Original Research Article

JOURNAL OF RESEARCH

AATCC Journal of Research
2025, Vol. 12(3) 1–9

DOI: 10.1177/24723444251342866
journals.sagepub.com/home/aat
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Influence of Stitch Density on Seam Strength in Cotton Fabrics

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Abstract

The goal of this paper was to investigate the influence of three different fabric thread densities per weft (10, 17, and 25 cm^{-1}) as well as three different linear densities of weft threads (20, 30, and 50 Tex) on the seam strength of cotton fabrics. When measuring seam strength, the values of the *F*–ε curve were monitored. In this, a uniform increase in force is observed in all samples up to a certain point. After that point, the force suddenly begins to decrease for a while. Then, the same force begins to increase again. That part of the curve at the point where the force begins to decrease is defined in this paper as seam yielding. Therefore, it is concluded that the seam at this point is significantly damaged in structure. The results obtained show that the values of seam strength, for all samples, increase with increasing: stitch density, weft thread density, and weft linear density. It is concluded that the average yield force in samples B decreases by 21.54% and by 32.94% in samples C, compared to the average yield force values of samples A. The average yield force in samples E decreases by 23.24% and that in samples F decreases by 37.92% compared to the average yield force values of samples D. The average yield force in samples H decreases by 19.87% and in samples I it decreases by 24.92% compared to the average yield force values of samples G. The results obtained show that weft yarns with a larger cross-section more intensively resist thread yielding in the seam. Defining these parameters represents a significant contribution for manufacturers of quality clothing because it is possible to project in advance the intensities of forces to which seams in clothing can be subjected to without impairing their quality.

Keywords

Breaking Point of the Seam, Stitch Density of Sewn Seams, Strength of Sewn Seams, Structure and Density of Fabrics, Yield Point of the Seam

Introduction

Fast fashion today requires fabric manufacturers to respond very quickly to the demands of clothing manufacturers. Namely, clothing manufacturers often have requests for fabrics with different surface masses. Fabric manufacturers, to a certain extent, can quickly respond to this by changing the fineness of the weft and the density of threads per weft. This can be easily done on modern textile machines today. The fabrics available on the market today have different textile characteristics. Therefore, in this paper, fabric samples for testing were made in three different weft finenesses and three different thread densities per weft. The fastest

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Date Received: 17 December 2024; Revised: 1 April 2025; Accepted: 28 April 2025

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assessment of fabric properties is by touch. Touch is a fully sensory experience where the fabric is touched with the fingers.[1] Each fabric, for making clothes, is a complex material and the properties of the clothes depend on its structure. Therefore, many researchers are engaged in the analysis of fabric structure, which is considered one of the basic parameters that contribute to the dominant physical and qualitative properties of woven material.[2]

Woven textile materials are most often joined by seams using the sewing technique. A large number of factors affect the quality of seams. Some of them are the type of material, types of sewing points, types of sewing stitches, stitch density, linear density of sewing thread, mechanical properties of sewing thread, tension force of sewing thread when forming a stitch, sewing speed, fineness and shape of needle tip, and other elements of sewing machines that participate in making a seam.

According to research,[3] damages that appear on the seams of clothing products due to stretching range from 68.3% on pants, where they are the largest, to shirts and blouses up to 9.4%, jackets 8.9%, skirts 8.4% and up to 5.0% for dresses. The largest deformations occur on the seat seam of pants and skirts, ranging up to 59.1%, on the part of the seam at the junction of the sleeves and the back of shirts and jackets up to 27.1%, on the side seams of pants, dresses and skirts, up to the interval 9.0%, on the seam in the middle of the back of the upper garments 3.9% and on other seams on the clothing range in the interval up to 0.9%.

The seam is one of the most important parameters of garments, because it joins pieces of fabric and gives the garment its final shape. The correct selection of fabric, sewing thread, and type of stitching greatly affects the comfort of the wearer and the aesthetic and functional requirements of the garment. This area is extensively researched providing a new approach for predicting seam quality and strength.[4]

It is necessary for fabric manufacturers to know how the structure of the fabric affects the quality of the seam, that is, the slippage of the threads in the seam.[5] For this reason, a large number of studies are conducted on the effect of stitch types, stitch density and sewing direction on the quality of stitches in terms of seam strength and seam slippage.[6] Nowadays, the following are mainly researched: the effect of thread density of fabrics and seam structure of linen fabrics on seam slip characteristics and seam strength;[7] complex dynamic interactions between fabric performance, sewing process parameters, and seam puckering;[8] the efficiency, the strength, and elongation of seams on cotton fabrics;[9] the influence of different sewing parameters, such as type of sewing thread, type of seam and direction of the seam as well as stitch density on the strength of the seams;[10] the influence of stitch density and seam class on moisture management properties in seams;[11] the durability of clothing depending on the strength of seams, density of stitches, aesthetic appearance, and puckering of seams on different fabric structures;[12] the influence of different stitch densities on the achievement of proper and adequate seam quality;[13] the influence of the relationship between the types of fabrics, the fineness of the sewing thread, and the parameters of the sewing needle on the strength, efficiency and puckering of seams;[14] the influence of seam parameters on the lifetime of clothing;[15] the influence of the deformation method, in the direction along the warp and weft of the fabric, on the slippage of seams;[16] yarn slip resistance in the seam for designing fabrics before their industrial production;[17] the reasons that lead to poor seam quality when sewing;[18] slip resistance of seams of unbalanced fabrics;[19] and seam appearance depending on the types of sewing threads, fabrics, and stitches.[20]

