

A Study on the Effect of Weft Knitted Structures and Stitch Length on the Pilling Behavior of Weft Knitted Fabrics

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Abstract - Determination of the effects of knit construction and the Stitch Length on the pilling behavior of selected basic weft knitted fabrics were studied. The Single jersey Plain, Polo Pique, Single Lacoste and Double Lacoste fabrics were produced from 100% cotton ring yarns. The pilling performance of dyed (finished) fabrics was measured. The testing standard followed during pilling test with Martindale abrasion and pilling tester was of SN198525 & The degree of pilling was assessed using the following 5 point scale from the photographic plate. The results obtained were classified according to the knit construction & Stitch length. Pilling performance of Double Lacoste fabrics were found to be higher than those of other fabrics & also resistance to pilling of weft knitted fabric increases by decreasing of stitch length.

Key Words: Stitch Length; Ring Yarn; Weft Knitted Fabric; Pilling; Pilling Resistance.

1. INTRODUCTION

Knitted fabrics provide outstanding comfort qualities, and they have been preferred as fabrics in many kinds of clothing for long time. Clothing comfort is an extremely complex phenomenon resulting from the interaction of various physical and non-physical stimuli on a person wearing clothing under given environmental conditions. In clothing design and manufacturing, fabric characteristics are usually dictated by specified end-use. A fabric may lose its aesthetic appearance due to wear, which is combined effect of several factors like abrasion, repeated laundering, the application of forces in dry and wet states etc. arising from everyday use and service.

1.1 Knitted Stitch:

Stitch (Fig. 01) is the smallest dimensionally stable unit of all weft knitted fabric.

It composed of:

- A Head
- Two side legs or limbs and

- Feet

And the types of Stitches are:

- Knit loop
- Tuck loop
- Miss loop

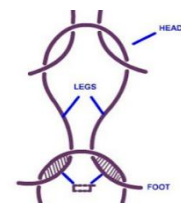


Figure 01: Knitted Stitch

1.2 Stitch Length & Its Effects:

Stitch length (Fig. 02) is the average length of yarn in a knitted stitch. It is sometimes called loop length.

Stitch Length is the most important variable which needs to be controlled to produce a quality fabric. It affects Stitch density, Fabric weight & cost, Fabric dimensions, Dimensional stability such as Relaxation, Shrinkage and Physical performance such as Pilling, Burst strength. Average stitch length must be maintained at the required value during the entire production of a particular fabric quality. A careful knitter with correct equipment should be able to contain stitch length variability to plus or minus 1.5%.

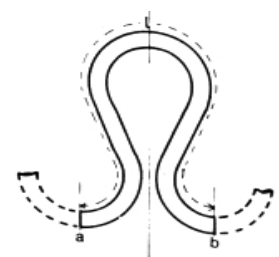


Figure 02: Stitch Length

1.3 Stitch Density:

It (Fig. 03) is the total number of needle loops in a given area such as square inch or square centimeter.

Stitch density = Wales per Cm x Course per Cm.

