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# Investigation of Seam Performance of Chain Stitch and Lockstitch Used in Denim Trousers

# Denim Pantolonlarda Kullanılan Zincir ve Düz Dikişin Dikim Performansının İncelenmesi

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***Araştırma Makalesi / Research Article***

# INVESTIGATION OF SEAM PERFORMANCE OF CHAIN STITCH AND LOCKSTITCH USED IN DENIM TROUSERS

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***ABSTRACT:*** Denim trouser is the most preferred garment in the clothing industry. The seam performance of the stitches of denim trouser is very important for the quality of the product. Seam perfromance of garment depend on fabric structural properties such as weave type, fabric thickness, weight, yarn density and stitch types. Seam strength and seam efficiency are two important parameters for seam performance. The purpose of this study is to determine the seam performance of the chain stitch and lockstitch used in denim trouser. For this reason, fabric strength, seam strength and seam efficiency of cotton denim woven fabrics with elastane and without elastane which are widely used in garment have been examined.

***Key Words:*** Seam performance, chain stitch, lockstitch, denim trouser

# DENİM PANTOLONLARDA KULLANILAN ZİNCİR VE DÜZ DİKİŞİN DİKİM PERFORMANSININ İNCELENMESİ

***ÖZET :*** Denim pantolon konfeksiyon sektöründe en fazla tercih edilen giysidir. Kot pantolonunda kullanılan dikişlerin sağlamlığı, ürünün kalitesi için çok önemlidir. Giysinin dikim performansı, kumaşın doku tipi, kumaş kalınlığı, gramajı, iplik sıklığı gibi yapısal özelliklerine ve dikiş tiplerine bağlıdır. Dikiş mukavemeti ve dikiş yeterliliği dikim performansı için iki önemli parametredir. Bu çalışmanın amacı, denim pantolonunda kullanılan zincir dikişin ve düz dikişin dikim performansını belirlemektir. Bu nedenle, elastanlı ve elastansız pamuklu denim dokuma kumaşların kumaş mukavemeti, dikiş mukavemetini ve dikiş yeterliliği test edilmiştir.

***Anahtar Kelimeler:*** Dikim performansı, zincir dikiş, düz dikiş, denim pantolon

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## 1. INTRODUCTION

Denim trouser is the most preferred garment in the clothing industry. Recently the fashion trent is moving from denim to stretch denim. Different elastane yarn types in denim adds freedom of movement and greater elasticity to the denim. Denim fabric comprises of elastane-cotton weft yarns and 100% cotton indigo dyed warp yarns. Denim fabrics' weft yarns are usually produced with the core spun yarns where there is an elastomeric filament in the core and the staple fibers locating around it [1]. Also multi component core-spun yarns called dual-core (DC) yarns have been used in denim fabrics [2].

In recent years in garments fabrics and stitches are required to stretch in accordance with body movements, and also afters stretching, to retain their original shape without any deformation [3]. The quality of seam greatly influences on the quality of garment. The most important factor in garment quality is to choose the fabric which has good sewability [4,5,6]. Seam performance is an important factor in determining the durability and quality of a garment also a denim trouser.

The seam used at the inner leg of a denim trouser is lapped seam type. The seam at the outer leg of denim trouser is superimposed seam type. Figure 1 showed seams at the outer leg of denim trouser and Figure 2 showed superimposed seam types that used in denim trouser.

Lapped seam is a seam type in which the fabric edges overlap especially. Lapped seam (LS) in a cloth made by extending a cut or folded edge over a cut edge to the width of the seam allowance and stitching in place. Superimposed seam (SS) is the simplest and most widely used seam type. The border of one fabric piece is kept on another piece of fabric, and then the two are sewn together. Superimposed seam is formed by superimposing two or more plies of material which have overlock stitches at the edges and seaming them with one or more rows of 301 or 401 stitches a specified distance from their edges [7].

Seam performance of a garment depends on structural and mechanical properties of the fabric and strength, extensibility, security, durability, appearance and efficiency of the seams [8].

Seam strength is an important parameter in determining the seam performance of a garment. The inappropriate choice of a stitch or seam type can cause in failure of the sewn seam at a garment [9]. Fabric structure, stitch and seam types, sewing thread type and stitch density affect the seam strength. It was observed that in the garments seam, seam strength increased when the number of stitches/cm and sewing thread size increased [10]. Generally, the greater the stitch density in a seam, the greater is the seam strength. There are various seam and stitch types for sewing different types of garments [11]. Generally a seam made with chain stitch will be stronger than the lockstitch [12].

