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YÜNLÜ GİYSİLERDE FARKLI DİKİM TİPLERİNİN DİKİŞ VERİMLİLİĞİNİN İNCELENMESİ

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INVESTIGATION OF SEAM EFFICIENCY OF DIFFERENT SEAM TYPES IN WOOLEN GARMENTS

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ABSTRACT: Seams are very important for the quality of woolen garments. Seams of the garment must be durable and smooth. Seam performance is an important factor determining the durability of a garment. The tensile characteristics of seamed fabric changes with the change of fabric bias angle, stitch and seam types. In this study, three wool fabrics with different properties were chosen. Fabrics have been cut in the angles 0°, 30°, 45°, 60° and 90° and then sewn with six different seam types (SSa-1/301, LSc-1/301, LSq-2/301, LSb-1/301, SSc-1/301, LSc-2/301). In these samples, the effects of different seam types at different seam angles of stitching on seam strength and seam efficiency were investigated. Results indicated that, the woolen fabrics seamed with different seam types at different angles possessed statistically different seam strength and seam efficiency values. Fabrics seamed with LSc-2 seam type give the highest seam strength and seam efficiency values and the seams prepared with 30° and 60° bias angles give the lowest seam strength values. Generally, SSa superimposed seam type is preferred in garments. As can be seen from this study, if LSc lapped seam type is used instead of SSa superimposed seam type, the seams would be more durable.

Keywords: Woolen fabric, seam angle, seam type, seam efficiency

YÜNLÜ GİYSİLERDE FARKLI DİKİM TİPLERİNİN DİKİŞ VERİMLİLİĞİNİN İNCELENMESİ

ÖZ: Yünlü giysilerin kalitesi için dikişler çok önemlidir. Giysinin dikişleri dayanıklı ve düzgün olmalıdır. Dikiş performansı, bir giysinin dayanıklılığını belirleyen en önemli faktördür. Dikilmiş kumaşın mukavemet özellikleri, kumaş verev açısı, dikiş ve dikim tiplerinin değişmesiyle değişir. Bu çalışmada, farklı özelliklere sahip üç çeşit yünlü kumaş seçilmiştir. Kumaşlar 0°, 30°, 45°, 60° ve 90° açılarda kesilmiş ve daha sonra altı farklı dikim tipi ile dikilmiştir (SSa-1/301, LSc1/301, LSq-2/301, LSb-1/ 301, SSc-1/301, LSc-2/301). Bu numunelerde, farklı dikim açılarında, farklı dikim tiplerinin dikiş mukavemeti ve dikiş verimliliği üzerindeki etkileri araştırılmıştır. Sonuçlar, farklı dikim tipleri ile farklı açılarda dikilen yünlü kumaşların istatistiksel olarak farklı dikiş mukavemeti ve dikiş verimliliği değerlerine sahip olduğunu göstermiştir. LSc-2 dikim tipi ile dikilen kumaş numuneleri en yüksek dikiş mukavemeti ve dikiş verimliliğini, 30° ve 60° verev açılarda dikilen dikişler de en düşük dikiş mukavemetini vermiştir. Giysilerde genellikle SSa birleştirme dikim tipi tercih edilmektedir. Bu çalışmadan da görüldüğü gibi, SSa birleştirme dikim tipi yerine LSc katlamalı dikim tipi kullanıldığında dikişler daha dayanıklı olmaktadır.

Anahtar kelimeler: Yünlü kumaş, dikim açısı, dikim tipi, dikiş verimliliği

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1. INTRODUCTION

The characteristics of a properly constructed seam are its strength, elasticity, durability, stability and appearance [1, 2]. Seam type must be suitable for the overall construction of the garment [3]. The anisotropic nature of textile fabrics affects the mechanical property of seamed fabric with the change of the test direction [4]. In garment manufacture, which requires conforming a two-dimensional fabric into a three-dimensional surface, seams joining fabric plies along different directions [5]. The seam is defined as a juncture at which two or more planar structures, such as textile fabrics, are joined by sewing, usually near the edge.

Seam types are shown as an alphanumeric designation relating to the essential characteristics of fabric positioning and rows of stitching in a seam. Standards are very important in determining seam types. Six basic seam types and their subgroups are specified in the ASTM D 6193-16 "Standard Practices for Stitches and Seams" standard. The most important reasons for choosing different types of seams in garments are their seam strength and aesthetic appearance. Some of the most commonly used seam types in the garments are superimposed seams (SS) and lapped seams (LS). Lapped seam type is preferred in places where more strength is required. Usually, the appearance of the seam in garments is ignored. However, the seam should look good on the inside as well as on the outside of the garment.

