

INFLUENCE OF WOMEN'S DRESS WOVEN FABRIC STRUCTURE ON BENDING AND DRAPABILITY PROPERTIES

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Received: 28.02.2017; revised: 30.03.2017; accepted: 11.04.2017

Abstract: Good tailorability is a required property for clothing manufacturers. Fabrics will be able to pass through the garment manufacturing process easily without any problems for good appearance and wear performance. Functionality of a garment can be improved by the combination of fibre, yarn, fabric or garment stages. In recent years, women's dress fabrics have an important place in the fabric industry. Most women's dresses are complex products, resulting from fibre, yarn, fabric and garment structure combined with mechanical and chemical finishing procedures to provide a garment that meets of all the requirements of users like aesthetic, design, fit or performance. First of all, softness, drapability and comfort are required for women's dresses. In this study, we investigated the influence of women's dress viscose woven fabric structure on bending and drapability properties.

Key Words: Women's dress, bending rigidity, drapability

Bayan Elbiselik Dokuma Kumaş Yapısının Eğilme ve Dökümlülük Özellikleri Üzerine Etkisi

Öz: İyi dikilebilirlik giysi üreticileri için istenen bir özelliktir. Kumaşların iyi bir giyim performansı ve görünümüne sahip olabilmesi için konfeksiyon işlemlerinden problemsiz geçebilmeleri gerekir. Konfeksiyonun fonksiyonelliği lif, iplik, kumaş ve giysi oluşum aşamalarının kombinasyonları ile geliştirilebilir. Son yıllarda bayan elbiselik kumaşları, kumaş endüstrisinde önemli bir yere sahip olmuştur. Çoğu bayan elbiseleri, estetik, tasarım, vücuda uygunluk veya performans gibi kullanıcıların tüm gereksinimlerini karşılaması için mekaniksel, kimyasal apre prosedürleri, lif, iplik, kumaş ve giysi yapısının etkileşimi ile oldukça karmaşık ürünlerdir. Bayan elbiseleri için ilk önce yumuşaklık, dökümlülük ve konfor istenir. Bu çalışmada, bayan elbiselik viskon dokuma kumaş yapısının eğilme ve dökümlülük özellikleri üzerine olan etkileri araştırılmıştır.

Anahtar Kelimeler: Bayan elbisesi, eğilme rijitliği, dökümlülük

1. INTRODUCTION

Women's dress fabrics should have some important properties. Yarn and fabric structural parameters affect performance of women's dresses. Improving fabric and garment drape and stiffness are very important for a good appearance.

In assessing the fabric, we used sensory characteristics such as surface friction, bending stiffness, compression, thickness and small-scale extension and shear, all of which play a role in determining handle and garment making-up and appearance during wear (Sinclair, 2015).

A bending test measures the severity of the flexing action of a material. The bending behaviour of fabrics is presented by bending rigidity. The bending rigidity, which is related to the perceived stiffness, is calculated from the bending length and mass per unit area. Fabrics with low bending rigidity may exhibit seam pucker and prone to problems in cutting out.

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Drape is an important parameter in the application of body scanning, mass customisation, CAD-CAM and automatic pattern making in clothing design and manufacturing. Fabric drape is determined largely by the fabric bending and shear stiffness properties, with fabric thickness, low deformation tensile properties and weight also importance.

The drape coefficient has been developed to describe the degree of drape and drape shape. A lower drape coefficient mean the fabric is softer, and its drapability is better. In other words, the higher the drape coefficient the stiffer the fabric is (Hu, 2008). In recent years the most important properties for viscose fabrics is low drape coefficient for high drapability.

Viscose rayon is used for a wide range of apparel applications. Blouses, skirts, dresses, and shirts are often made of viscose fabrics for excellent drapability and comfortability. Viscose rayon is also blended with wool, polyester or acrylic for suits, jackets and blazers for the purpose of enhancing appearance and moisture permeability.

Although viscose rayon brings unique features of drapability, softness and moisture absorption to both formal and casual apparel products, it can also have some drawbacks. These include easy stretching with poor elastic recovery, low abrasion resistance, wet shrinkage and low wrinkle resistance (Sinclair, 2015).

Viscose rayon used for women's dress fabrics, too. Material drape and luster properties are essential consideration for fashion designers to achieve the required structural and luxurious appearance. Viscose rayon was the first man-made fiber invented for use in the textile and fashion apparel industries with the original name "artificial silk".