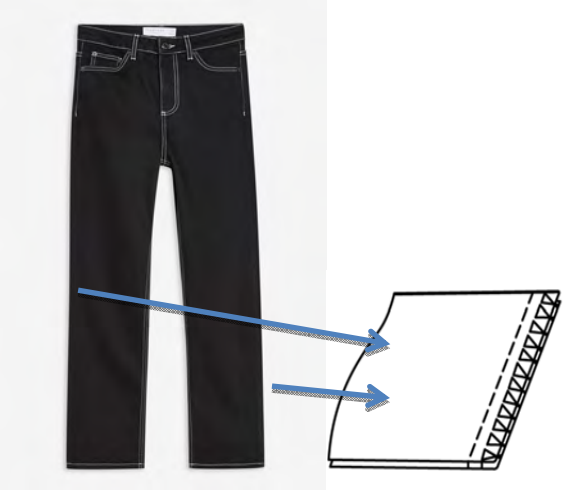
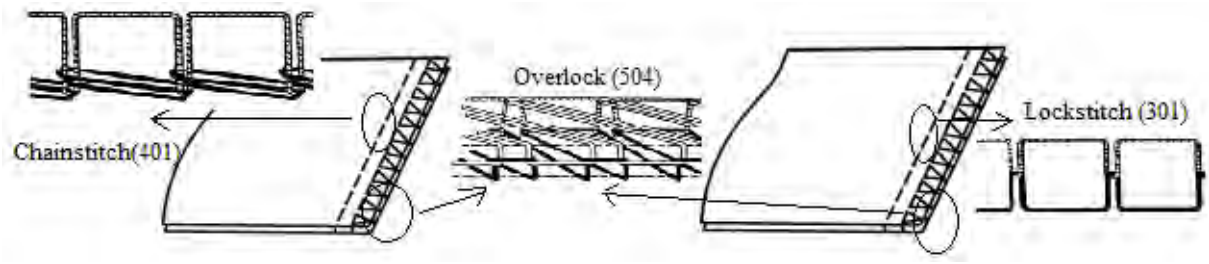


**Figure 1.** Seams at the outer leg of denim trousers

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. Seam efficiencies of 60-80 % are common but efficiencies between 80 and 90 % are more diffucult obtaining from garment seams. Low seam efficiency values indicate that the sewn fabric is damaged during sewing [13]. If the seam efficiency value falls below 80 %, the fabric has been excessivelly damaged by the sewing operation [14]. The failure of the seam makes a trouser unsuitable even though the fabric may be in a good condition [15]. Previous studies showed that seam appearance and performance depend on the interrelationship of fabrics, threads, stitch types and sewing conditions [16,17,18].




a-SSa-2/(504+401) b- SSa-2/(504+301)

**Figure 2.** Seam types at the outer leg of denim trousers a- SSa-2/(504+401), b-Ssa-2/(504+301)

According to the newly development processes in clothing industry, particularly in denim garment, the seam performance of denim is important. In the sewing process, a fabric with high density, thickness and weight such as denim fabric is more phone to seam and stitch damages [19]. Breaking strength and elongation of the fabric and sewing thread had an excellent correlation with seam efficiency [20]. The studies showed that the relationship between of denim and seam quality is essential for producing high quality garments [21].

The purpose of this study is to investigate the effect of the denim fabrics structure, stitch type and stitch density on the seam performance of denim trouser. The originality of this work is to investigate seam performance of chain stitch at different stitch densities. There are lots of studies about the seam performance of lockstitch at different stitch densities but there aren't any about chain stitch.

## 2. MATERIAL AND METHOD

### 2.1. Material

In this study, three types of denim woven fabrics with different structural properties were used. Structural properties of the fabric samples are given in Table 1. Denim fabric comprises of cotton/ elastane mono-corespun weft yarns and 100% cotton indigo dyed warp yarns is coded as (E) and denim fabric comprises of cotton/ elastane (dual-corespun) weft yarns and 100% cotton indigo dyed warp yarns is coded as (ET). Dual-corespun yarn comprises of polyester-elastane comingling yarn as dual core and cotton fiber as sheath component. Denim fabric comprises of 100% cotton weft yarns and 100% cotton indigo dyed warp yarns is coded as (P). 50 ticket number spun polyester sewing thread was used for stitches. Overlock, chainstitch and lockstitch sewing machines were used for seams of denim trouser.

