(REFEREED RESEARCH)

SLIPPAGE AND GRINNING BEHAVIOUR OF LOCKSTITCH SEAMS IN ELASTIC FABRICS UNDER CYCLIC LOADING CONDITIONS

ELASTİK KUMAŞLARDAKİ DÜZ DİKİŞLERİN TEKRARLI YÜKLEME ŞARTLARI ALTINDA KAYMA VE SIRITMA DAVRANIŞI

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ABSTRACT

In this study, slippage and grinning behaviour of lockstitch seams on elastic woven fabrics (seam type 1.01.01 SSa-1 stitch type 301) under cyclic loading conditions has been analyzed. The influence of repeated extension and recovery was investigated. For this purpose two different fabric types with two different weft densities and with two different elastane yarn types were taken as samples for the experiments. In total six samples having different specifications were obtained. The effects of mechanical properties of fabrics on the amount of seam slippage and seam grinning are experimentally investigated and statistically analyzed. Seam slippage and grinning on the sewn fabrics increase with decrease weft density and with increasing fabric extensibility. The slippage results of the samples were between 7-14 mm and grinning results were between 0.86-0.94 mm. under cyclic loading conditions. Photographs were taken with an optical microscope to show the slippage and grinning behaviour of the elastic fabrics after 300 cyclic loading conditions.

Key Words: Lockstitch, Seam slippage, Seam grinning, Elastic fabric, Seam.

ÖZET

Bu çalışmada, elastik dokuma kumaşlardaki düz dikişlerin (dikim tipi 1.01.01 SSa-1 dikiş tipi 301) tekrarlı yükleme şartları altında kayma ve sırıtma davranışları analiz edilmiştir. Tekrarlı uzama ve geri toplanmanın etkileri araştırılmıştır. Bu amaçla, deneylerde kullanılmak üzere iki farklı elastanlı iplik, iki farklı atkı sıklığı ve iki farklı kumaş tipi seçilmiş, böylece farklı özelliklere sahip altı kumaş numunesi elde edilmiştir. Dikiş kayması ve sırıtma miktarı üzerine kumaşların mekaniksel özelliklerinin etkisi de deneysel olarak incelenmiş ve istatistiksel olarak değerlendirilmiştir. Dikilmiş kumaşlardaki dikiş kayması ve sırıtması kumaş uzayabilirliğinin artması ve atkı sıklığının azalması ile artmaktadır. Numunelerin tekrarlı yükleme şartları altında dikiş kayması değerleri 7-14 mm arasında ve sırıtma değerleri de 0.86-0.94 mm arasında bulunmuştur. Elastik kumaşlardaki dikişlerin 300 devirli yükleme sonucunda dikiş kayması ve sırıtmasının fotoğrafları optik mikroskopta görüntülenmiştir.

Anahtar Kelimeler: Düz dikiş, Dikiş kayması, Dikiş sırıtması, Elastik kumaş, Dikiş.

Received: 10.04.2009 Accepted: 16.10.2009

1. INTRODUCTION

Seams on garments are subjected to repeated loading during daily use, such as walking, sitting, squating down, etc. This repeated loading causes several seam defects, such as slippage for woven fabrics and seam grinning. Seam slippage (opening) is a mode of failure evidenced by yarn movement at either side of the seam creating a gap or opening as can be seen Figure 1 (1,2). Seam grinning is one of the most important seam defects when considering the apperance and aesthetics of both garments seams (3). Seam grinning may be described as the seperation of the interface line between two sewn fabrics as can be seen Figure 2.

Elastic fabrics have more tendency to seam slippage as the seams at elastic fabrics do not have enough elasticity like the elastic fabric.

The quality and performance of a sewn garment depends on various factors such as seam strength, slippage, grinning, puckering, apperance and yarn severance. Nowadays, apparel plants decrease their quality defect rates, therefore they can become more advantageous in the conditions of competition (4, 5).

When a seam is stretched at right angles to its direction, seam slippage normally occurs. If the slippage is conspicuous, it is regarded as a sewing defect. The former is connected with seam slippage and has been reported to be influenced mainly by fabric characteristics such as weave, type of weaving yarn, coefficient of friction between yarns, fabric density, and so on.

Some researches developed a theoretical model to predict the influence of thread properties, stitch density, applied load and number of loading cycles on the amount of seam grinning (6).

Some researches examined the effects of repeated extension and recovery on selected physical properties of lockstitched seams (7). They found that fabric type and extension limit were important in determining load at maximum initial extension and load change over the first 100 cycles.

