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Analysis of Seam Strength on Denim Fabric by Employing Different Sewing Parameters through Chain Stitch

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Abstract
This research work was intended to analyze the effect of various sewing parameters on seam strength of chain stitched denim fabric. Three different types of sewing thread like 100% cotton spun with a 14-tex linear density, 100% polyester spun with a 24-tex linear density and 100% nylon spun with a 60-tex linear density were used in the study. All experimental tests were carried out according to ASTM (American Society for Testing and Materials) standards. Two types of superimposed seams (SSa and SS_b type) were employed in both warp and weft direction of the fabric. The samples were sewn with three different stitch densities like 7, 9, 11 SPI (stitch per inch). It was found that, different sewing parameters affect chain stitch seam strength in various dimension. In SS_b type seam, higher seam strength was found for using coarser sewing thread (60tex) in the warp direction and 11 stitches per inch (SPI).

Keywords: *Sewing, Chain Stitch, Denim fabric, Seam, Seam Strength*

I. Introduction

The RMG sector in Bangladesh is continuously doing great in the world garments business and this country earns foreign currency approximately 81.16% from garments exports [1][2]. This revenue percentage day by day increased gradually because of increasing Bangladeshi product quality [3][4].

Among many other artifacts, Denim is well known as the oldest fashion products in the world which is made of twill weave structure with 100% cotton and this fabric is comfortable to feel undoubtedly [5][6]. During manufacturing a complete garment, there is required multiple processes to assemble the various parts of garments. Due to this many human labors always work together to join or assemble these parts [7]. To ensure the performance of a garment, several considerations must be made while sewing or assembling various parts of garments. These considerations include the proper machine usage, correct settings of sewing machine, correct needle usage, perfect sewing thread selections, fabric specifications, also stitch density and stitch type during sewing [8]. Some characteristics of the fabric also impact the quality of a garments product such as how the fabric responds to a dynamic force exerted are important observations in the textile industries and these characteristics of fabric play a vital role in the seam quality of garments [9]. In sense of garments quality, it reflects the perfection or standard of a product. To maintain a good quality garments product, the seam of the garments is a crucial criterion, and to serve consumers with perfect quality product, it is significant in today's competitive global market. On the other hand, the seam performance and appearance can be used to measure its quality which is depend upon the seam type, density of stitch, thread tension, appearance, durability, and strength of the seam during production of seam [10].

To check the quality of the seam, seam strength is one of the determining factors to evaluate the durability of the seams and due to the fact that, these seam qualities are directly involved with the garments quality, then the applied seam must fulfill the aforementioned requirement like adequate seam strength, proper appearance, durability [11]. Another significant aspect of seam quality is the stretching capability allowing the user to move freely without damaging or pressuring the seam [12]. Sewing factors such as the type of seam, type of stitch, stitch per inch or stitch density, type of sewing threads, and needle selection influence seam strength as well as seam efficiency [13].

The seam efficiency is directly influenced by the type of sewing thread used during sewing. Also, the linear density of a sewing thread is the most important factor to control seam strength [14].

It is needless to say that, a lot of advancement has taken place regarding the processing and manufacturing of textiles [15]. Some researchers investigated the effects of sewing thread and stitch type on the cotton fabric using superimposed seam [16]. Also, the impact of needle was determined and found that the size of the needle used in sewing, is highly related to the seam strength.

The goal of this research was to examine and demonstrate how various sewing factors, such as type of sewing thread, type of seam, stitch per inch (SPI), and layers of sewn fabric affect denim fabric seam strength using chain stitch.

II. Materials And Methods

2.1 Materials

For experimentation, 98% cotton and 2% spandex 3/1 twill denim fabric (figure 1.a) was used for this study. Fabric properties, sewing parameters, and sewing threads details are shown in Table 1, Table 2, and Table 3 respectively.

Table 1: Fabric details

Parameters		Unit	Value	Parameters		Unit	Value
Thickness		mm	0.52	Count	Warp	tex	80
Surface density		g/m^2	182		Weft	tex	70
Breaking force	Warp	cN	1025	Elongation	Warp (EPcm)	%	11
	Weft	cN	890		Weft (PPcm)	%	8
Density	Warp (EPcm)	cm^{-1}	28	Tenacity	Warp way	cN/tex	12.81
	Weft (PPcm)	cm^{-1}	20		Weft way	cN/tex	12