It is clear from the available literature that sewing damage problems do not have a simple solution. Therefore, a large number of parameters, such as fibers, yarns, fabric construction, sewing thread, stitch types, and sewing machines, must be tested specifically in almost every sewing condition, which are often different from each other.[21]

It is noted that in all the aforementioned tests, the breaking force is taken as one of the key indicators of the quality of the seams. However, the research in this paper has revealed that the quality of the seam is impaired even before its breaking point. Namely, it has been determined that the seams deform to the extent that they violate the required seam structure. The results of research in this area enable textile manufacturers to learn to what extent seams on textile products can be loaded with external deformation forces without compromising the quality of the product. This means that we learn what value of the load force causes the seam to deform, or rather, the quality of the textile product to deteriorate.

Materials and Methods

The research presented in this paper looked into the influence of stitch density on seam strength in cotton fabrics. For the purposes of the research, various samples of cotton fabrics were made in industrial conditions on a “Vamatex” loom with a weft feeding system with grippers. The loom was equipped with an electronic thread machine. The nominal width of the loom is 210 cm. The samples were made on the same loom in order to avoid the influence of different machines on the production of samples. For the production of samples for the research, an article with a raw material composition of 100% cotton in a 1/1 plain weave with a warp linear density of Tt 40 Tex and a yarn density per warp of 24 cm^{-1} for all samples was selected. The yarn density per warp and weft was tested according to the EN 14971 standard. The yarn density per weft was changed to three values: 10, 17, and 25 cm^{-1}. For each of these weft densities, three linear densities of weft yarns were used: Tt 20 Tex, Tt 30 Tex, and Tt 50 Tex. The linear densities of warp and weft yarns were determined according to the standards SRPS ISO 7211-5 and SRPS F.S2.511. The surface masses of nine different samples of woven fabrics for testing were determined according to the standard SRPS EN 12127:2014.

For testing the strength of seams, fabric samples were prepared according to the regulations of the ISO 13935-1 standard. Laboratory samples of all nine fabrics measuring 350 × 700 mm were cut in the weft direction. Then, each of the samples was individually folded in half so that the longer side was parallel to the folded part. The samples were then sewn in the warp direction with the selected type of sewing stitch marked 1.01.01/301 according to the international standard ISO 4916. The samples were sewn on a universal sewing machine manufactured by Juki marked DDL-5550 with stitch type 301. The following parameters were set on the machine: sewing speed, 3000 stitches/min; needle fineness, Nm 90; foot pressure, 2.8 N; and thread tension, 0.50 N. The stitch density was adjusted on the machine in five steps. After measurements on sewn seams, values of 3, 4, 5, 6, and 7 stitches/cm were obtained. The same type of thread was used for sewing the tested samples, with a fineness of Tt 47.7 Tex, a strength of 23.37 N and a breaking elongation of 19.17%. The thread was made of 100% polyester fiber. The measurement of the strength of the seams was performed on a Tenso Lab 3 dynamometer, series 2512A, manufactured by the Italian manufacturer Mesdan S.p.A. Figure 1 shows prepared sample for testing (a) and sample tearing on the dynamometer (b).

The dynamometer provides tabular numerical values but also plots the F–ε (force–elongation) curve. By analyzing the results, the movements of the force values depending on the elongation were accurately determined at each point of the diagram. Table 1 shows different samples of the tested fabrics that were sewn with the type of sewing seam marked 1.01.01/301. In Table 1 marking d_{wa} indicates the density of threads in the warp direction per 1 longitudinal centimeter, while d_{we} indicates the same but in the weft direction.

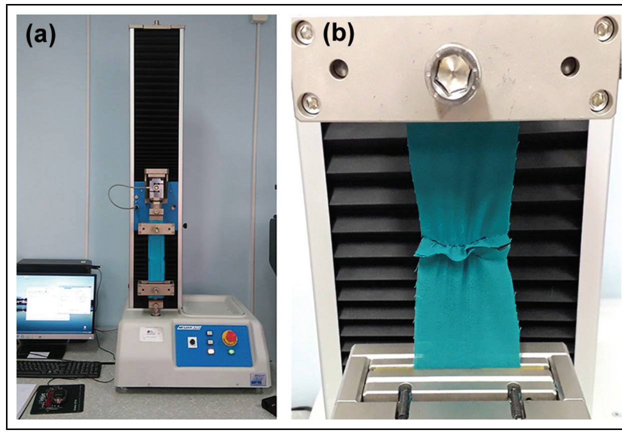

Figure 1. Prepared sample for testing (a) and sample tearing on dynamometer (b).

