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Research Article

Effect of Seam Formation on Draping Quality of the Stitched Fabric

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Abstract

The drape is the important aesthetic property of the fabric which allows a fabric to bend in multi-directions. Since last so many years, the researcher has studied the fabric drapability in order to improve the drape and appearance of the garment over the body. However, fabric panels must be stitched together to form the garment. A seam and stitch are believed to affect a garment appearance significantly.

Thus, the study of the fabric drape can be more realistic with stitches and seams. In this paper, the study was made to check the effect of stitches and seams on the different GSM of the fabric.

Keywords: Drape; Sewn; Seam, Garment, Stitches, GSM and fabric

Introduction

The stitched fabric or the apparel is assembled by cutting and sewing the fabric panels together. The seam is the joint where the sequence of stitches unites two or more layer of the fabrics together, and this seam affects the fabric stiffness greatly [1]. It is unrealistic to realise the appearance of the apparels without the consideration of the seams and the methods of assembling of fabric into the garments [2]. Therefore, there is a necessity to optimise the seam parameters in order to decrease the stiffness of the fabric of the garment [3]. The beauty of the garment seems to affect the seam formation. Bending of the fabrics are evaluated by 2 dimensional whereas drape is evaluated for 3-dimensional properties of the garment [4].

To overcome the limitations of estimating fabric drape via two-dimensional measurement of stiffness, researchers in Fabric Research Laboratories developed the F.R.L. Drapemeter by the Chu, Cummings, and Teixeira [5].Later Cusick [6] developed a drapemeter based on a similar principle. By developing drapemeter, Chu et al., and Cusick made a significant contribution to the practical determination of this fabric property by measuring drape in three-dimensions.

Dhingra and Postle investigated bending properties of fabrics with a seam. Two plain seams, one vertical (perpendicular) and one parallel (horizontal) to the bending axis, were tested. With the introduction of the vertical seam, bending properties were greatly increased and they were further increased when the seam allowance was increased to 10 mm. [7]. Suda and Nagasaka investigated the effect of the seam on fabric bending rigidity tested in the Kawabata Evaluation System (KES) by varying seam allowances, the number of seams on the same specimen, the type of stitches, seam and sewing thread. They concluded that a seam has distinctive effects on the bending property of the fabric [8,9]. Although thread balance during sewing, thread crimps, width, layers and thickness of the seamed piles [10-13] are important factors affecting the drape of fabrics.

Materials and Methods

Materials

The upper garment i.e. the shirt under study was made with 100% cotton fabrics for the premium shirts. The specification of the material used is given in Table 1.

Methods

The stitch samples are prepared on the single needle lock stitch machine of make Silversun of model SMX 8700. The Needle number used is DB X 1 of 14 Nos. for light and medium weight whereas DB X 1 of 16 No. is used for the heavyweight material. The sewing thread used was 3 ply polyester having ticket number 80. The same thread is used to avoid any variation for seam formation. Apart from this overlock, multithread chain stitch and flat lock machines were used for the stitching of the sample preparation of shirts. All specimens were ironed at standard temperature and conditioned at 27°C and 65 RH for 24 hours before testing.

For manufacturing, the shirt various seams are used. In the research study, the shirt is assembled with a superimposed seam, lapped seam and flat seam. The experimentation was carried out with a combination of the superimposed seam with lock stitch in 3 different GSM of a fabric. Likewise, the lapped seam with chain stitch and flat lock with covering chain stitches was used for the preparation of 9 samples with lightweight, medium weight, and heavy weight

Table 1: Fabric specification.