Table 2: Sewing parameter selection

Sewing parameters	Elaboration		Expression/ Value
Class of seam	Superimposed seam*		SS
Type of seam	Superimposed Seam	Layers-two*	SSa
		Layers- three *	SSb
Direction of seam	Seam were produced in both (warp & weft) directions		Wp, Wf
Stitch per inch (SPI)	Three different stitch densities are expressed as SPI-1, SPI-2, and SPI-3 respectively		7, 9, 11
Sewing thread	Three different sewing threads are marked as thread one, thread two, and thread three		T1, T2, T3
Size of needle (Metric)	Needle sizes for T1, T2, and T3 sewing threads		100,100,150

(*ASTM D 6193 standard)

Table 3: Details of sewing threads

Parameters	Unit	T1	T2	T3
Number of ply	-	2	2	3
Composition	-	Spun, 100% polyester	Spun, 100% Cotton	Spun, 100% polyester
Count	tex	14	24	60
Ticket number		215	125	50
Breaking force	N	8.4	10.6	24
Breaking elongation	%	17.87	7.37	46

b.

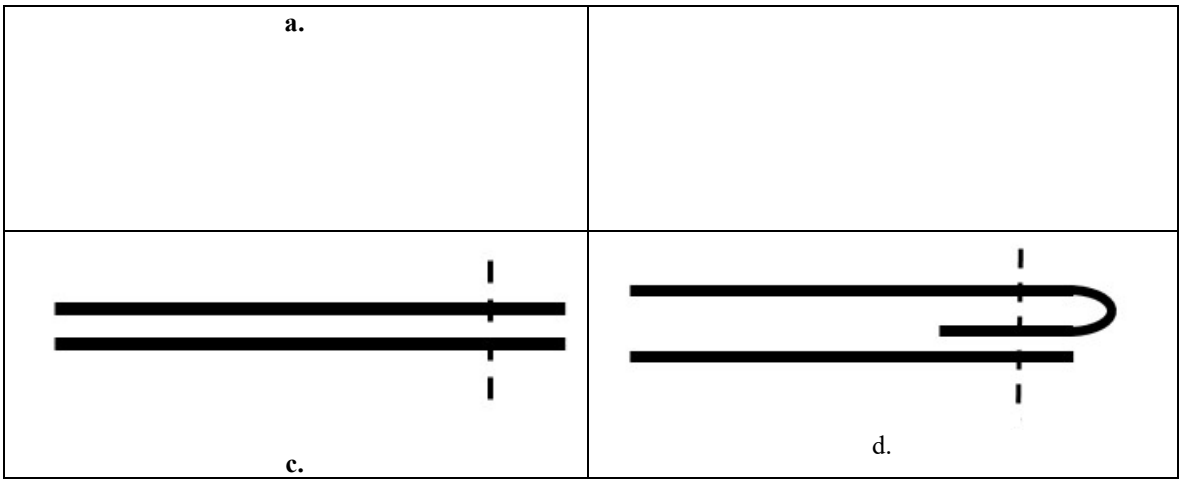


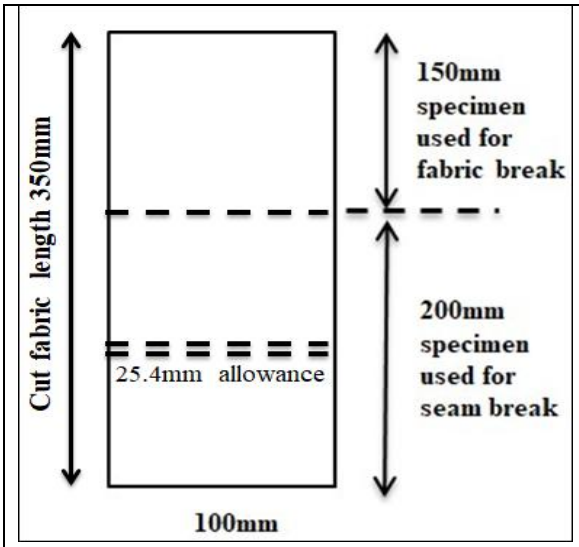
Figure 1: a. Denim fabric, b. Seamed fabric, c. SSa type seam, d. SSb type seam

2.2 Method of sample making

In this study, two type superimposed seam (figure 1.c and 1.d) were made with a seam allowance of 25.4 mm stitch class 401 (figure 2.b and 2.c) in accordance with ASTM D 6193. The needle sizes list which is chosen in this study were mentioned in Table 2. Both the warp and weft direction of the fabric were used to stitch samples along the seam line. The fabric sample was stitched using three different SPI to examine the impact of stitch density on seam strength.

