OPENING MINDS:
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DEVELOPMENT

Effect of Sewing Thread Count and Needle Size on Seam Stiffness of 100% Cotton Twill Fabrics

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1 INTRODUCTION

Sewing is a widely used technique to join fabric cut panels in the apparel industry. Seams are formed when two or more fabric cut panels are joined with a stitch. The important characteristics of a seam are strength, durability, elasticity, stiffness, security and comfort, which will affect the performance and aesthetic appeal of a garment. There are several factors affecting the quality and characteristics of a seam such as sewing thread, needle, fabric, sewing speed, stitch density, sewing condition, stitch and seam types. Sewing thread is the important material used to stabilise the seam and the needle is important in stitch formation (Farhana *et al.*, 2015).

It was reported that sewing thread count significantly affects the flexural properties and stiffness of a seam (Farhana *et al.*, 2015). The bending length increased in the vertical seam but did not affect seam allowance to bending length. (Gϋrarda, 2009). The twill fabric rigidity is higher on the technical backside of the fabric and bending rigidity is different in weft and warp direction (Tohidi, 2013). Although much research has been done to investigate the many factors affecting seam properties, very few studies have been done on the impact of needle size and thread count on the stiffness of a seam. The selection of needle size and thread size depends on the fabric weight, fabric thickness, seam type, stitch type and machine speed. Seam stiffness affects the comfort, flexibility and appearance of a garment when it is worn. The higher the stiffness, the higher the strength, although the flexibility and comfort is low. Depending on the end use of the garment, the optimum conditions of stiffness can be determined. The aim of this study is to investigate the effect of sewing thread count and needle size on seam stiffness of 100% cotton twill fabrics.

2 METHODOLOGY

2.1 Material

100% cotton twill fabrics of two structures in two weights of medium heavy weight (A) and light weight (B) were used for specimens. The specifications of the fabrics that were used are given in Table 1 and the fixed and variable parameters are given in Table 2.

2.2 Sample preparation

Samples were prepared for two types of twill constructions (1/2 and 1/3), warp-wise and weft-wise, three thread counts and four needle sizes resulting in a total of 48 combinations. Specimen size is 25 mm±1 in width and 200 mm±1 in length.

Table 1: Fabric specifications

Fabric types	Fabric type	Fabric structure	Yarn density		Mass	Thickness
			Warp/cm	Weft/cm	(g/m^2)	(mm)
"A" Fabric	100% cotton	Twill 1/2	28	18	289	0.59
"B" Fabric	100% cotton	Twill 1/3	69	42	177	0.27

Table 2: Fixed and variable parameters

Fixed parameters	Variable parameters	
Thread type -100% Spun polyester thread	Sewing thread count	27 Tex (120tkt)
Stitch type- Lock stitch 301		40Tex (75tkt)
Seam type- Superimposed plain seam		60Tex (50tkt)
Stitch density -5/cm	Needle size(metric)	75
Stitch length -2.5mm		90
Sewing speed – 1500rpm		100
Fabric composition – 100% cotton		110
Vertical seam	Fabric types	Fabric "A"
		Fabric "B"

2.3 Procedure

The seam stiffness test was carried out according to Cantilever method of ASTM D 1388 standard using Shirley stiffness tester. 25mm x 200mm size samples were cut and vertical seams were made using lock stitch 301 type machine. The experiments were carried under standard atmospheric conditions, at 27ºC± and 65±2% relative humidity. All the specimens were conditioned under standard atmosphere for 24 hours before testing. Four edges were tested using the Shirley stiffness tester and the overhang length was recorded. Averages of the four readings were taken as the overhang length. 5 samples were prepared for 48 combinations giving a total of 240 samples. From the overhang length, the bending length was calculated using formula (a) given below and then the flexural rigidity was calculated according to the formula (b) given below.

Bending length (C) = O/2;

where O = overhang length (cm)…….(a)

Flexural rigidity (G) in (gcm) = WC^3;

where W= weight per unit are (g/cm^2) (b)

The collected data was analysed using line diagram, linear dimension and regression value (R^2) under 95% confidence levels. The higher the flexural rigidity, the higher the stiffness, which means that the seam is more resistant to bending.

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3 RESULTS AND DISCUSSION

Table 3 gives the flexural rigidity of 48 test combinations, where two fabrics, warp direction and weft direction, three thread sizes and four needle sizes were taken as variable parameters. The needle size is determined by the blade diameter (i.e., size 75 is .75 mm) and sewing thread size is given in Tex.