There are high correlation between drapability and bending properties of fabrics. Resistance to bending or flexural rigidity is called stiffness in textile test methods. The longer the bending length, the stiffer is the fabric. Fabrics with very high bending rigidity values may lead to sewing and handling problems as they are too stiff to be manipulated and controlled. Light weight fabrics usually have low bending rigidity and this makes it difficult to handle during cutting because of its flexibility and can cause seam puckering. It is recommended that light weight fabrics should have a minimum value of 5 μNm for warp and weft direction bending rigidity (Cheng, How and Yick, 1996; Hui, Chan, Yeung and Ng, 2007).

During recent years, the investigation of fabric stiffness has attracted the attention of many researchers because of the attempts to realize the clothing CAD system by introducing the fabric properties (Hu, Chung and Lo, 1997; Sun, 2008).

Fabric stiffness may not be wanted too high for a good drape in apparel fabrics. Therefore there is necessity to optimize the seam parameters such as sewing thread size, stitch density and seam allowance in order to decrease the stiffness of the fabric on the garment (Gurarda, 2009).

Increasing drape coefficient means decreasing fabric drapability (Omeroglu, Becerir and Karaca, 2010). Drape modelling, in particular 3-D visualisation of designed garments in draped form, is one of the key technologies in computer-aided garment design (CAD) (Hunter, Fan and Chau, 2009). Drape is of much importance for the selection of appropriate fabric for intended garment, and therefore the correlation between the drape and fabric properties must be known (Sharma, Behera, Roedel and Schenk, 2004).

Bending and drapability properties of fabrics are very important for a garment's aesthetic appearance and also play an important role in garment comfort and determining the fit of clothing around the human figure (Seram and Rupasinghe, 2013).

In this study, we investigated the influence of the structure of women's dress viscose woven fabrics on their bending and drapability properties.

2. MATERIAL AND METHOD

2.1. Material

In this research, eight different types of woven fabrics with plain and twill structure, which are commonly used for production of women's dresses, were measured. The properties of fabrics used can be seen from Table 1.

Table 1. The properties of fabrics produced for the study

Fabric Code	Weave	Density (thread/cm)		Yarn Count (Ne)		Thickness (mm)	Weight (g/m ²)
		Warp	Weft	Warp	Weft		
T1	Twill 3/1/1/1	42	27	28/1 Viscose	28/1 Viscose/PET 80/20	0.35	160
T2	Twill 3/1/1/1	33	27	28/1 Viscose	28/1 Viscose/PET 80/20	0.33	145
T3	Twill 2/1	43	27	28/1 Viscose	28/1 Viscose/PET 80/20	0.4	160
T4	Twill 2/1	33	27	28/1 Viscose	28/1 Viscose/PET 80/20	0.36	145
P5	Plain	33	22	20/1 Viscose	28/1 Viscose	0.42	163
P6	Plain	40	24	60/1 Viscose	36/1 Viscose	0.33	104
P7	Plain	36	21	44/1 Floss	21/1 Viscose	0.41	155
P8	Plain	33	21	28/1 Viscose	28/1 Viscose	0.42	154

2.2. Method

To investigate the stiffness of a fabric, bending length and flexural rigidity must be obtained. Bending rigidity tests were carried out according to ASTM 1388-64 and TS 1409 with using a stiffness tester according to Cantilever bending principle. Equations (1), (2) and (3) were used to calculate the stiffness of fabrics for each fabric strip (ASTM D 1338-64; TS 1409).

$$c = O / 2 \quad (1)$$

c = Bending length

O= The length of overhang, cm

$$G = W (O / 2) ^ 3 = W \times c ^ 3 \quad (2)$$

G = Flexural rigidity, mgcm

W = Weight per unit area, mg/ cm²

$$G_o = (G_w \cdot G_f) ^ {1/2} \quad (3)$$

G_o = Overall flexural rigidity

G_w = Warp flexural rigidity

G_f = Weft flexural rigidity

The drapability tests of the fabric samples were performed according to ISO 9073-9 by using Cusick Drapemeter. The drape coefficient DC (%) is defined at Equation (4).

$$DC (\%) = (W2 / W1) \times 100 \quad (4)$$

DC = Drape coefficient (%)