Results and Discussion

The strength of fabric samples was measured in the weft direction. The seams were sewn parallel to the warp direction. This was done in order to determine the influence of different thread thicknesses on the deformation of the seams. The seams were sewn with different stitch densities. This was done in order to determine the influence of the seam density on its strength. Based on the measurements and research into the influence of different fabric densities on the mechanical characteristics of the seams, the results obtained are presented. Tables 2–4 show the results of measuring fabric samples with weft densities of 25, 17, and 10 cm^{-1}.

Figures 2–4 show the force–elongation curves, which represent the comparative results of measuring the seam strength of all samples sewn with stitch densities of 3 and 7 cm^{-1}. The curves show the force values at the yielding points of the seam. The yield points are located before the breaking points of the seams.

Figure 5 shows the correlation between the force at the yield point of the seam and the total breaking force of the seam for samples with thread density per weft of 25, 17, and 10 cm^{-1}.

During the research, it was noticed that the basic difficulties in testing the strength of the seams stem from various types of damage when the seams breaks. Any damag observed can be classified as: fabric break, fabric break at clamps, fabric break at seam, sewing thread break, thread pulled, or any combination of the above. During testing, only those samples where a break

Table 1. Different fabric samples sewn in the weft direction with the sewing seam type 1.01.01/301.

Sample marking	Weave structure	Linear density T_t (tex)		Yarn type		Density		Surface mass m ($g{\cdot}m^{-2}$)
		For warp	For weft	For warp	For weft	Warp d_{wa} (cm^{-1})	Weft d_{we} (cm^{-1})	
A	Plain 1/1	40	50	100 Co	100 Co	24	25	232.52
B	Plain 1/1	40	30	100 Co	100 Co	24	25	190.32
C	Plain 1/1	40	20	100 Co	100 Co	24	25	153.40
D	Plain 1/1	40	50	100 Co	100 Co	24	17	175.77
E	Plain 1/1	40	30	100 Co	100 Co	24	17	154.45
F	Plain 1/1	40	20	100 Co	100 Co	24	17	132.30
G	Plain 1/1	40	50	100 Co	100 Co	24	10	153.40
H	Plain 1/1	40	30	100 Co	100 Co	24	10	136.52
I	Plain 1/1	40	20	100 Co	100 Co	24	10	121.75

Table 2. Measurement results of fabric samples with a weft density of 25 cm^{-1}.

Sample marking	Stitch density (cm^{-1})	Seam yielding			Breaking point		
		Elongation (%)	Force (N)	Coefficient of variation (%)	Elongation (%)	Force (N)	Coefficient of variation (%)
A	3	7.466	179	17	11.200	308	21
	4	9.105	252	12	10.778	332	22
	5	9.691	263	13	11.556	345	24
	6	9.505	282	11	10.251	359	22
	7	9.649	296	12	10.391	372	20
B	3	8.189	168	18	10.421	261	19
	4	7.990	175	16	9.849	286	21
	5	8.350	191	13	11.133	302	20
	6	8.548	226	12	10.220	312	18
	7	8.535	238	11	9.278	322	17
C	3	9.464	147	19	12.246	247	22
	4	7.641	147	17	10.065	257	23
	5	6.886	150	18	8.375	265	20
	6	7.073	194	15	8.748	275	18
	7	7.236	215	14	8.164	287	19

Table 3. Measurement results of fabric samples with a weft density of 17 cm^{-1}.

Sample marking	Stitch density (cm^{-1})	Seam yielding			Breaking point		
		Elongation (%)	Force (N)	Coefficient of variation (%)	Elongation (%)	Force (N)	Coefficient of variation (%)
D	3	8.153	186	18	10.190	273	22
	4	6.906	225	14	9.146	285	20
	5	8.338	240	13	9.820	303	18
	6	7.713	258	14	8.631	315	17
	7	8.920	296	15	10.593	330	19
E	3	6.690	128	19	10.035	239	22
	4	7.226	152	18	9.264	244	23
	5	8.350	191	17	11.133	249	20
	6	6.514	226	18	7.816	265	22
	7	8.189	228	15	8.933	277	23
F	3	6.906	118	12	8.586	203	24
	4	5.983	131	14	8.973	209	22
	5	8.313	150	17	11.084	221	21
	6	8.548	171	15	12.265	241	25
	7	8.375	178	18	9.864	251	23

Table 4. Measurement results of fabric samples with a weft density of 10 cm^{-1}.

