ANALYSIS OF PILLING PERFORMANCE OF DIFFERENT FABRIC STRUCTURES WITH RESPECT TO YARN COUNT AND PICK DENSITY

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Abstract: *Fabric of three basic weave structure such as plain, twill, satin and their derivative matt and diamond consisted of 100% cotton fibre composition were tested with different picks per inch of 42, 52, 66 and different yarn count of Ne 20/1, Ne 30/1 and Ne 40/1 to determine their surface pilling performance. The investigation developed a way so that it can be visualized or can forecast the resulting fabric specification with required configuration. The research emphasized on the adjustable points mainly controlled physical parameters on which fabric pilling performance directly or indirectly depends. The pilling were evaluated according to the standard ISO 12945-2 and up to 2000 multi-directional rubbing cycle. From the visual assessment it can be approached that fabric pill formation decreases with the increase of picks per inch and same number of ends. Higher yarn count causes compact fabric structure resulting less fibre migration and surface pilling. At different ranges of yarn count and pick density the variation of finished fabric pilling performance with different weave structure is different. Open structure consist of long float length facilitates high degree of pilling and vice versa. From a constant, grade of pilling can be obtained for a particular fabric type, structure and yarn countcount.*

Key words: *Pilling, Fabric composition, Yarn count, Pick density, Weave structure.*

1. INTRODUCTION

The range of usage of woven fabrics is quite varied. In general any woven fabric has a smooth surface, thickness, tensile strength and flexibility [1]. Mechanical characteristics are very important within fabric characteristics. The mechanical characteristics of fabrics generally affect fiber, yarn and fabric characteristics and the finishing process [2].

Pilling is a fabric defect which is observed as small fiber balls or group consisting of intervened fibers that have been attached to the fabric surface by one or more fibers [3]. Pilling in general, is a self-limiting process which emerges at three consumptive different stages. Formation of surface fuzz, entanglement, and transformation into pills. Subsequently, pills are broken off the fabric surface when by excessive frictions, the anchor fibers are broken [4]. The pills are formed during wear and washing, which means that fabrics are affected by friction forces during usage. Friction forces results in the abrasion and pilling of fabric. Consequently there are some relationships between abrasion resistance and pilling .The construction of the fabric is also important in determining its susceptibility to pilling. A very tight, compact construction, such as denim, usually pills very little. However, a loosely knitted or woven fabric will show more pilling with both wear and cleaning. Pills do not interfere with the functionality of the textile, unless a spot with a lot of pills turns into a hole in the fabric. This is because both pills and holes are caused by the fabric wearing [5].

Many textile scientists have studied the factors that generally affect pilling performance [6-9]. Pilling attitude is prejudiced by not only the structure of the yarn and fabric but also by the fiber properties, e.g. tensile strength, percent elongation, flex abrasion, bending rigidity, fiber titer, shape of fiber cross-section and friction [10]. A mathematical model was extablished to evaluate fiber–fiber friction and that gave an indication of the pilling properties of man-made cellulosic knitted fabrics [11]. In another work, fabric pilling was evaluated with light-projected image analysis. It was found that the method could eliminate interference with pilling information from the fabric color and pattern [12]. Different pilling testers may give different pilling results for the same fabric, and it has different sensitivities for various yarn fibre and fabric parameters [13].

2. MATERIAL AND METHOD

The objects of investigations were woven fabrics of five different weave structures which main characteristics are presented in Table 1.

Table 1: *Test Material Specification*

Fabric Type	EPI	PPI	Warp Count	Weft Count
100 % Cotton	80	42, 52, 66	Ne 30/1	Ne 20/1, 30/1, 40/1
70% Polyester 30% Cotton		56		Ne 40/1
100% Polyester		56		75D

The fabric went through enzymatic desizing. Chemicals used for desizing were Hostapal Xtra Liquid conc, Sirrix Antox CN liquid, Cytosol PHC liquid and acetic acid. The liquor PH was 5-5.5 at 90°C temperature for 30 minutes. Soaping was done to the desized fabric for 10 minutes at 90°C temperature. 1gm/liter of Hostapal Xtra liquid conc. was used.

