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Volume Based Measurement of Fabric Drape using Surfer Software and Studies on Effect of Influencing Factors

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Abstract

The human being needs more comfort on clothing than its color, design and appearance. Drape is one of the important factor influencing the aesthetics and comfort of fabrics. In the initial days fabric drape was measured by using Cusick's drape meter. Due to technology development and up gradation several instruments were developed by many researchers. In this research work one such latest technology was used to measure fabric drape in three dimensional way using SURFER software.

Here, the instrument used for measuring fabric drape was slightly modified from the Cusick Drape meter. The perforated circular disc was placed over the sample to measure the xyz coordinates of sample on radials range from 9.5cm to 14.5cm at each 5° intervals. The civil engineers use XYZ coordinates to measure the surface the of land profile (either hill or valley) using software. The same concept was followed to measure the profile of drape in three dimensional way using SURFER software. The xyz values are fed as input to the software and it generates contour lines, 3D view, vector lines, drape volume and drape profile area as output.

The drape coefficient was computed from the volume of drape profile and analyzed to study the effect of six different seams, seam directions and number of stitches with two different stitch densities. The seam type, number of stitches (single/double), their interaction density * number of stitches and stitch density * seam have significant effect on volume based drape coefficient.

The calculated volume (obtained from average radius and height) is compared with volume generated by SURFER software method and it was found that there is significance difference exists.

Keywords: Drape coefficient; Seam; Seam direction; Drape meter

Introduction

Clothing is one of the fundamental needs of the human being. It acts as the interface between the body and the environment and influences the comfort perceptions of the wearer.

Clothing selection is based on the needs and desires of the people. By touching one gets information such as perception of the surface, its temperature, hardness and roughness, etc. All though in some cases it is recommended to wear certain clothing and selection is not possible, for example dress of a fire fighter, military uniform, etc. Textiles differ from other technical structures in that it must have sufficient strength and at the same time it is to be flexible, elastic and easy to pleat and shape.

The clothing satisfies some aesthetic needs or fulfills any particular demand of human being. Aesthetics is a branch of philosophy dealing with the nature of beauty, art and taste with the creation and appreciation of beauty. It is more scientifically defined as the study of sensory or sensory-emotional values. The fabrics or garments are comfortable in aesthetic and physiological sense when we evaluate textiles in traditional use [1-5].

There are number of properties of fabric which plays a significant role in aesthetic comfort. Some are listed below;

1. Bending rigidity
2. Drape
3. Thickness
4. Grams per meter square (density)
5. Surface smoothens
6. Compressibility
7. Stretch ability
8. Shear rigidity
9. Bulkiness
10. Surface friction
11. Air permeability
12. Moisture permeability

Drape is one of the important terms to express the comfort and aesthetics of apparel products. Drape is a property which characterizes the shape of a fabric when it is hanging down of its own weight. "Drape Co-efficient (DC)" is the main parameter used to quantify fabric drape. Several physical properties have been suggested as contributors to the drape of woven fabrics. Drapability of a fabric is combined effect of several factors such as: stiffness, flexural rigidity, weight, thickness etc. It plays a significant role in providing graceful aesthetic effects in garment [6-9].

There are number of testing instruments which are used to assess

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the aesthetic comfort of fabrics. One such instrument is Cusick's drape meter. The drape node number and drape coefficient are important factors to express the drape behavior of fabric, which was calculated from the shadow obtained in drape meter.

The presence of seam line influences the drape of the fabrics. The fabric has more stiff along the seam line than the remaining parts. However, fabric drape can be more realistically investigated by considering seams. The fabric is converted into garment by means of seam. The seam is a line where two or more fabrics are joined. The stitch is the configuration of the interlacing of sewing thread in a specific repeated unit [10].