### 2.2. METHOD

In this study, three different denim fabrics and SSa-2/401 and SSa-2/301 seam types (Superimposed seam type with "overlock with chain stitch" and "overlock with lockstitch") were used at the outer leg of the denim trouser. Three different stitch densities (3-4 and 5 stitch/cm) were used at chain stitch and lockstitch. Therefore 18 different samples with different stitch properties were obtained.

The ASTM D 3776-09a standard was used to measure the mass per unit area, and the ASTM D 3775-17 standard was used to measure the warp and weft density of the fabric samples [22, 23].

Seam strength, fabric strength and seam efficiency were measured according to the ASTM-D 1683-11a "Standard test method for failure in sewn seams of woven apparel fabrics" [24].

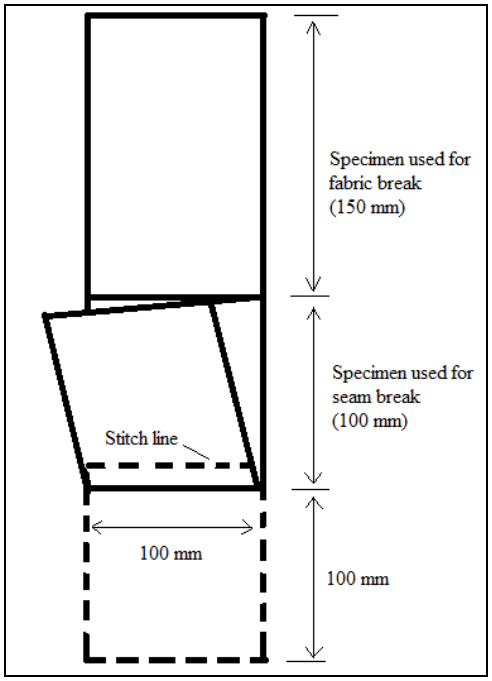



**Figure 3.** Seamed specimen dimensions prepared from fabric [24]

Test specimens were cut 350±3mm by 100±3 mm with long dimensions parallel to the weft direction of the fabric. Fabric specimen was folded 100±3 mm from one end with the folded parallel to the short direction of the fabric. The fabric samples were sewn with "overlock with chain stitch" and "overlock with lockstitch" from the edge as indicated in the Figure 3. Tests were done with a Shimadzu AG-X HS model tensile testing machine.

**Table 1.** Structural parameters of fabrics used

| Fabric Code | Weave Type | Yarn Density (Thread/cm) | | Yarn Count (Ne) | | Warp Yarn Type | Weft Yarn Type | Thickness (mm) | Weight (g/m$^2$) |
|---|---|---|---|---|---|---|---|---|---|
| | | Warp | Weft | Warp | Weft | | | | |
| E | 3/1 z Twill | 36 | 24 | 14 | 18 | Cotton (100%) | Cotton/ Elastane Mono-Corespun (95%-5%) | 0.50 | 225 |
| ET | 3/1 z Twill | 40 | 30 | 14 | 18 | Cotton (100%) | Cotton/ Elastane (Dual-Corespun) (95%-5%) | 0.51 | 245 |
| P | 3/1 z Twill | 24 | 18 | 7 | 7 | Cotton (100%) | Cotton (100%) | 0.7 | 390 |

Seam efficiency was calculated as the percent seam strength over fabric strength by using following Equation (1) [9].

Seam efficiency (%) = Seam strength / Fabric strength x 100 (1)

Measurement was performed under standard climatic conditions. For each fabric, three repetitions of the measurement were made, and the arithmetic mean was calculated from the individual measurement results. Seam strength and fabric strength were measured weft side of the fabric.

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 results were evaluated statistically with using SPSS 14.0 program. Completely randomized single-factor (one way) multivariate analysis of variance (ANOVA) as a fixed model was applied to data. Student-Newman-Keuls (SNK) tests were used to compared the means. The treatment levels were marked in accordance with the mean values, and levels were marked with different letter (a, b, c and d) to show that they were significantly different.

## 3. RESULTS AND DISCUSSION

The seam strength, seam elongation, fabric strength and seam efficiency values of the chain stitch and lockstitch are given in Table 2 and 3.