The finish with silicone reduces the slippage resistant at the elastic fabrics. This can be explain that the silicone finish reduces the friction between the threads of the fabrics by increasing their movability (8).

2. MATERIALS AND METHODS

PET/Elastane weft stretch twill and plain fabrics were woven with the weft yarn of 150/40 denier PET/elastane air-covered and twisted yarn and warp yarn of 70/72 denier PET yarn. Twill and plain fabrics were woven with two different weft densities. Some essential properties of the fabrics are given in Table 1.

100x150 mm specimens were prepared from these six fabrics in weft direction as described in ASTM 1683. Standard atmospheric conditions were maintained during tests. The samples were sewn with 80 ticket number sewing thread and 90/14 needle size. ISO-301 sticth type was applied with Juki DDL-5550 lockstitch sewing machine with 5 **stitches**/cm.Table 2 shows the properties of sewing thread used.

Repeated extension and recovery tests have been set according to ASTM D 1682- 1683 as carried out by Webster (9, 10). Cyclic loading was applied on Instron tensile testing machine. Specimens were positioned with the seam centered longitudinally in the jaws. 150 mm/minute jaw speed was selected to simulate a steady rate of movement as for a garment which is similar to Webster's study. Extension limit was chosen 40 % for stretch direction to represent the strains encountered in garment wear. Table 5 shows the seam slippage values in stretch direction of the fabric. 40 % extension was applied in weft direction during cyclic loading.

In this study, seam slippage and grinning of the yarns were measured after 50, 100, 200 and 300 cyclic loading. The length of seam slippage and grinning were measured at their 40 % extension in weft direction after 50,100,200 and 300 repeated loading. After the relevant cycles were completed, the seam opening values were measured immediately with an accurate linear compass in order to avoid creep effect (11).

The photographs of the seam slippage and grinning on the fabric samples were taken with an optical microscope. Optical microscopic analysis was carried out by automatic Trinoculer Stereo Zoom Microscope (Olympus SZ 6045 Model).

Table 1. Properties of fabrics used

No	Fabric code	Weave	Density (thread/cm)		Weight (g/m^2)	Fabric Breaking Strength (N)		Seam Strength (N)	
			Warp	Weft		Warp	Weft	Warp	Weft
1	DPA1	Twill	74	26	133	718.6	631.6	449.8	262.7
2	DPA2	Twill	74	29	142	718.3	682.7	442.5	329
3	BTA1	Plain	72	27	132	656.3	707.6	432	414.5
4	BTA2	Plain	72	30	135	678.2	751.7	406	377
5	DTA1	Twill	73	26	134	777.6	713.6	392.3	261.8
6	DTA2	Twill	73	29	134	730.3	753.8	419	338

- D : Twill, B : Plain, A : Weft density (A1,A2)
- P : Air-covered elastic weft yarn, T : Twisted elastic weft yarn

Tablo 2. The properties of sewing thread used

No	Ticket Number	Type	Twist (T/m)	Count (tex)	Tenacity (cN/tex)
1	80	2 Ply PET Spun	805 (Z)	20.5 x 2	25

Tablo 3. SNK test of the seam slippage results under cyclic loading on the twill fabrics at different weft densities

Weft Density (weft/cm)	50 Cycle	100 Cycle	200 Cycle	300 Cycle
26	14.01 a	14.04 a	14.09 a	14.11 a
29	10.58 b	10.62 b	10.66 b	10.68 b

Tablo 4. SNK test of the seam slippage results under cyclic loading on the twill and plain fabrics at different elastane and weave type

		50 Cycle	100 Cycle	200 Cycle	300 Cycle
Elastane	Air-covered	2.37 a	12.39 a	12.44 a	12.46 a
Type	Twisted	12.32 a	12.34 a	12.39 a	12.42 a
Weave	Plain	10.61 b	10.63 b	10.67 b	10.70 b
Type	Twill	14.08 a	14.11 a	14.16 a	14.18 a

Table 5. Seam slippage in weft direction with 40 % extension

No	Fabric Code	50 Cycle		100 Cycle		200 Cycle		300 Cycle	
		Load (N)	Slippage (mm)	Load (N)	Slippage (mm)	Load (N)	Slippage (mm)	Load (N)	Slippage (mm)
1	DPA1	116.5	14.15	102.26	14.17	83.36	14.12	70.63	14.24
2	DPA2	207.23	10.83	181.03	10.68	163.16	10.9	150.86	10.92
3	BTA1	191.53	10.62	171.66	10.64	155.53	10.7	143.23	10.72
4	BTA2	295.46	7.76	276.23	7.78	244.26	7.83	248.63	7.86
5	DTA1	88.6	14.01	72.6	14.04	59.13	14.09	56.6	14.11
6	DTA2	128.3	10.58	118	10.62	94.3	10.66	84.9	10.68

