Effect of Different Types and Orientations of Fusible Interlinings On Men Striped Shirt Cuffs

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Abstract: Interlining is a layer of knitted, woven or non-woven fabric placed between the garment fabrics and facing to reinforce, to give form and to prevent stretching, the interlining type and its cut direction affects physical and mechanical properties of the garment. The aim of this study is to research the effects of different interlinings and their orientation on shirt cuffs characteristics. In this study, woven fabrics fused with five different fusible interlinings were examined by subjective and objective methods. Both fabric and fusible interlining were cut and fused in following directions 0°, 15°, 30°, 45°, 60°, 90° to form 30 cuff specimens. All specimens were subjected to microscopic examination, bending rigidity for fusible interlining, bending rigidity for fused fabric, bending rigidity for seamed fused fabric, lamination force (N), elongation (%) and appearance tests. Results were analyzed statistically. The highest bending rigidity for cuffs was detected by using the fourth type of fusible interlining at orientation 15°, 30°, 60° and 90°, the lowest bending rigidity was detected by using the fifth type at 15°, the highest lamination force was recorded by using the fifth type of at 45°, the highest elongation was shown by using the first type at 45°, the best appearance for the cuffs was established by using the first type at 45°.
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1. Introduction

Cotton fabrics are the most popular products in the world trading market for elderly, youth and children (Sen, A. K., 2001). It is known that the quality of the product depends on several factors, including the proper selection of fabrics, interlinings, materials, design, and pattern, operating quality, finishing and the appropriate price. Interlining is a layer of knitted or woven or non-woven fabric placed between the shell fabrics and facing (Yıldız E.Z., Pamuk O. and Öndoğan, Z., 2011). Interlining which uses a thermoplastic resin for attaching the face fabric is known as an adhesive or fusible interlining and it is usually used nowadays because of its convenience (Kim K., Inui S. and Takatera M., 2011). Interlinings play an important role in building shape into the detail areas of clothes, such as the fronts of coats, collars, lapels, cuffs, and pocket flaps. Also, they stabilize and reinforce areas subject to extra wearing stress, such as necklines, facings, patch pockets, waistbands, plackets, and button holes (Jeong S.H., Kim J.H. and Hong C.J., 2000).

Functions of fusible interlining in garments can be summarized as the ease of garment manufacturing due to stability of shell fabric, endowment of volume due to good formability, silhouette and shape retention of garment due to repetition of dry cleaning (Kim S.J., Kim K.H., Lee D.H. and Bae G.H., 1998), achievement of appropriate flexibility, improvement of the look, fall and applicable properties of a produced garment (Geršak J. and Šarič A., 1995). The bending properties of shell fabric and interlining ensure the suitable appearance and the "fall" of stabilized garment parts (Esra zeynep yildiz, Nilgün özdil, 2014).

Although interlining is an invisible interior part of a garment, the interlining construction and the fusion process of interlining and shell fabric affect sewability, appearance and mechanical properties of the garment. There are different types of interlining: non-woven interlining which are made up of 100% polyamide products giving a more fine coating to the clothes, hair interlines made from horse hair that are mostly used in blazers and men's formal jackets (www.kkinterlining.com/blog/interlinings-accessories-to-accentuate-your-garments-look_1036, 2012), woven interlinings which are made from lightweight fabrics and are used in jackets as well as in waist bands, knitted interlinings which are used in knit garments and also used in stretchable merged areas and the most common are fusible interlinings that have two types; woven and non-woven (Kristina Dapkūnien, 2008).

Non-woven interlining has superior quality of raw material which is used in the manufacturing of this interlining while the woven interlinings used in any garment that makes the fabric highly durable and can be used for a long-span of time. Interlinings are used for various purposes such as; 1) Interlining is used in shirt collars and cuffs giving them more thick, firm look, and extra strength that gives the garment a more formal look. 2) An interlining is highly essential as it gives the embroidered logo a more firm and thick base. 3) Interlinings are soft, flexible, act as the insulators (www.kkinterlinings.com, 2012) so it can be used in winter coats and pants, thus giving a thicker layer to the clothes. 4) Interlining is used behind thin fabrics, which gives a thicker look to the fabric and making it look more appealing. 5) Interlining is used behind embroideries in order to give a thicker appearance to the embroideries and enhancing its look on any piece of cloth. 6) With the help of interlining sewing of the clothes can be much easier and faster. 7) Depending on the color of the garment, the color of the interlining can be chosen accordingly (K Phebea, K Krishnaraj & B Chandrasekaran, 2014).