When superimposed seam is used, seam allowances occur on both sides of the sewing line inside the garments and its appearance is not aesthetic. If lapped seam type is used instead of superimposed seam, the seam allowance will not occur. So that different versions of superimposed seams (SSa-1 and SSc-1) and lapped seams (LSc-1, LSq-2, LSb-1 and LSc-2) were chosen to see the differences between them in this study. The SSa seam type shall be formed by superimposing two or more plies of material and seaming them with one or more rows of stitches a specified distance from their edges. SSc seam type shall be formed by superimposing two plies of material, turning the edges of both plies a specified distance to the inside and seaming through the turned edges with one or more rows of stitches a specified distance from the edges.

The LSb seam type shall be formed by folding under the edge of one ply of the material overlapping it at the edge of another ply and seaming with one or more rows of stitches. The LSc seam type shall be formed by folding in and interlapping the edges of two plies of material so that the edges of the material are concealed and seaming with one or more rows of stitches. The LSq seam type shall be formed by: (a) superimposing two plies of material and seaming as in seam type SSa-1, and (b) the top ply shall then be turned back sharply over the first row of stitching and seamed with one or more rows of stitches [6]. LSc-1 and LSc-2 seam types are preferred for the inner side seams of the trousers, especially the inner side seams of the denim trousers, due to its durability. This seam type can also be preferred in woolen trousers. LSc-2 seam type is more durable than the SSa-1 seam type which used more frequently in the woolen trousers.

Seam strength can be measured according to the ASTM D 1683/D1683M-17 "Standard test method for failure in sewn seams of woven fabrics" test method for failure in sewn seams of woven fabric. The ASTM 1683/D1683M-17 standard is preferred because of its accuracy and ease of use. Hence, this method is widely used by the apparel industry for the evaluation of seam strength worldwide [7,19].

Tensile properties of fabrics and seams are often theoretically and experimentally investigated for warp and weft directions, but in the garments the stress is applied in the different directions which are defined according to the fit of the garment. Although there are lots of work on seam strength, researching the effect of seam angle on fabric and seam strength is very limited [8,9].

The maximum stress on the garment seams are occurred at the seams on arm hole and crotch area of trousers. Therefore, more seam failure occurs in these areas. The failure of the seam makes a trouser unsuitable even though the fabric may be in a good condition. Although some of the seams such as the shoulder seams of the jacket are important in the appearance of the garment, they are not subjected to high levels of stress or extension during use. In contrast, some seams, such as the arm hole seams of the jackets and the crotch area seams of the trousers, are subjected to high levels of stress during wear [10,11].

Jacket, trouser and trouser pattern are seen in Figure 1. In the crotch area seams of the trousers and the arm hole seams of the jackets, the seams are applied not only in the direction of the weft and warp, but also in the different bias angles. Therefore, measurement of seam strength at different bias angle (an acute angle between warp and specimen length/test direction) becomes more important in garments [12]. The durability of the seam can be measured in terms of seam efficiency. Seam efficiency is affected by various factors such as fabric structure, seam and stitch types, seam angles, stitch density, sewing threads and sewing needles. Seam efficiencies of 60–80% are common, but efficiencies between 80 and 90% are more difficult obtaining from garment seams. If the seams are occurred at different angles, the seam efficiency can also be over 100%. Low seam efficiency values indicate that the sewn fabric is damaged during sewing [13,14,15].

Seam efficiency is defined as the capacity of the material itself to carry a seam. Seam efficiency is the ratio of seam strength to fabric strength [16,17,18]. In this study, it was aimed to determine the effects of different seam types at different seam angles on the seam strength and the seam efficiency of woolen garments.

2. MATERIAL AND METHOD

2.1. Material

In this study, three different woven fabrics used in woolen garments were selected. The structural properties of the fabrics used in this study are shown in Table 1.

2.2. Method

The test to determine the "seam strength" and "fabric strength" were carried out according to ASTM D 1683/D1683M-17 "Standard test method for failure in sewn seams of woven fabrics" test method [19]. The samples were stitched on an industrial lockstitch sewing machine. Fabrics have been cut in the angle 0°, 30°, 45°, 60° and 90° and then sewn six different seam types (SSa-1/301, LSc-1/301, LSq-2/301, LSb-1/301, SSc-1/301, LSc2/301) with lockstitch (301) for each fabric angles. Therefore, 90 different seamed specimens were prepared. Three repetitions were prepared for each samples. The sewing thread used was 100% polyester, 80 ticket number core spun yarn. As the stitch density, 5 stitches/cm was used for lockstitch.

