Influence of sewing thread count and sewing speed on seam strength and efficiency of 100% cotton woven fabric

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Abstract

This study explores the influence of sewing thread count and speed on seam strength and efficiency in 100% cotton woven fabric. Utilizing samples with thread counts of 21 tex, 27 tex, and 40 tex, sewn at speeds of 3000 rpm, 4000 rpm, and 5000 rpm, a superimposed seam was applied. Results reveal that increasing thread count enhances both seam strength and efficiency. Higher thread counts (tex) contribute to stronger and more efficient seams. However, escalating sewing speeds (rpm) exhibit a mitigating effect on both strength and efficiency, compromising overall seam quality. The research provides crucial insights for garment manufacturers and designers, guiding the optimal selection of thread count and speed to achieve desired seam quality in 100% cotton woven fabric. This knowledge is instrumental in enhancing the quality and appearance of garment products, fostering greater customer satisfaction, and bolstering competitiveness in the dynamic fashion industry. Ultimately, the findings offer practical recommendations for industry professionals to fine-tune their manufacturing processes, ensuring superior seam performance and contributing to overall success in the market.

Keywords: Sewing Thread; Sewing Speed; Seam Strength; Seam Efficiency; Linear Density

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1. Introduction

The advent of sewing machines during the First Industrial Revolution revolutionized the textile industry by reducing the reliance on manual sewing in textile factories. This technological innovation significantly increased productivity and efficiency within the apparel industry. While the appearance of garments remains a critical factor in determining their quality, technical properties, particularly seam strength, also play a crucial role. Several factors contribute to seam strength, including fabric direction, stitch type, needle type, sewing thread type, and speed of the sewing machine. Seam efficiency is defined as seam strength ratio to un-sewn fabric strength which is presented as a value of percentage, which is another important aspect to consider [1]. The entire quality and performance of a garment to the customer are primarily single-minded by the quality of seam and stitching [2]. Seams, which join two or more pieces of fabric through sewing, have a profound impact on the overall quality of garments. Assessing seam quality involves evaluating efficiency, stiffness, elongation, abrasion resistance, bending, seam slip resistance, wrinkling, tightness, strength, seam damage, etc. [3].

To meet various functional and aesthetic requirements, a wide range of stitching techniques have been developed. Sewing threads, in particular, remain an irreplaceable material in the apparel sector despite advancements in automation. Recent studies by manufacturers have addressed the issues arising from sewing threads, ensuring the use of smooth, steady, and robust threads that benefit all stitch types [7].
Different properties like physical, mechanical, strength, extensibility, durability, safety, visual appearance, and seam efficiency depend on the performance of seam quality [8].
The fundamental raw materials of garments, fabric, and sewing threads significantly impact apparel seam quality [9]. The durability of seam performance relies on the strength, efficiency, and appearance of the seams, with particular

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attention given to seam puckering along the seam line [10]. These seam parameters hold significant importance for garment manufacturers and customers, influencing customers' perceptions of garment quality [11]. However, some manufacturers may overlook the influence of stitch classes, stitch density, and sewing threads on the overall performance of apparel, leading to seam failures during use [12].

In the time of high-speed sewing processes, sewing threads undergo multiple passes through the needle's hole, fabric layers, and bobbin case before incorporating into the seam [13]. Extensive research has demonstrated that various fabric quality issues, such as density, extensibility, thickness, bending rigidity, tensile strength, and shear rigidity, significantly affect the quality of seams [14]. Even when materials possess high strength, inadequate seam performance can render the garment unsuitable, highlighting the importance of evaluating seam strength to the garment's performance during use [15]. The tensile possessions of sewing threads involve dynamic loading, yet the precise mechanism behind strength loss in these threads remains unclear. It is essential to investigate how thread structural and surface properties impact strength retention, as well as how specific fabric characteristics influence the degree of strength loss [16]. In research, the seam performance of 100% cotton plain woven fabric was investigated varying sewing thread linear densities like 40s/2, 50s/2, 60s/2, and four different types of stitch structures [17]. Tuteja, S., & Sen, P. analyzed the seam strength and efficiency of denim fabric changing with stitch density (SPI 10 & SPI 13) and sewing thread count (60 Tex, 90 Tex, 150 Tex) [18]. In another study, the seam quality of 100% cotton woven fabric was also examined by applying different stitch types and four sewing thread types [19]. Several studies were done regarding the impact of sewing thread parameters on seam performance of plain woven fabric but no study was found regarding the effect of sewing speed on seam quality.

The main aim of this research is to examine the impacts of sewing thread size(count) and sewing speed on both seam strength and seam efficiency. Through this exploration, valuable insights will be gained, benefiting garment manufacturers and researchers in their endeavors to enhance the quality and performance of garments.

