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Seam analysis of wool and blended speciality hair fibres

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ABSTRACT

Purpose : Seam quality is affected by various fabric with mechanical properties. This study analyzed the seam quality of wool and speciality hair fibre blended fabrics. **Design/Methodology/ approaches** : Seam strength, seam efficiency and seam puckering behaviour were analyzed. ASTM1683-04 standard test method was used for the seam strength and seam efficiency. Thickness strain method was used for evaluation of seam puckering behaviour. Sewing thread strength was measured on universal yarn tester. **Findings:** The seam strength of Wool –Polyester-angora and Wool –Polyester-Pashmina is better than Commercial wool fabric. . Wool-Polyester-Angora, Wool-Polyester-Pashmina and Commercial Wool were found in acceptable range of extensibility for seamed apparel. Wool-Polyester-Pashmina fabric has good seam efficiency for apparel. Wool-Polyester-Angora has low seam efficiency. It needs extra care in apparel manufacturing. Wool-Polyester-Angora found highest fabric thickness and seam thickness. Wool-Polyester-Pashmina is found finest fabric. Wool-Polyester-Pashmina and Wool- Nylon-Pashmina fabric are more flexible than Wool-Polyester-Angora and Commercial Wool fabrics. Cover factor is found in adequate range for seamed apparel. **Originality/Value** : Blending of Speciality hair fiber improves the seam strength,seam efficiency and seam puckering behaviour of wool fabric. Medium thickness wool fabric is acceptable for seamed apparel.

Key Words : Seam quality, Seam strength, Seam efficiency, Seam puckering and cover factor

INTRODUCTION

Seaming is the most valuable technique for joining two or more piece of fabrics. Consumer evaluates seam quality as the seam appearance and durability after wear, however, the manufacturer evaluates the seam quality during product development. The seam quality should be appropriate that could provide adequate performance to ensure serviceability during use. It should also provide a saleable appearance. There are several functional and aesthetic requirement of good seam quality. The quality of the seam depends on its strength, elasticity, stability and appearance (Mandal *et al.*, 2010, Mandal, 2008 and Ebrahim, 2012). It is evaluated

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in terms of seam stability, seam strength, seam slippage, seam efficiency, seam elasticity, puckering etc. (Brown, 1992). The seam strength and seam efficiency are used to evaluate the functional performance of seam in term of durability. Puckering is an unacceptable waviness in appearance along the seam length that occurs immediately after seam construction or that may develop after several washing and drying processes (Ukponmwan *et al.*, 2000). Seam puckering is used to measure the appearance along with the seam line and seam aesthetic performance.

A good quality seam should have flexibility and strength with no seaming defect such as puckering or skipped stitches. The overall appearance of the seam should meet the design requirement of the apparel product. The functional garments such as sport wear requires higher seam strength than that of seam appearance, however, the seam appearance has more importance for apparel product than that of seam strength (Mandal *et al*., 2010).

Behera (1997), Behera *et al*. (2000) and Mukhopadhaya *et al.* (2000) reported that seam appearance and performance depend on the interrelationship of fabric threads, stitch size, seam selection and sewing conditions for a particular type of material that are assembled with the sewing thread. The present study was carried out to assess the quality of pure wool and blended fabrics of wool, polyester and angora; wool, polyester and pashmina and wool, nylon pashmina. Detail investigation was also made to study sewing performance of wool and wool blended fabrics.

METHODOLOGY

Materials :

Pure wool and wool blended fabrics of wool, polyester and angora; Wool, Polyester and Pashmina and Wool, Nylon and Pashmina were used for present study to evaluate sewing performance of these fabrics. The polyester cotton wrap thread having 20 tex was used for sewing of fabrics.