Seam strength tests were done with Shimadzu AG-X HS model tensile testing machine. Measurement was performed using standard climatic conditions. Arithmetic mean was calculated from the individual measurement results. Prior to the tests, all fabric samples were conditioned for 24 hours in standard atmospheric conditions (at a temperature of 20 ± 2 °C and relative humidity of 65 ± 4%).

The SPSS 14.0 Statistical software package was used for conducting all statistical procedures. Completely randomized, single-factor (one way) multivariate analysis of variance (ANOVA) as a fixed model was applied to data in order to investigate the statistical importance of stitch density and seam angle on seam strength and on breaking elongation properties of wool fabrics. The means were compared by Student-Newman-Keuls (SNK) tests. The value of significance level (α) selected for all statistical tests in the study is 0.05. Treatment levels were marked in accordance with the mean values, and levels marked by different letters (a, b, c) showed that they were significantly different.

Figure 2 shows the placement of the seamed samples on the fabric at different angles. Figure 3 shows six different seam types used in the study. Figure 4 shows the seamed specimen dimensions, prepared from fabric for seam strength test.

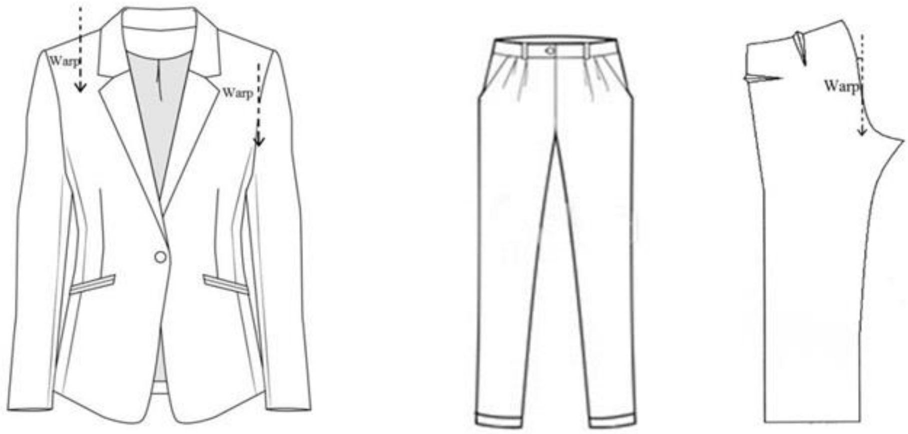


Figure 1. Jacket, trouser and trouser pattern

Table 1. Structural properties of the fabric used in the experimental study

Fabric Code	Weave Type	Density (thread/cm)		Yarn Count (Nm)		Weight (g/m^2)	Construction
		Warp	Weft	Warp	Weft		
A1	Plain	31	24	64/2	32/1	255	% 100 WO
A2	Plain	29	24	70/2	70/2	275	%43WO %53PES %4EL
A3	Plain	30	24	72/2	72/2	280	%81WO %15CO %4EL

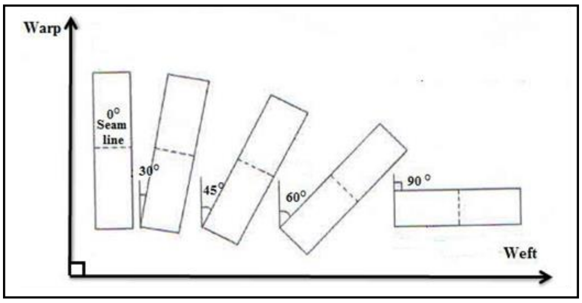
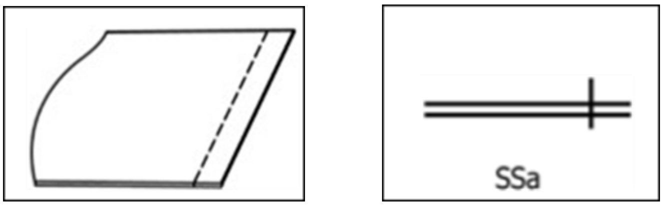
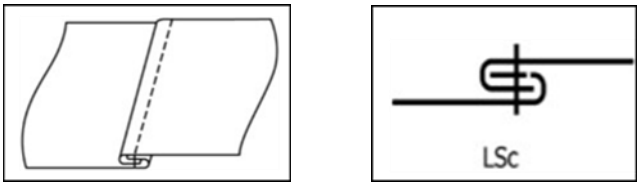


