Flexural Behaviour of Polyester/Cotton Plain Woven Fabrics with Superimposed Seam

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1 INTRODUCTION

The flexural behaviour of fabric influences its aesthetic appearance and functionality. The flexural behaviour of fabric is expressed in the terms of stiffness, which influences the flexibility and drape-ability of fabrics and garments (Ayça, G. 2009 and Megeid, *et al.*, 2013). It measures how the material bends under its own weight. Stiffer materials will restrict the flexibility and flexural behaviour of garments or garment parts (Megeid, *et al.*, 2013). Flexural rigidity is the mechanical property, which is generally used in the computation of the fabric stiffness, relating to fabric areal density and the bending length (Ayça, 2009).

The formation of a seam may change the bending behaviour of fabrics in a garment and it will totally change the aesthetic appearance and functions of garments (Nilgün, *et. al.*, 2014). In this research project, the effect of seam parameters such as sewing thread size (ticket number), stitch density, and seam allowance for the variations of flexural behaviour on 65/35 polyester cotton plain woven fabric seamed with superimposed (SSa) seam which is mostly used in garment construction was investigated.

2 METHODOLOGY

2.1 Material

Polyester cotton (65/35) plain woven fabric was used for specimens. Fabric specifications of the material used are given in Table 1 and the fixed and variable parameters are given in Table 2.

Table 1: Fabric specifications

Ends (cm)	Picks (cm)	GSM (gm^{-2})	Thickness (mm)
57	27	113	0.22

Table 2: Fixed and variable parameters

Fixed parameters	Variable parameters	
	Sewing threads	75 Tkt
Vertical seam		120 Tkt
Sewing speed (4000 rpm)	Seam allowances (mm)	6 (SA6)
Fabric type (65/35 polyester/cotton)		10 (SA10)
Stitch Type - 301		14 (SA14)
Plain seam	Stitch densities (SPI)	10 (SD10)
Needle size 14		12 (SD12)
		14 (SD14)

2.2 Procedure

The experiments were carried out under the standard atmospheric conditions, at $27^0C\pm2$ and 65±2% relative humidity**.** Fabric samples were cut in warp and weft directions. The specimens were in the size of 25mm±1 width and 200mm±1 length. Lock stitch type 301 was used in stitching and vertical seams (i.e. a seam which is parallel to the length direction of the sample) were made in the middle of each specimen. All specimens were conditioned under standard atmosphere for 24 hours before testing. Stiffness tests were carried out according to ASTM 1388-68 using the Shirley stiffness tester. Based on the overhang length measurements, bending length was determined using the formula (1) given below. Sample size was five and four readings were taken for each specimen such as one face up and one face down on one end and then the same for the other end. To calculate the flexural rigidity, following formula (2) was used.

Bending length (C) = O/2;
Where O= over hang length (cm) ---- (1)

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

Where W= Weight/unit area (g/cm^2)--(2)

Before investigating the flexural rigidity of sewn samples, the flexural rigidity of unsewn samples (control sample) cut in warp and weft directions was measured.

3 RESULTS AND DISCUSSION

3.1 Flexural rigidity of the control sample

Mean flexural rigidity of control samples cut in warp and weft direction are shown in Figure 1.

According to Figure 1, warp direction shows higher flexural rigidity than weft direction because warp density is higher than weft density. Samples cut in the warp direction, have more warp yarns in unit length. Therefore, they can give a higher bending length and weight per unit area.

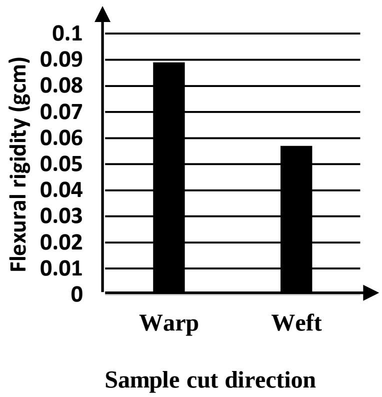

Figure 1: The mean flexural rigidity of the control sample

3.2 Flexural rigidity of plain seam with 75 ticket number in warp and weft directions

Figure 2 shows the mean flexural rigidity of plain seam with 75 Tkt in warp and weft directions respectively for three different seam allowances (SA) and stitch densities (SD).

