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Research Article

NOVEL METHODS OF ASSESSMENT OF AESTHETIC PROPERTIES OF DRESS MATERIAL

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A B S T R A C T

New methods including new drape parameters were proposed for measuring drape of fabric in the present research work. The various research workers were of the opinion that using flat fabric methods do not accurately reflect fabric and garment drape. Thus this work avoided the usual cumbersome methods of assessment of projected drape area (including image analysis techniques) and replaced with a new geometrical analysis technique of constructing Drape polygon. A new non - power operated instrument (drape and stiffness tester - DST) for measuring static drape along with fabric stiffness and with retro - fitted electric power and measuring electronic devices for dynamic drape were covered under the present investigation.

INTRODUCTION

Fabric drape is the ability of a fabric in circular form of standard size to deform gracefully under its own weight in specified conditions (5-8). Fabric drape along with lustre, colour, texture, etc. defines fabric and garment appearance. Drape is generally evaluated by textile apparel technicians in the fabric and garment design and manufacturing industry. To measure drape it is important to find a reliable, efficient and accurate method to reflect fabric drape characteristics realistically. Different studies have been carried out concerning the development of drape meters to make the measurement process easier, more accurate, less dependent on operator skills and to arrive at a satisfactory quantification for drape. Proposing alternative fabric drape parameters which was a result of drape meter development has also taken place. Moreover the development of dynamic drape-meters enabled researchers to study dynamic drape behaviour similar to the human body motion.

Conventional Methods

Measurement of fabric drape started with Pierce in 1930. Bellinson set up a drape tester at the M. I. T. Textile Research Laboratory. A fabric specimen was attached to the edge of a horizontal circular disc movable vertically and supported on a column to be suspended vertically. The specimen width equaled the semi-circumference of the disc.

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The greater the drape length the more flexible the material would be. The radius of curvature of the sample and its variation along sample tested length was also used to compare between fabric's drape. It had negative relation with fabric drape. Fabric drape was not clearly determined by those tests based on two-dimensional distortion of sample tested, as they measured bending properties rather than drape.Mono-planar drape-meters were not reliable testers for fabric drape measurement. Consequently, a three-dimensional distortion apparatus was introduced by the Fabric Research Laboratories in Massachusetts. This tester measured drape quantitatively in a way which showed its significant anisotropic properties. In this optical apparatus, the sample tested was sandwiched between two circular plates mounted on a movable (up and down-wards) pedestal, and positioned so that it could not touch the apparatus base. The optical system of this apparatus was used to cast the image of the sample draped on the ground glass. It was placed above the circular plates, the image of which was traced by the operator. The Drape coefficient, F was developed as a parameter to analyse drape test data/image. It was defined as the fraction of the area of the annular ring placed concentrically above a draped fabric covered by the projection of the draped sample (see Fig.1). The higher the drape coefficient, the less was the drape for the fabric. It is noteworthy that this drape coefficient was used in most drape studies (see Table 2 and 3). A study on the accuracy of this apparatus revealed that there were errors which reached 17% in the measured area for 25mm elevated levels of fabric edge. This was because fabric drape occurred with double curvature. The principle of F. R. L. drape-meter of draping the sample tested on a circular disc was the basis of almost all the further developed drape-meters. Improvements were carried out only to obtain more expressive and accurate data easily.

An improved F. R. L. drape-meter was developed to dispense with the error in the original drape-meter. In the improved tester, a sample (250 or 300 mm diameter) was draped on a circular disc (100 or 125 mm in diameter) which was one of the two synchronized turn tables and a standard circular chart was mounted on the other one. An optical system mechanically connected to a pen was used to scan the edge of the sample tested continuously and automatically in order to draw/trace the scanned edge on the chart. A plani-meter was used to obtain the drape coefficient using area ratio.

A further upgrade was carried out for the F. R. L. drape-meter by Cusick in 1962. In this tester, the sample tested was also sandwiched between two horizontal sample discs. The sample's shadow was projected on a table underneath the apparatus by means of a light source and spherical mirror positioned above it which produced near parallel vertical light. The projected shadow was drawn on a sheet of paper placed on the table. A plani-meter was used to measure the drape coefficient DC. The supporting disc with 180 mm diameter and the fabric sample with 300 mm diameter were found to be the best standards and the most sensitive to a wide range of fabrics from limp to stiff which produced DCs from 30 to 98 %. Drape coefficient value errors were greatest at high values of DC.