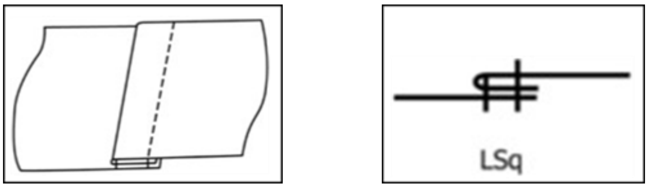
Figure 2. Placement of seam specimens on fabric at different angles [8]



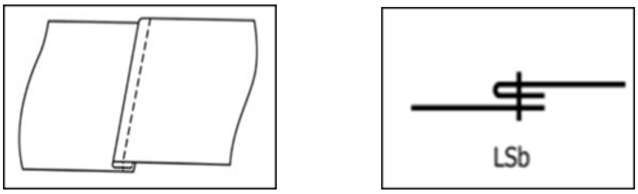
1. Seam type (SSa-1/301)



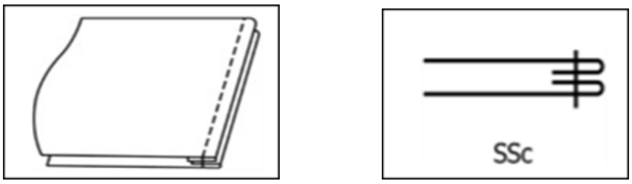
2. Seam type (LSc-1/301)



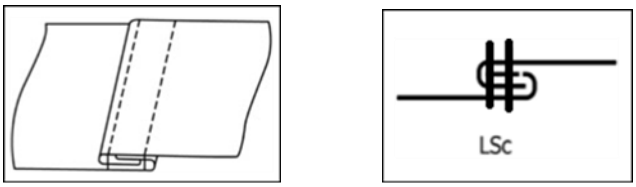
3. Seam type (LSq-2/301)



4. Seam type (LSb-1/301)



5. Seam type (SSc-1/301)



6. Seam type (LSc-2/301)

Figure 3. Six different seam types used [6]

Seam efficiency is calculated by using the Equation (1) [15,16].

$$\text{Seam efficiency} = 100 \times (\text{Seamed fabric strength} / \text{Unseamed fabric strength}) \qquad (1)$$

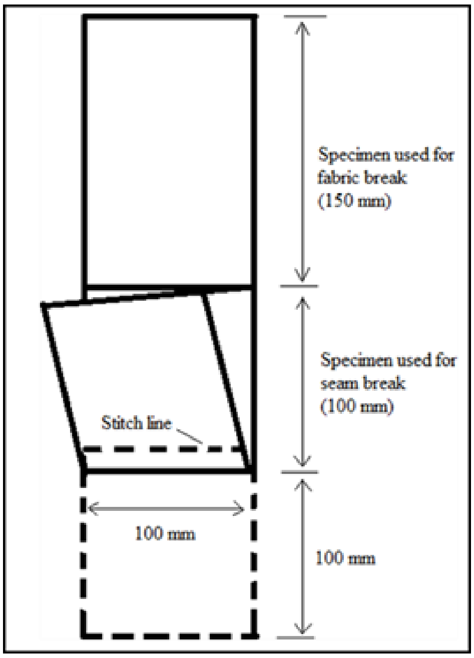


Figure 4. Test specimen for seam strength [19]

3. RESULTS AND DISCUSSIONS

The results of fabric strength at different angles are given in Table 2. Figures 5 and 6 are shown seam strength and seam breaking elongation values of A1 fabric sample with different seam types at different seam angles. The results of the ANOVA test given in Table 3, indicated that, there were statistically significant (%5 significance level) differences between seam strength, seam types and seam angles.