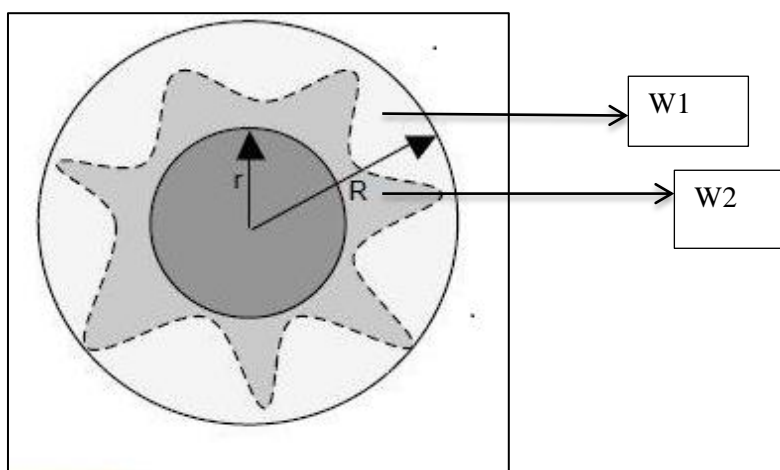
W1 = Initial weight of the paper ring before the drapability test

W2 = Weight of the paper ring cut along the traced shadow configuration (shadow image)(ISO 9073-9).

The paper ring (W1) and shaded area (W2) was shown in Figure 1 (Kenkare and May-Plumlee, 2005). The schematic view of the cusick's drapemeter was shown in Figure 2 (Chung, 1999).

Prior to the tests, all fabric samples were conditioned for 24 hours in standard atmospheric conditions (at a temperature of $20 \pm 2^\circ\text{C}$ and relative humidity of $65 \pm 2\%$)

The SPSS 14.0 Statistical software package was used for conducting all statistical procedures. Completely randomized single-factor (one way) multivariate analysis of variance (ANOVA) as a fixed model was applied to data in order to investigate the statistical importance of polyester yarn type parameter on breaking strength, breaking elongation, abrasion resistance and air permeability properties of fabrics from these yarns. The means were compared by Student-Newman-Keuls (SNK) tests. The value of significance level (α) selected for all statistical tests is 0.05. The treatment levels were marked in accordance with the mean values, and levels marked by different letter (a, b, c) showed that they were significantly different.



(R = Radius of the paper ring, r = Radius of the support disk)

Figure 1:

Draped configuration of fabric (Kenkare and Plumlee-May, 2005)

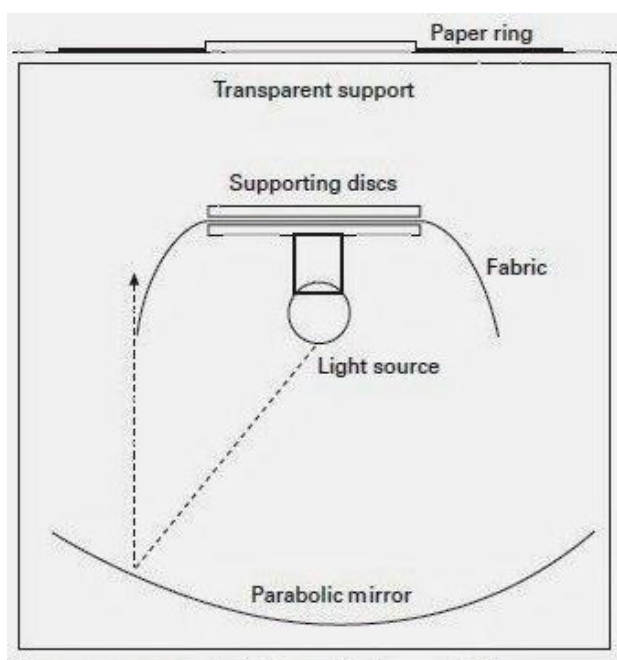


Figure 2:

Cusick's drapemeter (Chung, 1999)

3. RESULTS AND DISCUSSION

3.1. Bending Test Results

Fabric samples' bending length, flexural rigidity and overall flexural rigidity tests results can be seen from Figure 3-5.

It can be seen from Figure 3 that the minimum warp bending length was measured for the plain fabric sample P6 as 0.95 cm while the maximum warp bending length was measured for the plain fabric sample P7 as 1.53 cm. Twill fabric samples with high warp density (T1 and T3) have high bending length as shown in Figure 3. It can be also seen from Figure 3 that the minimum weft bending length was measured for the plain fabric sample P6 as 0.85 cm while the maximum weft bending length was measured for the plain fabric sample P7 as 1.18 cm.