Cusick in 1968 further improved the F. R. L. drape-meter in terms of obtaining more accurate drape coefficients with less tedious and costly procedures. He suggested three proposals in this drape-meter development. First, three different sample sizes, 240, 300 and 360 mm in diameters were chosen. They were chosen as the smallest and largest samples. It turned out that the smaller samples were more sensitive for limp and stiff fabrics. A second alternative proposal was the use of a less expensive optical system (divergent light). Thirdly a cut and weigh method was proposed to measure the drape coefficient rather than using a plani-meter. The drape coefficient was measured using weight ratio [8]. In 2003, Behera and Pangadiya developed a drape-meter with an optical system based on the principle of Cusick's drape-meter but in a turned over position, and it was devised with a camera to capture images of tested fabrics [3]. Three British standards published by the British Standards Institution were found for measuring fabric drape coefficient. First: Method for the assessment on the drape of fabrics (BS 5058:1973), Second: Textiles - Test methods for nonwovens - Part 9: Determination of drape Coefficient (BS EN ISO 9073-9:1998) and Third: Textiles - Test methods for nonwovens Part 9: Determination of drape including drape coefficient (ISO9073-9:2008).

Image Analysis Technique

Researchers investigated the use of image processing technology in studying drape. In this method a digital camera was attached to a drape tester in order to capture images for draped samples. By means of computer software detailed data such as drape shape parameters and statistical information including drape wave amplitude, wavelength and number of nodes were developed and computed from drape image. Moreover, it enabled researchers to carry out studies such as fabric drape dependence on time from minutes to hours and investigated drape value instability and repeatability. Studying the relation between the rotation speed of the fabric tested and its drape was difficult without employing an image analysis method.Jeong found that conventional measurement of drape coefficient was very time consuming and needed skilled operator. Correlation between conventional method and image analysis method for measuring DC was found with R^2=0.8 and good agreement of p value > 0.05. However, image analysis method had better repeatability [12, 13].

Kenkare and Plumlee investigated the correlation between cut and weigh and image analysis techniques. The overall drape coefficients of 10 fabrics were calculated using both methods. Pearson product-moment correlation was 0.99. Differences between digital and conventional drape coefficients of each fabric tested were calculated. They found that the differences were 3% or less [14]. Also, Behera and Mishra found good correlation between conventional and image analysis methods [2]. Farajikhah *et al* studied the virtual reconstruction of draped fabric using shadow moiré topography employing front lighting and linear grating. A capture of image centre and points located in the fringes were made. The intensity and height of all pixels in the fringes were determined and plotted against the radius of the fabric edges. Using the radius (x), intensity (y) and height (z) values calculated by given equations, 3D profiles of draped fabrics were generated.

Dynamic Drape-meter

Drape researchers were concerned with obtaining drape values which correlated with real fabric drape and movement. Different fabrics would have similar static drape behaviour, while differ in dynamic drape behaviour. The dynamic drape presented the real fabric performance and would help textile clothing and design workers in quantifying realistic drape behaviour of fabrics. Ranganathan *et al* used a dynamic apparatus to measure fabric drape. The test procedure was inspired by the shape and dimensions of the sample from the bending behaviour and shape of real folds constituting fabric drape. The sample was clamped in the apparatus using needle and arm, and was used to rotate the sample. The movement of both the arm and the response of the needle touching fabric sample were recorded by means of a protractor to obtain a hysteresis diagram. The maximum value at 45◦ rotation and the area of the hysteresis loop were used as parameters of drape behaviour [21]. Dynamic drape behaviour was studied later using a system consisting of a drape-meter with a circular rotatable supporting disc and image processing devices (CCD camera and PC). The camera used was able to capture images for the tested sample at very short intervals of every (1/30)th second. The range of the revolution speeds changed according to the investigation. Matsudaira and his colleagues published a series of papers focused on dynamic drape. The tester consisted of rotatable circular supporting disc with speed ranged between 0 - 240 rpm. An image analysis system was employed to capture and analyse the images of the tested draped samples. New dynamic drape parameters were developed. The first property was the revolving drape-increase coefficient (DCr) which presented the overhanging span of fabric spreading with increasing revolutions presented by slope of the curvilinear relation between revolutions and drape coefficients in the speed range between 50 - 130 rpm. High DCr value indicated a fabric's ability to change easily with revolutions. Drape at 200 rpm was selected for the dynamic drape coefficient (DC 200) which presented fabric spreading at rapid revolutions, as the change of the drape coefficient became lower than the previous stage [17,18].