Method :

Evaluation of physical properties of fabrics :

Physical and mechanical properties *i.e. EPC*, PPC, weight and cover factor of the commercial and developed fabrics are determined as per standard method. Yarn count in terms of tex was determined as per ISI specification IS -681-1964. The cover factor of fabric is determined using following formula.

$$\text{Cover factor (k)} = \frac{K_1 + K_2 - (K_1 \times K_2)}{28}$$

where K_1 = Warp cover factor

K_2 = Warp cover factor

Warp and Weft cover factors are calculated as given below

$$K_1 = \frac{n_1 \sqrt{N_1}}{10}$$

$$K_2 = \frac{n_2 \sqrt{N_2}}{10}$$

where n1 and n_2 represent ends and picks per cm N_1 and N_2 represent warp and weft count in Tex.

Evaluation of seam performance:

The seam and tensile strength of fabric in warp and weft direction were determined as per ASTM 1683(04) standard using Universal Tensile testing machine *i.e.* Instron Model 4114.

The test specimen of 350 mm × 100 mm was cut and used for testing from both directions. The specimens were folded with 100 mm from one end with fold parallel to straight direction of fabric. The gauze length was used 100 mm and cross-head speed was kept at 100 mm/minute. The maximum load in Kg and extensibility (%) were determined and reported.

After the seaming cut the fold opens, the test specimens contain a seam approximately 100 mm from one end. The specimen was sewn at 25 mm seam allowance. Test specimen was used for seam strength of 150 mm sample size. Yarn parallel to the direction of force and perpendicular to the seam when tested, indicates seam strength test direction.

The seam strength is expressed as maximum force required to rupture the specimen. This is measured by following equation.

Ss = KSb

where

Ss = Sewn Seam Strength (N)

K = a constant equal to 1000 for SI units

Sb = Observed seam breaking force (N)

Determination of Seam efficiency:

Seam efficiency measures the durability along the seam line. According to ASTM standard, It is define as ratio of seam strength to fabric strength. It provides an accurate measure of seam efficiency and widely accepted in apparel industry (Cheng and Poon, 2002, Mohanta, 2006, Mandal, 2008, Tarafdar *et al.,* 2001, Gurada, 2008 and Ebrahim, 2012).

The seam efficiency was measured by using following equation

$$\text{Seam efficiency (\%)} = \frac{\text{Seam tensile strength x 100}}{\text{Fabric tensile strength}}$$

Seam puckering:

Seam puckering appears along the seam line of garment when the sewing parameters and sewn material properties are not properly selected. Seam puckering is calculated by measuring the difference in fabric and seam thickness under constant compressive load of 100 g/m2A specimen of 20 cm × 20 cm of each fabric sample was cut parallel to the length and width. The seam specimen was prepared in such a way that existing seam ran through the middle of each specimen. SiroFAST-1 was used for assessment of fabric thickness and seam thickness, which are related to seam puckering. This method is known as "thickness strain method" (Behera, 1997b and Kothari, 1999).

Seam puckering is calculated by using the following formula-

$$\text{Seam} = \frac{ts - 2t}{2t}$$

where

ts = Seam thickness

t = Fabric thickness

This method is widely used for seam puckering because it is well referred and gives more accurate result than any other method. It is also easy to calculate and is less time consuming than other methods.

Sewing parameters:

Sewing yarn quality, seam type, stitch density and needle size were used for as ASTM standard for medium density of fabric as shown in Table 1.

Table 1 : Sewing parameters of fabric

Seam allowance	25 mm
Needle size	Metric 110 (0.044 in.)
Finish	Chrome
Point	Medium ball (No. 43/ 44)
Polyester-core (polyester core spun with cotton wrap)	Tex 20
Seam type	SSn-2
Stitch type	301
Stitch density	4.7 stitches per cm (12 stitches per inch)

RESULTS AND DISCUSSION

Fabric constructional properties:

Sewing behavior of the fabric is a mainly governed by fabric thickness and cover. This factor depends on yarn liner density and ends picks density. The constructional properties of the fabrics are shown in Table 2. The yarn liner density is a term of Tex is ranging between 14-21 tex. The yarns used for CW and WPA are of similar count, however yarn of wool-pashmina blended yarns (WPP and WNP) are finer than CW and WPA blended yarns. In order to make fabrics comparable, the picks density was adjusted in this way so comparable cover factor was obtained. The ends per cm was the range of 20.2- 20.5, however picks per cm was found range 16.4- 24.1. The picks density was almost similar for CW and WPA fabrics, however, it was higher for Wool-Pashmina blended fabric to compensate cover factor due to finer count of the weft yarn. The cover factor obtained for this fabric is ranging 16-18, which is within the desirable range of woven garments.