GSM cutter (SDL International, England) was used to cut the fabric specimen and electronic precision balance (AND Company Ltd., England) was used to weight the test samples.

Wet and Dry Bulb Hygrometer (ZEAL, England) was used to determine the atmospheric condition of the testing room. During pilling test in testing lab the temperature was 24°C and corresponding relative humidity was 68%.

Pilling test was done by Martindale Pilling Tester (SDL International, England). Method used for the experiment was ISO 12945-2 [14]. Specimen Size was 140 mm and Sample Size was 90 mm. Weight of Specimen: 423+/-7 gm. (For Woven). The samples were subjected to multi-directional rubbing for 125, 500 and 2000 cycles. After each completed cycle the samples were brought under sufficient light and compared to standard photographs and grading was done. The grading system for visual pilling assessment authorized by ISO is given in Table 2.

Table 2: *Grading of Pilling*

Grade	Description
5	No change
4	Slightly surface fuzzing and some pills formed
3	Moderate surface fuzzing and moderate pilling
2	Distinct surface fuzzing and distinct pilling
1	Dense surface fuzzing and severe pilling

3. RESULT AND DISCUSSION

During testing, the experimental data for five weave structures were observed and shown on the Table 3-7.

Table 3: *Pilling rating for 1/1 Plain structure*

Sample no.	Weft Count	Picks per inch	Pilling rating at 125 cycles	Pilling rating at 500 cycles	Pilling rating at 2000 cycles
01	Ne 20/1	42	4-5	4	3
02	Ne 20/1	52	4-5	4	3-4
03	Ne 30/1	42	4-5	4	3
04	Ne 30/1	52	4-5	4	3
05	Ne 40/1	42	4-5	3-4	2
06	Ne 40/1	52	4-5	4	2-3
07	Ne 40/1	66	4	3	3
08	Ne 40/1	52	4-5	4	2-3
09	Ne 40/1	66	4	3	3

Table 4: *Pilling rating for 2/2 Matt structure*

Sample no	Weft Count	PPI	Pilling rating at 125 cycles	Pilling rating at 500 cycles	Pilling rating at 2000 cycles
1	Ne 20/1	42	4	3-4	2-3
2	Ne 20/1	52	4-5	3-4	2-3
3	Ne 20/1	66	4-5	3-4	2-3
4	Ne 30/1	42	3-4	2-3	1-2
5	Ne 30/1	52	3-4	3	2
6	Ne 30/1	66	3-4	2	2
7	Ne 40/1	42	3-4	2-3	1
8	Ne 40/1	52	4	3-4	1-2
9	Ne 40/1	66	4-5	4	2

Table 5: *Pilling rating for 3/1 Twill structure*

Sample no	Weft Count	PPI	Pilling Rating at 125cycles	Pilling Rating at 500 cycles	Pilling Rating at 2000 cycles
1	Ne 20/1	42	5	5	3
2	Ne 20/1	52	5	4	3
3	Ne 20/1	66	5	4-5	3-4
4	Ne 30/1	42	4-5	4	2-3
5	Ne 30/1	52	4-5	3-4	3
6	Ne 30/1	66	4	3-4	3
7	Ne 40/1	42	4-5	3-4	2
8	Ne 40/1	52	4-5	3-4	2-3
9	Ne 40/1	66	4-5	4	2-3

Table 6: *Pilling rating for 2/2 Diamond structure*

Sample no	Weft Count	PPI	Pilling rating at 125 cycles	Pilling rating at 500 cycles	Pilling rating at 2000 cycles
1	Ne 20/1	42	5	4-5	3
2	Ne 20/1	52	5	4-5	3-4
3	Ne 20/1	66	4-5	4	3-4
4	Ne 30/1	42	4-5	3-4	2-3
5	Ne 30/1	52	4	3-4	3
6	Ne 30/1	66	4	3-4	3
7	Ne 40/1	42	4-5	3-4	2-3
8	Ne 40/1	52	4-5	4	3
9	Ne 40/1	66	4-5	4	3