The bending length is a measure of the interaction between fabric weight and fabric stiffness in which a fabric bends under its own weight. It reflects the stiffness of a fabric when bent in one plane under the force of gravity, and is one component of drape. Thus bending length is also called drape stiffness. The bending length is dependent on the weight of the fabric (Hu, 2008). Fabric parameters like fabric thickness, density, weave type and weight play the main role in determining fabric bending properties. Therefore, any factor, such as weave structure and fabric relaxation, which increases the fibre and yarn freedom of movement within the fabric will decrease the fabric bending stiffness, and therefore the fabric drape coefficient.

The flexural rigidity, which is related to the perceived stiffness, is calculated from the bending length and mass per unit area. It can be seen from Figure 4 that the maximum warp and weft flexural rigidity were obtained for the plain fabric sample P7 as 55.57 mgcm and 25.74 mgcm and minimum warp and weft flexural rigidity were obtained for the plain fabric sample P6 as 9.10 mgcm and 6.47 mgcm, respectively. The stiffness of a fabric in bending is very dependent on its thickness. The thicker the fabric, the stiffer it is, if all other factors remain the same. It can be seen from Figure 4 that the maximum overall flexural rigidity was obtained for the plain fabric sample P7 as 192.14 mgcm and minimum overall flexural rigidity was obtained for the plain fabric sample P6 as 19.53 mgcm. The SNK test results given in Table 2 revealed that, warp and weft bending length, flexural rigidity and overall flexural rigidity of the plain fabric sample P7 and twill woven fabric sample T1 were significantly different from others.