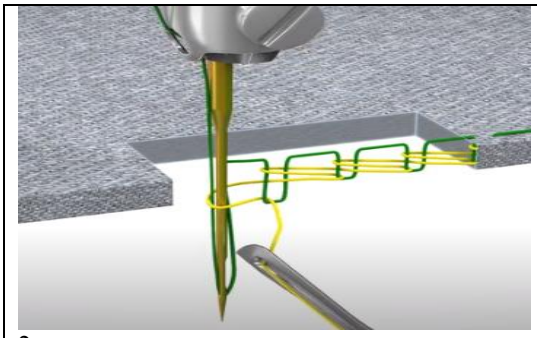
2.2 Evaluation of seam strength

According to the ASTM D 5034 method, the seam strength of samples was determined. The length of the experimental sample was 350 mm which one side is 150mm seam line and another side seam line 200mm and 100mm width is parallel to the seam line were created which is shown in Fig. 2.a. This sample were tested under 1% of the estimated breaking load under tension in titan universal strength tester (2.d). The result shown here is the average value of five repeatedly tested samples.



2.a

2.b



2.c

2.d

Figure 2: a. Cut fabric and seamed fabric dimension, b. Chain stitch sewing machine, c. 401 chain stitch diagram, d. Titan Universal Strength Tester

III. Results and Discussion

3.1 Impact of seam types on seam strength

Superimposed seams, SSa and SSb types were produced for this study. The graphical representation presented in Fig. 4.d shows that there is observable difference in seam strength as fabric layers get increased. This effect is found for all kind of sewing parameters that is seam direction, sewing thread and stitch density. For all the cases, seam strength gets increased as the increase of fabric layers (see figure 3). This is because, an increase in fabric layer increases number of contact points between fabric yarns and sewing threads, thus a tighter surface is obtained. As a result, tensile forces get distributed over a larger number of points and the resistance is higher.

3.2 Impact of seam direction on seam strength

It is clear from the graph presented in figure 4.c that seam direction consistently has a large impact on strength of the seam of the sewn fabrics. The study indicates that for all kinds of stitch types, seam types, stitch densities, and sewing thread types, seams formed in the warp direction most of the cases show greater seam strength than that of weft (see figure 3). The linear density of the warp and weft threads, as well as the fabric's EPI and PPI numbers, can be used to explain the fact. As the warp thread linear density was higher than the weft thread as well as the EPI of the fabric is more than PPI, so the fabric seam strength shows more in warp directions in most cases.

3.3 Sewing thread effects on seam strength

It is a well-known fact that the seam strength of materials that have been sewed increases with increasing sewing thread strength. This is due to the fact that increasing the thread strength increases the strength of the seam they produce. The findings of numerous previous studies also support this study. The impact of sewing threads on seam strength has been shown in Figure 4.a. The impact of sewing threads varying different sewing parameters has been presented in the Figure 3 and it is found that seam strength always gets increased as the increase of sewing thread size for all kind of sewing parameters that is seam direction, fabric layers and stitch density.

3.4 Impact of stitch density on seam strength

Figure 4.b unambiguously represents how stitch densities affect strength of the seam of chain stitched denim fabric. The strength of the seam increases as the stitch density of the seam increases. And for all other sewing-related factors, such as stitch type, seam type, seam direction, and sewing thread types the phenomena is remain same which is showed in figure 3. Actually, with the increase of stitch density the number of loops per unit length of the fabric increases; therefore, the higher force is required to deform such a seam.