This research focuses the new method to measure the third dimension of fabric drape with an attachment designed to Cusick's drape meter and to study the effect of various seams, seam directions, number of stitches (single/double) with two stitch densities on drape. The SURFER software package generates drape profiles and provides detailed information for analysis of drape in better way (Figure 1) [11-14].
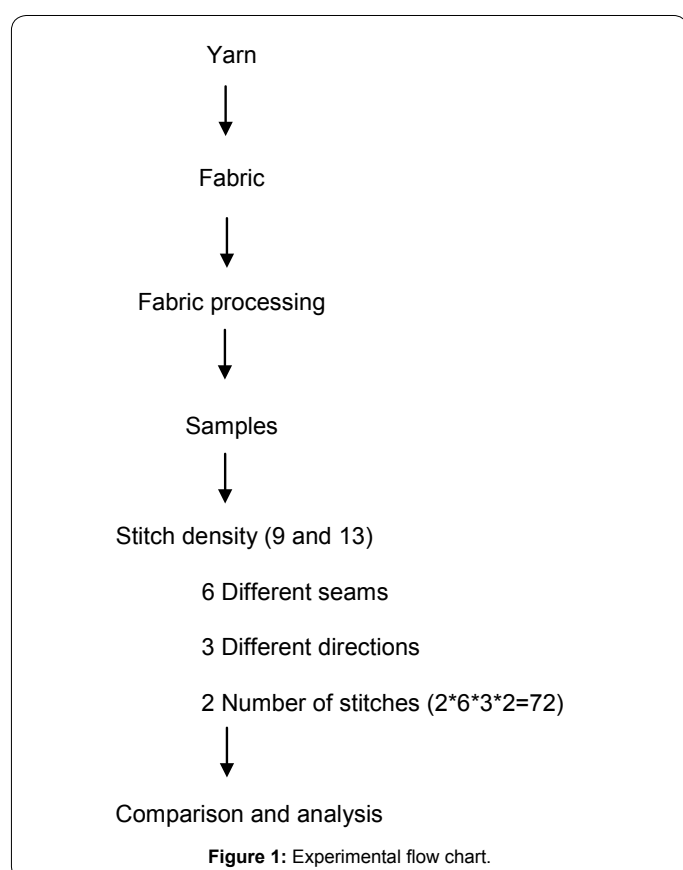
Materials

To analyze the effect of various seams in different directions with two stitch densities the following yarn and fabric particulars were used (Tables 1-3).

Pre-treatment

The following sequences of pre treatment were given to the fabric.

Scouring → bleaching → cold wash → neutralization → calendaring

Figure 1: Experimental flow chart.

S.No	Particulars	Values
1	Yarn Count, Tex, (Ne)	14.7x2,(2/40)
	CV	2.4
2	Twist per cm,(TPI)	6.85, (17.4)
	CV	3
3	CSP	5298
	CV	3.1
4	Blend composition, %	
	Polyester	65
	Cotton	35

Table 1: Yarn Particulars.

S.No	Particulars	Values
1	Warp and weft yarn Count, Tex, (Ne)	14.7x2,(2/40)
2	Threads per cm	
	Warp (Ends per Inch)	24.4 (62)
	Weft (Picks per Inch)	22.8 (58)
3	GSM	148.3
4	Crimp %	
	Warp	7.8
	Weft	5.1
5	Breaking load, kg	
	Warp way	74.9
	Weft way	63.4
6	Bending Length (cm)	
	Warp way	2.36
	Weft way	2.18
7	Elongation %	
	Warp way	101
	Weft way	13.2

Table 2: Fabric Particulars.

	Polyester sewing thread	
1	count, Tex, Ne	14.5x2, 19.5
	Ticket Number	99
	CV	2.2
2	Twist per cm, (TPI)	7.2, (18.3)
	CV	5.6
3	Yarn Strength, kg	1.09
	CV	2.32
4	Elongation %	10.9
	CV	5.2

Table 3: Sewing Thread Particulars.

Cutting and stitching

The fabric is cut and sewn 3 different directions (warp, weft and bias) with single & double stitches as shown below (Figure 2).