Sr. No.	Parameter	Light Weight Fabric	Medium Weight Fabric	Heavyweight Fabric
1	Ends/inch	168	160	152
2	Picks/inch	102	58	62
3	Warp Yarn Count (Ne)	65.62	49.21	32.81
4	Weft Yarn Count (Ne)	49.21	21.87	13.12
5	Warp crimp %	3%	2%	6%
6	Weft crimp %	6 %	8%	10%
7	Warp cover factor	20.73	22.80	26.53
8	Weft cover factor	14.54	12.40	17.11
9	Cloth cover factor	24.50	25.10	27.42
10	GSM in (gms/Sq. meter)	116	127	222

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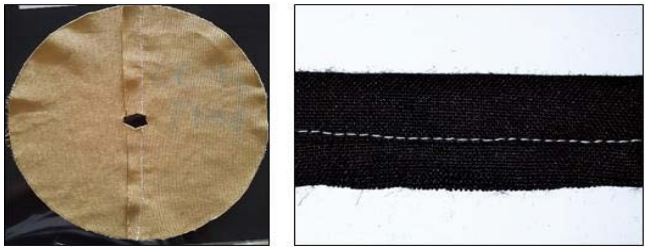

Figure 1: Sample preparation for drape coefficient and stiffness.

Figure 2: Superimposed seam.

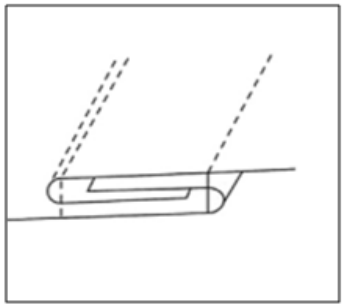

Figure 3: Lapped seam.

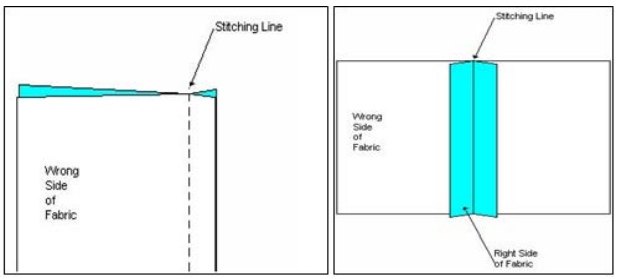

Figure 4: Flat seam.

GSM of fabrics. Following seam and stitch combination is used for Shirt sample preparation under study.

1. Superimposed seam and lock stitch
2. Lapped seam with chain stitches
3. Flat lock seam and covering chain stitch

Seam and stitch sample preparation

The samples are prepared on the single needle lock stitch sewing machine for the stiffness and drape coefficient with a seam. Hence, the seam is formed on the samples according to the seam standards. Actually, in the garment when the seams are used these are basically formed with the same allowance rather than varying seam allowance. But different types of seams are mostly used in a wide variety of garments. So here the study was made particularly with the seams used for the bottom wear and upper wear garments.

The Figure 1, shows the representative sample preparation for the DC% and stiffness calculation with seams.

The samples for the upper wear garments particularly for shirts were prepared from varying GSM viz. lightweight, medium weight and heavyweight, by forming the basic seams like a superimposed, lapped, and flat seam. It is very important here to discuss the properties of the seams though explained earlier in the literature review.

Superimposed seam: The superimposed seam is the most commonly used seam in the garment. The panels of the garment are just exactly kept over each other and then the stitch is formed on that garment panels to be joined together. So the limited edge of the panels is overlapped over each other Figure 2.

As shown in the diagram the two layers of the fabrics were exactly kept over each other and the dotted line shows form the stitches over it for joining purpose.

Lapped seam: The lapped seam is formed when the limited edge of the panels of the fabrics are overlapped for the limited width. This type of lapped seam formation is basically seen in the shirts. As shown in the below Figure 3, the one edge of the fabric is folded inside to the other edge of the fabric, so that the firm locking is formed between the edges of the fabric and over which the stitches are formed for joining purpose.

Flat seam: The flat seam as the name itself explains aims to reduce the thickness of the seams. Because when any seams will be formed the thickness at the overlapping area will be doubled or in the multiplication of original sample. So in this seam, the samples are just butted together. This is mostly suitable for the joining the panels of the undergarments so to avoid any discomfort to the body Figure 4.

Stitch formation

Lock stitch: It is the most common stitch made by the single needle lockstitch sewing machine. The lock stitch uses two threads upper thread which passes through the needle and bottom thread i.e. bobbin thread. Lock stitches are the secured stitches because they formed the locking with each successive needle penetration and hence it's unravelling are quite difficult Figure 5.