2. Material and Methods

This study aims to investigate the effect of different fusible interlinings and their orientations on striped shirt cuffs as regard their microscopic examination, bending rigidity for fusible interlining, bending rigidity for fused fabric, bending rigidity for seamed fused fabric, lamination force (N), elongation (%) and appearance.

In this study, colored striped cotton of plain woven fabric (figure 1) has been used for outer layer and five different types of fusible interlining fabrics that are usually used for shirt cuffs were supplied.

Figure (1): Studied Fabric

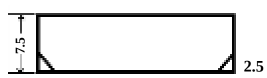

Figure (2): Cuff Pattern

Shell fabric was fused with five different woven fusible interlining by sandwich fusing method with two outer fabrics on the outside of the sandwich and one-side fused interlining on the inside. The fusing was performed by using iron. Both fabric and fusible interlining were cut (figure 2) and fused in following directions 0°, 15°, 30°, 45°, 60°, 90° to form 30 cuffs test specimens (figure 3).

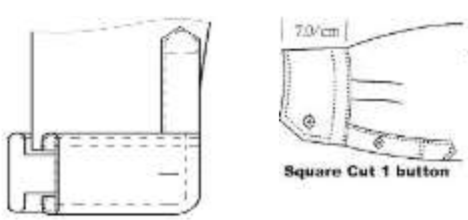

Figure (3): Final Cuff Shape

All specimens were subjected to the following tests:

Subjective tests; In subjective assessments, Appearance of each specimen was assessed with ten juries of experts that have knowledge and experience from the textile and clothing sector, they were chosen for fabric hand evaluation, and the test was performed in standard atmosphere conditions (20±2 ° C temperature and 65±5% relative humidity). Specimens were prepared from each fused panel for subjective tests.

Objective tests; Microscopic examinations, bending rigidity of textile materials and fused systems, lamination force, and elongation were tested, the results were analyzed. All the measurements were performed after conditioning of the fused panels for 24 hours under the standard atmospheric conditions: 20°C ± 2°C and humidity 65% ± 5%.

Microscopic examination: All specimens were examined by fluorescence microscope in National Institute for Standards (NIS), Giza, Egypt. Specimens are self illuminated by internal light, so bright objects are seen in vivid color against a dark background as shown in figure (4).

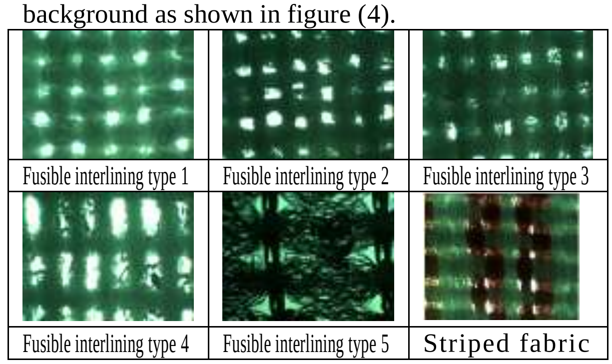

Figure (4): Fluorescence microscopic pictures for striped fabric and all types of fusible interlining

Bending rigidity test: Bending properties of pure bending was applied in meantime using FAST bending meter (Kristina ancutienė, Eugenija strazdienė, Anastasija nesterova, 2010), bending length c, mm is defined on the basis of which bending rigidity B_{FAST}, and μNm is calculated (figure 5). Cantilever bending principle described in British Standard method (BS: 3356, 1990) was applied in this system (BS3356, 1990). Bending rigidity was calculated according to the following equation: $B_{FAST} = W\times c3\times 9.807\times 10^{-6}$, where (W) is the area density in g/m2. Tests of bending rigidity were performed for each: 1) fuse only, 2) fusible interlining specimen cuff (unseamed) and 3) for seamed fused specimen cuff.