Sample marking	Stitch density (cm^{-1})	Seam yielding			Breaking point		
		Elongation (%)	Force (N)	Coefficient of variation (%)	Elongation (%)	Force (N)	Coefficient of variation (%)
G	3	6.690	147	18	10.035	254	22
	4	7.433	168	19	10.593	266	20
	5	7.073	176	21	9.864	278	25
	6	7.269	218	22	9.505	287	24
	7	8.238	242	24	9.923	294	27
H	3	6.133	97	22	10.220	206	25
	4	6.309	122	20	9.278	212	24
	5	7.444	165	23	9.678	220	28
	6	7.226	187	26	9.079	232	27
	7	7.630	191	23	9.119	244	25
I	3	5.591	101	26	8.574	172	34
	4	6.710	146	24	8.388	179	32
	5	7.093	141	25	9.706	193	31
	6	7.280	151	23	8.586	201	29
	7	6.494	175	20	8.535	216	27

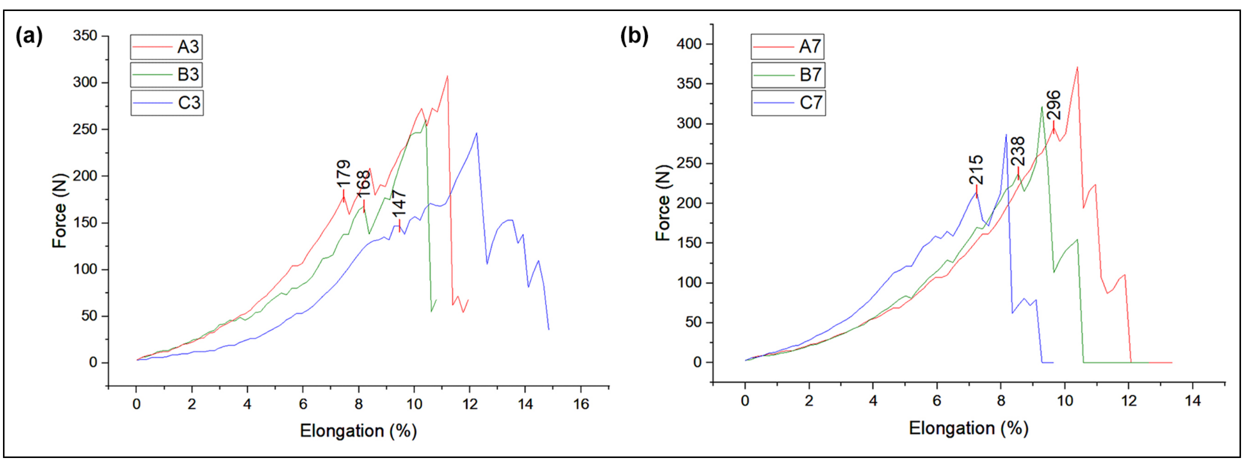

Figure 2. Comparative results of the influence of different linear densities of weft yarns at densities of 25 cm^{-1} and the number of stitches, 3 cm^{-1} (a) and 7 cm^{-1} (b), on the strength of the seam.

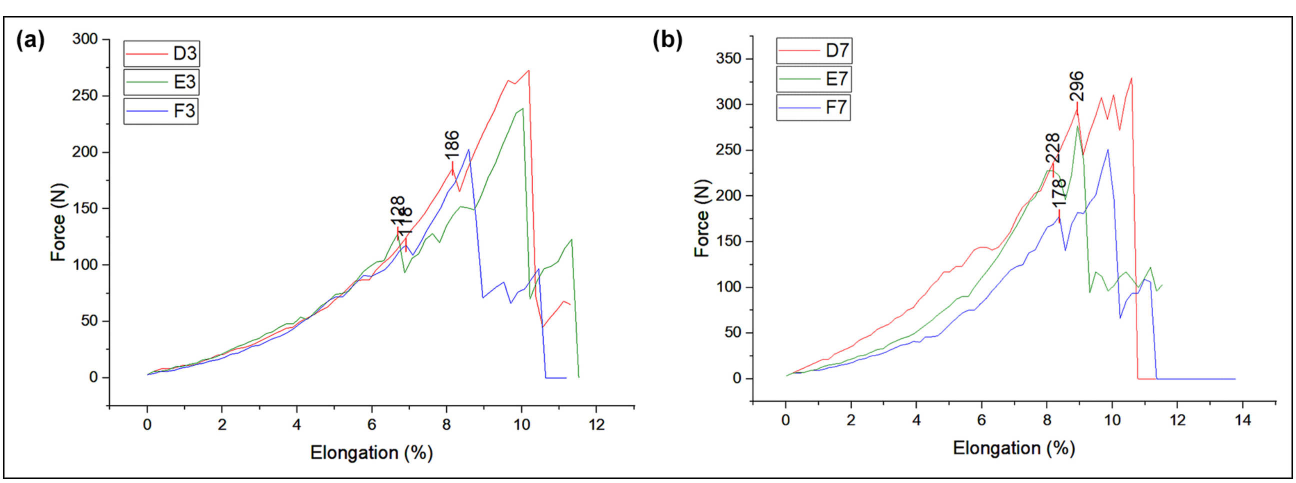

Figure 3. Comparative results of the influence of different linear densities of weft yarns at densities of 17 cm^{-1} and the number of stitches, 3 cm^{-1} (a) and 7 cm^{-1} (b), on the strength of the seam.