**Table 2.** Seam strength, seam elongation, fabric strength and seam efficiency values of chain stitch

| Fabric Code | Stitch Density (stitch/cm) | Seam Strength (N) | Seam Elongation (%) | Fabric Strength (N) | Fabric Elongation (%) | Seam Efficiency (%) |
|---|---|---|---|---|---|---|
| E | 3 | 510.07 | 82.02 | 984.89 | 87.06 | 51.78 |
| | 4 | 556.49 | 80.58 | 984.89 | 87.06 | 56.50 |
| | 5 | 580.56 | 84.81 | 984.89 | 87.06 | 58.94 |
| ET | 3 | 690.36 | 89.14 | 1126.81 | 90.60 | 61.26 |
| | 4 | 854.18 | 92.53 | 1126.81 | 90.60 | 75.80 |
| | 5 | 867.11 | 88.54 | 1126.81 | 90.60 | 76.95 |
| P | 3 | 920.02 | 26.69 | 1814.11 | 24.96 | 50.71 |
| | 4 | 971.10 | 28.82 | 1814.11 | 24.96 | 53.53 |
| | 5 | 1140.59 | 31.54 | 1814.11 | 24.96 | 62.87 |

**Table 3.** Seam strength, seam elongation, fabric strength and seam efficiency values of lockstitch

| Fabric Code | Stitch Density (stitch/cm) | Seam Strength (N) | Seam Elongation (%) | Fabric Strength (N) | Fabric Elongation (%) | Seam Efficiency (%) |
|---|---|---|---|---|---|---|
| E | 3 | 471.84 | 84.35 | 984.89 | 87.06 | 47.90 |
| | 4 | 592.39 | 81.17 | 984.89 | 87.06 | 60.14 |
| | 5 | 649.51 | 81.82 | 984.89 | 87.06 | 65.94 |
| ET | 3 | 628.69 | 84.28 | 1126.81 | 90.60 | 55.79 |
| | 4 | 646.94 | 83.30 | 1126.81 | 90.60 | 57.41 |
| | 5 | 750.79 | 89.13 | 1126.81 | 90.60 | 66.62 |
| P | 3 | 755.95 | 26.35 | 1814.11 | 24.96 | 41.67 |
| | 4 | 835.84 | 26.24 | 1814.11 | 24.96 | 46.07 |
| | 5 | 958.54 | 30.68 | 1814.11 | 24.96 | 52.83 |

Analysis of variance and Student-Newman-Keuls test results are given in Tables 4.

**Table 4.** Statistical analysis (Analysis of variance and SNK test) results for chain stitch and lockstitch

| Parameters | | Seam Strength (N) | | Seam Elongation (%) | | Seam Efficiency(%) | |
|---|---|---|---|---|---|---|---|
| | | P/Sig. | SNK | P/Sig. | SNK | P/Sig. | SNK |
| Fabric Type | E | .000* | 560.14 a | .000* | 82.45 b | . 000* | 56.87 b |
| | ET | | 739.68 b | | 87.82 c | | 65.63 c |
| | P | | 935.89 c | | 28.43 a | | 51.86 a |
| Stitch Density (stitch/cm) | 3 | .000* | 668.38 a | .000* | 65.47 a | .000* | 51.82 a |
| | 4 | | 742.82 b | | 65.48 a | | 58.24 b |
| | 5 | | 824.51 c | | 67.75 b | | 64.02 c |
| Stitch Type | C | .000* | 787.83 b | .000* | 67.18 b | .000* | 60.92 b |
| | L | | 702.65 a | | 65.29 a | | 55.13 a |

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

### 3.1. Seam Strength Test Results of Denim Trousers

Seam strength is depends on the fabric quality, sewing thread strength, stitch density and stitch and seam types.
Seam strength test results of fabric samples with overlock and chain stich at three different stitch densities (3-4-5 stitch/cm) can be seen from Figure 3 and seam strength test results of fabric samles with overlock and lockstitch at three different stitch densities (3-4-5 stitch/cm) can be seen from Figure 4.