Table 7: *Pilling rating for 8-ends Satin structure*

Sample no	Weft Count	PPI	Pilling rating at 125 cycles	Pilling rating at 500 cycles	Pilling rating at 2000 cycles
1	Ne 20/1	42	3-4	2-3	2
2	Ne 20/1	52	3-4	2-3	1-2
3	Ne 20/1	66	3-4	2-3	1-2
4	Ne 30/1	42	3-4	2	1-2
5	Ne 30/1	52	3-4	2-3	1-2
6	Ne 30/1	66	3-4	2	1-2
7	Ne 40/1	42	3-4	2	1
8	Ne 40/1	52	3-4	2	1
9	Ne 40/1	66	3-4	2	1

3.1. Effect of yarn count on pilling

From graph 1 it is seen that pilling rating decreases for finer count in all cases. The reason behind that fabrics made with finer yarn i.e. Ne 40/1 are less compact than the coarser yarn i.e. Ne 20/1 even though same structure. If the fabric is made with finer yarn the GSM and compactness will be less. As a result there is more chance of migration of loose fiber on the fabric surface which is responsible for the increase of pilling. For this reason pilling rating of a plain fabric consist of Ne 20/1 weft yarn is 3 which is better than plain fabric consists of Ne 40/1 which pilling rating is 2. This is true for all the structures.

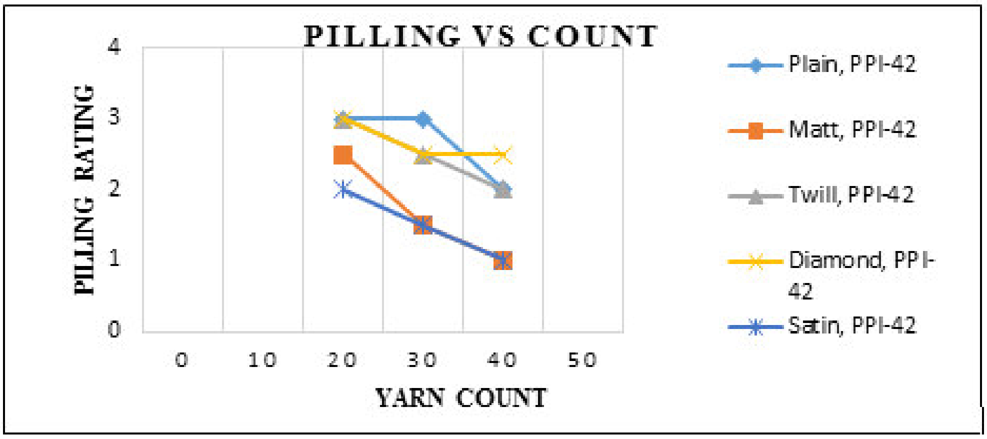

Fig 1: Effect of yarn count on pilling

3.2. Effect of pick density on pilling

From the graph 2 it is seen that pilling performance improve in case of higher pick density. The reason is that higher number of picks per inch causes tight and compact structure of fabrics and thus pilling performance is improved. Due to this reason for 42 ppi pilling rate is lower than the fabric having 52 and 66 ppi. It can be seen in all the fabric structures those have been tested.