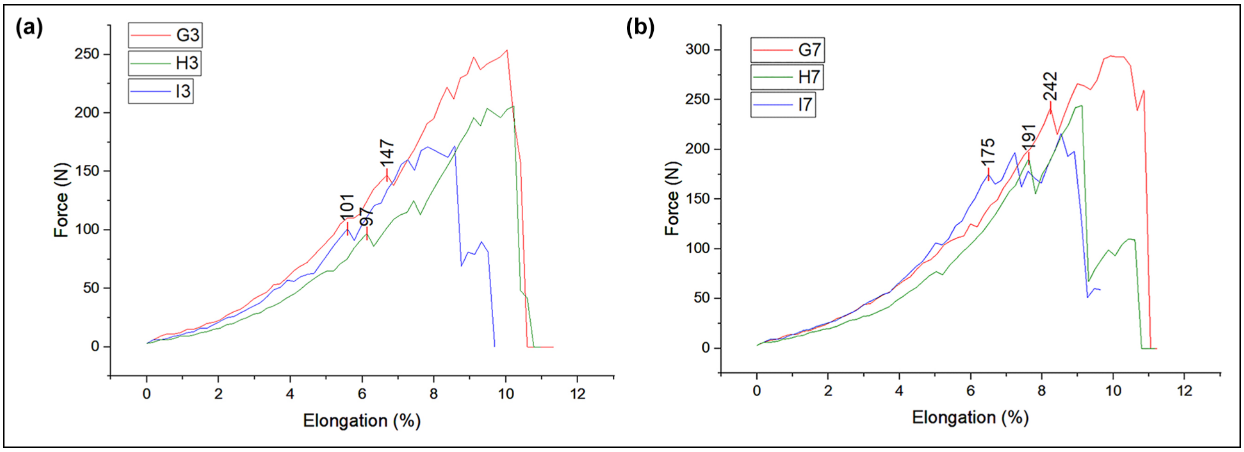

Figure 4. Comparative results of the influence of different linear densities of weft yarns at densities of 10 cm^{-1} and the number of stitches, 3 cm^{-1} (a) and 7 cm^{-1} (b), on the strength of the seam.