As shown in the Figure 2, stitch density has a positive correlation to flexural rigidity, because the mass and rigidity of the stitches made by the sewing thread will add to the seam to increase flexural rigidity more than the control sample. Flexural rigidity shows positive correlation to bending length up to seam allowance 10, but seam allowance 14 shows lower flexural rigidity. This may be due to the increase in the weight of fabric with sewn seams. Similar tendencies were also observed in Figure 2 (b).

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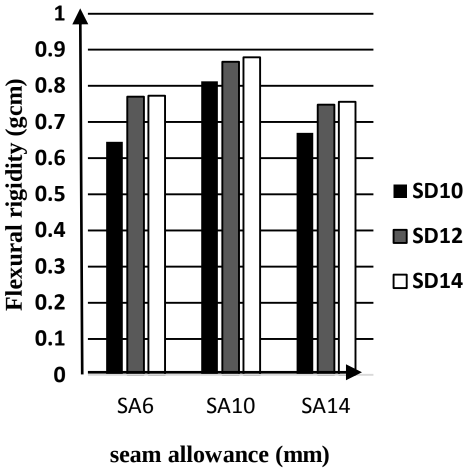
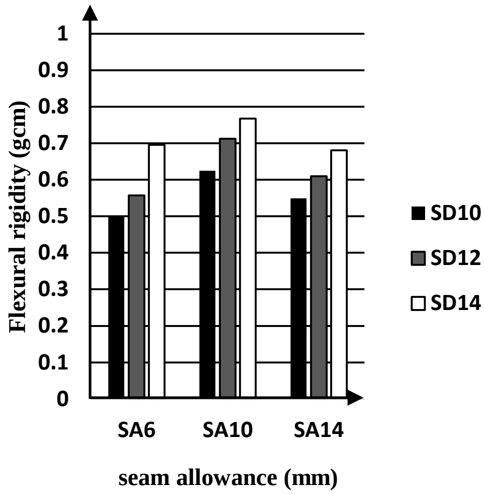
According to the ANOVA analysis given in Table 3and 4, seam allowance and stitch density are significantly affected on flexural rigidity and stiffness under 95% level of significance.



(a) Warp direction



(b) Weft direction

Figure 2: Mean flexural rigidities of plain seam with 75 ticket number

Table 3: ANOVA results for flexural rigidity of samples cut in warp direction and sewn with 75 ticket number

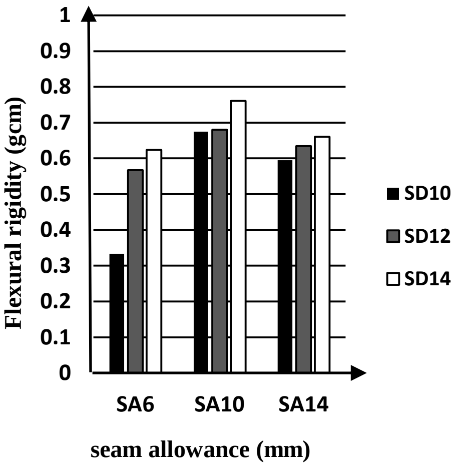
	Sum of squares	**Degrees of freedom(df)**	**Mean square**	**F value ($F_{0.05}$= 6.944)**
Between SAs'	0.031785	2	0.015892333	40.99484093
Between SD's	0.016109	2	0.008054333	20.77644024
Residual	0.001551	4	0.000387667	
Total	0.049444	8	0.0061805	

Table 4: ANOVA result for flexural rigidity of samples in weft direction and sewn with 75 ticket number