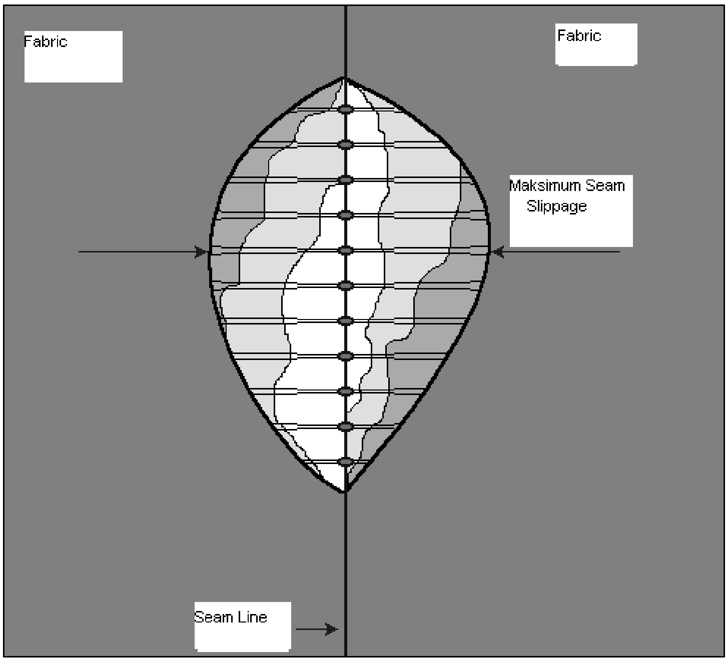

Figure 1. Seam slippage problem (2)

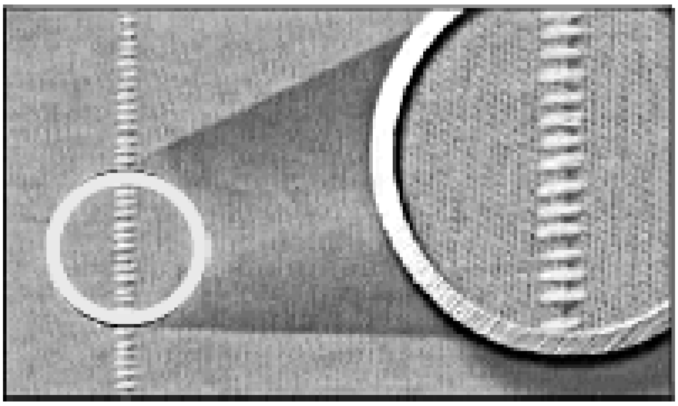

Figure 2. Seam grinning problem (12)

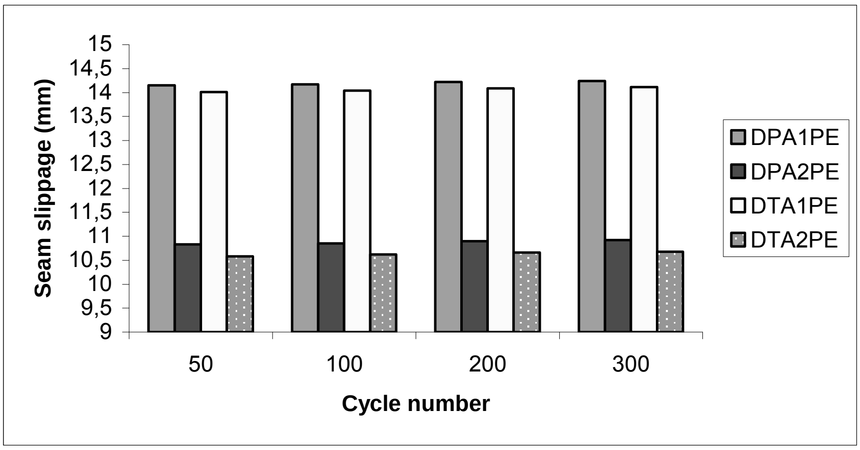

Figure 3. The variation of weft direction seam slippage according to the cycle number at twill fabric samples

Costat was used for all statistical procedures. The results were evaluated by analysis of variance (Anova) and Student-Newman-Keuls (SNK) test. Anovas were applied to data to understand the statistical importance of parameters on seam opening and seam grinning. All test results were assessed at significant levels of a $\alpha \leq 0.05$.