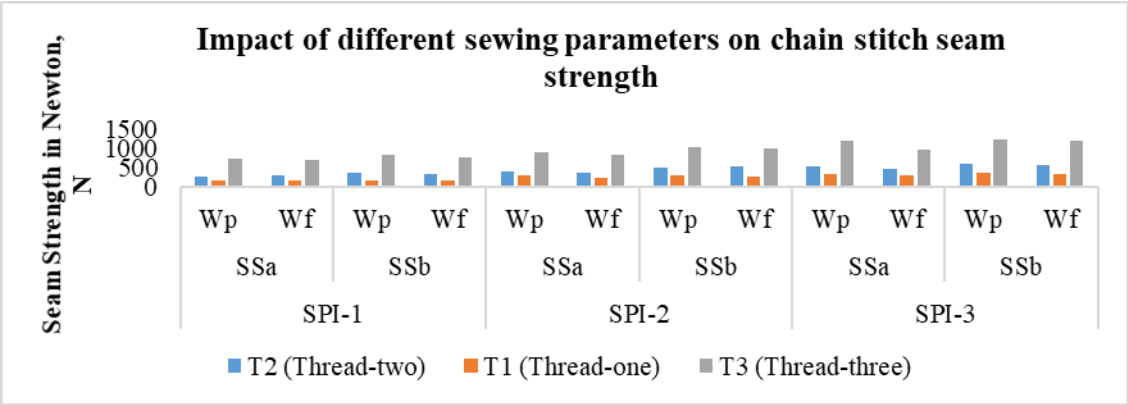


Figure 3: Impact of different sewing parameters on chain stitch seam strength

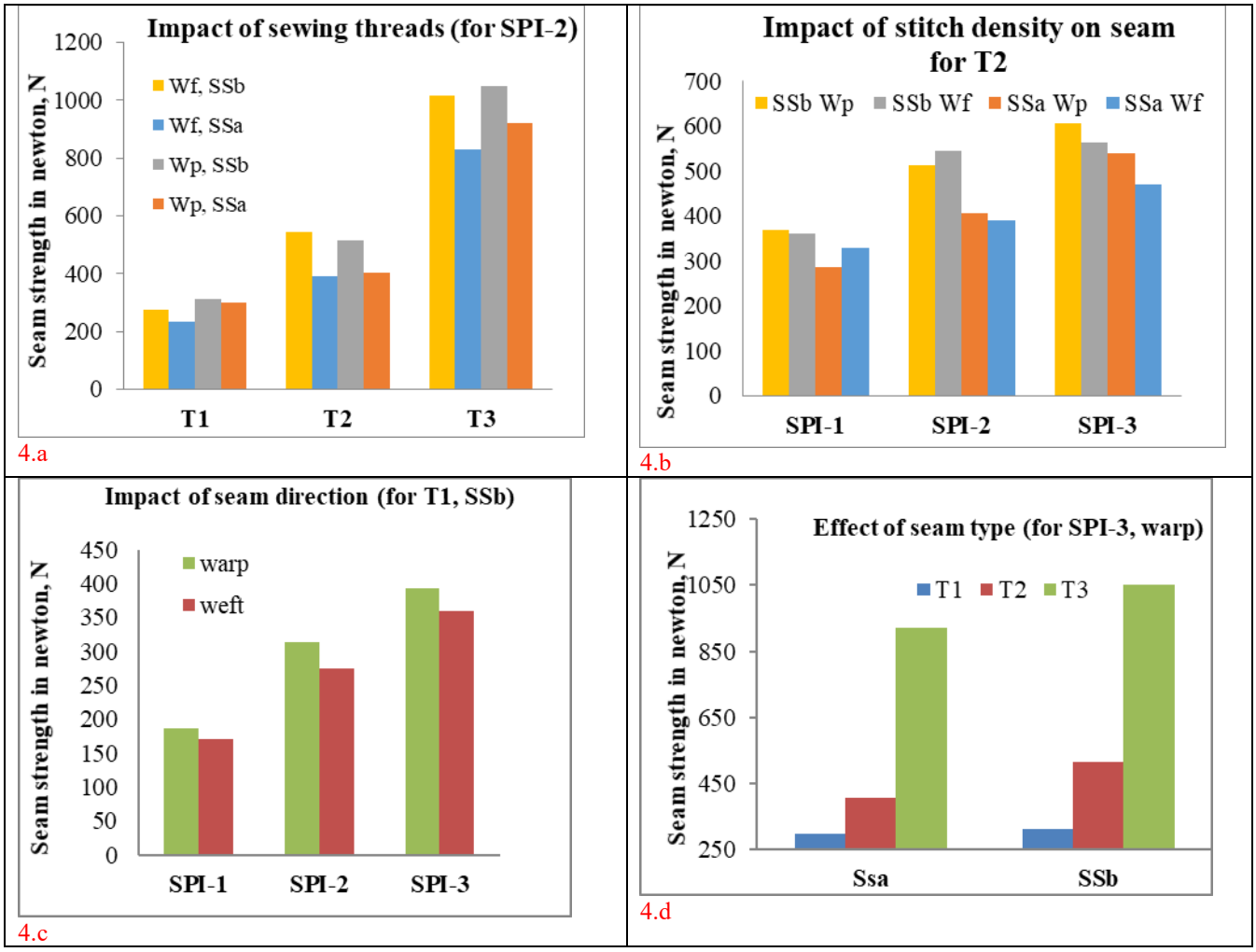


Figure 4: Impact of a. sewing threads, b. stitch density, c. seam direction, d. seam type on chain stitch seam strength

IV. Conclusion

The outcome of the study shows that the selected sewing parameters have significant effect on the strength of chain stitched denim seam. There is less increase in seam strength when seam type is varied by increasing layer of fabric. Although the higher stitch densities and coarser sewing threads were found to have higher seam strengths, to remain seam quality satisfactory level these two factors should be determined carefully because at SPI-3 (11 stitches per inch) some sample had slipped stitches, which indicate that the fabric is not suitable to stitch at 11 SPI for all the time.

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