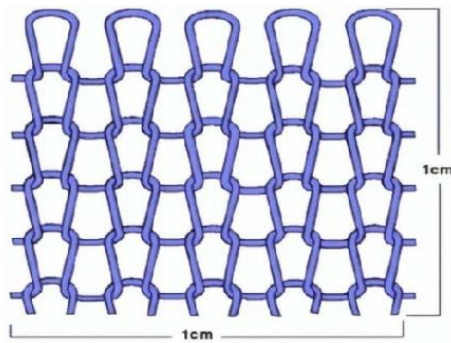


Figure 03: Stitch Density of Knitted Fabric

1.3.4 Double Lacoste Structure:

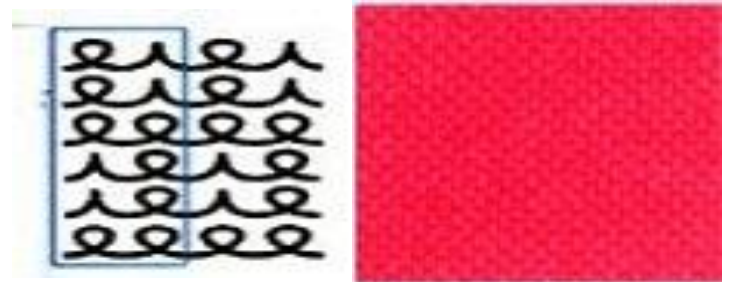


Figure 07: Chain Notation Diagram & Technical Face of Double Lacoste Fabric

1.3.1 Single Jersey Plain Structure:

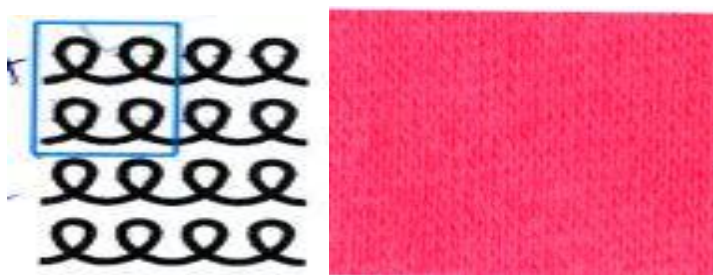


Figure 04: Chain Notation Diagram & Technical Face of Single Jersey Plain Fabric

1.4 Pilling:

Pills are small knots or balls of mixture of large number of small fibers accumulated at the surface of the fabric and entangled by the mild frictional action during processing or wearing. They are soft but firmly held on the surface of the material.

1.4.1 Mechanism of Pilling:

Pilling is a fabric surface fault characterize by balls of entangled fiber clinging to the cloth surface. Pilling happens due to wearing of the surface. The surface of the fabric when abraded the constituent fibers from the yarn surface get liberated and become loose and further abrasion out entanglement on its surface.

1.3.2 Polo Pique Structure:



Figure 05: Chain Notation Diagram & Technical Face of Polo Pique Fabric

These loose fibers or entangled fibers from hard pills on the fabric surface giving an unsightly appearance. The appearance of pills is more prominent in the synthetic material and also materials blended with synthetic fibers.

1.4.2 Effect of Pilling:

Pilling affects the actual durable of a fabric. Give the garment an unsightly appearance. The fabric loses its desirable handle or other qualities. The color of the pills may differ from the body of the garment and the fault is emphasized. It detracts from the appearance of the fabric, making it look old and worn, and it is often difficult to restore a garment with fabric pilling to its original condition.

1.3.3 Single Lacoste Structure:



Figure 06: Chain Notation Diagram & Technical Face of Single Lacoste Fabric

Single jersey structures are the most common and widely used weft knitted fabric in the knitting sector of Bangladesh. Among many problems faced by these fabrics, pilling is one. The pilling of knitted fabrics is very complex property because it is affected by many factors which may include type of fiber or blends, fiber dimensions, yarn and fabric construction, and fabric finishing treatment. The pilling resistance of a specific fabric in actual wear varies more with general conditions of use and individual wearers than in replicate fabric specimens subject to controlled laboratory tests. The experience should be borne in mind when adopting levels of acceptability for any series of standards.

Finishes and fabric surface changes may exert a large effect on pilling.

Pilling performance is the most important mechanical characteristic of fabrics. Many textile scientists have studied factors that have an effect on pilling and abrasion resistance Baird *et al*[1]. Stated that washing increases pilling tendency and speed. Alston *et al*. [2] compared knitted fabrics from compact spun yarns with classic ring spun yarns and reported that knitted fabric from compact yarns demonstrated better pilling performance. Candan & Önal [3] evaluated the pilling performance of weft knitted fabric made of open-end and ring spun yarns. They re-Ported that 100 % cotton samples knitted from ring spun yarns tend to have lower pilling rates than those constructed from 100 % cotton open-end spun yarns. Akaydin [4] studied basic knitted fabrics from ring combed and compact yarns and determined that the abrasion resistance and pilling performance of supreme fabric were lower than interlock fabrics. A.Siddika *et al*. [5] Stated that the pilling tendencies of woolen jersey and rib knit fabrics can be predicted by looking at fibres, thread and fabric properties using artificial neural networks. The study by Nergis & Candan [6] included the pilling performance and abrasion resistance of plain knitted fabric from chenille yarns. The results showed that yarn properties (component yarn count, pile length) and laundering or dry-cleaning do not influence the pilling performance and abrasion resistance of dry relaxed fabrics, whose component yarns tend to decrease.

We tried to our best level to find out the pilling behavior of Single jersey Plain, Polo Pique, Single Lacoste and Double Lacoste fabrics for stitch length of 2.90mm, 2.75mm and 2.65mm.

2. MATERIALS AND METHODS:

2.1 Materials

Fabrics were knitted or produced with 100% cotton ring yarns & 30 Ne carded cotton yarn at Shahil knitting Ltd. The fabrics were dyed and finished at Shahil knit dyeing Ltd, BSCIC, and Narayangonj.