2. Materials and Method

2.1 Materials

100% cotton sewing thread was selected for making all the samples for this research work and the count of the thread was 21 Tex, 27 Tex, and 40 Tex. 100 % cotton fabric has been used for this research work which was collected from Green Smart Shirt Ltd. Fabric specification is 76x68/30x30x60".

2.2 Machinery

A single needle lock stitch is used for sewing the sample. It produces a lock stitch with 3000 rpm to 5000 rpm speed.

2.3 Sample preparation

The sample utilized in this study had dimensions of 15cm × 10cm, employing a superimposed seam in the warp direction. The samples are then sewed using different sewing thread counts like 21 Tex, 27 Tex, and 40 Tex with varying 3000 rpm, 4000 rpm, and 5000 rpm of the sewing machine.

2.4 Calculating seam efficiency (%)

Seam efficiency (%) is the proportion of seam strength and fabric strength which is expressed as percentages. Seam efficiency is calculated using the below equation no. 01.

$$Seam\ strength = \frac{Seam\ strength}{Fabric\ strength} \times\ 100\% \tag{1}$$

3. Results and Discussions

3.1 Effect of sewing thread count on seam strength

Figure 1 represents the seam strength value with varying sewing thread counts. It is seen that 156.85 N for 21 tex, 158.77 N for 27 tex, and 164.28 N for 40 tex were found in the sewn sample at 3000 rpm. That means seam strength has increased with the increasing sewing thread count. This is because the sewing thread becomes thicker when the sewing thread count has increased. So, 40 tex sewing threads show the highest seam strength value. We have also found similar trends for 4000 rpm and 5000 rpm sewn samples.

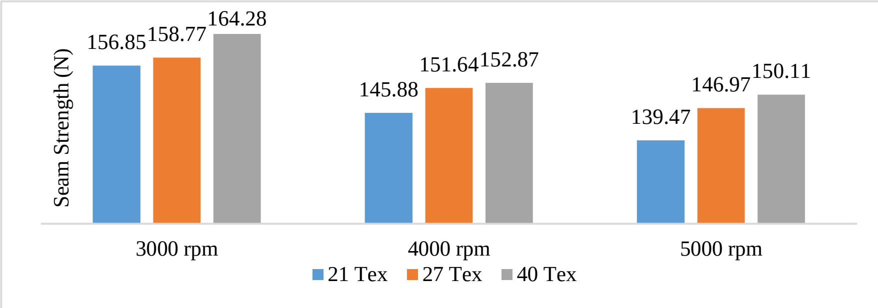

Fig. 1. Effect of sewing thread count on seam strength

3.2 Effect of sewing speed on seam strength

Figure 2 represents the seam strength value with varying sewing speeds. It is seen that 156.85 N for 3000 rpm, 145.88 N for 4000 rpm, and 139.47 N for 5000 rpm were found in the 21 tex sewn sample. That means seam strength has decreased with the increase in sewing speed. This is because the needle thread becomes weaker due to the reason of increased needle heat when the sewing speed has increased. So, 40 tex sewing threads show the lowest seam strength value. We have also found similar trends for 27 tex and 40 tex-sewn samples.

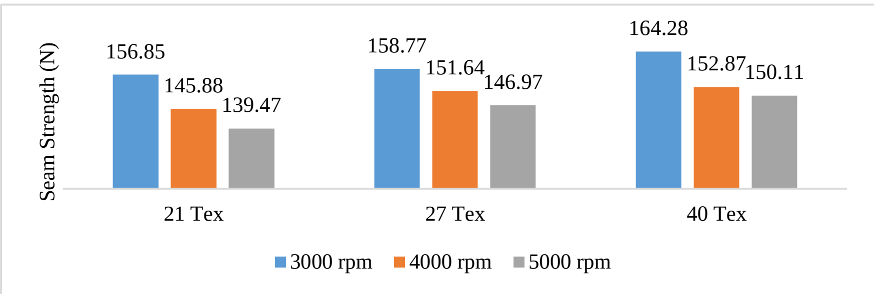

Fig. 2. Effect of sewing speed on seam strength

3.3 Effect of Sewing Thread Count on Seam Efficiency

Figure 3 represents the seam efficiency value with varying sewing thread counts. It is seen that 35.19% for 21 tex, 35.62% for 27 tex, and 36.86% for 40 tex were found in the 3000 rpm sewn sample. This indicates that as the sewing thread count increased, the seam efficiency also improved. This is because the seam strength increases due to become thickness of the sewing thread. So, 40 tex sewing threads show the highest seam strength value. We have also found similar trends for 4000 rpm and 5000 rpm sewn samples.