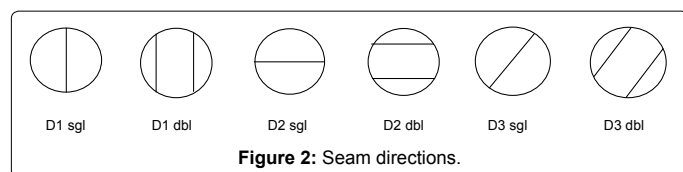D1 sgl: Single row of stitch parallel to warp

D1 dbl: Double row of stitches parallel to warp

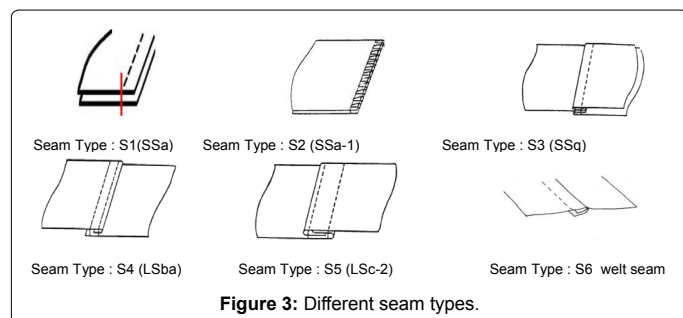D2 sgl: Single row of stitch parallel to weft

D2 dbl: Double row of stitches parallel to weft

D3 sgl: Single row of stitch in bias direction

D3 dbl: Double row of stitches in bias direction.

Figure 2: Seam directions.

Figure 3: Different seam types.

Stitch types

Stitch is one unit of thread formation by passing the needle thread through the material and interlocking with a bottom thread.

SEAM. A seam is a joint consisting of a sequence of stitches uniting two or more pieces of fabric material. In this project, six most common types of seams are used to make samples from two groups, ie superimposed seam, and lapped seams.

Class SS, Superimposed Seams: The superimposed seams are formed by placing two plies of fabrics one over other and seam it. Superimposed seams are usually made with two plies of material, although more than two plies can be used for special projects. Types of superimposed seams used are SSa, SSa-1 and SSq.

Class LS-Lapped Seams: Lapped seams are formed by overlapping the material with sufficient distance and stitch it with one or more rows. Types of lapped seams used are LSba, LSc-2, and welt. It is shown below (Figure 3).

Methodology

Surfer software method

In this method perforated disc was placed over the sample and XYZ values were measured by at each 50 intervals on different radial diameters such as 19, 21, 23, 25, 27, and 29 using specially designed scale, which is shown below (Figure 4).

The XYZ values are fed input to Surfer software, which is a grid-based mapping program that interpolates irregularly spaced XYZ data into a regularly spaced grid. The grid is used to produce different types of maps including contour, vector, image, shaded relief, 3D surface, and 3D wire frame maps (Figure 5).

The surfer generates grid file from X,Y,Z values which was used to generate contour map, 3D map, vector map, etc.

Gridding overview

A grid is a rectangular region comprised of evenly spaced rows and columns. The intersection of a row and column is called a grid node. Rows contain grid nodes with the same Y coordinate, and columns contain grid nodes with the same X coordinate. Gridding generates a Z value at each grid node by interpolating or extrapolating the data values.

Advantages of using surfer

It generates the 3D drape profile along with contour lines using the XYZ data, which is illustrated in the above figure 6).

The contour map shows lines of equal elevation (i.e. depth in this case) of the draped fabric. The lines spaced closely indicate a steeper bending, while the spaced line indicates more flatter region.

From the same map a 3D Surface can be generated which gives the visual appearance of draped sample. The Vector map shows the direction and magnitude of flow that is curvatures and also we can visualize top and front view of drape profile using this software (Figure 7).