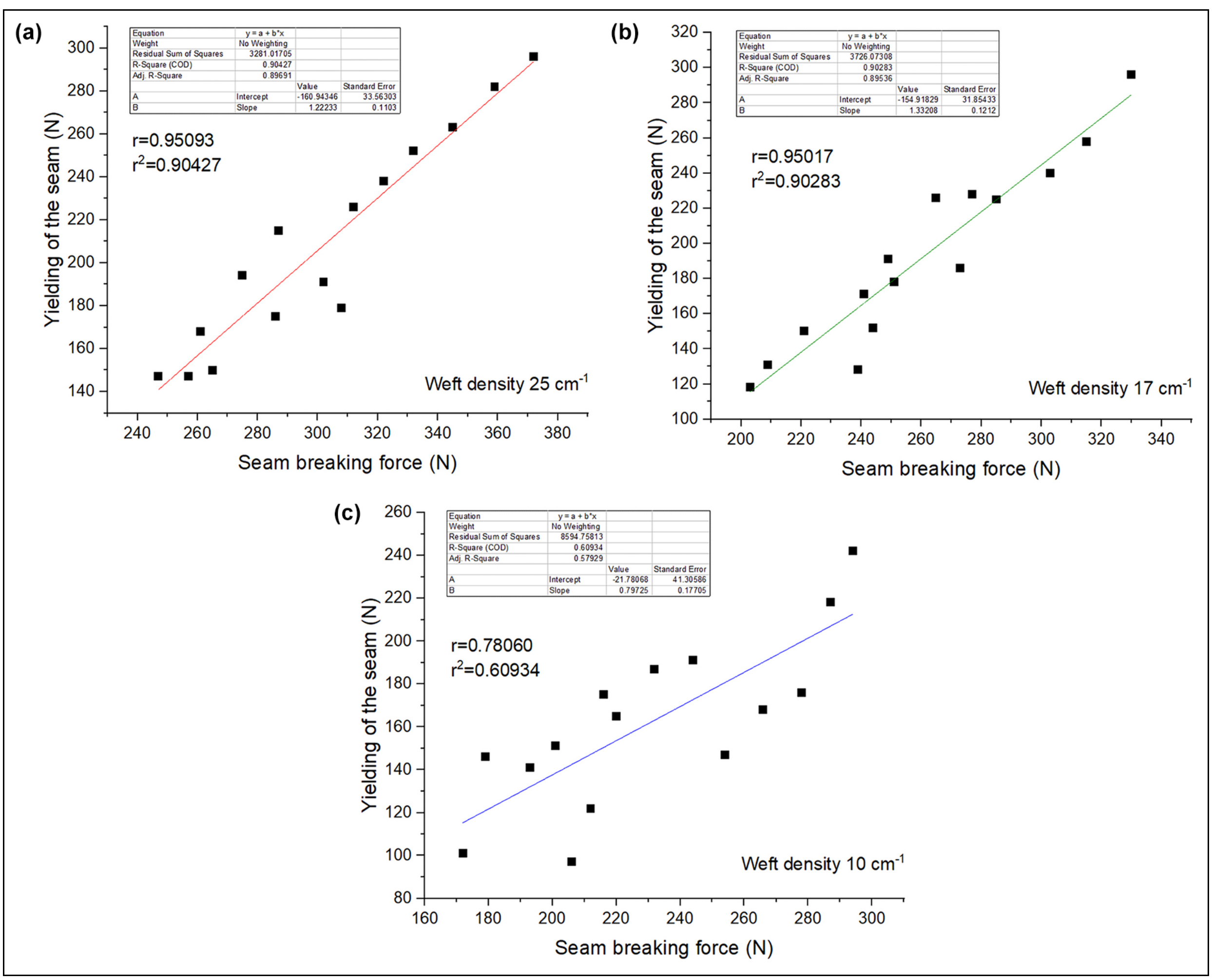

Figure 5. Representation of the correlation between yield strength and seam breaking force in fabrics with weft thread density of 25 cm^{-1} (a), 17 cm^{-1} (b), and 10 cm^{-1} (c).

occurred at the seam itself were taken as relevant results. All other samples where breaks occurred in other places were not taken for analysis in this research. For easier analysis of test results, a video camera was used to record the sample during testing. It can be seen from the recordings that, from the beginning of the test, the force and elongation increase. However, at one point the force value decreases sharply, but then starts to increase again to the point of breaking the seam. This phenomenon is recorded by the sample tearing instrument and plotted on the force–elongation diagram. This phenomenon is analyzed in detail in this paper because in the available literature only the end point of breaking is taken as the strength of the seams. However, when assessing the quality of a seam on a garment, it is important to determine that the seam is damaged to the extent that its appearance impairs the quality of the garment. From obtained results it was determined that this is precisely what happens during the test at the point where the value of the forces suddenly starts to decrease. Following the values of the F–ε curve, a uniform increase in force up to a certain point was observed in all samples. After that point, the force suddenly starts to decrease and then the same force starts to increase again. That part of the curve, at the point where the force starts to decrease, in this paper for all samples, is defined as seam yielding. A review of the videos shows that at that point there is a significant disruption of the seam structure. However, the dynamometer continues to operate, and the force and elongation continue to increase, until the seam is completely split. At the place of a sudden decrease in the force value, seam damage occurs, which is mainly caused by the slippage of the fabric threads along the weft in the seam itself, where these threads were held by the sewing thread.

The obtained results show that the values of the force at the point of yielding of the seam and the breaking force of the seam are greatly influenced by the stitch density. Namely, if we look at the values shown in Table 2, for sample A, it can be seen that the force values increase during the yielding of the seam with an increase in stitch density. This happens because denser stitches strengthen the seam structure itself. This makes the seam more resistant to external forces. The force values at the yield point of the seam increase in samples B and C. This increase in force in samples B and C is for the same reason as in sample A. So, denser stitches strengthen the structure of the seam itself, and with increasing stitch density, the force also increases opposition to external forces of deformation.

It was observed that, even after the yield point, the breaking forces of the stitches increase with the increase in stitch density in all samples. This happens because denser stitches, despite the damage to the seam at the point of seam yielding, still retain, to a certain extent, the remaining strength of the seam structure.

In Tables 3 and 4, the values for samples D, E, F, G, H, and I are shown. For all these samples, the values of the force at the yield point of the seam and the values of the breaking force of the seam can be explained in the same way as for samples A, B, and C. The obtained results show that the values of the force at the yield point of the seam and the breaking force of the seam are affected by the thread density per weft. Namely, for the same linear density of the weft, which amounts to $T_t = 50$ Tex, sample A has a density per weft of $25\,\mathrm{cm}^{-1}$, sample D has a density per weft of $17\,\mathrm{cm}^{-1}$, and sample G has a density per weft of $10\,\mathrm{cm}^{-1}$. In terms of seam yielding and seam breaking force, it can be seen that the force values are the highest for all stitches in sample A. Then they decrease in sample D and are the least in sample G. The deviation in seam yielding is seen only in sample A for density stitch of $3\,\mathrm{cm}^{-1}$, where the force value is lower than the value for sample D. Also for $7\,\mathrm{cm}^{-1}$, the seam yield force values are the same for these two samples.