Table 2 : Fabric identification and their codes

Fibre composition	Code
Wool/Polyester/Angora (50:30:20)	WPA
Wool/Polyester/Pashmina (50:30:20)	WPP
Wool/Nylon/Pashmina (50:30:20)	WNP
Commercial wool fabric (100%)	CW

Table 3 : Constructional properties of fabric

Fabric ID	EPC	PPC	Count (Tex)	Fabric cover
CW	20.31	16.38	35.7	15.9
WPA	20.47	17.32	41.7	17.0
WPP	20.15	18.74	31.3	16.1
WNP	20.34	24.09	27.8	18.0

Tensile strength of the fabric:

The fabric and seam strength and their elongation are shown in Table 4. Fabric strength of WPA fabric is highest followed by CW, WPP and WNP fabrics. The fabric strength significantly differs from each other at 99% confidence level mainly due to the different fiber composition in the blends. Analysis of one way Anova showed that developed fabrics of WPA, WPP and WNP have significantly different in fabric strength at 99% confidence level. The extensibility of fabric at break is found in the range of 29-41. WNP fabric shows highest extensibility followed by WPA, CW and WPP fabrics.

Seam strength:

Seam strength is a measure of load required to break a seam. It is reported that load required to rupture the seam is generally less than fabric strength. Sahran (2013) reported that stitch density, sewing size and fabric type have significant influence on seam strength. It reveals that fiber composition have significant influence on seam strength.

Statistical analysis of results indicate that seam strength significantly differs between commercial fabric with WPA and WNP at 99% confidence level, however no significant difference is observed between CW and WPP fabrics.

Extensibility:

Seam elongation refers to elastic behavior of a seam and it is defined ratio of length extended to original length of seam. Sahran (2013) reported that seam elongation is found higher in WNP followed WPP, WPA and CW. It is mainly due to the different fiber composition in the fabric.

Table 4 : Tensile properties of fabric and seam

Fabric ID	Fabric strength		Seam strength		
	Maximum load (kgf)	E@ Max load (%)	Maximum load (kgf)	E@ Max load (%)	Seam efficiency (%)
CW	41.038	35.68	22.4596	35.68	54.728788
WPA	52.626	41.02	14.7748	41.02	28.075096
WPP	21.905	29.02	19.037	63.02	86.907099
WNP	27.154	41.78	25.147	106.17	92.608824

Seam efficiency:

Seam efficiency of different fabrics are show in Table 4. Seam efficiency is ratio of seam strength and fabric strength which define garment performance during wearing. The

Table 5 : One way ANOVA result of seam strength of all fabrics

Sample ID		Sum of square	df	Mean square	F	Sig
CW, WPA, WPP, WPN	Between in groups	545.547	3	181.849	33.336	0.000
	With in groups	87.280	16	5.455		
	Total in groups	632.827	19			
CW, WPA	Between in groups	206.025	1	206.025	45.491	0.000
	With in groups	36.231	8	4.529		
	Total in groups	242.256	9			
CW, WPP	Between in groups	0.832	1	0.832	0.272	0.616
	With in groups	24.466	8	3.058		
	Total groups	25.298	9			
CW, WPN	Between in groups	76.535	1	76.535	12.799	0.007
	With in groups	47.838	8	5.980		
	Total in groups	124.373	9			
WPA, WPP, WNP	Between in groups	538.467	2	269.234	42.149	0.000
	With in groups	76.652	12	6.388		
	Total in groups	615.119	14			
WPP, WNP	Between in groups	93.330	1	93.330	14.626	0.005
	With in groups	51.048	8	6.381		
	Total in groups	144.379	9			

results showed that seam efficiency is highest in WNP followed by WPP, CW and WPA fabrics. The seam efficiency of WPA is significantly lower, which indicate that blending of angora in wool and polyester blended fabric adversely affects sewn ability of fabric due to slippery behavior of angora hair fiber. It may also due to higher thickness of the fabric, which may require extra care during garment making from WPA fabric. Among these fabrics WPP fabric shows very good seam efficiency and it is well accepted from sewing behavior point of view of the fabric.