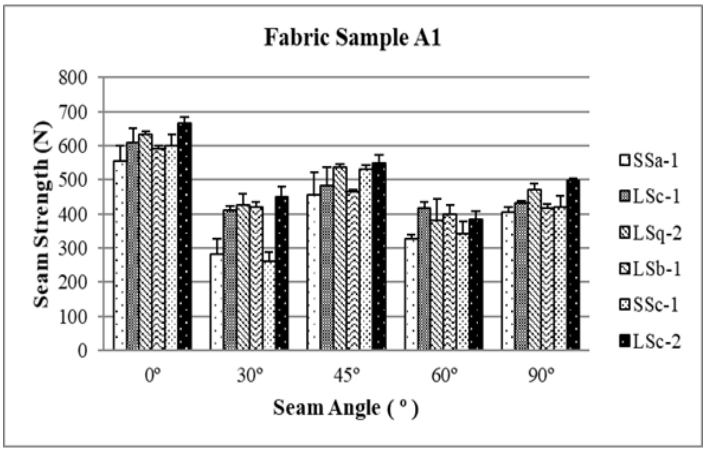


Figure 5. Seam strength values of A1 with different seam types at different seam angles

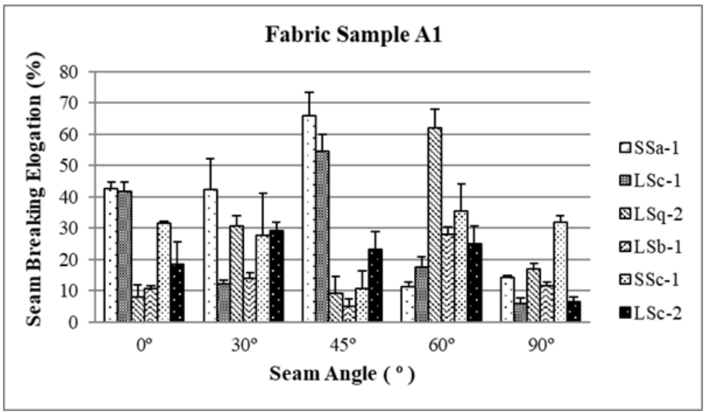


Figure 6. Seam breaking elongation values of A1 with different seam types at different seam angles

Figures 7 and 8 are shown seam strength and seam breaking elongation values of A2 fabric sample with different seam types at different seam angles. The results of the ANOVA test given in Table 4, indicated that, there were statistically significant differences between seam type, seam angles and seam strength.

Figures 9 and 10 are shown seam strength and seam breaking elongation values of A3 fabric sample with different seam types at different seam angles. The results of the ANOVA test given in Table 5, indicated that, there were statistically significant differences between seam angle and seam strength.

The results of the seam efficiency of fabric samples at different seam angles with different seam types are given in Table 6.

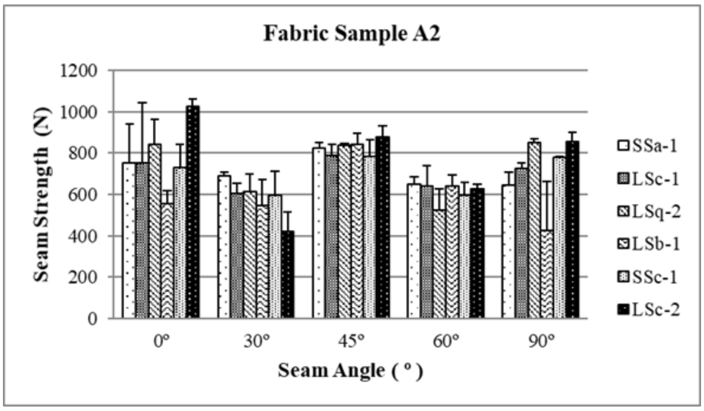


Figure 7. Seam strength values of A2 with different seam types at different seam angles

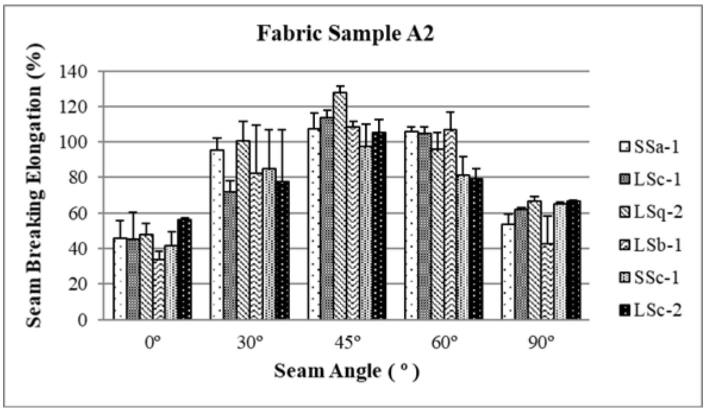


Figure 8. Seam breaking elongation values of A2 with different seam types at different seam angle

Table 3. Statistical analysis (Analysis of variance and SNK test) results for seam strength and seam breaking elongation properties for fabric A1