C	Single Lacoste	30 Ne carded cotton	2.90mm, 2.75mm, 2.65mm	Dyed, Finished & Pink Color
D	Double Lacoste	30 Ne carded cotton	2.90mm, 2.75mm, 2.65mm	Dyed, Finished & Pink Color

Table 01: Samples are tested in this Research

2.2 Knitting Machine:

Tested fabrics are produced by Single Jersey Circular Knitting Machine having diameter of 18 inch width 1358 needle & 24 gauges and

Pai Lung Machinery Co Ltd (Taiwan)

Model- Pl-XS3B/CE, Feeder – 54, Gauge – 24

2.3 Testing Methods:

Testing Standard: The testing standard followed during pilling test with Martindale abrasion and pilling tester was of SN198525.

2.4 Pilling Tester:

Martindale Abrasion and Pilling Tester (M235) were used to determine the amount of pilling of the specimen. It is used to determine the abrasion and pilling resistance of all kinds of textile structures. Sample is rubbed against abradant at low pressures and the amount of pilling or abrasion is compared against standard parameters. The design of the M235 allows removal of individual sample holders for examination without lifting the top motion plate. The equipment is supplied with individual sample counters. A choice of loading weights and pressing weight is there to ensure correct loading weight and pressing weight to ensure correct loading of the abradant fabric.

Pilling Machine Settings:

Total stroke of the outer peg	24.0+/-0.5mm
Total stroke of the inner peg	24+/-0.5mm
Abrasion area of the specimen holder	64 sq cm
Mass of specimen holder and spindle (For knitted fabrics)	163g+/-7g

S.I. No.	Sample structures	Yarn Count & Types	Stitch Length	Sample State
A	Single Jersey Plain	30 Ne carded cotton	2.90mm, 2.75mm, 2.65mm	Dyed, Finished & Pink Color
B	Polo Pique	30 Ne carded cotton	2.90mm, 2.75mm, 2.65mm	Dyed, Finished & Pink Color



Figure 08: Martindale Abrasion and Pilling Tester



Figure 09: Specimen Cutter of Martindale Abrasion and Pilling tester



Figure 10: Accessories of Martindale Abrasion and Pilling Tester

2.5 Evaluation Standard: The degree of pilling was assessed using the following 5 point scale from the photographic plate.

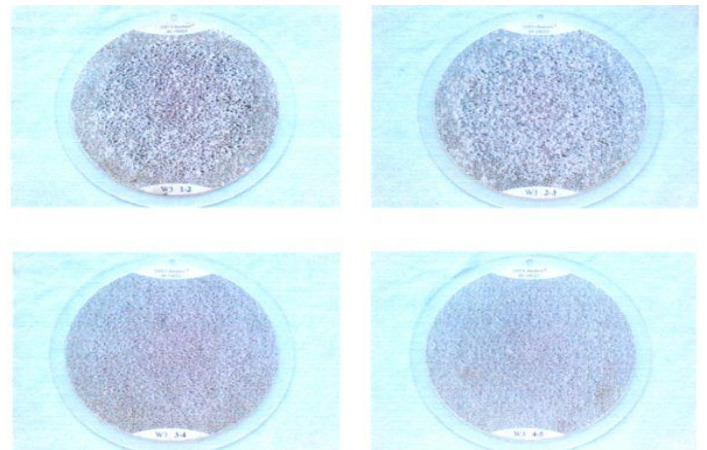


Figure 11: A set of Photographs provided by SDL

3. RESULT & DISCUSSION

Observation-A (Single Jersey Plain Structure)

No. of Observation	Stitch length	Pilling Grade	Stitch length	Pilling Grade	Stitch length	Pilling Grade
1.	2.65	2.5	2.75	1.5	2.9	1
2.	2.65	2.5	2.75	2	2.9	1
3.	2.65	3	2.75	2	2.9	1
4.	2.65	3	2.75	2	2.9	1.5
5.	2.65	3	2.75	2	2.9	1.5
Average		=2.8		=1.9		=1.2
		≈3		≈2		≈1