Chain stitch: Chain stitch is made by using one or more group of sewing threads. The stitch which is formed by using two or more groups of sewing thread is called multi-thread chain stitch. Here, the loop of one group sewing threads is bounded by interloping with the

Figure 5: Lock stitch.

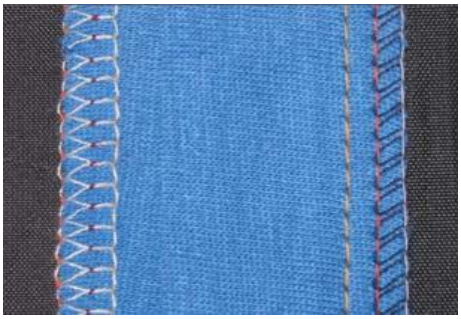

Figure 6: Chain stitch.

Figure 7: Covering chain stitches.

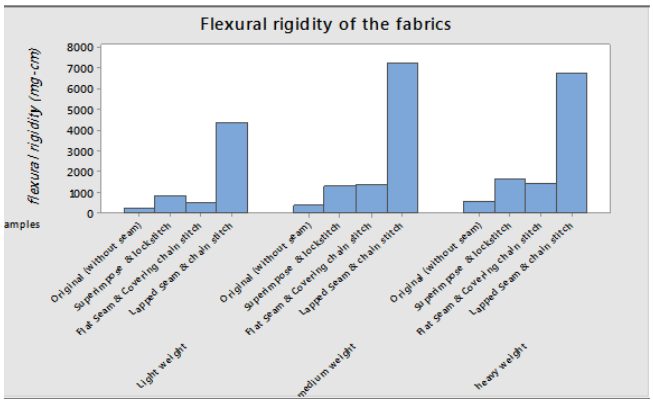

Figure 8: Flexural rigidity of the different GSM fabrics.

loop of another group of sewing threads. Stitch type-401 is called multi-thread chain stitch Figure 6.

Covering chain stitches: Class-600 named as covering chain stitch which is produced with three groups of threads. Threads of two groups can be seen from either side, the first group of the thread is called needle thread, the second group is called top cover thread and the third group is called bottom cover thread. This stitch is very complex and uses up to 9 threads in producing these types of stitch. These types of stitch are used for knits, lingerie, binding elastics, decoration, etc Figure 7.

Results and Discussion

Stiffness testing

Bending length known as drape Stiffness is very important property which decides the two-dimensional drape of the fabric. As studied by the pierce [4] this property is one of the major for the study of the drape. The rectangular strip of fabric is mounted on the horizontal platform and slides until the fabric overhang like a cantilever. Flexural rigidity was also calculated by multiplying the thickness of the samples and expressed in the table below.

Table 2: Flexural rigidity (mg-cm).

Sr. No.	Shirt Samples	Light weight	Medium weight	Heavy weight
1	Original (without seam)	266.43	382.63	537.82
2	Superimpose Seam & lockstitch	844.87	1301.33	1660.13
3	Flat Seam & Covering chain stitch	494.35	1392.49	1443.71
4	Lapped Seam & chain stitch	4358.82	7266.1	6793.98

Shirley stiffness tester was used for stiffness calculation. The testing was done according to IS 6490-1971 based on the BS 3356: 1961 and ASTM Designation: D 1388-64. The average of the five samples each taken for the warp and weft way. Prior to the test, the fabric samples were conditioned at moisture equilibrium and tested in standard atmospheric conditions of 65 % RH and 27°C temperature

The Figure 8 and the Table 2 shows the flexural rigidity of the light, medium and heavyweight fabric. The lapped seam is formed with chain stitch combination. As lapped seam is formed by binding the hem together of the fabrics and hence it shows more resistance towards the bending of the fabrics. Whereas the flat seam forms almost the same type of combination as that of original fabrics although the fabric shows more resistance to bending than the original without seam fabrics. This is because of the formation of the flat seam as very less thickness is used for the joining of the edges of the fabrics.