Lin *et al* studied the dynamic drape of four natural fibre fabrics at a wider range of revolution speeds (0 - 450) rpm for a sample disc with 180 mm diameter. The resultant curve which presented the relation between drape coefficient and revolution speed, showed four stages of dynamic drape behaviour by the tangent partition method. These were initial growth, fast growth, slow growth and the last stage was the stable dynamic drape -coefficient. Plots of experimental drape coefficients showed that the order of the fabrics was dependant on the revolution speed at which the DC was measured. Their order was changed three times in the fast growth stage and returned to the initial growth order and became stable at the two periods which followed the fast growth [16].

Stylios 3D drape tester based on 3D scanning of the fabric was developed by Al-Gaadi *et al* (1). The software was developed to reconstruct a virtual image for the scanned fabric from which ordinary drape parameters were calculated. Annular supporting discs with 210,240 and 270 mm were used to exert dynamic impact (similar to real dynamic effect of a garment) on the fabric supported by a circular disc (180 mm diameter). Using this tester they studied fabric drape in terms of the effect of composite yarns' twist direction on dynamic drape [28, 29]. Hu and Chung determined drape behaviour of seamed woven fabrics in terms of drape coefficient, node analysis and drape profile. The variability of number of nodes was used as an indicator of fabric drape stability. Regularity of node arrangement, their orientation, location and highest and lowest node length were proposed as drape parameters [11]. Rodel *et al* characterized the drape configuration by area, form and amplitude of the folds, the number of folds and their position with regard to warp and weft directions [23]. Jeong proposed Drape distance ratio as an alternative measure of drape. It increased as the fabric became more flexible and was calculated using the following formula:

$R_d = (r_f - r_{ad}) / (r_f - r_d) \times 100$ ……………………………………………(1)

R_d is the drape distance ratio, r_f is the radius of the undraped sample, r_{ad} is the average radius of draped sample's profile, r_d is the radius of the supporting disc [12,13]. Four virtual parameters were used by Stylios and Wan to define the drape of textile materials as follows: virtual drape coefficient, drape fold number, fold variation and fold depth [28]. Behera and Pangadiya proposed using a combination of drape parameters namely: Drape coefficient, average, maximum and minimum radius, drape distance ratio (DDR) and $\left[\frac{r_2-r_s}{r_2-r_1}\right]$, the amplitude to average radius ratio (ARR) [4].

MATERIALS AND METHODS

Materials

Samples of two different apparel grade woven fabrics, which are typical examples of commercial materials currently used for the construction of shirting and suiting types were selected. The two woven fabrics included a light weight 120 gm/sq.m. cotton fabric and a medium weight 304 gm/sq.m. cotton fabric. Further descriptions of the fabrics is given in the Table 1. As noted from Table 1, the construction of the cotton shirting fabrics was not square plain but poplin as there were approximately twice as many warp yarns as weft yarns. The construction of the suiting fabric was also similar to that of the shirting fabric, also not square plain woven fabric, but poplin construction. The number of parameters for comparison worked out to be six (6): for two commercial woven fabrics, three testing methods and one technical quality parameter, that was 'drape coefficient' (2x3x1= 6).

Table 1 Fabric Physical Properties

S. No	Parameter	Shirting Fabric	Suiting fabric
1	Gsm (g/m^2)	120	304
2	Count (warp)	37^s	2/34^s
3	Count (weft)	41^s	2/24^s
4	Ends/inch	141	132
5	Picks/inch	78	70
6	Warp Crimp (%)	5.8	9.7
7	Weft Crimp (%)	8	6.1

Methods:Conventional Cusick method and Geometric Analysis of Drape Polygon method

To accomplish the objective of accurate estimation of the area of drape pattern, selecting a specified geometric area known as 'drape octagon/ drape polygon' was suggested.