Table 02: Assessment data for Pilling effect on Single Jersey Plain Structure

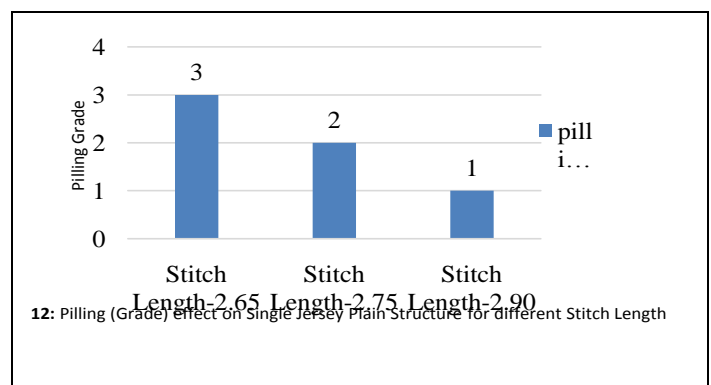


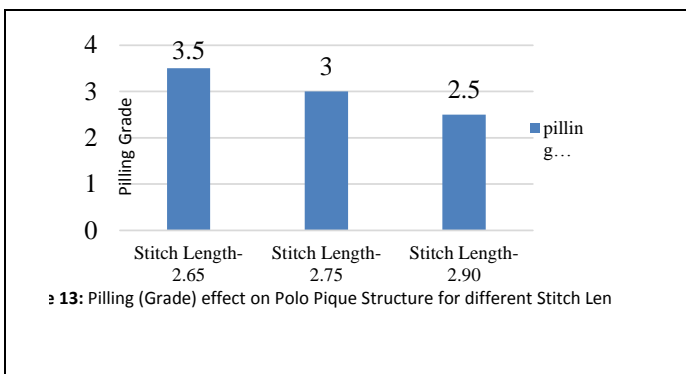
Figure 12: Pilling (Grade) effect on Single Jersey Plain Structure for different Stitch Length

The above Table 02 & Figure 12 shows that, increasing the stitch length of single jersey plain fabric decreasing the pilling resistance.

Observation-B (Polo Pique Structure)

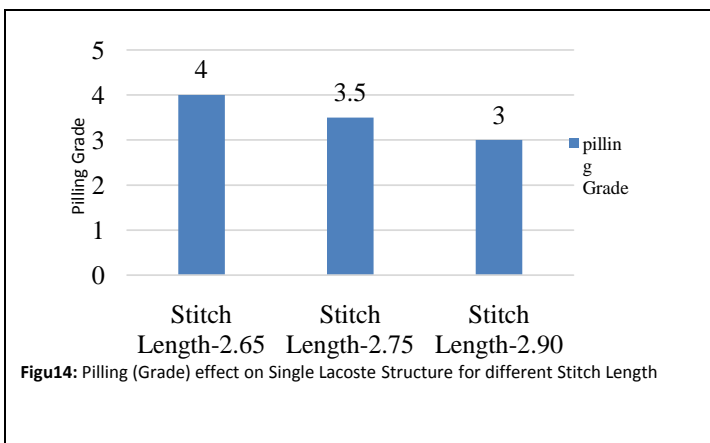
No. of Observation	Stitch length	Pilling Grade	Stitch length	Pilling Grade	Stitch length	Pilling Grade
1.	2.65	3.5	2.75	3	2.9	2.5
2.	2.65	3.5	2.75	3.5	2.9	2.5
3.	2.65	3	2.75	3	2.9	3
4.	2.65	3.5	2.75	3	2.9	2.5
5.	2.65	3.5	2.75	3	2.9	2.5
Average		=3.4		=3.08		=2.6
		≈3.5		≈3		≈2.5

Table 03: Assessment data for Pilling effect on Polo Pique Structure for different Stitch Length



The above Table 03 & Figure 13 shows that, increasing the stitch length of Polo Pique fabric decreasing the pilling resistance.

Observation-C (Single Lacoste Structure)



The above Table 04 & Figure 14 shows that, increasing the stitch length of Single Lacoste fabric decreasing the pilling resistance.

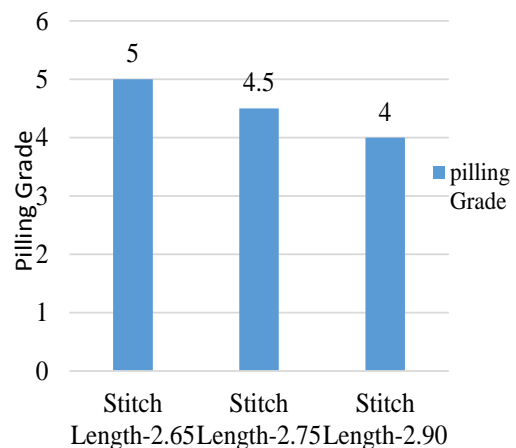
Observation-D (Double Lacoste Structure)

