was taken as raw material to produce 30 Ne carded Z twisted single ring yarn. ND/2, OF- CAR interlock knitting machine (Well-knit Machinery Co Ltd, Taiwan) was used. Gauge, No. of feeder, Machine diameter and No. of needle were 24E, 68, 34", and 2544 respectively.

B. Methods

Yarn from the same lot are placed in the creels carefully for knitting. After knitting the samples were dry relaxed & then processed, processing includes conditioning of the fabrics at 65% relative humidity & 30°C ± 2°C. After relaxation, the following tests were carried out at 27°C± 2°C & 65% RH.

1) *Loop Length determination:* By the help of HATRA coarse length tester, coarse length of different produced fabrics is measured. Coarse length = π × diameter of the machine × Gauge × Loop length. So, Loop Length = (coarse length)/ (π × diameter of the machine × Gauge) [4].

2) *Determination of WPI, CPI, Loop density and loop Shape factor:* With the help of counting glass we measured WPI & CPI of various Loop length. We calculate Loop density & loop shape factor [5]. Loop density = WPI × CPI. Loop shape factor = CPI/WPI

3) Determination of Fabric Weight (GSM): After relaxation & conditioning of knit fabric samples, GSM of samples were tested by taking test samples with the help of GSM cutter & weighting balance (electronic) [6].

4) Determination of Fabric Thickness: After relaxation & conditioning the tubular fabric was turned into open width form by slitting along the slit line measuring tape, the width of the fabric is measured for different Loop length containing samples [7].

5) Determination of spirality: First cut a sample (50cm×50cm) with the scissor. Then by the over lock sewing m/c the 4 ends of the cut fabric were sewn. After sewing, again by a scale mark (25cm×35cm) on the fabric & then sample washed with a standard soap solution (1g/l). After washing the sample was tumble dried at 65°C± 15°C for 60 minutes. Then after cooling the sample tested with the shrinkage tester scale also the spirality was tested. Shrinkage was tested length wise & width wise along the mark of (35cm×35cm). And spirality was tested along sewing line alignment. (Distortion of the formation of Loops) [8].

6) Determination of bursting strength: Bursting strength of samples was measured by an automatic bursting strength tester. Samples are gradually set on the diaphragm, the automatic bursting strength tester, measures time, distortion, pressure & the flow rate to burst the fabric. For different samples we recovered there parameters [9].

7) Determination of Abrasion resistance: The abrasion properly was tested with the help of Martindale abrasion tester. Each specimen of 38mm diameter are cut from the specimen holders with a circle of standard from behind the fabric being tested. The test specimen holders are mounted on the machine with the fabric under test next to the abrading and a pressure of 12 Kpa is applied through a spindle which is inserted through the top plate. After that a revaluation of 10000 cycles is operated & finally the samples are assumed [10].

8) Determination of pilling resistance: For this test, each specimen is prepared at (125mm×125mm) and cut from the fabric. A seam allowance of 12mm is marked on the back of each square. The samples are then folded face to face & a seam is sewn on the marked line. Each specimen is turned inside out & 6mm cut off each end of it thus removing any sewing distortion. The fabric tabs made are then mounted on rubber tubes. So that the length of table showing at each end is the same. Each of the loose end is taped with PVC tape so that 6mm of the rubber tube is left exposed. All the specimens are then placed in 3 pilling boxes. All the specimens are then placed in 3 pilling boxes. The samples are then tumbled together in a cork-lined box. We used 8000 cycles of revaluations for the test [11].

9) *Determination of Fabric Width:* After relaxation & conditioning the tubular fabric was turned into open width form by slitting along the slit line measuring tape, the width of the fabric is measured for different Loop length containing samples [12].

III. Result and Discussion

A. Effect on WPI, CPI, Loop density and loop shape factor

When Loop length increased, the WPI, CPI, Loop density, loop shape factor, decreased correspondingly. Table 1 for

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different Loop length in interlock fabric represents the change of WPI, CPI, Loop density & loop shape.