When the linear density is 30 Tex, sample B has a density per weft of $25\,\mathrm{cm}^{-1}$, sample E has a density per weft of $17\,\mathrm{cm}^{-1}$, and sample H has a density per weft of $10\,\mathrm{cm}^{-1}$. In terms of seam yielding and seam breaking force, it can be seen that the force values are the highest for all stitches in sample B. Then they decrease in sample E and are the least in sample H. Deviation in seam yielding is seen only in sample B for density $5\,\mathrm{cm}^{-1}$ puncture, where the force value is the same as for sample E.

When the linear density is 20 Tex, sample C has a density per weft of $25\,\mathrm{cm}^{-1}$, sample F has a density per weft of $17\,\mathrm{cm}^{-1}$, and sample I has a density per weft of $10\,\mathrm{cm}^{-1}$. In terms of seam yielding and seam breaking force, it can be seen that the force values are the highest for all stitches in sample C. Then they decrease in sample F and are the least in sample I. Deviation in seam yielding is seen only in sample C for density $5\,\mathrm{cm}^{-1}$ puncture, where the force value is the same as for sample F.

The obtained results show that the values of the seam yielding force and the breaking force are affected by the linear density of the threads per weft. Namely, the linear density of threads per weft is $T_t = 50$ Tex for sample A, $T_t = 30$ Tex for sample B, and $T_t = 20$ Tex for sample C. In the case of seam yielding and seam breaking force, it can be seen that the force values are the highest for all stitches in of sample A. Then that they decrease in sample B and that they are the least in sample C. If it is expressed as a percentage, then the average yield force in samples B decreases by 21.54% in relation to the values the average yield force of samples A. Also, the average yield force of samples C is reduced by 32.94% compared to the values of the average yield force of samples A. The same is true for samples D, E, and F, as well as for samples G, H, and I. If it is expressed as a percentage, then the average yield force of samples E decreases by 23.24% compared to the values of the average yield force of samples D. Also, the average yield force of samples F decreases by 37.92% in relation to the values of the average yield force of samples D. Also, the average yield force of samples H decreases by 19.87% in relation to the values of the average yield force of samples G. Furthermore, the average yield force of samples I decreases by 24.92% in relation to the values of the average yielding force of samples G. From the obtained results, it can be seen that the yarns for the weft with a larger cross-section more intensively oppose the slippage of the threads in a seam. The results show that the correlation coefficient between the analyzed parameters is the highest for fabrics with the highest density of weft threads and the lowest for fabrics with the lowest density of weft threads.

The reason why the correlation coefficient is highest in a fabric with a density of $25\,cm^{-1}$ threads per weft is because this fabric has the most stable structure. A higher density of the fabric per weft provides a very small space between the individual threads. This small space prevents the threads from sliding or moving when external deformation forces act. This means that the sliding of the threads over each other is reduced because the friction forces are high. This compactness of the threads better resists external forces that deform the fabric. As the density of the fabric per weft decreases, the interspaces between the threads increases. This facilitates the movement of the threads when deformation forces act on the fabric and the threads slide more easily. The correlation coefficient decreases due to the reduced stability of the fabric structure.

Conclusion

This research elucidates the effect of stitch density on seam strength in cotton fabrics. In the paper, the values of the F–ε curve are monitored. At the same time, an even increase in force up to a certain point is observed in all samples. After that point the force starts to decrease abruptly for a while. Then that same force begins to increase again. That part of the curve at the point where the force starts to decrease is defined in this paper as seam yielding. Therefore, it is concluded that the structure of the seam at this point is greatly disturbed. This means that this point is the limit of the maximum value of the load force that the seam can withstand without impairing the quality of the garment.

The obtained results show that the values of the seam yielding and breaking force are affected by the linear density of the threads per weft. Namely, the linear density of threads per weft is T_t = 50 Tex for sample A, T_t = 30 Tex for sample B, and T_t = 20 Tex for samples C. In the case of seam yielding and seam breaking force, it can be seen that the force values are the highest for all stitches in of sample A. Then they decrease in samples B and they are the least in samples C. If it is expressed as a percentage, then the average yield force in samples B decreases by 21.54% in relation to the values the average yield strength of samples A. Also, the average yield force of samples C is reduced by 32.94% compared to the values of the average yield force of samples A. The same is true for samples D, E, and F, as well as for samples G, H, and I. If it is expressed as a percentage, then the average yield force of samples E decreases by 23.24% compared to the values of the average yield force of samples D. Also, the average yield force of samples F decreases by 37.92% in relation to the values of the average yield force of samples D. Likewise, the average yield force of samples H decreases by 19.87% in relation to the values of the average yield force of samples G. Also, the average yield force of samples I decreases by 24.92% in relation to the values of the average yielding force of samples G. From the obtained results, it can be seen that the yarns for the weft with a larger cross-section more intensively oppose the yielding of the threads in a seam.