Fabric thickness:

The fabric thickness influenced the seam thickness and finally affects the seam puckering behavior. The fabric thickness and seam thickness are show in Table 5. The fabric thickness varies from 0.59 to 0.72 mm. The thicknesses is found highest in WPA fabric followed by CW, WPP and WNP. WPP is found finest fabric among the all fabrics. It reveals that thickness of CW, WPP and WPA significantly differs, however no significant difference is observed between CW and WPP fabrics.

Seam thickness:

Seam thickness is found highest for WPA followed by CW, WNP and WPP fabrics. Statically analysis using one way Anova test revels that seam thickness among the fabric significantly differs. It is also found that seam thickness between CW and WPA significantly differ however the differences between seam thickness of CW and WNP and WPP fabrics have no significant difference.

Seam puckering:

Seam puckering behavior of the fabrics during sewing depends on difference of fabric and seam thickness. Higher value of seam puckering refers to fabric structure jamming which need to lower flexibility at the seam. The results of seam puckering are shown in table: 6. The lower flexibility of CW fabric show higher value of seam puckering followed by WPA, WPP and WNP fabrics. WNP show significantly lower value of seam puckering as compared to WPA and WPP mainly due to lower value of fabric thickness. It indicates that WPA and WPP are more flexible than of CW and WNP fabrics.

Table 6 : Seam puckering behavior of pure wool and blended wool

Fabric ID	Fabric thickness	Seam thickness	Seam puckering
CW	0.627	14.23	14.28
WPA	0.721	1.601	11.03
WPP	0.588	1.195	12.51
WNP	0.688	1.407	4.29

Table 7 : One way ANOVA results of all fabrics

Sample ID		Sum of square	df	Mean square	F	Sig
CW, WPA, WPP, WPN	Between groups	161.711	3	53.904	6.665	0.024
	With in groups	48.525	6	8.088		
	Total groups	210.236	9			
CW,WPA	Between groups	7.042	1	7.042	0.595	0.582
	With in groups	11.834	1	11.834		
	Total groups	18.875	2			
CW,WPP	Between groups	2.350	1	2.350	0.176	0.715
	Total groups	26.645	2	13.323		
	With in groups	28.995	3			
CW,WPN	Between groups	79.840	1	79.840	23.841	0.016
	Total groups	10.047	3	3.349		
	With in groups	89.887	4			
WPA,WPP,WNP	Between groups	131.932	2	65.966	8.156	0.019
	Total groups	48.525	6	8.088		
	With in groups	180.457	8			
WPP,WNP	Between groups	115.832	1	115.832	15.784	0.011
	Total groups	36.692	5	7.338		
	With in groups	152.523	6			

Statistical analysis using one way Anova test reveals that there is no significance difference in seam puckering behavior of CW, WPA, WPP and WNP. Similarly no significance difference is found between CW and WPA, CW and WPP and found 95% confidential. It is observed that CW and WPP, CW and WNP found significance difference and 99% confidential. WPA, WPP and WNP found no significance difference and 95 % confidential.

Conclusion:

Cover factor is found in adequate range for seamed apparel. The seam strength of

Wool –Polyester-angora and Wool –Polyester-Pashmina is better than Commercial wool fabric. Wool-Polyester-Angora; Wool-Polyester-Pashmina and Commercial Wool were found in acceptable range of extensibility for seamed apparel. Wool-Polyester-Pashmina fabric has good seam efficiency for apparel. Wool-Polyester-Angora has low seam efficiency. It needs extra care in apparel manufacturing. Wool-Polyester-Angora found highest fabric thickness and seam thickness. Wool-Polyester-Pashmina is found finest fabric. Wool-Polyester-Pashmina and Wool- Nylon-Pashmina fabric are more flexible than Wool-Polyester-Angora and Commercial Wool fabrics.

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