TABLE I
CHANGE OF WPI, CPI, LOOP DENSITY AND LOOP SHAPE FACTOR WITH DIFFERENT LOOP LENGTH

Obs. No	Loop Length (mm)	WPI	CPI	Loop Density (WPI ×CPI)	Loop Shape Factor
01	2.50	30	62	1860	2.67
02	2.60	29	59	1711	2.03
03	2.70	28	57	1596	2.04
04	2.74	28	56	1568	2.00
05	2.78	27	54	1458	2.00
06	2.85	25	51	1275	2.04
07	3.05	21	46	966	2.19

B. Effect on Fabric Weight (GSM)

GSM depends on knit structure, yarn count & dimensional properties of knit fabrics. When fabrics density is more, fabrics weight is also more. From the figure 1 it is found that, fabric GSM decreases with the increased Loop. GSM can also vary for some yarn characteristics used in the formation of fabric.

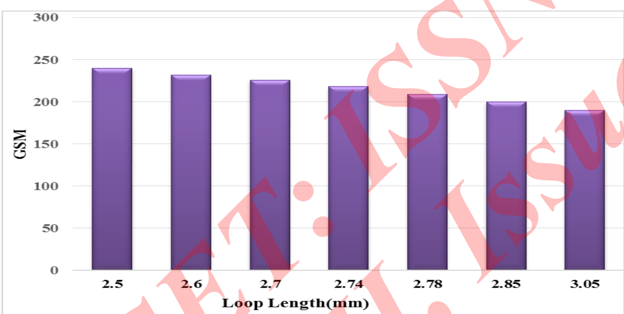

Fig. 1 Change of GSM of fabric with Loop length

C. Effect on Fabric Thickness

Fabric thickness depends on loop shape, compactness of structure & relative closeness of the loops. From the figure 2 it is found that, fabric thickness decreases with the increased Loop length. Thickness can also vary for high yarn diameter, low yarn twist, less lateral compression force etc.

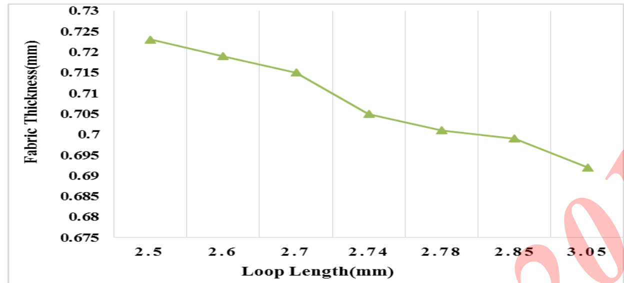

Fig. 2 Change of Fabric Thickness with Loop length

D. Effect on fabric width (open width)

Fabric width depends upon the bending property of loops, type of loops employed, yarn count, cylinder diameter etc

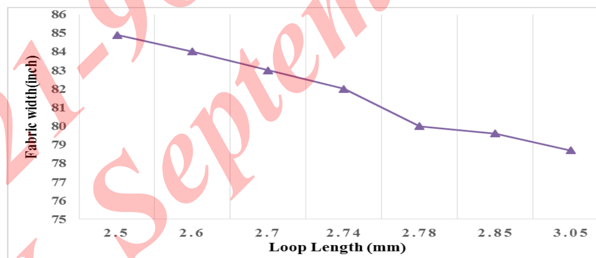

Fig. 3 Change of width with Loop length

From the figure 3 it is seen that with the increasing value of Loop length, fabric width is decreased. This is due to when Loop length increases the loop is less bent than the tension impose upon it. As a result after relaxation, the loops go to their flexible bent position without altering Loop length.

E. Change in bursting strength

From the figure 4 it is seen that if the Loop length increases, bursting strength is decreased. This is due to the fact that, when stich length is less, no. of loops per square inch is more. Therefore, the resistance towards the force is more in case of less Loop length of fabric.

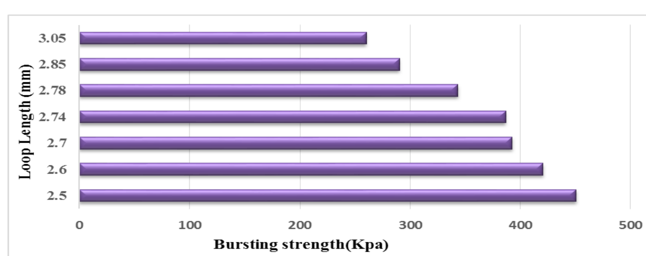

Fig. 4 Effect of Loop length on bursting strength

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F. Change in abrasion resistance

The abrasive wear of a material depends on the construction of the yarn & the structure of the fabric. It was established that abrasion was less for higher density fabrics. This was because of the fact, when the density was more, more loops contributed to the wear & so its abrasion resistance increased.