The obtained results show that the stitch strength values, for all samples, increase with the increase in stitch density, thread density per weft, and linear density of threads per weft. Defining these parameters represents a significant contribution for manufacturers of quality clothing. These data allow them to project the necessary parameters of clothing production in advance. By knowing these data, it is possible to project in advance the intensities of the forces to which the seams can be subjected in clothing without impairing their quality.

Declaration of conflicting interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author(s) received no financial support for the research, authorship, and/or publication of this article.

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References

1. Sadhna Kumar R, Maanvizhi M, et al. Impact of stitch density on tactile comfort properties of seams. *AATCC J Res* 2022; 10(2): 73–79.
2. Begum MS and Milašius R. Factors of weave estimation and the effect of weave structure on fabric properties: a review. *Fibers* 2022; 10: 74.
3. Kunštek A. Strength of sewn seams of clothing. In: *Proceedings of SITTH and ITO symposium*, Zagreb, Croatia, 31 January to 2 February 1989. Zagreb: University of Zagreb, pp.73–89.
4. Jaouadi M, Msahli S and Jedda H. A new approach for predicting seam strength. *Ind Textila* 2024; 75(3): 283–288.
5. Malciauskiene E, Milašius A and Milašius R. Influence of fabric structure parameters on seam slippage. *Fibres Text East Eur* 2012; 20(3): 98–101.
6. Altay P, Çelikkanat OT, Evren A, et al. Influence of different sewing parameters on the seam quality of cotton sateen fabric. *J Text Eng Fash Technol* 2024; 10(1): 11–15.
7. Akram MW, Mahmud SH, Bin Habib MA, et al. Investigating the influence of yarn density and seam construction on the seam performance of woven linen fabric. *Adv Res Text Eng* 2022; 7(1): 1067.
8. Chen D, Cheng P and Li Y. Investigation of interactions between fabric performance, sewing process parameters and seam pucker of shirt fabric. *J Eng Fiber Fabr* 2021; 16: 1–11.
9. Islam MR, Asif AAH, Razzaque A, et al. Analysis of seam strength and efficiency for 100% cotton plain woven fabric. *Int J Text Sci* 2020; 9(1): 21–24.
10. Hossain A, Rokonuzzaman M, Siddiquee AB, et al. Effect of different sewing parameters on lockstitch seam strength for denim fabric. *J Eng Adv* 2020; 1(4): 139–143.
11. Maanvizhi M, Prakash C and Rameshbabu V. Effect of stitch density and stitch type on the moisture management properties of seams for high active sportswear application. *Fibres Text East Eur* 2020; 28(6(144)): 72–78.
12. Kabir HMJ, Sultana S and Ali A. Impact of stitch type and stitch density on seam properties. *Int J Sci Res* 2018; 7(9): 1407–1414.
13. Islam MM, Hossain MT, Repon MR, et al. Seam strength prediction for different stitch types considering stitch density of cotton woven fabrics. *Text Leather Rev* 2022; 5: 53–69.
14. Choudhary AK and Goel A. Effect of some fabric and sewing conditions on apparel seam characteristics. *J Text* 2013; 2013: 157034.
15. Bharani M, Shiyamaladevi PSS and Mahendra Gowda RV. Characterization of seam strength and seam slippage on cotton fabric with woven structures and finish. *Res J Eng Sci* 2012; 1(2): 41–50.
16. Daukantienė V and Lapinskienė M. Influence of the deformation mode on seam slippage in woven fabrics. *Fibers Polym* 2012; 13(8): 1086–1093.
17. Malčiauskien E, Milašius A, Laureckienė G, et al. Influence of weave into slippage of yarns in woven fabric. *Mater Sci* 2011; 17(1): 47–51.
18. Islam MM, Saha PK, Islam MN, et al. Impact of different seam types on seam strength. *Glob J Res Eng* 2019; 19(4): 23–25.
19. Malčiauskienė E, Milašius A and Milašius R. Weave factor for seam slippage prediction of unbalance fabrics. *Fibres Text East Eur* 2011; 19(4(87)): 101–104.
20. Amir M and Stylios GK. An experimental analysis into thread cycling recovery on seam appearance. *J Fash Technol Text Eng* 2020; 8(4): 3.
21. Choudhary AK, Sikka MP and Bansal P. The study of sewing damage and defects in garments. *Res J Text Appar* 2018; 22(2): 109–125.