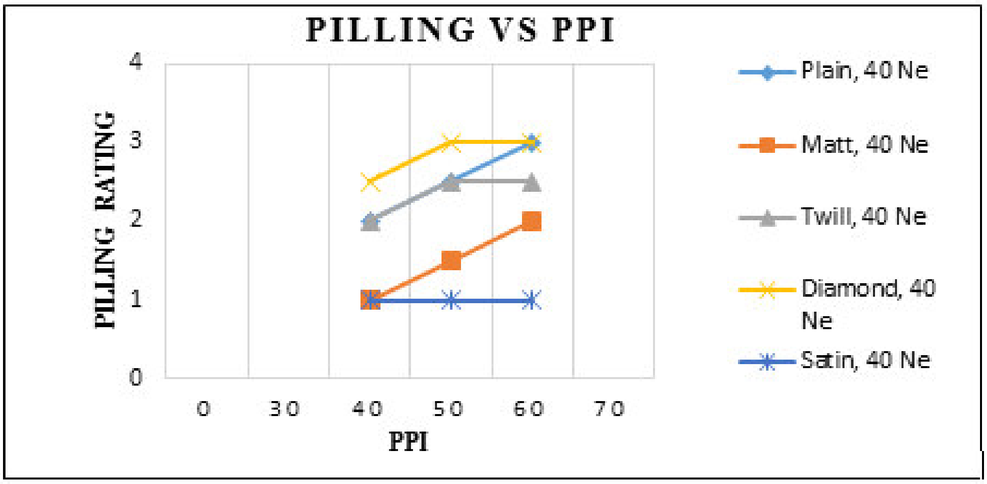

Fig 2: Effect of pick density on pilling

3.3. Effect of fabric structure on pilling

The movement of fibers at the fabric surface is influenced by the binding structure. The open structure, long float length facilitates fiber migration to the surface during wearing. In graph 3, plain weave has compact structure and having small float length so plain structure has lower pilling tendency i.e. pilling rating is 3. On the other hand satin has loose structure and long float length as a result pilling tendency is higher i.e. pilling rating is 1. Twill and matt have less compactness than plain fabric but more than satin. So both of them are showing higher resistance to pilling than satin.

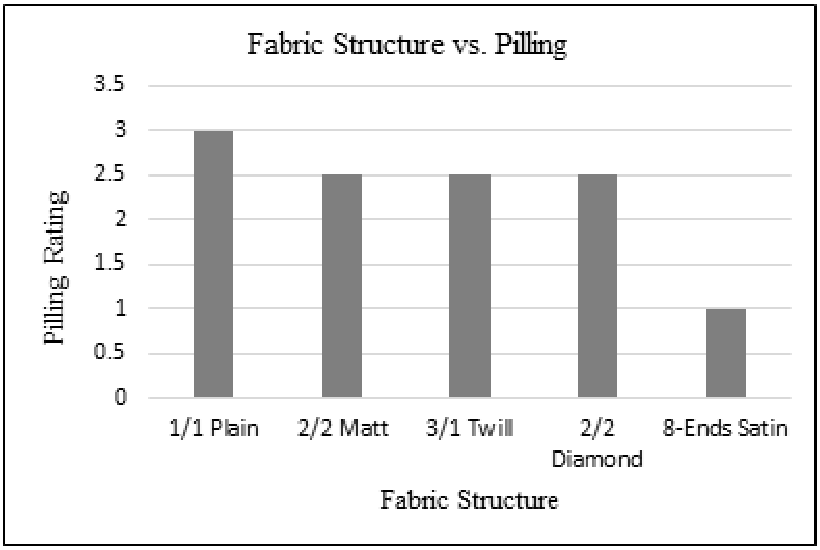

Fig 3: *Effect of fabric structure on pilling*

4. CONCLUSIONS

In this paper, woven fabric of five different weave structure with variable weaving parameters were investigated. According to the result obtained, surface pilling of woven fabrics are indeed dependent on pick density and yarn count incorporated with the fiber type and weave structure. In case of finer yarn count, due to the loose cover factor of fabric surface, pill tends to form more rapidly than that of coarser yarn count. Similarly if pick density is high then fabric structure become tighter and loose fibre migration become difficult resulting low pilling tendency.

Weave structures also plays major role in fabric pilling. Compact woven fabric like plain with short yarn floating is resistent to pilling than satin and twill fabric which due to their open structure facilitate yarn to come out and increase pilling. In case of fiber type, fabrics made of synthetic fiber is more prone to severe pilling but it needs longer wear and abrassion to visualize this properties.

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