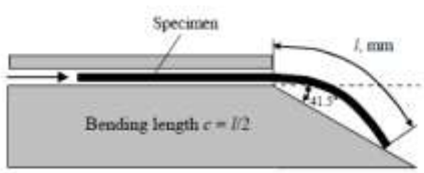

Figure (5): Specimen bending in FAST system

Weight of square meter of fused specimen cuff: All specimens (10×10)cm were weighted by "Mettler digital analytical balance" with 0.1 mg readability in National Institute for Standards (NIS). Table (1) lists the weights of fusible interlining weight and fused fabric (gm/m^2)

Table (1): Fusible interlining weight and fused fabric weight (gm/m^2)

Fabric Type	Fusible interlining weight (gm/m^2)	Fused fabric weight (gm/m^2)
Interlining type 1	220.04	317.34
Interlining type 2	199.61	296.91
Interlining type 3	182.82	280.12
Interlining type 4	226.10	323.4
Interlining type 5	37.48	134.78

Tensile strength and elongation: Tensile strength and elongation tests (figure 6) were performed in National Institute for Standards (NIS) according to H5KT/130 –5000N/[E139-34A. TSX–2.5]- EN ISO 13934-1;999 Maximum Force & Elongation–strip Method. All tests were performed in standard conditions: temperature 20°C ± 2°C and humidity 65% ± 5% (according to standard LST EN ISO 139: 2005)

Figure (6): Tinius Olsen tensile strength and elongation tester

Appearance: Simulated cuffs were prepared as specimens from each fused fabric and were subjected to an assessment model using a 10-point scale, then evaluated through 10 juries from experts (Apparel department staff, textile and clothing sectors) were asked to evaluate the appearance of the specimens.

3. Results

Laboratory tests were performed; results were documented and analyzed statistically according to equations and correlation coefficient to show the effect of different variables on fabric characteristics of this study, table (2) lists the study tests results.

Table (2): Mean values of bending rigidity for fusible interlining, bending rigidity for fused fabric, bending rigidity for seamed fused fabric, lamination force (N), elongation (%) and appearance tests

no.	Fuse no.	Cut Direction	Bending Rigidity (Fuse)	Bending Rigidity (Fused fabric)	Bending Rigidity (Seamed fused fabric)	Lamination force (N)	Elongation (%)	Appearance
2	F1	0°	4.0	10.0	24.3	22.5	194.0	4.3
6	F1	15°	6.2	10.5	20.7	37.0	256.0	5.2
5	F1	30°	3.5	9.0	24.1	10.9	214.0	5.8
3	F1	45°	3.5	12.1	24.9	34.4	327.0	9.8
4	F1	60°	0.7	2.1	24.7	32.5	58.8	8.8
1	F1	90°	3.7	6.4	24.5	29.5	186.0	8.6
8	F2	0°	6.3	12.3	22.6	12.5	103.4	4.2
12	F2	15°	3.2	6.4	12.1	23.0	108.3	4.9
11	F2	30°	3.6	7.6	21.1	29.5	172.8	5.5
9	F2	45°	2.3	5.0	22.9	31.5	131.2	9.3
10	F2	60°	1.1	3.4	21.6	33.2	71.0	8.5
7	F2	90°	1.7	4.7	22.6	21.5	106.8	9.6
14	F3	0°	1.0	4.3	10.3	21.5	197.0	4.1
18	F3	15°	0.4	1.2	7.8	37.2	136.8	5.3
17	F3	30°	0.5	1.9	7.5	19.9	35.4	4.8
15	F3	45°	0.6	1.4	5.8	20.7	97.8	9.0
16	F3	60°	0.7	1.3	7.9	22.5	211.2	9.4
13	F3	90°	1.5	2.6	15.5	23.0	108.3	8.7
20	F4	0°	2.5	7.8	25.2	11.5	232.0	4.5
24	F4	15°	1.6	7.0	25.4	9.5	68.4	4.5
23	F4	30°	1.0	5.5	25.4	9.5	232.8	4.7
21	F4	45°	5.8	14.2	25.0	9.7	228.0	8.1
22	F4	60°	1.2	6.2	25.4	9.2	136.0	8.9
19	F4	90°	3.8	10.7	25.4	9.5	165.0	6.3
26	F5	0°	0.0	0.2	1.2	20.7	97.8	3.1
30	F5	15°	0.0	0.1	0.2	3.5	41.6	3.2
29	F5	30°	0.0	0.1	0.6	2.2	18.8	3.6
27	F5	45°	0.0	0.1	0.5	40.0	27.0	4.7
28	F5	60°	0.0	0.1	1.4	11.4	26.0	4.1
25	F5	90°	0.0	0.1	0.8	6.7	194.0	4.9

1- Bending Rigidity Test for fusible interlining: Table 2 illustrates that the lowest bending rigidity factor for the first type of fusible interlining estimate

-ed at 60° orientation was (0.7), whilst the highest bending rigidity factor at 15° orientation was (6.2). As regard lowest bending rigidity factor for the second type of fusible interlining estimated at 60° orientation was (1.1), however the highest bending rigidity factor at weft direction was (6.3). For the third type of fusible interlining estimated at 15° orientation the lowest value was (0.4), while the highest bending rigidity factor at warp direction was (1.5). The lowest bending rigidity for the fourth type of fusible interlining was (1.0) at 30° orientation, whilst the highest bending rigidity was (5.8) at 45° orientation. Finally, the lowest bending rigidity for the fifth type of fusible interlining was (0) at all orientations.