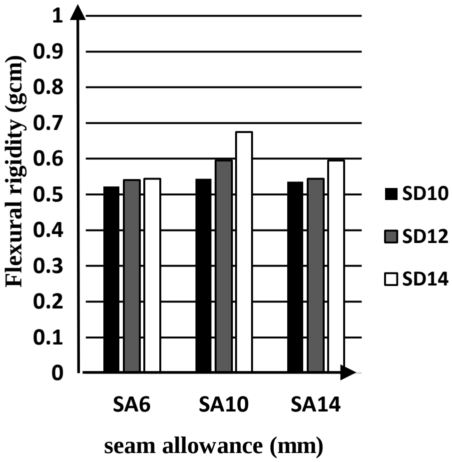
	Sum of squares	**Degrees of freedom(df)**	**Mean square**	**F value ($F_{0.05}$= 6.944).**
Between SAs'	0.022372	2	0.011185778	19.34883721
Between SD's	0.037167	2	0.018583444	32.14510859
Residual	0.002312	4	0.000578111	
Total	0.061851	8	0.007731361	

3.3 Flexural rigidity of plain seam with 120 ticket number in warp and weft direction

Figure 3 shows the mean flexural rigidity of plain seam with 120 ticket number. As shown in the Figure 3, the variation of stitch densities shows a positive correlation with flexural rigidity because of the mass and rigidity of the stitches made by sewing thread. Up to seam allowance 10, the flexural rigidity shows a positive correlation with bending length but seam allowance 14 has a lower flexural rigidity. This may be due to the weight of the fabric. It was observed that there are similar tendencies in Figure 3 (b). Considering the three graphs with SA 6 of Figure 2(a) shows higher value than Figure 3(a). It means fabric samples sewn with 75 ticket number sewing thread have higher flexural rigidity than 120 ticket number.



(a) Warp direction



(b) Weft direction

Figure 3: The mean flexural rigidity of plain seam with 120 ticket number in warp and weft direction

This tendencies can be seen with other graphs also. That was due to the variation of sewing thread thickness. According to ANOVA analysis given in Table 5 and 6, seam allowance and stitch density are not significantly affected on flexural rigidity and stiffness under 95% level of significant for 120 ticket number.

Table 5: ANOVA result for flexural rigidity of samples in warp direction and sewn with 120 ticket number

	Sum of squares	Degrees of freedom(df)	Mean squares	F value ($F_{0.05}$=6.944)
Between SA's	0.05947	2	0.029734333	5.64201006
Between SD's	0.03328	2	0.016641333	3.1576484
Residual	0.02108	4	0.005270167	
Total	0.11383	8	0.014229	

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Table 6: ANOVA result for flexural rigidity of samples in weft direction and sewn with 120 ticket number

	Sum of squares	**Degrees of freedom(df)**	**Mean squares**	**F value ($F_{0.05}$=6.944)**
Between SA's	0.00748	2	0.003741444	4.445573965
Between SD's	0.00768	2	0.003838778	4.561225163
Residual	0.00337	4	0.000841611	
Total	0.01853	8	0.002315861	

4 CONCLUSIONS

Flexural behaviour of a fabric has a positive correlation to flexural rigidity-1. Flexural rigidity of unsewn fabrics showed higher values in warp direction than weft direction depending on the warp and weft densities, which means fabrics in warp direction have a lower flexural behaviour than fabrics in the weft direction. After seaming, the flexural rigidity increased (i.e., reducing the flexural behaviour) in both directions compared to unsewn samples. Due to the variations of flexural rigidity, it can be concluded that the flexural behaviour of fabrics will reduce with an increase in stitch density. Further, flexural behaviour will also decrease with more seam allowances, but it will not continuously decrease. When seam allowance increased more than 10 mm, flexural behaviour will also increase. Thus, fabrics sewn with lower ticket number sewing thread will result in all the above effects with higher significance at 95% confidence level. But, these effects are insignificant at 95% confidence level, when the fabrics are sewn with a higher ticket number sewing thread.

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REFERENCES

Ayça, G. (2009). The effects of seam parameters on the stiffness of woven fabrics. Journal of Textile and Apparel, Vol (23/3), pp 242-247

Megeid, Z. A., Ezzat, M. M., Elzaki, G. M. (2013). Studying the Bending Stiffness of Polyester/Linen Fabric Seams with Different Structures. International Journal of ChemTech Research Vol (9/04), pp 1-6

Nilgün, Ö. Arif, T. Gamze, S. Sima, S. (2014) Influence of yarn and fabric construction parameters on drape and bending behaviour of cotton woven fabrics. Journal of Textile and Apparel, Vol24 (2), pp 102-108