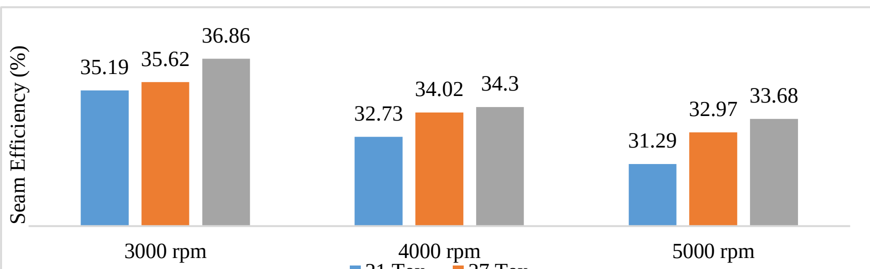

Fig. 3. Effect of sewing thread count on seam efficiency

3.4 Effect of sewing speed on seam efficiency

In Figure 4, the variation in sewing speeds is depicted along with the corresponding seam efficiency values. It can be observed that the 21 tex sewn sample exhibited seam efficiency values of 35.19 N for 3000 rpm, 32.73 N for 4000 rpm, and 31.29 N for 5000 rpm. This indicates a decrease in seam efficiency as the sewing speed increases. The reduction in seam efficiency can be attributed to the decrease in seam strength, which occurs due to the weakening of the needle thread caused by increased needle heat. Notably, the 40 tex sewing threads demonstrated the lowest seam strength value. Similar trends were also observed for the 27-tex and 40-tex sewn samples.

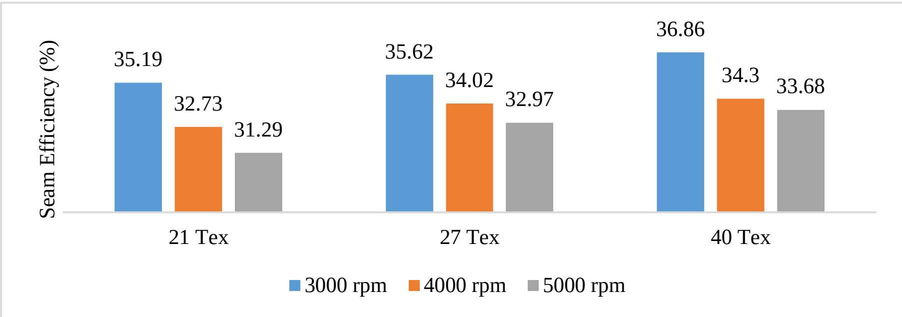

Fig. 4. Effect of sewing speed on seam efficiency

3.5 ANOVA Analysis

Let us take the null hypothesis of the tests that there are no remarkable variations between the seam strength of sewing speed and the seam strength of sewing thread count.

Table 1. ANOVA Analysis.

Sewing Thread Count	Sewing Speed			
	3000 rpm	4000 rpm	5000 rpm	
21 Tex	156.85	145.88	139.47	442.2
27 Tex	158.77	151.64	146.97	457.38
40 Tex	164.28	152.87	150.11	467.26
	479.9	450.39	436.55	1366.84

- The sum of values, T=1366.84
- The correction factor, C= 2007583.51
- The sum of squares of total value = 208027.729
- The sum of the square between columns (sewing speed) = 326.85

- The sum of squares between rows (sewing thread count) = 106.22
- The total sum of square= 444.22

3.6 ANOVA Table

Table 2. ANOVA Table.

Source of variation	Sum of square	Degree of freedom (df)	Mean Square
Between Column (sewing speed)	326.85	2	163.425
Between Row (sewing thread count)	106.22	2	53.11
Residual	11.15	4	2.79
Total	444.22	8	

Now, first compare the sewing speed variance estimate with the residual variance estimate,

thus, $F = \frac{163.425}{2.79} = 58.56$

The Table 2 value of F for 2 and 4 degrees of freedom at a 5% level of significance is 6.94. As the computed value surpasses the critical value, the null hypothesis is rejected. Thus, a significant difference in the mean seam strength of sewing speed has been established.

Now, let us compare the sewing thread count variance estimate with the residual variance estimate,

thus,$F = \frac{53.11}{2.79} = 19.04$

At a 5% level of significance, the critical F-value for 2 and 4 degrees of freedom is determined to be 6.94 based on the table. Upon calculation, the obtained value exceeds the critical value. Therefore, the null hypothesis is rejected, indicating a significant variance in the mean seam strength concerning sewing thread count.