Overall it can see that if the thickness and the weight are the influencing factors for flexural rigidity. So the increase in thickness will increase the stiffness and found to be more in heavyweight fabric and lapped seam.

Seam strength

Seam strength refers to the load required to break a seam. This measures the strength and tenacity of a seam. Two pieces of woven fabric are joined by a seam and if tangential force is applied the seam line, rupture ultimately occurs at or near the seam line. It is a function of the strength of thread used for the seam, type of seam assembly in a garment and type of fabric used. Tensile tests on the sample fabrics were performed to determine seam efficiency using the ASTM D 5034-95 (grab) methods. Or a large number of tests are done with ASTM 1683-04 standard which expresses the value of seam strength in terms of maximum force to cause the seam specimen to rupture (Table 3).

As observed Figure 9, the seam strength for warp way is higher for superimposed seam and lock stitch combination. Where as it shows less for the lapped and chain stitch combination. The strength of seam is the combined effect of fabric strip strength and seam strength. For the warp, the lockstitch is having more strength than other chain stitches. Whereas for the weft, the trend shows that the superimposed seam shows highest seam strength because of its locking for each successive needle penetration.

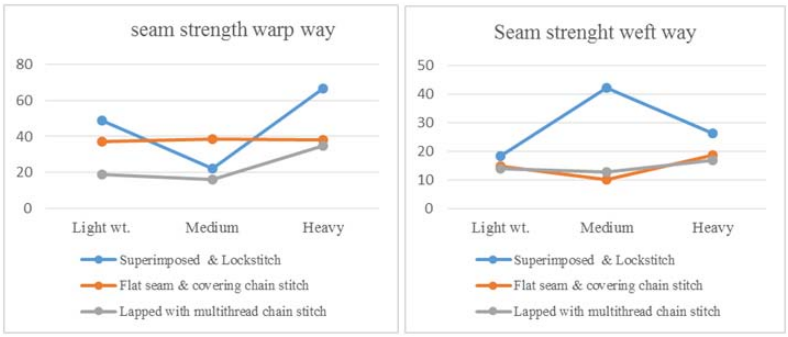

Figure 9: Seam strength in warp and weft way.

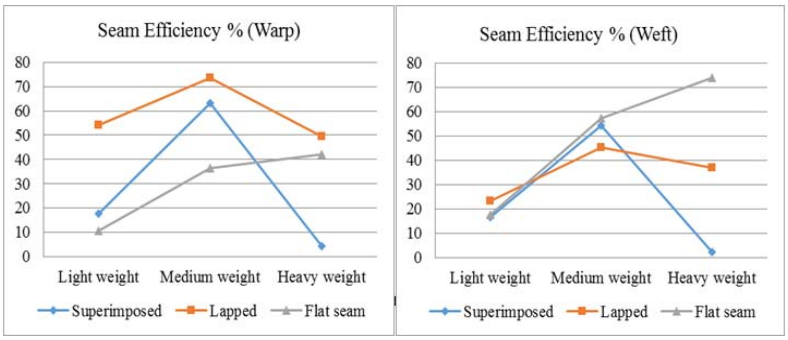

Figure 10: Seam efficiency in warp and weft direction.

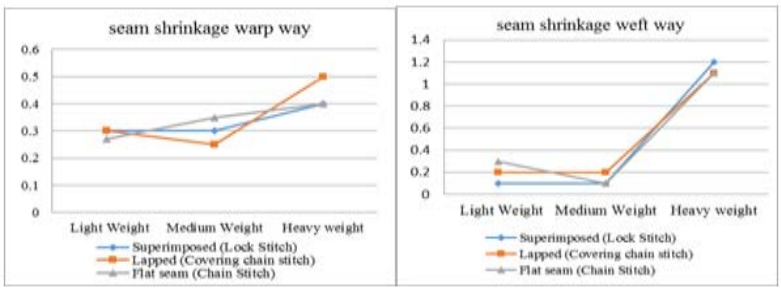

Figure 11: Seam shrinkage in warp and weft way direction.