- An alternative geometrical construction in the form of octagonal diagram was presented in this work.
- In this drape octagon method, analysing of drape coefficient was minimum time consuming.
- The drape octagon was constructed by drawing radial lines mutually subtending an angle of 45° at the centre of the draped pattern.

Since a specified geometric area was used for computation, a standard formula for determining the area of drape pattern could be made possible, even though the draped patterns of different fabrics were widely different and irregular. Area of Drape Octagon = $1/2\sqrt{2}$ [a_2 (a_1+a_3) + a_4 (a_3+a_5) + a_6 (a_5+a_7) + a_8 (a_7+a_1)] where, a_1, a_2, a_3, a_4, a_5, a_6, a_7, a_8 ………, were the radial line distances of the drape octagon/ drape polygon. This selected drape octagon included and excluded certain nodal projections. However, this included and excluded areas do not unduly alter the total area of draped profile, as we take into account three consecutive radial lines within the 45^0 sector and take average. The difference between the areas of conventional draped pattern and the area of drape octagon, when exhibited 'not significant' value, it was self-evident that the new procedure of representing a draped pattern or profile by the newly developed drape octagon, was a valid approach. A regression graph relating to conventional draped areas of the fabric samples on X- axis and areas of the drape octagon on Y-axis, when yielded higher regression co-efficient (R^2>0.9) for the regression equation representing the straight line of best fit, it was evident that the new approach of estimation using drape octagon brought forth reliable results of drape. It meant that these two areas were statistically highly correlated and no significant difference was observed. The suggested statistical tests to establish that the three methods of drape estimates, namely traditional (standard) Cusick Method, Image Analysis Method and Drape Octagon Method were homogeneous in distribution are: a) t-test b) F-test.

By extrapolating the drape coefficients of conventional drape, DC and F of the drape octagon in the above regression graph, in the form of a bi-plot, the deviations in DC, if any, due to the newly evolved area of drape octagon could be analysed. As these deviations were minimal and also within acceptable levels of allowance, it was obviously evident that drape octagon method produced reliable estimates for drape coefficients. Refining of this estimate may be possible by selecting acute or lower angles for the drape polygon, to the extent of 15˚ between a pair of radial lines. Fig.4 presents the newly designed non - power operated static drape and stiffness tester (DST) with additional power and measuring electronic devices for measurement of dynamic drape. This was developed by the first author of this paper.DC or F = $\frac{(A-d)}{(D-d)}$x100, where, F is the Drape coefficient; A the projected area (measured by any of the three methods); D the diameter of the fabric; d the diameter of the supporting disc.

Methods: Computer aided Drape Test

The image data of a draped pattern was processed by the software designed for the system [P. Tamás, J. Geršak, M. Halász, 2006], which could be used effectively for three dimensional simulation. The computer draws the shadow line on a ring and based on the images it created a 3D image of the given fabric, which could be rotated in several directions. The program calculated the following data: drape coefficient, DC (%), number of waves and the area covered by waves (pixels), minimum and maximum radius (mm). The minimum and maximum radius were used to describe drape, which were the distances from centre of the circle to the smallest and the largest crest. The images of drape were captured using a digital camera that was fixed on the drape measuring device and the drape coefficient was determined using Photoshop image processing software. The calculation of drape coefficient was based on counting the number of pixels of inner and outer area of the draped image.

The steps included the use of a backlight to directly acquire a drape image, conversion to a gray scale image, calculation of the gradients of the image, calculation of the threshold value of the gradients using Kittler & Illingworth's threshold method, and finding the edge points of the fabric contour from the outer margin. The connection of these points formed a contour, which was then used to calculate the area of the fabric drape and the drape coefficient. An even background brightness enhanced the contrast between the background and fabric image, and facilitated tracing of the fabric contour (22, 27,30).