Parameters		Seam Strength (N)		Seam Breaking Elongation (%)	
		P/Sig	SNK	P/Sig	SNK
Seamtype	1- SSa-1	0.00*	421.56 a	0.38	41.93 a
	2- LSc-1		475.47 b		40.79 a
	3- LSq-2		490.58 c		41.45 a
	4- LSb-1		458.57 b		38.75 a
	5- SSc-1		431.43 a		42.12 a
	6- LSc-2		509.93 d		42.10 a
Seam angle (º)	0	0.00*	626.79 d	0.00*	24.40 a
	30		375.66 a		35.87 b
	45		503.87 c		62.42 d
	60		375.56 a		50.36 c
	90		441.06 b		32.91 b

**: statistically significant (P < 0.05)*
(a), (b), (c), (d) represent the statistical difference ranges according to SNK test

Table 4. Statistical analysis (Analysis of variance and SNK test) results for seam strength and seam breaking elongation properties for fabric A2

Parameters		Seam Strength (N)		Seam Breaking Elongation (%)	
		P/Sig	SNK	P/Sig	SNK
Seamtype	1- SSa-1	0.00*	439.13 a	0.24	79.47 a
	2- LSc-1		452.79 c		79.87 a
	3- LSq-2		443.50 b		79.18 a
	4- LSb-1		420.87 a		73.19 a
	5- SSc-1		438.30 a		75.34 a
	6- LSc-2		446.71 b		76.77 a
Seam angle (º)	0	0.00*	784.71 c	0.00*	45.35 a
	30		579.28 a		85.37 c
	45		825.43 c		110.06 e
	60		613.89 a		95.68 d
	90		712.87 b		59.40 b

**: statistically significant (P < 0.05)*
(a), (b), (c), (d) and (e) represent the statistical difference ranges according to SNK test

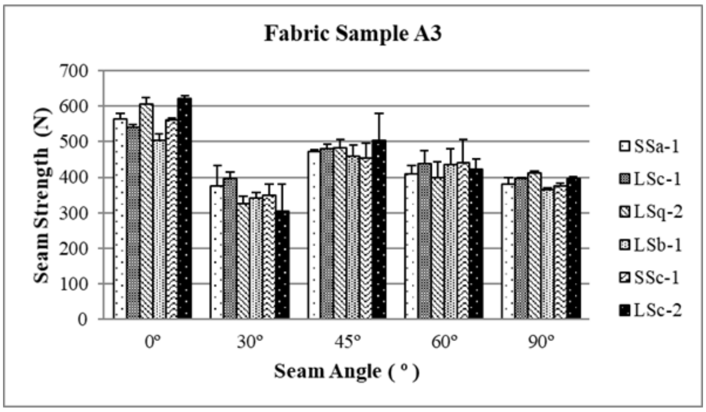


Figure 9. Seam strength values of A3 with different seam types at different seam angles

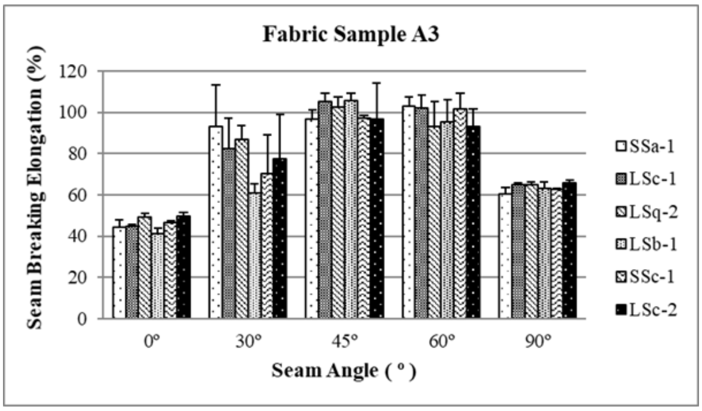


Figure 10. Seam breaking elongation values of A3 with different seam types at different seam angles

Table 5. Statistical analysis (Analysis of variance and SNK test) results for seam strength and seam breaking elongation properties for fabric A3

Parameters		Seam Strength (N)		Seam Breaking Elongation (%)	
		P/Sig	SNK	P/Sig	SNK
Seamtype	1- SSa-1	0.16	440.28 a	0.26	79.53 a
	2- LSc-1		449.94 a		79.72 a
	3- LSq-2		445.19 a		79.37 a
	4- LSb-1		420.87 a		73.19 a
	5- SSc-1		435.51 a		75.65 a
	6- LSc-2		449.94 a		76.47 a
Seam angle (º)	0	0.00*	565.99 e	0.00*	45.92 a
	30		348.76 a		78.57 c
	45		474.98 d		100.61 d
	60		424.20 c		97.96 d
	90		387.16 b		63.55 b