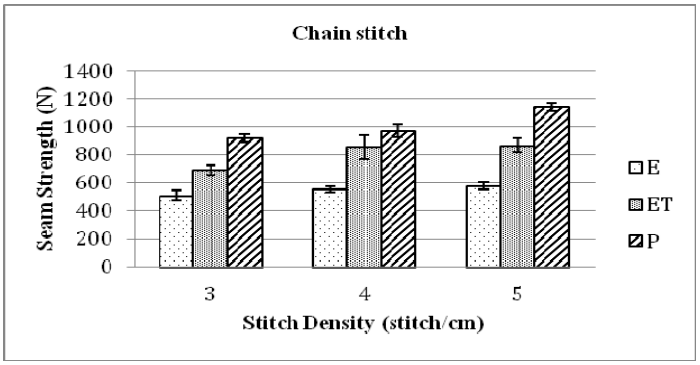



**Figure 3.** Seam strength values of chainstitch

It can be seen from Figure 3 that the minimum seam strength was measured for the fabric sample with overlock and chain stitch (E) with 3 stitch/cm as 510.07 N while the maximum seam strength was measured for the (P) with 5 stitch/cm as 1140.59 N. It can be seen from Figure 4 that the minimum seam strength was measured for the fabric sample with overlock and lockstitch (E) with 3 stitch/cm as 471.84 N while the maximum seam strength was measured for the (P) with 5 stitch/cm as 958.54 N. While compare the fabric samples with overlock and chain stitch with the fabric samples with overlock and lockstitch it can be seen that the seam strength values of the fabric samples with overlock and chain stitch were higher than fabric samples with overlock and lockstitch. Increasing the stitch density helps to increase seam strength at the same type of fabric samples, too. Generally a seam made with chain stitch will be stronger than the lockstitch [12]. It can be seen that the seam strengths of (E),(ET) and (P) fabric samples sewn by chain stitch are higher.

The SNK test results given in Table 4 revealed that, fabric type, stitch density and stitch type are statistically significant on the seam strength. Cotton fabric sample (P) without elastane has the higher seam strength than cotton fabric sample (ET) with elastane and fabric samples (E). Elastane yarns increase the extensibility of the fabric. Increase the fabric extensibility leads to decrease in seam strength [25].

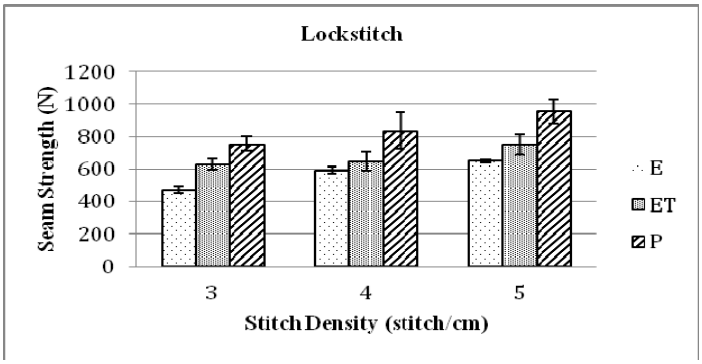



**Figure 4.** Seam strength values of lockstitch

### 3.2. Seam Elongation Test Results of Denim Trousers

In recent years, the elasticity of the seam has become more important with the use of stretched fabrics in the garment. The elongation of a sewn seam depends on fabric type and strength, stitch and seam type, stitch density and sewing thread elasticity [26].

Denim trousers should have appropriate seam strength and seam elongation for appropriate fit during movement.

Seam elongation test results of fabric samples with overlock and chainstich at three different stitch densities (3-4-5 stitch/cm) can be seen from Figure 5 and seam elongation test results of fabric

samles with overlock and lockstitch at three different stitch densities (3-4-5 stitch/cm) can be seen from Figure 6.

It can be seen from Figure 5 that the minimum seam elongation was measured for the fabric sample with overlock and chain stitch (P) with 3 stitch/cm as 26.69 % while the maximum seam elongation was measured for the (ET) with 4 stitch/cm as 92.53 %. It can be seen from Figure 6 that the minimum seam elongation was measured for the fabric sample with overlock and lockstitch (P) with 4 stitch/cm as 26.24 % while the maximum seam elongation was measured for the (ET) with 5 stitch/cm as 89.13 %. Chain stitch is formed by two sets of threads named needle thread and looper thread. Lockstitch is formed by two sets of thread name needle thread and bobbin thread. In the case of chain stich, sewing threads are bonded together by interlooping and interlacing. In the case of lockstitch, threads are bounded together by interlacing. Therefore, thread consumption and extensibility of chain stitch is higher than lockstitch. While compare the fabric samples with overlock and chain stitch with the fabric samples with overlock and lockstitch it can be seen that the seam elongation values of the fabric samples with overlock and chain stitch were higher than lockstitch.