Accordingly, the highest bending rigidity was fulfilled by using the second type of fusible interlining at weft direction (0°), compared with the lowest bending rigidity for the fifth type cut at any other orientation. By statistical analysis and Anova test as shown in table (3), it was revealed that the difference of cut orientation has no significant effect, while the variability of fusible interlining types has high significance on bending rigidity.

Table (3): the correlation between cut direction and fusible interlining type in bending rigidity test

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Rows (cut direction)	12.5437	5	2.5087	1.3213	0.2952	2.7108
Columns (Fuse type)	56.5494	4	14.137	7.4459	0.0007	2.8660

By applying the results of bending rigidity test graphically as shown in figure (7), there are significant correlations as regard the second and the third type of fusible interlining [$R^2 = 0.8881$],[$R^2 = 0.9113$] respectively. However the first, fourth and fifth type of fusible interlining shows non-significant correlation.

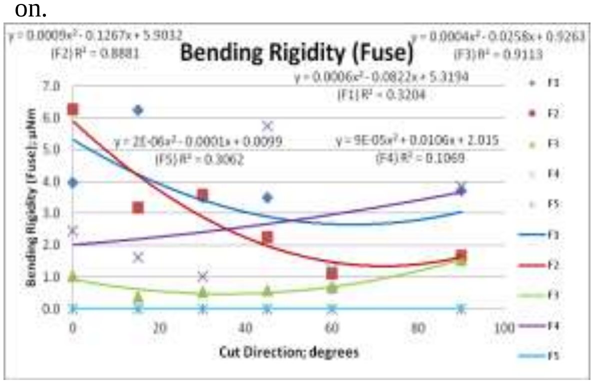

Figure (7): Bending Rigidity for fusible interlining

2- Bending Rigidity Test for seamed fused fabric: Table 2 illustrates that the lowest bending rigidity factor for the first type of seamed fused fabric estimated at 15° orientation was (20.7), whilst the highest bending rigidity factor at 45° orientation was (24.9). As regard lowest bending rigidity factor for the second type of seamed fused fabric estimated at 15° orientation was (12.1), however the highest bending rigidity factor at 45° orientation was (22.9). For the third type of seamed fused fabric estimated at 45° orientation the lowest value was (5.8), while the highest bending rigidity factor at warp direction was (15.5). The lowest bending rigidity for the fourth type of seamed fused fabric was (25.0) at 45° orientation, whilst the highest bending rigidity was (25.4) at 15°, 30°, 60°, 90° orientation. Finally, the lowest bending rigidity for the fifth type of seamed fused fabric was (0.2) at 15° orientation, however the highest bending rigidity factor at 60° orientation was (1.4).

Accordingly, the highest bending rigidity was fulfilled by using the fourth type of seamed fused fabric at 15°, 30°,60°, 90° orientation, compared with the lowest bending rigidity for the fifth type cut at15° orientation. By statistical analysis and Anova test as shown in table (4), it was revealed that the difference of cut orientation has no significant effect, while the variability of seamed fused fabric has high significance on bending rigidity.

Table (4): the correlation between cut direction and seamed fused fabric in bending rigidity test

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Rows (cut direction)	56.81634	5	11.3632	2.2333	0.0909	2.7109
Columns (Fuse type)	2681.286	4	670.321	131.74	5E-14	2.8661

By applying the results of bending rigidity test graphically as shown in figure (8), there is significant correlation as regard the third type of seamed fused fabric [$R^2 = 0.972$]. However all other types of seamed fused fabric show non-significant correlation.