**: statistically significant (P < 0.05) (a), (b), (c), (d) and (e) represent the statistical difference ranges according to SNK test*

Table 6. Seam efficiency results of samples

Fabric Code	Seam Type	Seam Efficiency (%)				
		0°	30°	45°	60°	90°
A1	SSa-1	80.30	83.29	136.67	129.55	95.55
	LSc-1	88.07	120.88	144.28	165.70	101.42
	LSq-2	91.61	125.61	160.69	151.39	111.03
	LSb-1	85.22	123.73	139.11	158.02	98.41
	SSc-1	86.75	76.85	159.32	135.37	99.16
	LSc-2	96.13	132.32	164.74	152.30	117.44
A2	SSa-1	69.19	133.29	141.15	116.49	66.91
	LSc-1	69.10	116.86	135.20	115.37	74.92
	LSq-2	77.63	118.24	143.27	94.53	87.93
	LSb-1	51.00	105.38	143.99	115.24	43.87
	SSc-1	67.09	103.31	133.98	107.30	80.71
	LSc-2	94.51	81.22	150.13	113.01	88.61
A3	SSa-1	87.34	102.80	135.54	114.93	102.03
	LSc-1	83.67	108.05	137.71	123.51	105.98
	LSq-2	93.96	89.09	138.32	112.49	110.33
	LSb-1	78.14	93.48	131.59	122.62	97.42
	SSc-1	96.48	95.25	130.02	123.79	100.56
	LSc-2	96.48	83.18	137.40	118.62	106.23

3.1. Effect of Seam Type on Seam Strength and Breaking Elongation Results

The Anova and SNK test results given in Tables 3-5 indicated that, the woolen fabrics seamed with different seam types and seam angles possessed statistically different seam strength values. Fabrics seamed with seam LSq-2 and LSc-2 seam types give the highest seam strength values at three fabric samples. The Anova and SNK test results given in Tables 3-5 also indicated that, the woolen fabrics seamed with different seam types didn’t possess statistically different seam breaking elongation values.

It can be seen from Figure 5 that the maximum seam strengths were measured for the fabric sample (A1) seamed at 0° seam angle with LSc-2/301 seam type as 665.63 N and for the fabric sample seamed at 45° seam angle with LSc-2/301 seam type as 550.46 N. It can be seen from Figure 7 that the maximum seam strengths were measured for the fabric sample (A2) seamed at 0° seam angle with LSc-2/301 seam type as 1027.15 N and for the fabric sample seamed at 45° seam angle with LSc-2/301 as 877.10 N. It can be seen from Figure 9 that the maximum seam strengths were measured for the fabric sample (A3) seamed at 0° seam angle with LSc-2/301 as 622.30 N and for the fabric sample seamed at 45° seam angle with LSc-2/301 seam type as 502.78 N.

Generally, SSa seam type is preferred in garments. If LSc seam type is used instead of SSa seam type, the seams would be more durable.

3.2. Effect of Seam Angle on Seam Strength and Breaking Elongation Results

Measurement of seam strength at different bias angles become more important in garments where seams are not only in the warp or weft directions but also at different seam angles. When the seams of a garment were examined, it was observed that the angle between the warp direction and the stitch direction of the fabric was different. In the study, it was found that the seam strength was maximum at 45° bias angle [20].

The Anova and SNK test results given in Tables 3-5 indicated that, the woolen fabrics seamed with different seam angles possessed statistically different seam strength and seam breaking elongation values. Seams prepared with 0°-45°-90° bias angle gives the highest seam strength values all over the samples. Seams prepared with 30° and 60° bias angle give the lowest seam strength values all over the samples. For a seamed fabric, if the bias angle increases from 0° to 45°, seam-breaking elongation increases up to 45°. If the bias angle continues to increase from 45° to 90°, the seam-breaking elongation decreases [22].

The result of the seam breaking elongation indicates that the seam angle has a significant influence on the seam breaking elongation [21].

3.3. Effect of Seam Type on Seam Efficiency Results

The results given in Table 6 indicated that, fabric samples seamed with different seam types have different seam efficiency values. Seams prepared with LSc-2 and LSq-2 seam types give the highest seam efficiency values all over the samples. Seams prepared with SSa-1 seam type give the lowest seam efficiency values all over the samples.