Seam efficiency

Seam efficiency measures the durability along the seam line. Durability is identified as necessary to satisfactory seam's functional performance and efficient seams are assumed to be more durable than weak ones. Seam efficiency is measured by the strength tester, based on the pendulum lever principle according to the ASTM 1683-04 standard method. In this method, seam efficiency was measured by using the following formula (Table 4).

$$Seam\ efficienfy\ (\%) = \frac{(Fabric\ with\ seam\ tensile\ strenght)}{fabric\ tensile\ strength} * 100$$

Seam strength is inversely proportional to the fabric strength. The same trend is seen in the warp direction for the superimposed seam but observed different with other seam and stitch combination. For the weft way, the same trend is observed. As the superimposed is most commonly used seam for shirting whereas another seam formation is quite different for the lapped and flat seam. And hence the trend for the superimposed seam is same for warp way and weft way direction Figure 10.

Seam shrinkage

This test is carried out for dimensional stability of the seams after different washing. Shrinkage can be expressed in percentage (Table 5).

It is observed from the Figure 11, that the heavy weight fabric shows more shrinkage than the light and medium weight fabrics under study.

Drape coefficient of seamed fabric

The drape ability of seamed fabric or garment affected by both the flexibility of the materials and by the construction of the seam. The drape is calculated as the area covered by the shadow of the draped specimen expressed as a percentage of the annual ring of fabric (Table 6).

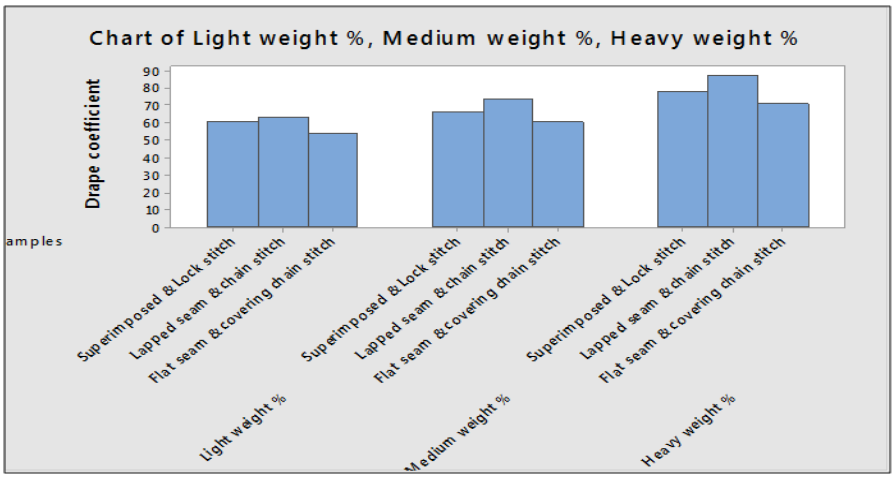

Figure 12: Drape coefficient of different seamed fabric with stitches.

Table 3: Seam strength of warp and weft way samples.

Sr. No.	Seams & Stitches	Fabric Sample	Load in kgf for warp	Load in Kgf for weft
1	Superimposed seam & lockstitch	Light Weight	48.8	15.2
2		Medium Weight	22.4	42.2
3		Heavyweight	66.6	26.4
4	Lapped seam & Chain Stitch	Light Weight	37.2	15
5		Medium Weight	38.6	10
6		Heavyweight	38	7.06
7	Flat seam &Covering Chain stitch	Light Weight	19	14
8		Medium Weight	16	12.8
9		Heavyweight	35	17

Table 4: Seam Efficiency in warp and weft way.

Seams & Stitches	Fabric Sample	Warp efficiency %	Weft efficiency %
Superimposed &lockstitch	Light Weight	17.82	16.48
	Medium Weight	63.27	54.35
	Heavyweight	4.32	2.22
Lapped &Chain Stitch	Light Weight	54.10	23.07
	Medium Weight	73.77	45.29
	Heavyweight	49.56	37.03
Flat seam &Covering Chain	Light Weight	10.14	17.58
	Medium Weight	36.27	57.26
	Heavyweight	42.24	73.85

The graph shows the drape coefficient of the varying GSM of the fabrics under study. Superimposed-lock stitch combination and Flat seam-covering chain stitch combination shows an almost same trend for the drape coefficient of the fabrics. Whereas the Lapped seam-chain stitch combination shows the higher drape coefficient for all the varying GSM of the fabrics. This is because of the structure formation with a lapped seam.