3. RESULTS AND DISCUSSION

All test results are evaluated separetly as given below.

3.1. Seam Slippage Results

Seam slippage results of the samples in weft directions after 50,100,200 and 300 cyclic loading are shown in Figure 3 and 4.

The SNK results at Table 3 and 4 show that significant effects of weft density and weave type in the weft direction seam slippage under cyclic loading conditions. Twill fabric samples had high seam slippage values at 50, 100, 200 and 300 cycles then plain fabric samples. The SNK results show that no significant effects of both air-covered and twisted elastane yarn type in the weft direction seam slippage under cyclic loading conditions.

As can be seen from Figure 3, the seam slippage results were nearly the same both the twill fabric with air-covered and twisted elastane yarn samples.

The SNK results show that significant effects of weft density in the weft direction seam slippage under cyclic loading conditions were seen. While the weft density increased seam slippage values decreased at 50, 100, 200 and 300 repeated cyclic loading.

The fabric structure has been more rigid at high weft densities and seam slippage couldn’t seen much more. As can be seen from Figure 3 and 4 seam slippage values were decreased at 50, 100, 200 and 300 repeated cyclic while weft densities were increased.

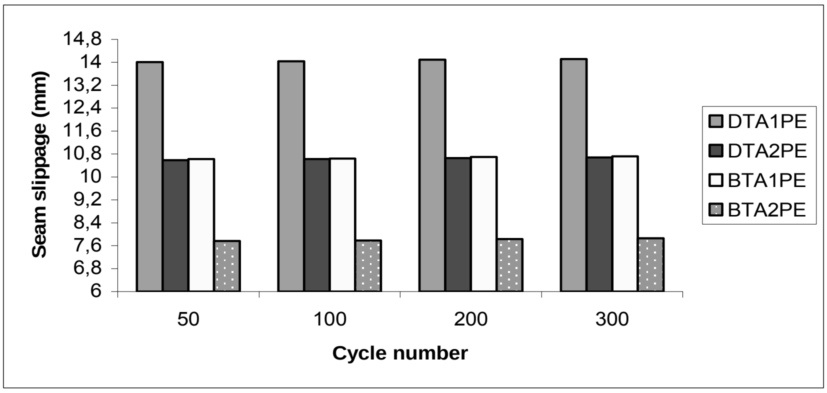

Figure 4. The variation of weft direction seam slippage according to the cycle number at twill and plain fabric samples

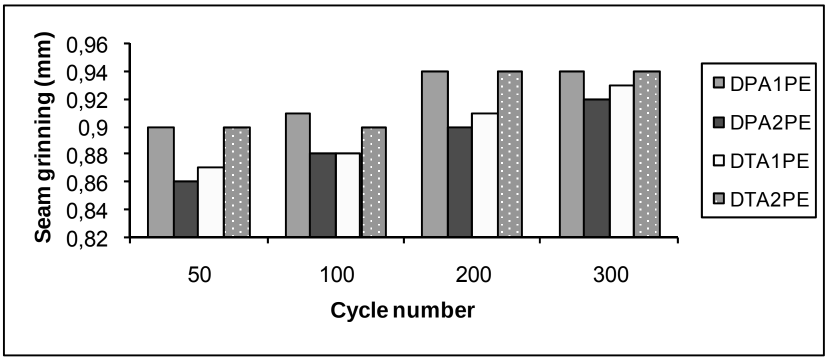

Figure 5. The variation of weft direction seam grinning according to the cycle number at twill fabric samples

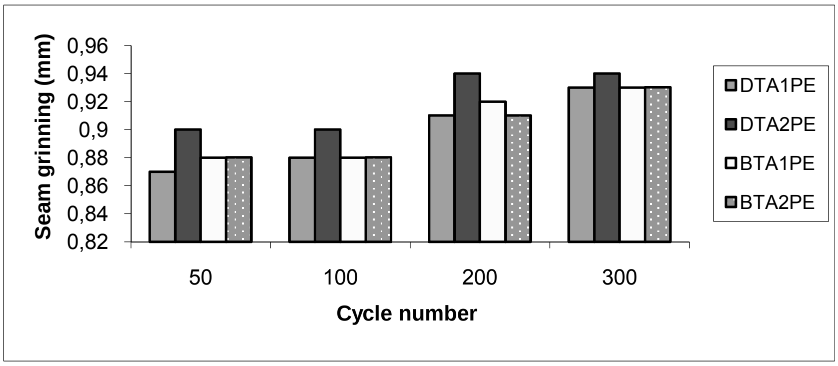

Figure 6. The variation of weft direction seam grinning according to the cycle number at twill fabric samples

3.2. Seam Grinning Results

Seam grinning is one of the most important seam defects when considering the apperance and austhetics of both garments seam.