The SNK test results given in Table 4 revealed that, fabric type, stitch density and stitch type are statistically significant on the seam elongation. Fabric samples (E) and (ET) have the higher seam elongation than fabric sample (P). Fabrics with elastane (E) and (ET) have high seam elongation due to high elasticity.

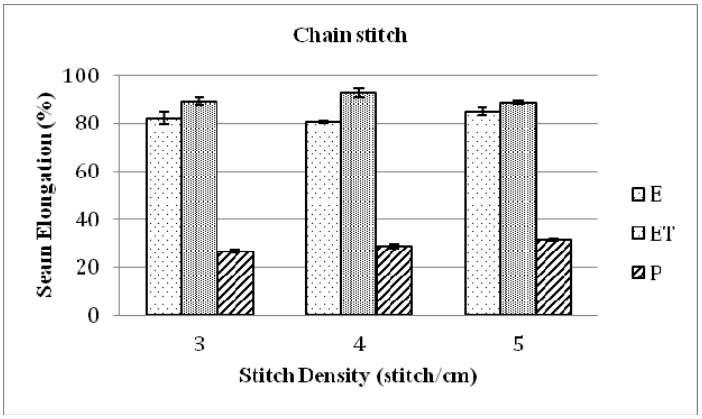



**Figure 5.** Seam elongation values of chainstitch

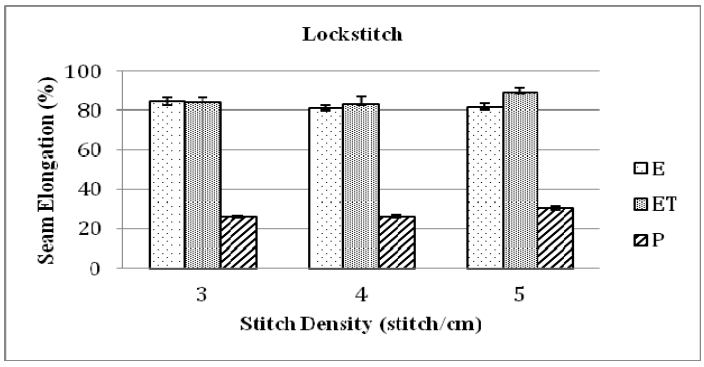



**Figure 6.** Seam elongation values of lockstitch

### 3.3. Seam Efficiency Test Results of Denim Trousers

Seam efficiency test results of fabric samples with overlock and chainstich at three different stitch densities (3-4-5 stitch/cm) can be seen from Figure 7 and seam efficiency test results of fabric samles with overlock and lockstitch at three different stitch densities (3-4-5 stitch/cm) can be seen from Figure 8.

The durability of the seam can be measured in terms of seam efficiency. Seam efficiency can be optimized through various factors, such as fabric structure, seam type, type and density of stitches. Seam efficiencies of 60-80 % are common but efficiencies between 80 and 90 % are more difficult obtaining from garment seams. Low seam efficiency values indicate that the sewn fabric is damaged during sewing [13, 26]

It can be seen from Figure 7 that the minimum seam efficiency was measured for the fabric sample with overlock and chain stitch (P) with 3 stitch/cm as 50.71 % while the maximum seam efficiency was measured for the (ET) with 5 stitch/cm as 76.95 %. It can be seen from Figure 8 that the minimum seam efficiency was measured for the fabric sample with overlock and lockstitch (P) with 3 stitch/cm as 43.50 % while the maximum seam efficiency was measured for the (ET) with 5 stitch/cm as 66.62 %. While compare the fabric samples with overlock and chain stitch with the fabric samples with overlock and lockstitch it can be seen that the seam efficiency values of the fabric samples with overlock and chain stitch were higher than fabric samples with overlock and lockstitch. A higher stitch density consumed more thread in a stitch so that it has stronger seam. Increasing the stitch density helps to increase seam efficiency [26]. It can be seen that the seam efficiencies of (E), (ET) and (P) fabric samples increased with stitch densities increased.

The SNK test results given in Table 4 revealed that, fabric type, stitch density and stitch type are statistically significant on the seam efficiency. Fabric samples (E) and (ET) have higher seam efficiency than fabric sample (P). Fabric samples with overlock and chain stitch and lockstitch with 5 stitch/cm have higher seam efficiency values than 4 stitch/cm and 3 stitch/cm.