Subjective Analysis of the shirts

There are several dimensions for evaluation of the graceful appearance of the fabrics. In order to simplify the analysis of appearance, it is essential to choose only most important evaluating dimensions, which can well represent the overall graceful appearance of the garment. This study tried to identify the most important dimensions for the graceful appearance or fall of the garment through the subjective analysis of the samples.

Selection of the judges: The selection of judges is an important element for the subjective ranking in order to achieve greater reliability and consistency. The judges were selected from the Industry and academics of the apparels. It was found that researchers had industrial experiences in the garment field. They had experiences

Table 5: Average seam Shrinkage in percentage.

Seams & Stitches	Fabric Sample	Warp Shrinkage %	Weft shrinkage %
Superimposed &lockstitch	Light Weight	0.3	0.1
	Medium Weight	0.3	0.1
	Heavyweight	0.4	1.2
Lapped &Chain Stitch	Light Weight	0.3	0.2
	Medium Weight	0.25	0.2
	Heavyweight	0.5	1.1
Flat seam &Covering Chain	Light Weight	0.27	0.3
	Medium Weight	0.35	0.1
	Heavyweight	0.4	1.1

Table 6: Average of Drape Coefficient.

Samples	Lightweight %	Medium weight %	Heavyweight %
Superimposed& Lock stitch	63.67	74.05	78.04
Lapped seam & chain stitch	60.87	66.06	87.35
Flat seam& covering chain stitch	53.69	64.25	70.56

Table 7: The shirts were evaluated with three categories for functionality, serviceability and appearance of the garment.

Functionality				Serviceability			Viewing of garment	
S1	S2	S3	S1	S2	S3	S1	S2	S3
4	4	4	4	4	4	4	4	3

in areas such as apparel quality control, apparel design and apparel manufacturing. Based on this the results of the subjective ranking were calculated and interpreted in the table.

Subjective ranking: In order to evaluate the most important dimensions for the appearance of the garment i.e. shirts. The researchers were asked to give the ranking based on the appearance in the following category with the numbers.

1. Poor

2. Satisfactory

3. Moderate

4. Good

5. Excellent

The shirts were evaluated with three categories for functionality, serviceability and appearance of the garment Table 7.

where,

S1 – lightweight GSM of the fabric

S2 - Medium weight GSM of the fabric

S3 - Heavyweight GSM of the fabric

The shirts were evaluated with three categories for functionality, serviceability and appearance of the garment.

So overall the average ranking for the functionality is 4 which indicates that the shirt will be very good for the functionality whereas for the appearance of the garment for the light and medium weight shirts show the good appearance. But the heavyweight GSM shirt samples shows the Moderate ranking which means the heavy weight shirts does not look to be more graceful as per the appearance of the shirts is a concern [14-17].

Conclusion

The study was carried out on the different weight of the fabrics and the effect was studied with the combination of different seams and stitches, as it was used in the apparel manufacturing. The following conclusion is drawn

1. Heavyweight fabrics show the more resistance to bending as of flexural Rigidity, whereas the lapped seam with chain stitch formation exhibits more flexural rigidity.

2. The seam strength for warp and weft way seems to be more with the superimposed seam and lock stitch combination.

3. As fabric strength increases, the seam strength efficiency decreases because it is inversely proportional to the fabric strength. Hence the heavy weight fabric shows the less seam strength efficiency.

4. The shrinkage of the heavyweight fabrics is more as in comparison with the light weight and medium weight.

5. The drape coefficient of the lapped seam with heavy weight fabric is more with other two samples.

6. Light and medium weight GSM shirts show the good appearance than the heavyweight shirts.

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