Seam grinning results of the samples in weft directions after 50, 100, 200 and 300 cyclic loading are shown in Figure 5 and 6.

As can be seen from figures, the seam grinning values were nearly the same and very small (0.87- 0.94 mm) so that we can say there were no significant effects of weave type, elastane yarn type and weft density in the weft direction seam grinning.

The biggest seam grinning were seen at 300 cyclic loading at Figure 6. Cycle number is effective on seam grinning.

3.3. Optical Microscopic Studies

Figure 7, 8 and 9 show seam slippage and seam grinning on the different deformed fabric samples that we used in this study after 300 cyclic loading. The yarns were moved and slippaged near the seam line as can be seen on the photographs. Also some of the weft yarns were broken.

As can be observed at the photographs, the yarns at the seam line slippaged towards outside.

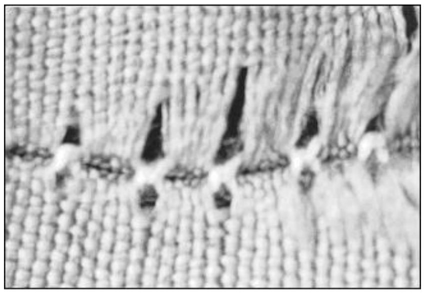

Figure 7. Apperance of seam slippage and grinning of the fabric DPA1 after 300 cyclic loading (x10)

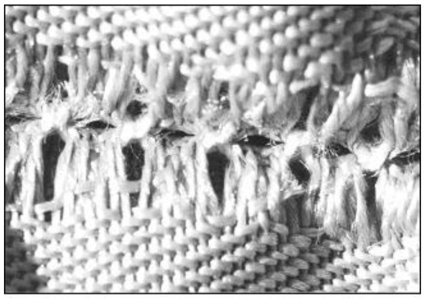

Figure 8. Apperance of seam slippage and grinning of the fabric DTA2 after 300 cyclic loading (x10)

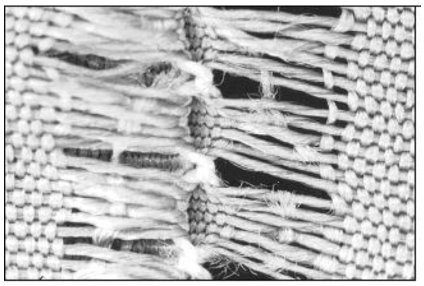

Figure 9. Apperance of seam slippage and grinning of the fabric BTA2 after 300 cyclic loading (x12)

4. CONCLUSION

Seams are essential to the construction of clothes and other textile goods. In general they are subjected to large numbers of loading cycles during use. If sewing conditions have been unsuitable, repeated loading will give rise to seam defects such as the familiar slippage and grinning.

Elastic behaviour of an ISO 301 stitched seam during repeated extension/recovery cycles at low loads in a direction parallel to the seam, we have found that weave type and weft density were necessary.

Seam slippage and grinning increase with decrease weft density and with increasing fabric structure extensibility.

The finish with silicone reduces the slippage resistant at the elastic fabrics. This can be explain that the silicone finish reduces the friction between the threads of the fabrics by increasing their movability. Not to use silicone in the finish procedures at these fabrics cause high slippage, too.

The grinning values were low in these samples when compaired with the seam slippage values which were high. If the slippage is conspicuous, it will be regarded as a sewing defect.

Especially at elastic fabrics, extensibility values must be between 10-20 % if we want low slippage at their seams. Our samples in this study haven't high extensibility. So that we have high slippage values.

At elastic fabrics insufficient seam elasticity cause seam slippage and also break of the seams. This study will be useful to analyze in the further studies the seam slippage behaviour with the different elastic fabric constructions.

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Bu araştırma, Bilim Kurulumuz tarafından incelendikten sonra, oylama ile saptanan iki hakemin görüşüne sunulmuştur. Her iki hakem yaptıkları incelemeler sonucunda araştırmanın bilimselliği ve sunumu olarak ***"Hakem Onaylı Araştırma"*** *vasfıyla yayımlanabileceğine karar vermişlerdir.*