Table 2 Fabric Drape Coefficient (%) for Shirting - Conventional Cusick Method (S.Nos. 1 to 5); Image Analysis Method (S.Nos. 6 to 10) and Geometrical Analysis Method (11 to 15)

S.No			Shirting		
	A	**R**	**(A-d)**	**(D-d)**	**F**
1	419	-	165	453	36.3
2	410	-	156	453	34.3
3	395	-	141	453	31
4	432	-	178	453	39.1
5	403	-	149	453	32.8
				Avg.	**34.7**
6	452	12	153	453	33.6
7	415	11.5	161	453	35.4
8	408	11.4	154	453	33.9
9	437	11.8	183	453	40.3
10	408	11.4	154	453	33.9
	Avg	**11.6**		**Avg.**	**35.4**
11	492	11,11.3,8.0,13,14, 14.7,10.5,12.8	179.6	453	39.5
12	461	12, 12.1,9.5,11. 7,9.5, 11.0,14.0,12.3	148.8	453	32.7
13	455	9.5,10.3,13.5,13.4 ,9.3,9.3,13.3,12.7	142.7	453	31.3
14	492	10.5,10.5,11.5,9.0, 13,12.5,13.5,14.0	179.6	453	39.5
15	455	10,12.6,12.5,10, 10,14,9.3,13	142.7	453	31.4
		-		**Avg.**	**34.8**

Note: A,d,D - Area of Draped Pattern, Supporting Disc, Fabric sample (sq.cm)
F – Drape Co-efficient (none), R – Radial line distances (cm)

Table 3 Fabric Drape Coefficient (%) for Suiting – Conventional Cusick Method (S.Nos. 1 to 5); Image Analysis Method (S.Nos. 6 to 10) and Geometrical Analysis Method (11 to 15**)**

S.No			Suiting		
	A		**(A-d)**	**(D-d)**	**F**
1	484	-	230	453	50.6
2	497	-	243	453	53.5
3	500	-	246	453	54.1
4	500	-	246	453	54.1
5	509	-	255	453	56.1
					53.7
6	475	12.3	221	453	48.6
7	506	12.7	252	453	55.4
8	500	12.6	246	453	54.1
9	502	12.6	248	453	54.6
10	514	12.8	260	453	57.2
	Avg	**12.6**			**54**
11	524	10.2,11.6,13,14, 10,11.2,13.8,14.5	212	453	46.55
12	560	12.3,15,10.8,15, 11.5,13,13,11	247	453	54.38
13	551	14.3,14,10.5,11.5, 10.5,13.5,12,14.7	239	453	52.5
14	556	14.2,12.5,10,13.5, 13.5,11,14.5,12	244	453	53.57
15	571	12.5,14.2,14, 12.3,13,13,11,12.5	258	453	56.82
		-			**52.8**

Note: A,d,D - Area of Draped Pattern, Supporting Disc, Fabric sample (sq.cm)
F – Drape Co-efficient (none), R – Radial line distances (cm)

RESULTS AND DISCUSSION

The drape patterns from which image area computations were made are shown in Fig. 1,2 & 3. Fig.4 shows the newly developed drape and stiffness tester (DST). The purpose of combining fabric drape and fabric stiffness measurements into one testing instrument was because stiffness and drape are mutually related.

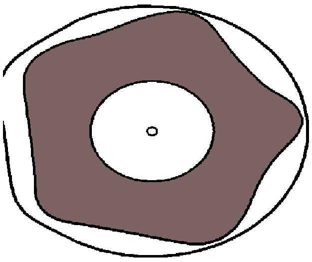

Fig.1 Drape Area (dark area) is shadow of the draped sample on the annular ring

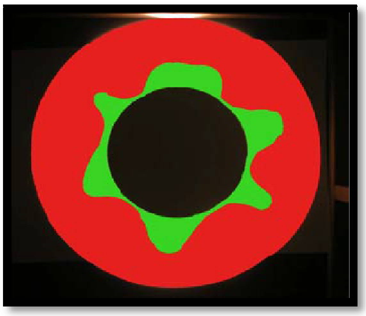

Fig. 2 Drape by computer aided digital image processing

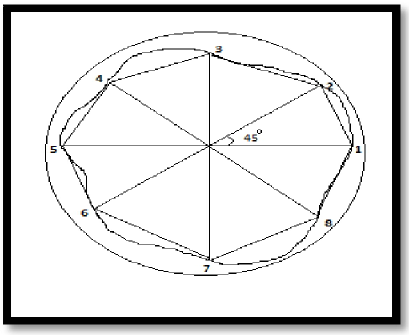

Fig. 3 Drape by area of octagonal diagram or drape polygon

Fig.4 Drape and Stiffness Tester (DST)

Referring to Table 2, we find that the Avg. Drape values determined by the three methods, namely, conventional Cusick method, equivalent radius of irregular object by computer software aided image processing method and geometrical analysis method were very near to the mean values of the statistical distribution of 15 values each for shirting and suiting fabrics. Statistical significance tests, such as t – test and F - test were performed and found no significant difference between the mean values of Drape coefficient (DC).