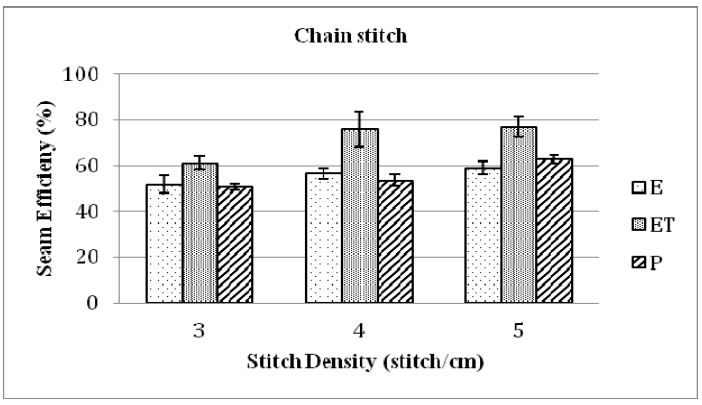



**Figure 7.** Seam efficiency values of chainstitch

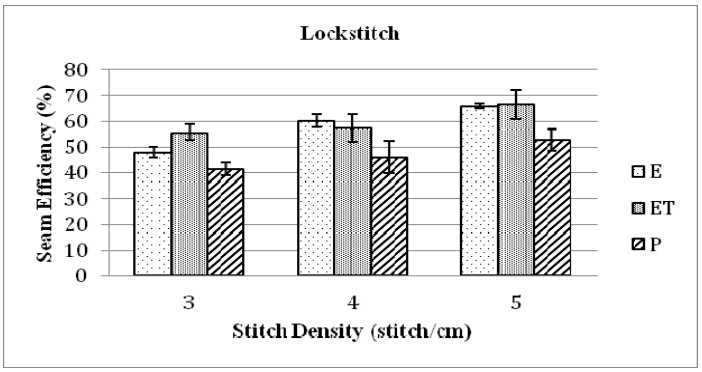



**Figure 8.** Seam efficiency values of lockstitch

## 4. CONCLUSION

Denim trouser is the most preferred garment in the clothing industry. Recently the fashion trent is moving from denim to stretch denim. Different elastane yarn types in denim adds freedom of movement and greater elasticity to the denim. The most important factor in garment quality is to choose the fabric which has good sewability. Seam performance is an important factor in determining the durability and quality of a denim trouser. The durability and quality of garment seams is one of the most important factor to evaluate the overall performance of garments.

Mostly, lapped seam type is used at the outer leg seams and superimposed seam type is used at the inner leg seams in denim trousers. Chain stitch or lockstitch prefered for superimposed seam type.

In this research, the effect of the denim fabrics structure, stitch type and stitch density on seam performance of denim trouser were investigated. The originality of this work is to investigate seam performance of chain stitch at different stitch densities. There are lots of studies about the seam performance of lockstitch at different stitch densities but there aren't any about chain stich.
The test results revealed that, fabric type, stitch density and stitch type are statistically significant on the seam strength, seam elongation, seam efficiency and seam performance. Superimposed seam type with overlock and chainstitch was found stronger than superimposed seam type with overlock and lockstitch. Cotton denim fabric without elastane seamed with chain stitch with 5 stitch/cm has higher seam strength than cotton denim fabric with elastane.

Increasing the stitch density helps to increase seam strength at the same type of fabric samples, too. Generally a seam made with chain stitch will be stronger than the lockstitch. Elastane yarns increase the extensibility of the fabric. Increase the fabric extensibility leads to decrease in seam strength

Seam efficiency is an important factor for seam performance of garments. 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. Seam efficiencies of 60-80 % are common but efficiencies between 80 and 90 % are more diffucult obtaining from garment seams. Low seam efficiency values indicate that the sewn fabric is damaged during sewing.
A higher stitch density consumed more thread in a stitch so that it has stronger seam. Increasing the stitch density helps to increase seam efficiency

Cotton denim fabrics with elastane seamed with superimposed seam type with chainstitch and 5 stitch/cm has higher seam efficiency values (77 %) than cotton denim fabric without elastane seamed with superimposed seam type with lockstitch with 5 stitch/cm. This means seam performance of denim trouser seamed with cotton denim fabric with elastane used superimposed seam type with chain stitch with 5 stitch/cm was higher.

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