Drape profile volume measurement
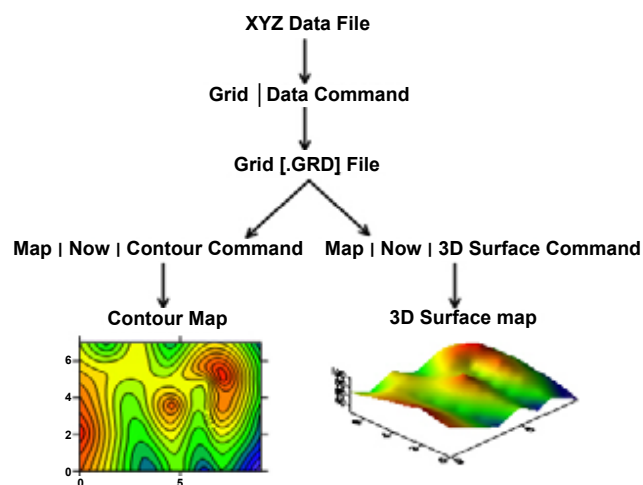
The SURFER software also measures volume of drape profile. This volume data is used as additional parameter along with drape coefficient to quantify fabric drape. The normalized volume of drape is defined as follows
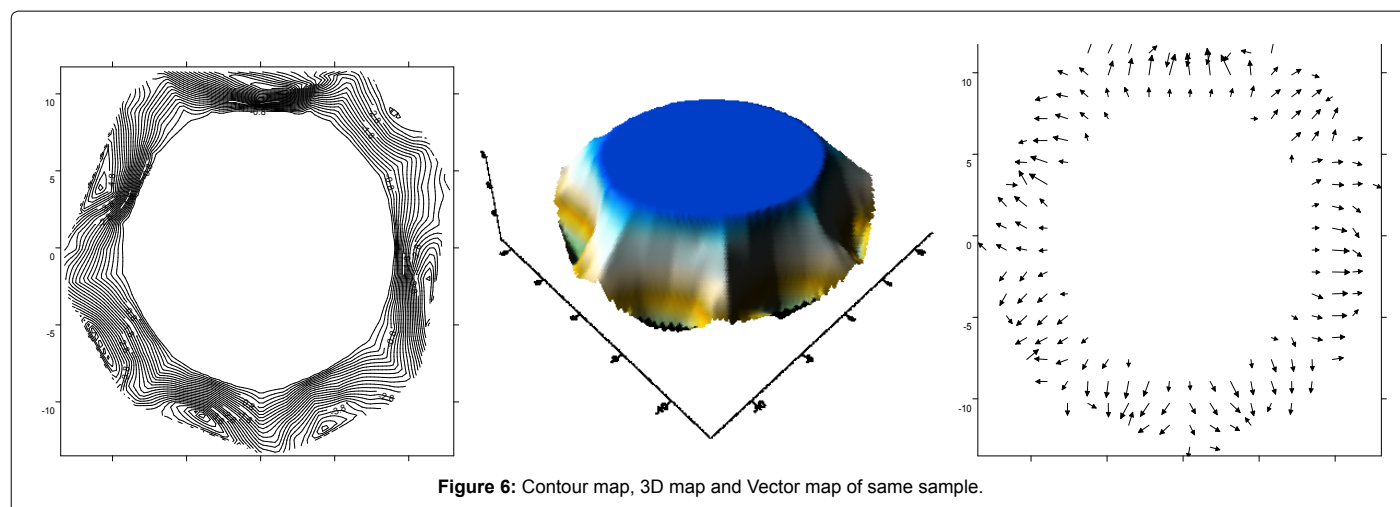
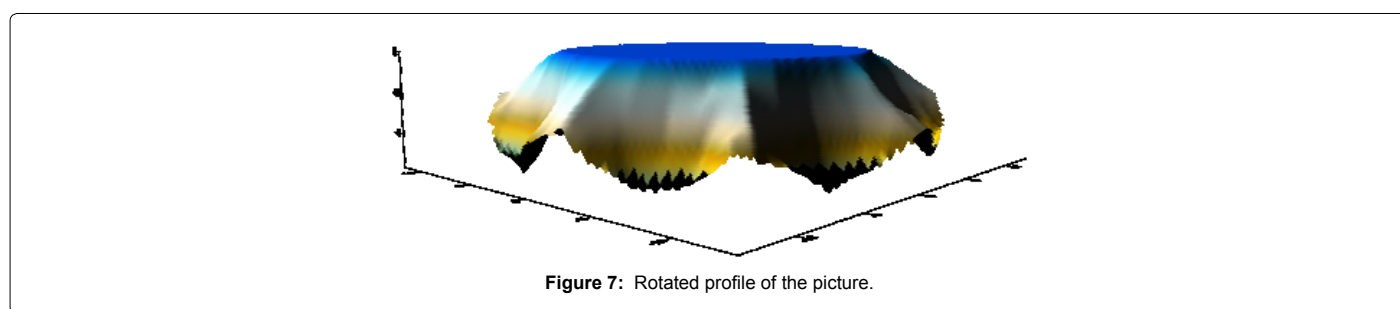Normalized Drape volume = Volume of drape profile / (Max. Volume - Min. Volume)
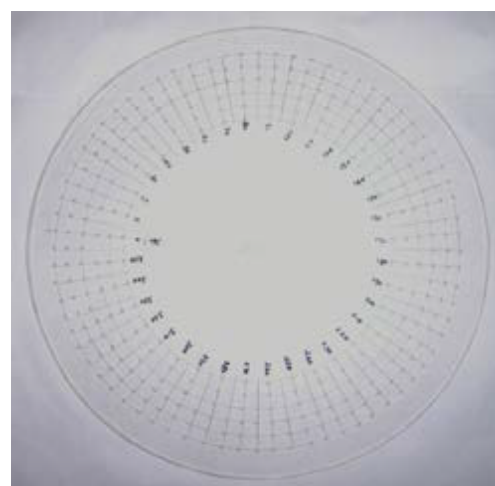
Figure 4: Circular perforated disc.