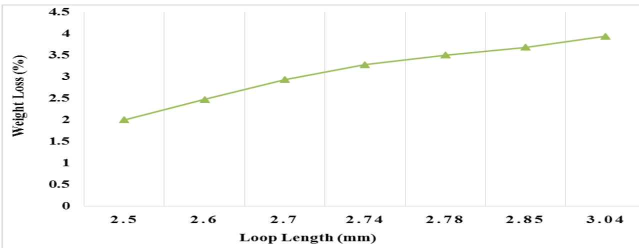

Fig. 5 Effect of Loop length on abrasion resistance

From figure 5 it is seen that, Interlock fabric showed higher abrasion loss% due to its soft nature on the surface.

G. Effect on Pilling Resistance

TABLE 2
CHANGE OF PILLING RESISTANCE OF FABRIC WITH LOOP LENGTH

Obs. no.	Loop Length(mm)	Pilling Resistance (rating)
1	2.50	4-5
2	2.60	4-5
3	2.70	4-5
4	2.74	4-5
5	2.78	4
6	2.85	4
7	3.05	4

From table 2, it is seen that, as the stich length increased, the polling grade values decreased from higher to lower grade. Again, it has been seen that, pilling resistance is very low.

H. Effect on Shrinkage

Shrinkage is an inherent property of knit fabrics which can't be prohibited, but for better quality, it must be controlled in a systematic way. After tumble drying & cooling of the fabric, shrinkage of this samples are measured both lengthwise & width wise.

From figure 6 we can see that with the increase of Loop length, width wise shrinkage is decreasing while lengthwise shrinkage is increasing. As the results are found in grey stage. So results are not compatible with the finished fabric. Because, after treatment shrinkage properties can remarkably be changed.

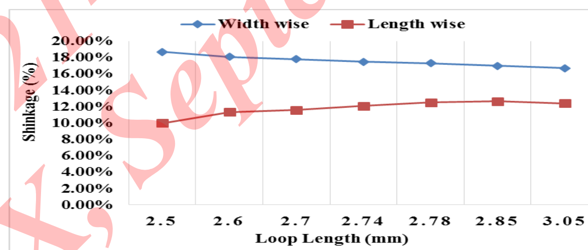

Fig. 6 Effect of Loop length on Shrinkage

I. Change in spirality

Spirality is the distortion of the place of loops where they formed. This is tested along with shrinkage test. It is also an inherent dimensional properties of knit fabrics, which is mostly found in interlock fabrics. From figure 7 it is obvious that with the increase in Loop length, spirality is decreasing.

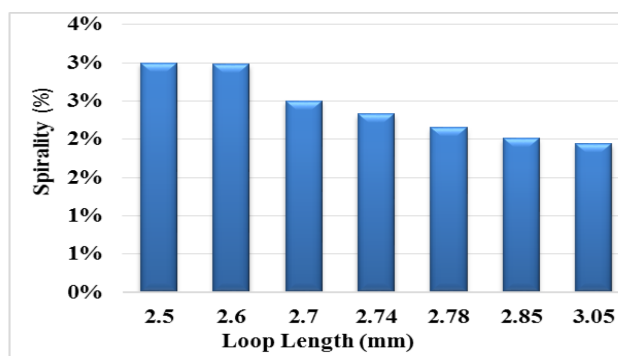

Fig. 7 Effect of Loop length on spirality

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IV. CONCLUSIONS

Loop/Stitch length is the fundamental unit which controls all the properties of weft knitted fabrics. Mainly Loop length & knit structure affects all the dimensional, comfort, handle & other properties. We only worked on interlock, but Loop length also plays a great roll on other structures also. From the analysis, we can get idea about grey stage of knit fabrics , that source will show better performance for the summer inner wear & some for winter outwear . It can be decided that very low Loop length is not also good. For a uniform comfort, handle & tensile properties in the fabric moderate Loop length should be maintained, which in the long run also depends upon the quality, cost & profit of the industry.

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