No. of Observation	Stitch length	Pilling Grade	Stitch length	Pilling Grade	Stitch length	Pilling Grade
1.	2.65	5	2.75	4.5	2.9	4
2.	2.65	5	2.75	4.5	2.9	4.5
3.	2.65	5	2.75	4.5	2.9	4
4.	2.65	5	2.75	4	2.9	4
5.	2.65	4.5	2.75	4.5	2.9	4
Average		=4.9		=4.4		=4.1
		≈5		≈4.5		≈4

Table 05: Assessment data for Pilling effect on Double Lacoste Structure for different Stitch Length

No. of Observation	Stitch length	Pilling Grade	Stitch length	Pilling Grade	Stitch length	Pilling Grade
1.	2.65	4	2.75	3.5	2.9	3
2.	2.65	4	2.75	3.5	2.9	3
3.	2.65	3.5	2.75	4	2.9	3
4.	2.65	4	2.75	3.5	2.9	2.5
5.	2.65	4	2.75	3.5	2.9	3
Average		=3.9		=3.6		=2.9
		≈4		≈3.5		≈3

Table 04: Assessment data for Pilling effect on Single Lacoste Structure for different Stitch Length



The above Table 05 & Figure 15 shows that, increasing the stitch length of Double Lacoste fabric decreasing the pilling resistance.

Observation-E (Comparative Pilling Grade)

Stitch Length	Stitch length-2.65	Stitch length-2.75	Stitch length-2.9
Fabric Structure			
Single Jersey Plain	3	2	1
D. Lacoste	5	4.5	4
S. Lacoste	4	3.5	3
Polo Pique	3.5	3	2.5

Table 06: Assessment data for comparative pilling effect in respect of fabric Structures & Stitch Length

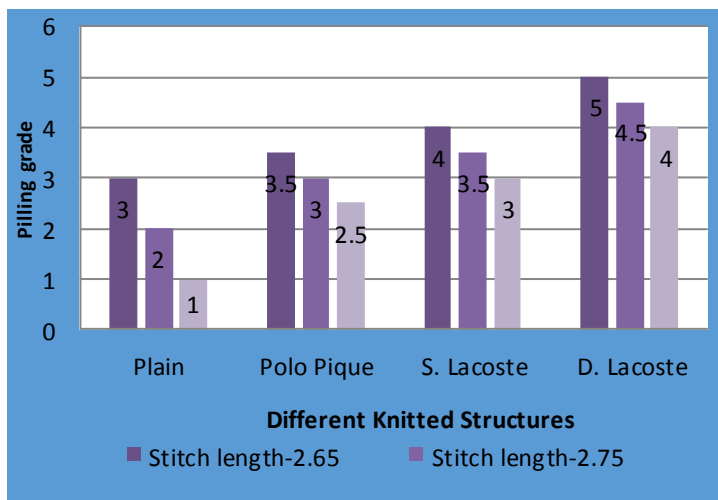


Figure 16: Comparative pilling effect in respect of fabric Structures & Stitch Length

The influence of knitting structure on propensity to pilling is evident from the data presented in fig. 16, the fabric knitted in double Lacoste design has the best grade of the visual assessment and the plain knitted fabric has the worst grade. Polo pique structure has better grade than the plain knitted fabric but worse than single Lacoste structure.

The influence of stitch length on pilling resistance is apparent from the data presented in Fig. (12-15). In all case propensities to pilling of weft knitted fabric decrease by decreasing of stitch length. Fabric of lower stitch length is knitted more tightly. A tight compact knitted construction will have the best pill resistance.

Plain knitted fabric with stitch length 2.65mm has half grade better visual assessment than jersey with 2.75mm. The same trends are got from comparison of visual assessment of other structures knitted with different stitch lengths

4. CONCLUSION:

Pilling resistance of examined weft knitted fabrics depends on stitch length, knitting structure and fabric density. The double Lacoste knitted fabric gives substantially fewer pills than the single Lacoste, polo pique and single jersey plain fabric because of less operated surface area. Also resistance

to pilling of weft knitted fabric increases by decreasing of stitch length. Fabric of lower stitch length is knitted more tightly. A tight compact knitted construction will have the best pill resistance.

5. REFERENCES

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BIOGRAPHIES



Mohammad Mosharof Hossain, trying to give his effort as a textile researcher in Bangladesh. He maintains close relation with industries to know what are going to face and try to mend the gap by updating. In addition, he is tendentious for fabric (Woven) structure, Design and analysis. Now, He is very near to achieve his M.Sc. in Textile Engineering degree from Bangladesh University of Textiles.



Md. Lutfor Rahman, a textile effluent specialist in Bangladesh. His another area of research interest is fabric science. He is a M.Sc. student of Bangladesh University of Textiles.