Figure 5: Procedural flow chart.

Figure 6: Contour map, 3D map and Vector map of same sample.

Figure 7: Rotated profile of the picture.

=Volume of drape profile / 2715 (3.14*15*15*6) – (3.14*9*9*6)

The low value of Normalized volume indicates the material is more stiff as it increases the material bends easily [15,16].

Result and Discussion

Effect of stitch densities, seams, and seam direction on volume based drape

(Nominalized volume) (Table 4)

Dependent variable: Normalized drape volume

Independent variables: Stitch density (2), Seam (6), Direction (3), Number of Stitch (2)

Null hypotheses: There is no effect of stitch density on Normalized drape volume.

There is no effect of seam on Normalized drape volume.

There is no effect of direction on Normalized drape volume.

There is no effect of number of stitches on Normalized drape volume.

There is no interaction effect of various factors on Normalized drape volume.

Alternative hypotheses: Stitch density has a significant effect on Normalized drape volume.

Density has a significant effect on Normalized drape volume.

Seam has a significant effect on Normalized drape volume.

Direction has a significant effect on Normalized drape volume.

Number of Stitches has a significant effect on Normalized drape volume.

There is a significant interaction effect of various factors on Normalized drape volume (Table 5) [17-20].

It can be seen from the above table that a high value of $F_{5,37}$ (4.274) and p-value of 0.004 for the factor Seam verify that the corresponding null hypothesis is rejected at 5% level of significance.

The $F_{1,37}$ value of 16.956 with a p-value of 0.000 for the factor Number of stitches (single/double) verify that the corresponding null hypothesis is significant at 5% level of significance and hence rejected.

It can also be seen from the above table that the value of F for the other main effect such as Density and Direction do not have any significant effect on Normalized drape volume.

The value of $F_{1,10}$ (3.264) with a p-value of 0.079 for the interaction between Density* Number of stitches verify that the null hypothesis is marginally rejected at 10% level of significance.

The $F_{5,10}$ value of (8.517) with p-value of 0.000 for the interaction between Density*Seam verify that the corresponding null hypothesis is rejected at 5% level of significance. The other interactions do not have any significant impact on Normalized drape volume.

Also it can be noted from the table that R-Square value is 0.737, which means that the model can explain about73.7 per cent of variability in Normalized drape volume. This is higher than that of drape co-efficient (71.5 percent), thus is more discriminative measure to characterize drape.