The LSc-2 seam type shall be formed by folding in and interlapping the edges of two plies of material so that the edges of the material are concealed and seaming with two rows of stitches. The LSq-2 seam type shall be formed by: first superimposing two plies of material and seaming as in seam type SSa-1, and then the top ply shall then be turned back sharply over the first row of stitching and seamed with one row of stitch [5]. Lapped seam (LS) is a seam type in which the fabric edges overlap especially. The SSa-1 seam type shall be formed by superimposing two or more plies of material and seaming them with one row of stitch a specified distance from their edges. Generally, the seam types used on the inner and outer legs of a woolen trouser are superimposed seam type. If lapped seam type is used on the inner and outer leg of a woolen trouser, the stitches will be more durable.

3.4. Effect of Seam Angle on Seam Efficiency Results

Seam efficiency is defined as the capacity of the material itself to carry a seam. The durability of the seam can be measured in terms of seam efficiency. The results given in Table 6 indicated that, fabric samples seamed with different seam angles have different seam efficiency values. Seams prepared with 45° and 60° bias angle gives the highest seam efficiency values all over the samples. The most important reason for this is the fabric strength is low at 45° and 60° bias angles. Seams prepared with 0° and 90° bias angles gives the lowest seam efficiency values all over the samples. In addition to this, it can be said that the seams are durable and quality since the seam efficiency is above 80% in all samples except a few samples.

4. CONCLUSION

In recent years the importance of woolen garments has increased in the apparel sector. A woolen garment is comfortable to wear, staying warm at cooler times of the year and more breathable when temperatures rise. Seam performance is very important for the quality of woolen garments. The characteristics of a properly constructed seam are its strength, elasticity, durability, stability and appearance.

Textile fabrics are highly anisotropic, so that their mechanical properties including strengths are a function of direction. Therefore, both fabric and seam strength differ at different bias angles. For this reason, measurement of seam strength at different bias angle (an acute angle between warp and specimen length/test direction) becomes more important in garments.

Seam angle directly affect the seam strength of the woolen garments. At seamed fabric, if the bias angle increases from 0° to 45°, seam strength first decrease and then increase up to 45°. If the bias angle continues to increase from 45° to 90°, the trend of seam strength is almost symmetric from 45° due to the use of plain square fabric.

The result of the seam breaking elongation indicates that the seam angle has a significant influence on the seam breaking elongation. For a seamed fabric, if the bias angle increases from 0° to 45°, seam-breaking elongation increases up to 45°. If the bias angle continues to increase from 45° to 90°, the seam-breaking elongation decreases.

When the bias angle is at 0°, all warp yarns oriented vertically and gripped by both the jaw while all the weft yarns remain parallel to jaw width. Seam strength and seam breaking elongation in this region are contributed mainly by the characteristics of warp and weft yarns, number of its interlacement points and corresponding frictional and contact forces between the yarns. In this case, the breakage of specimen occurs between the gauge lengths.

The main reason for the change in tensile properties at different bias angle is mainly because of change in yarn orientation and the change in number of different category of warp and weft yarns (the number of warp and weft yarns gripped by both the grips / either of the grips / neither of the grips) available between the grip lines. Yarns which are not under control either by jaw or intersecting points could lead to less seam strength [22]. At 45 bias angle, although the total number of yarns gripped by both the jaws becomes almost zero, still high strength and elongation are observed mainly because of enhancement in higher number of warp–weft interlacement points and complete symmetric orientation of warp–weft yarns inside specimen.

Seam efficiency is defined as the capacity of the material itself to carry a seam. The durability of the seam can be measured in terms of seam efficiency. Seams prepared with 45° and 60° bias angle gives the highest seam efficiency values all over the samples. The most important reason for this is the fabric strength is low at 45° and 60° bias angles. In addition to this, it can be said that the seams are durable and quality since the seam efficiency is above 80% in all samples except a few samples.

Results indicated that, the woolen garments seamed with different seam types at different seam angles possessed statistically different seam strength and seam efficiency values. Fabrics seamed with LSc-2 seam type give the highest seam strength and seam efficiency values. Generally, SSa seam type is preferred in garments. If LSc lapped seam type is used instead of SSa superimposed seam type, the seams would be more durable.

There are many stitch and seam types used in garments. This study will contribute to the investigation of the effects of different seam types and seam angles on seam efficiency.

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