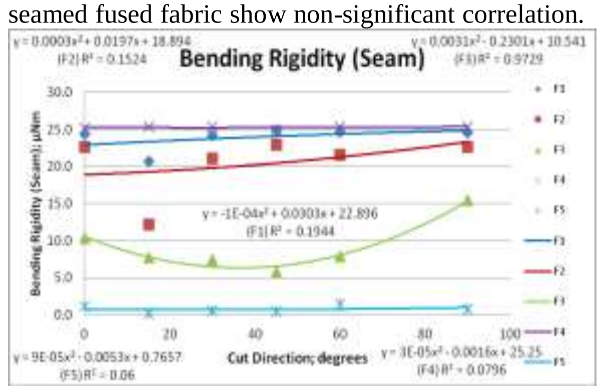

Figure (8) Bending Rigidity for seamed fused fabric

3- Lamination force Test for seamed fused fabric: Table 2 illustrates that the lowest lamination force factor for the first type of seamed fused fabric estimated at 30° orientation was (10.9), whilst the highest lamination force factor at 15° orientation was (37.0). As regard lowest lamination force factor for the second type of seamed fused fabric estimated at weft direction was (12.5), however the highest lamination force factor at 60° orientation was (33.2).For the third type of seamed fused fabric estimated at 30° orientation the lowest value was (19.9), while the highest lamination force factor at 15° orientation was (37.2). The lowest lamination force for the fourth type of seamed fused fabric was (9.2) at 60° orientation, whilst the highest lamination force was (11.5) at weft direction. Finally, the lowest lamination force for the fifth type of seamed fused fabric was (2.2) at 30° orientation, however the highest lamination force factor at 45° orientation was (40.0).

Accordingly, the highest lamination force was fulfilled by using the fifth type of seamed fused fabric at 45° orientation, and the lowest lamination force for the fifth type cut at 30° orientation. By statistical analysis and Anova test as shown in table (5), it was revealed that the difference of cut orientation has no significant effect, while the variability of seamed fused fabric has high significance on lamination force.

Table (5): the correlation between cut direction and seamed fused fabric in lamination force test

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Rows (cut direction)	499.5417	5	99.91	1.318	0.296	2.711
Columns (Fuse type)	1462.082	4	365.5	4.822	0.007	2.866

By applying the results of lamination force test graphically as shown in figure (9), there are significant correlations as regard the second and fourth type of seamed fused fabric [R^2 = 0.993],[R^2 = 0.753] respectively. However all other types of seamed fused fabric show non-significant correlation.

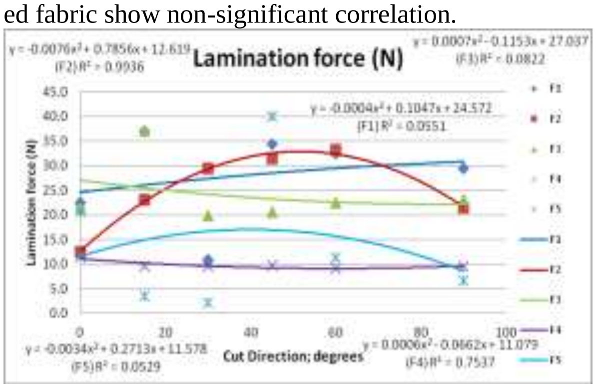

Figure (9): Lamination force for seamed fused fabric

4- Elongation Test for seamed fused fabric:

Table 2 illustrates that the lowest elongation factor for the first type of seamed fused fabric estimated at 60° orientation was (58.8), whilst the highest elongation factor at 45° orientation was (327.0). As regard lowest elongation factor for the second type of seamed fused fabric estimated at 60° orientation was (71.0), however the highest elongation factor at 30° orientation was (172.8). For the third type of seamed fused fabric estimated at 30° orientation the lowest value was (35.4), while the highest elongation factor at 60° orientation was (211.2). The lowest elongation for the fourth type of seamed fused fabric was (68.4) at 15° orientation, whilst the highest elongation was (232.8) at 30° orientation. Finally, the lowest elongation for the fifth type of seamed fused fabric was (26.0) at 60° orientation, however the highest elongation factor at warp direction was (194.0).

Accordingly, the highest elongation was fulfilled by using the first type of seamed fused fabric at 45° orientation, compared with the lowest elongation for the third type cut at 30° orientation. By statistical analysis and Anova test as shown in table (6), it was revealed that the difference of cut orientation has non-significant effect, while the variability of seamed fused fabric has high significance on elongation.

Table (6): the correlation between cut direction and seamed fused fabric in elongation test

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Rows (cut direction)	15742.05	5	3148.41	0.651	0.664	2.710
Columns (Fuse type)	69891.6	4	17472.9	3.613	0.022	2.866

By applying the results of elongation test graphically as shown in figure (10), there is significant correlation as regard the fifth type of seamed fused fabric[R^2 = 0.977]. However all other types of seamed fused fabric show non-significant correlation.