Table 3: Flexural rigidity values of 48 test combinations

Needle size (metric)	Flexural rigidity (mg cm)											
	Fabric "A"						Fabric "B"					
	Warp direction			Weft direction			Warp direction			Weft direction		
	tex 27	tex 40	tex 60	tex 27	tex 40	tex 60	tex 27	tex 40	tex 60	tex 27	tex 40	tex 60
75	5242	5362	5574	4052	5118	5998	2205	2645	2730	3323	3654	3688
90	5248	5326	5569	4502	5796	6717	2394	2571	2722	3423	3715	3739
100	5231	5499	5640	4499	6050	6767	2472	2515	2760	3396	3767	3804
110	5236	5327	5503	5454	6514	7427	2416	2632	2682	3614	3700	3971

Table 3 shows higher values in Fabric "A" than the Fabric "B", it was clear that when the fabric weight increases, the flexural rigidity values increases showing that the stiffness of the particular fabric is also higher.

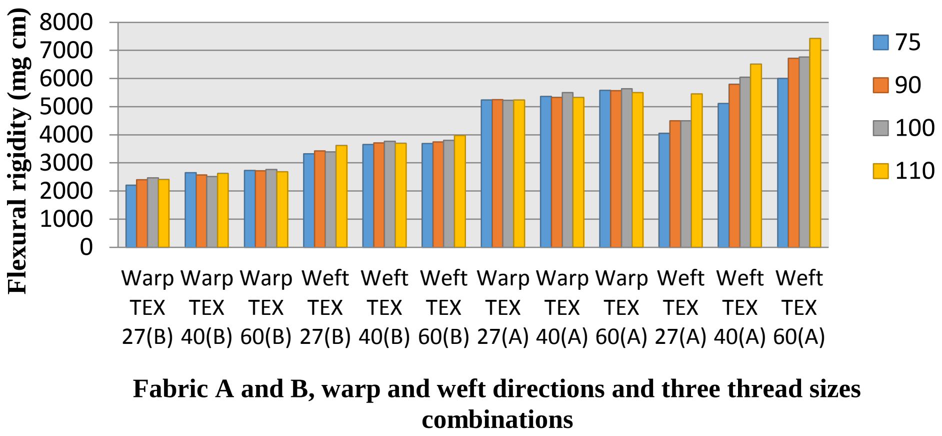

Figure 1: Variation of flexural rigidity value against needle size and 12 combinations of fabric A and B, warp and weft directions and three thread sizes

According the Figure 1, fabric "B" has higher flexural rigidity in weft direction than warp direction and fabric "A" shows higher values in warp direction than weft direction. This can be due to the structure of the twill fabric where the "B" fabric is 1/3 construction and the "A" fabric is ½ construction, and where the cover factor or the tensional forces between interlacing points may have given these results. Flexural rigidity shows a direct proportional relationship to thread count because when the thread count increases it slightly increases the bulkiness of the seam resulting in higher flexural rigidity. In fabric "A", the weft direction shows a direct proportional relationship to needle size. This may be due to the penetration that takes place when forming the stitch because when the needle blade diameter increases it pushes the yarns along the vertical seam increasing the frictional and tensional forces in-between warp and weft yarns. To determine the correlation between needle blade diameter/ needle size and the seam flexural rigidity linear dimension/scatter, diagrams were drawn and coefficient of determination (R^2) values were determined for the 12 combinations mentioned above. The R^2 values are given in Table 4 given below.

Table 4: R^2 value against the needle size

Parameters	Flexural rigidity (mg cm)											
	Fabric "B"						Fabric "A"					
	Warp direction			Weft direction			Warp direction			Weft direction		
	TEX 27	TEX 40	TEX 60	TEX 27	TEX 40	TEX 60	TEX 27	TEX 40	TEX 60	TEX 27	TEX 40	TEX 60
X	0.715	0.078	0.156	0.750	0.343	0.865	0.351	0.013	0.764	0.815	0.990	0.938
r value	0.845	0.280	0.395	0.866	0.586	0.930	0.593	0.112	0.874	0.903	0.995	0.968

X: R^2 value against needle size

If r = 1 or -1 it is a perfect linear relationship and if r = 0 there is no linear relationship between the variables.

As per the results obtained from the experiment, Fabric "A" (medium heavyweight 289 g/m^2) in weft direction shows a significant positive relationship with the increase of needle size (needle blade diameter), the higher the needle size, the higher the stiffness. Even though particular thread sizes show a positive correlation to needle size, a variation of flexural rigidity along with the needle size is insignificant in Fabric "B" (light weight) both in the warp and weft directions and the thread size.

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4 CONCLUSIONS

Based on the results of this research, stiffness or flexural rigidity of the seam significantly increases with the increase of fabric weight. The increase of the seam stiffness in relation to the increase of thread size is insignificant. On average, weft direction flexural rigidity values of the seam are higher than the warp direction values.

The seam stiffness of Fabric "A", a medium heavy weight fabric in weft direction shows a significant increase with the increase of the needle size. The relationship of the seam stiffness of fabric "B", a light weight fabric, with the needle size is insignificant. A similar insignificant relationship is also visible in Fabric "A" in the warp direction.

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