S.No	Stitch density	Seam type	Direction	Number of stitch	Volume	Normalized volume
1				single	641	0.2362
2			warp	double	651	0.2397
3				single	659	0.2427
4			weft	double	689	0.2539
5				single	624	0.23
6		S1	bias	double	634	0.2335
7				single	622	0.229
8			warp	double	617	0.2272
9				single	575	0.2117
10			weft	double	647	0.2384
11				single	563	0.2073
12		S2	bias	double	590	0.2173
13				single	620	0.2283
14			warp	double	611	0.2252
15				single	641	0.2362
16	9	S3	weft	double	555	0.2044
17				single	658	0.2423
18		S3	bias	double	593	0.2186
19				single	617	0.2272
20			warp	double	588	0.2167
21				single	598	0.2202
22			weft	double	618	0.2276
23				single	638	0.2349
24		S4	bias	double	553	0.2038
25				single	599	0.2206
26			warp	double	553	0.2036
27				single	590	0.2173
28			weft	double	599	0.2206
29				single	592	0.2182
30		S5	bias	double	543	0.2
31				single	634	0.2337
32			warp	double	551	0.2029
33				single	558	0.2055
34			weft	double	543	0.2001
35				single	552	0.2033
36	9	S6	bias	double	552	0.2034
37				single	643	0.2478
38			warp	double	569	0.2095
39				single	606	0.2232
40			weft	double	614	0.2261
41				single	628	0.2313
42		S1	bias	double	606	0.2232
43				single	636	0.2342
44			warp	double	573	0.211
45				single	636	0.2342
46			weft	double	564	0.2077
47				single	643	0.2368
48	13	S2	bias	double	510	0.1878
49	13			single	566	0.2084
50			warp	double	552	0.2033
51				single	610	0.2246
52			weft	double	479	0.1764
53				single	566	0.2084
54		S3	bias	double	483	0.1779
55				single	592	0.218
56			warp	double	558	0.2055
57				single	568	0.2092
58			weft	double	613	0.2257
59				single	630	0.232
60		S4	bias	double	559	0.2058
61				single	676	0.2489
62			warp	double	670	0.2467
63				single	632	0.2327
64			weft	double	603	0.222
65				single	641	0.236
66		S5	bias	double	629	0.2316
67				single	634	0.2335
68			warp	double	649	0.239
69				single	628	0.2313
70			weft	double	566	0.2084
71				single	621	0.2287
72		S6	bias	double	597	0.2198

Table 4: Normalized volume values of samples in SURFER software method.

Source	Sum of Squares	df	Mean Square	F	Sig.
Density	2.94E-05	1	2.94E-05	0.233	0.632
Seam	0.003	5	0.001	4.274	.004*
Direction	0	2	0	1.97	0.154
No.of.stitches	0.002	1	0.002	16.96	.000*
Density * Direction	0	2	5.17E-05	0.411	0.666
Density * No.of.stitches	0	1	0	3.264	.079**
Density * Seam	0.005	5	0.001	8.517	.000*
Direction * No.of.stitches	0	2	0	1.028	0.368
Seam * Direction	0.001	10	8.54E-05	0.679	0.737
Seam * No.of.stitches	0.001	5	0	1.177	0.339
Error	0.005	37	0		
Total	3.523	72			

R Squared = .737 (Adjusted R Squared = .496)
*Significant at 5% level of significance.
**Significant at 10% level of significance.

Table 5: Anova results of samples- Volume (Surfer method).

S.No	Stitch Density	Seam type	Direction	No.of Stitches	Calculated volume	Volume by SURFER
1			Warp	sgl	573.7	673
2				dbl	501.5	569
3	13	S1	Weft	sgl	496	606
4				dbl	522.3	614
5			Bias	sgl	524.5	628
6				dbl	509.7	606

Table 6: computed volume and SURFER volume for seam type 1.

Comparison of volume generated by SURFER software and calculated volume

The volume of drape profile to be computed from average radius and height values and it is compared with the volume generated by SURFER software method (Table 6 and 7).

From the results there is significant difference exists between computed volume and volume by SURFER. The volume computed by average height and radius gives only the volume of frustum. It doesn't include irregularities on drape profile, but SURFER volume gives

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	26878.7	1	26879	28	0.0004	4.9
Within Groups	9730.1	10	973			
Total	36608.9	11				

Table 7: Anova results of sample (computed volume and SURFER volume).

the exact volume of drape profile including drape nodes and other irregularities over surface [21-24].

Conclusion

Measurement of depth and analysis by SURFER software has opened up a new drape parameter namely Normalized volume based drape to be defined. The seam type, number of stitches (single/double), their interaction density * number of stitches and stitch density * seam have significant effect on volume based drape coefficient. The other main factors and interactions do not have significant effect on volume based drape.

The image processing method and other old techniques gives information about the 2D image of drape profile and drape profile area. Measuring the depth and use of SURFER software provides the detailed information about drape profile area, drape profile volume, 3D image of drape profile in 360^0 with rotation, vector image, contour image and variogram. Further one can easily identify the seam line on the image. It is a new tool to quantify the drape in better way.

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