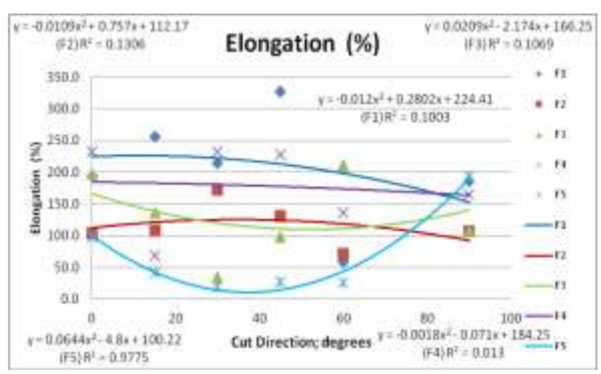

Figure (10): Elongation for seamed fused fabric

5- Appearance Test for seamed fused fabric: Table 2 illustrates that the lowest appearance factor for the first type of seamed fused fabric estimated at weft direction was (4.3), whilst the highest appearance factor at 45° orientation was (9.8). As regard lowest appearance factor for the second type of seamed fused fabric estimated at weft direction was (4.2), however the highest appearance factor at warp direction was (9.6). For the third type of seamed fused fabric estimated at weft direction the lowest value was(4.1), while the highest appearance factor at 60° orientation was (9.4). The lowest appearance for the fourth type of seamed fused fabric was (4.5) at 0°, 15°orientation , whilst the highest appearance was (8.9) at 60° orientation. Finally, the lowest appearance for the fifth type of seamed fused fabric was (3.1) at weft direction, however the highest appearance factor at warp direction was (4.9).

Accordingly, the highest appearance was fulfilled by using the first type of seamed fused fabric at 45° orientation, compared with the lowest appearance for the fifth type cut at weft direction. By statistical analysis and Anova test as shown in table (7), it was revealed that the difference of cut orientation and the variability of seamed fused fabric have no significant effect on appearance.

Table (7): the correlation between cut direction and seamed fused fabric in appearance test

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Rows (cut direction)	89.338	5	17.867	22.959	1.18E-07	2.710
Columns (Fuse type)	42.151	4	10.537	13.540	1.69E-05	2.8661

By applying the results of appearance test graphically as shown in figure (11), there are significa-nt correlations as regard the first type of seamed fus- ed fabric [$R^2 = 0.807$],the second type [$R^2 = 0.857$], the third type[$R^2 = 0.782$], the fourth type[$R^2=0.610$] and the fifth type [$R^2 = 0.818$].

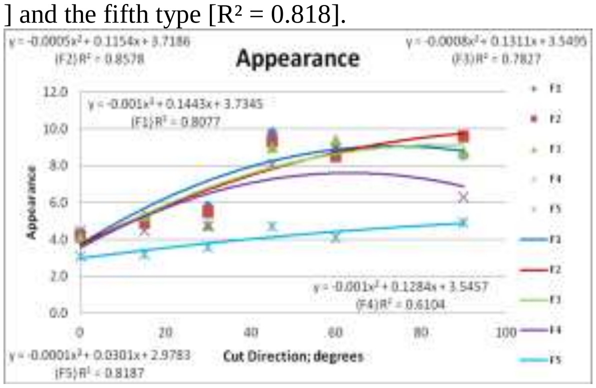

Figure (11): Appearance for seamed fused fabric

4. Discussions

As regard bending rigidity test, the highest bending rigidity for cuffs was detected by using the fourth type of fusible interlining at orientation 15°, 30°, 60° and 90°; this is possibly due to its material has more thickness, density and weight than other types of fusible interlinings used in this study. By using the fifth type of fusible interlining for cuffs, the lowest bending rigidity was detected at 15° orientation; and this is not preferable in men shirt cuff contrary to women shirt cuffs where it is suitable. For the lamination force test, the highest lamination force was recorded by using the fifth type of fusible interlining at 45° orientation, this is might be due to low cover factor of fusible interlining as a result of decrease in number of yarns per cm^2 (e.g. gauze) especially when adhesion of fabric with fusible interlining by heat and pressure infiltrates the adhesive substance into the striped fabric. As regard elongation test, the highest elongation was shown by using the first fusible interlining at 45° orientation, this orientation is considered malleable and fulfilled the highest percentage of fabric deviation. Finally, the best appearance for the cuffs was established by using the first fusible interlining at 45° orientation, which improved the appearance of striped fabric cuffs especially for men shirts.

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