4. Conclusions

This study investigated the impact of altering sewing thread linear density and sewing speed on the seam strength and efficiency of woven fabric. The results reveal a positive correlation between thread count, measured in tex, and both seam efficiency and strength. Increasing thread count leads to improved seam performance. Conversely, an increase in sewing speed is associated with a decrease in both sewing strength and efficiency. Among the tested thread types (21 Tex, 27 Tex, and 40 Tex), 40 Tex exhibited higher sewing strength and efficiency, while 21 Tex showed lower performance. Additionally, comparing sewing speeds at 3000 rpm, 4000 rpm, and 5000 rpm, higher strength and efficiency were observed at 3000 rpm, with lower performance at 5000 rpm. In conclusion, higher linear thread density (in the tex system) and lower sewing speed emerge as potential strategies to enhance seam performance.

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References

[1] Mukhopadhyay, A., Ghosh, S. and Bhaumik, S., 2006. Tearing and tensile strength behaviour of military khaki fabrics from grey to finished process. *International journal of clothing Science and technology*, *18*(4), pp.247-264.

[2] Ebrahim¹', F.F.S., 2012. Influence of mechanical properties of cotton fabrics on seam quality. *Life Science Journal*, *9*(2).

[3] Hu, J. and Chung, S., 2000. Bending behavior of woven fabrics with vertical seams. *Textile Research Journal*, *70*(2), pp.148-153.
[4] Gribaa, S., Ben Amar, S. and Dogui, A., 2006. Influence of sewing parameters upon the tensile behavior of textile assembly. *International journal of clothing science and Technology*, *18*(4), pp.235-246.
[5] Gribaa, S., Ben Amar, S. and Dogui, A., 2006. Influence of sewing parameters upon the tensile behavior of textile assembly. *International journal of clothing science and Technology*, *18*(4), pp.235-246.
[6] Rogina-Car, B. and Kovačević, S., 2022. The study of needle type influence on woven fabric surface area during the sewing process. *Textile research journal*, *92*(17-18), pp.3016-3033.
[7] Gurarda, A., 2008. Investigation of the seam performance of PET/nylon-elastane woven fabrics. *Textile Research Journal*, *78*(1), pp.21-27.
[8] Farhana, K., Syduzzaman, M. and Yeasmin, D., 2015. Effect of sewing thread linear density on apparel seam strength: a research on lapped & superimposed seam. *Journal of Advancements and Engineering and Technology*, *3*(3), pp.1-7.
[9] Hui, P.C., Chan, K.C., Yeung, K.W. and Ng, F.S., 2007. Application of artificial neural networks to the prediction of sewing performance of fabrics. *International Journal of Clothing Science and Technology*, *19*(5), pp.291-318.
[10] Rajput, B., Kakde, M., Gulhane, S., Mohite, S. and Raichurkar, P.P., 2018. Effect of sewing parameters on seam strength and seam efficiency. *Trends in Textile Engineering and Fashion Technology*, *4*(1), pp.4-5.
[11] Dobilaite, V. and Juciene, M., 2006. The influence of mechanical properties of sewing threads on seam pucker. *International Journal of Clothing Science and Technology*, *18*(5), pp.335-345.
[12] Ukponmwan, J.O., Mukhopadhyay, A. and Chatterjee, K.N., 2000. Sewing threads. *Textile progress*, *30*(3-4), pp.1-91.
[13] Gersak, J., 1995. Rheological properties of threads: their influence on dynamic loads in the sewing process. *International Journal of Clothing Science and Technology*, *7*(2/3), pp.71-80.
[14] Brain, D.H., 1970. 35—THE PREDICTION OF STRENGTHS OF LOCKSTITCH SEAMS IN WOVEN FABRICS. *Journal of the Textile Institute*, *61*(10), pp.493-505.
[15] Mukhopadhyay, A., Sikka, M. and Karmakar, A.K., 2004. Impact of laundering on the seam tensile properties of suiting fabric. *International Journal of Clothing Science and Technology*, *16*(4), pp.394-403.
[16] Sundaresan, G., Salhotra, K.R. and Hari, P.K., 1998. Strength reduction in sewing threads during high speed sewing in industrial lockstitch machine: Part II: Effect of thread and fabric properties. *International journal of clothing science and technology*, *10*(1), pp.64-79.
[17] Islam, M.R., Asif, A.A.H., Razzaque, A., Al Mamun, A. and Maniruzzaman, M., 2020. Analysis of seam strength and efficiency for 100% cotton plain woven fabric. *International Journal of Textile Science*, *9*(1), pp.21-24.
[18] Tuteja, S. and Sen, P., 2019. Influence of stitch density and sewing thread count on the seam performance of denim fabric. *Journal of The Textile Association*, *9*(2), pp.442-448.
[19] Akter, M. and Khan, M.R., 2015. The effect of stitch types and sewing thread types on seam strength for cotton apparel. *International Journal of Scientific & Engineering Research*, *6*(7), pp.198-205.