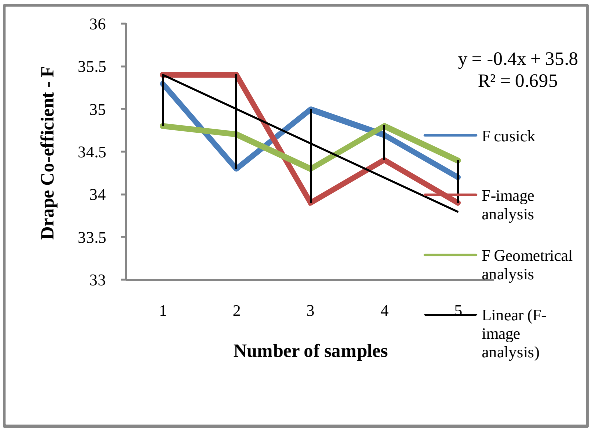

Fig. 5 Correlation graph between Drape Co-efficient of Conventional Draped pattern and Image analysis and drape octagon for shirting fabric.

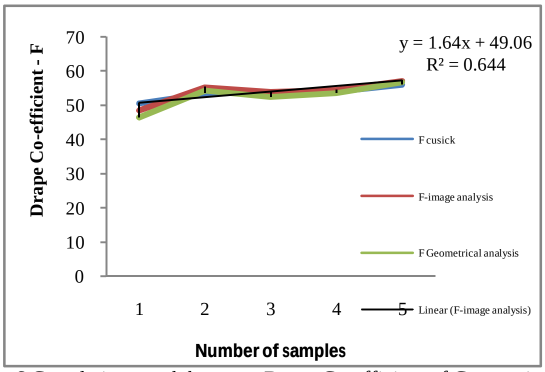

Fig. 6 Correlation graph between Drape Co-efficient of Conventional Draped pattern and Image analysis and drape octagon for suiting fabric.

Table 4 Statistical Tests

S.No	Type of Test	Shirting	Suiting
1	t-test	DOF = 4 t_{exp} = 0.139 t_{10} = 3.747 t_5 = 4.604 Inference: No significant difference	DOF = 4 t_{exp} = 0.274 t_{10} = 3.747 t_5 = 4.604 Inference: No significant difference
2	F-test	$[S_1^2/S_2^2]$= [18.1/8.19] =2.21 T_1% = 15.977 T_5%= 6.3883 Inference: The two populations have same variance	$[S_1^2/S_2^2]$= [14.43/10.43] =1.384 T_1% = 15.977 T_5%= 6.3883 Inference: The two populations have same variance

CONCLUSIONS

More easier and reliable methods for measurement of Fabric Drape were evolved which were based on computer aided image processing and geometrical analysis method and textile industry will be best exploiting the use of these techniques.

References

1. Al-Gaadi B, G¨oktepe F, Hal´asz M. (2011). A new method in fabric drape measurement and analysis of the drape formation process. *Text Res J*, 0(00): 1-11.
2. Behera BK, Mishra R. (2006). Objective measurement of fabric appearance using digital image processing. *J Text* I, 97(2): 147-153.

3. Behera BK, Pangadiya A. (2003). Drape measurement by digital image processing. *Textile Asia* 34(11): 45-50.
4. Behera BK, Pattanayak AK. (2008). Measurement and modeling of drape using digital image processing. *Indian J Fibre Text*, 33(3): 230-238.
5. British standards Institution. (1973). Method for the assessment of drape fabrics. London: BSI.
6. British Standards Institution. (2008). Textiles. Test methods for nonwovens. Determination of drapability including drape coefficient. London: BSI.
7. Collier BJ. (1991). Measurement of fabric drape and its relation to fabric mechanical properties and subjective evaluation. *CTRJ*, 10(1): 46-52.
8. Cusick GE. (1968). The measurement of fabric drape. *J Text* I, 59(6): 253-260.
9. Grover G, Sultan MA, Spivak SM (1993). A screening technique for fabric handle. *J Text* I, 84(3): 486-494.
10. Hearle JWS, Amirbayat J. (1988). The design of a multipurpose fabric tester. *J Text* I, 79(4): 588-597.
11. Hu JL, Chung SP. (1998). Drape behavior of woven fabrics with seams. TEXT RES J, 68(12): 913-9.
12. Jeong YJ, Phillips DG. (1998). A study of fabric drape behaviour with image analysis - Part II: The effects of fabric structure and mechanical properties on fabric drape. *J Text* I, 89(1): 70-79.
13. Jeong YJ. (1998). A study of fabric drape behaviour with image analysis Part I: Measurement, characterisation, and instability. *J Text* I, 89(1): 59-69.
14. Kenkare N.S. (2005). Three dimensional modeling for garment drape [PhD]. Reliegh: North Carolinastate.
15. Kim JO, Slaten BL. (1999). Objective evaluation of fabric hand - Part I: Relationships of fabric hand by the extraction method and related physical and surface properties. *Text Res J*, 69(1): 59-67.
16. Lin JY, Wang PN, Shyr TW. (2008). Comparing and modeling the dynamic drape of four natural-fiber fabrics. *Text Res J*, 78(10): 911-921.
17. Matsudaira M, Yang M, Kinari T, Shintaku S. (2002). Polyester “Shingosen” fabrics characterized by dynamic drape coefficient with swinging motion. *Text Res J*, 72(5): 410-416.
18. Matsudaira M, Yang M. (2000). Some features of the static and dynamic drape behaviour of polyester-fibre shingosen fabrics. *J Text* I, 91(4): 600-615.
19. Mizutani C, Amano T, Sakaguchi Y. (2005). A new apparatus for the study of fabric drape. *Text Res J*, 75(1): 81-87.
20. Pandurangan P, Eischen J, Jenkare N, Lamar TAM. (2008). Enhancing accuracy of drape simulation. Part II: Optimized drape simulation using industry -specific software. *J text* I, 99(3): 219-226.
21. Ranganathan TS, Ramaswamy D, Jayaraman KS, Sanjeevi R, Arumugam V, Das S, *et al*. (1986). A new approach to drape. *J text* I, 77(3): 226-228.
22. Robson D, Long CC. (2000). Drape analysis using imaging techniques. *CTRJ*, 18(1): 1-8.
23. Rodel H, Ulbricht V, Krzywinski S, Schenk A, Fischer P. (1998). Simulation of drape behaviour of fabrics. *Int J Cloth Sci Tech*, 10(34): 201-208.
24. Sanad R, Cassidy T, Cheung V. (2012). Fabric and Garment Drape Measurement Part 1. *Journal of Fiber Bioengineering and Informatics*. 5(4): 341-58.
25. Sanad R, Cassidy T, Cheung V. (2013). Fabric and Garment Drape Measurement - Part 2. *Journal of Fiber Bioengineering and Informatics*. 6 (1): 1-22.
26. Sharma KR, Behera BK, Roedel H, Schenk A. (2005). Effect of sewing and fusing of interlining on drape behaviour of suiting fabrics. *Int J Cloth Sci tech*, 17(1-2): 75-90.
27. Shyr TW, Wang PN, Lin JY. (2009). Subjective and objective evaluation methods to determine the peak trough threshold of the drape fabric node. *Text Res J*, 79(13): 1223-1234.
28. Stylios GK. (1999), Wan TR. The concept of virtual measurement: 3D fabric drape. *Int J Cloth Sci Tech*, 11(1): 10-18.
29. Stylios GK, Zhu R. (1997). The characterisation of the static and dynamic drape of fabrics. *J Text*, 88(4): 465-475.
30. Tandon S, Matsudaira M. (2010). Improved discrimination and prediction of drapability of fabrics. *Research journal of textile and apparel*. 14(3): 62-76.

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