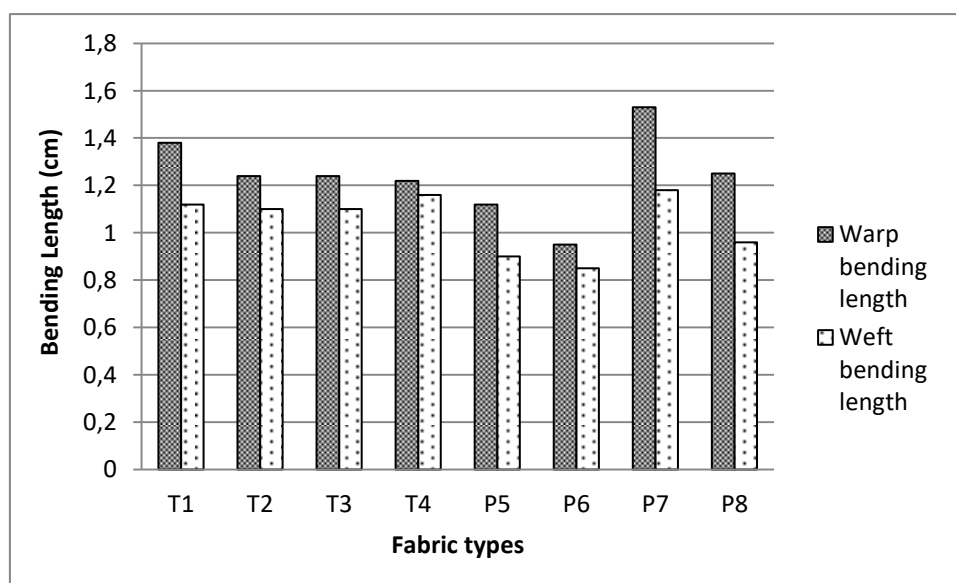


Figure 3:
Bending length of fabric samples

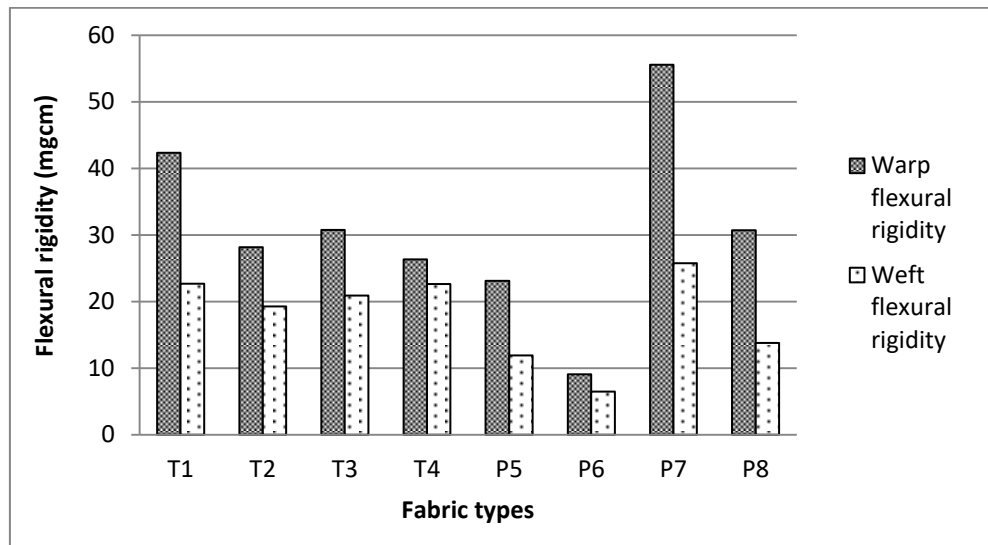


Figure 4:
Warp and weft flexural rigidity of fabric samples

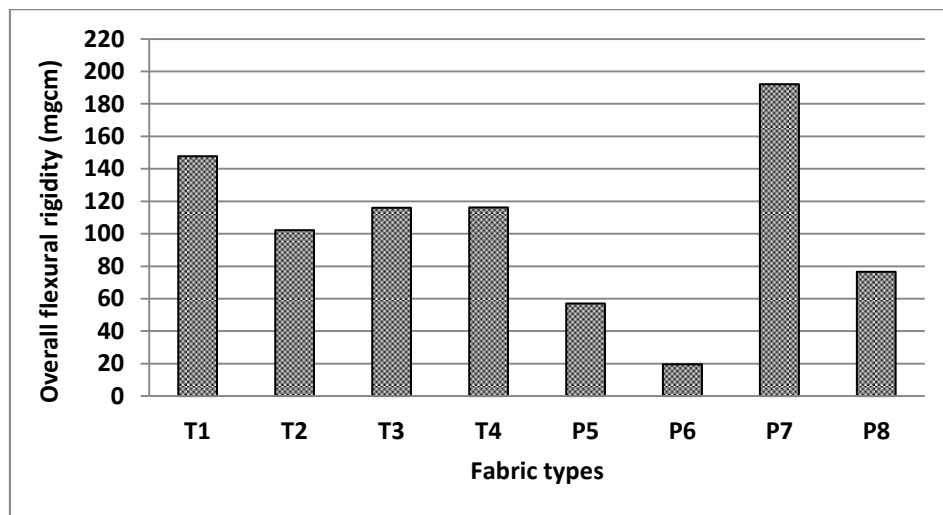


Figure 5:
Overall flexural rigidity of fabric samples

Table 2. Statistical analysis (ANOVA and SNK test) results for bending length and flexural rigidity

Fabric Code	Bending Length (cm)		Flexural Rigidity (mgcm)		Overall Flexural Rigidity (mgcm)
	Warp	Weft	Warp	Weft	
T1	1.38 d	1.12 e	42.36d	22.69d	147.81 d
T2	1.24 c	1.10 d	28.15c	19.29c	102.26 c
T3	1.24 c	1.09 d	30.75c	20.91d	115.93 c
T4	1.22 c	1.16 f	26.32c	22.64d	116.11 c
P5	1.12 b	0.90 b	23.11b	11.90b	57.12 b
P6	0.95 a	0.85 a	9.10 a	6.47 a	19.53 a
P7	1.53 e	1.18 f	55.57e	25.74e	192.14 e
P8	1.25 c	0.96 c	30.70c	13.79b	76.55 b

*:statistically significant ($P < 0.05$)

(a),(b),(c),(d),(e),(f) represent the statistical difference ranges according to SNK test.

3.2. Drape Coefficient Test Results

The drape coefficient (DC) has been developed to describe the degree of drape and drape shape. A lower DC value means the fabric is softer, and its drapability is better. In other words, the higher the drape coefficient the stiffer the fabric is (Hu, 2008). Fabric samples drape coefficient tests results can be seen from Figure 6.

It can be seen from Figure 6 that the maximum drape coefficient was obtained for the plain fabric sample P7 as 34.25 % and minimum drape coefficient was obtained for the plain fabric sample P6 as 25.56 %. Plain fabric P6 has the lowest thickness and weight among all fabric samples.

The SNK test results given in Table 3 revealed that, drape coefficient of the plain fabric sample P7 and twill woven fabric sample T1,T2 and T3 were significantly different from others.

At a constant weight, the fabric drape coefficient will decrease as the float length increases. Thus, for example, a twill weave fabric will have a lower drape coefficient than a plain weave fabric of the same mass per unit area (Hunter,Fan and Chau, 2009).

Increasing drape coefficient and overall rigidity of fabric means decreasing fabric drapability.

It can be observed from Table 4 that the drape coefficient has very strong positive correlation with bending length, flexural and overall flexural rigidity.

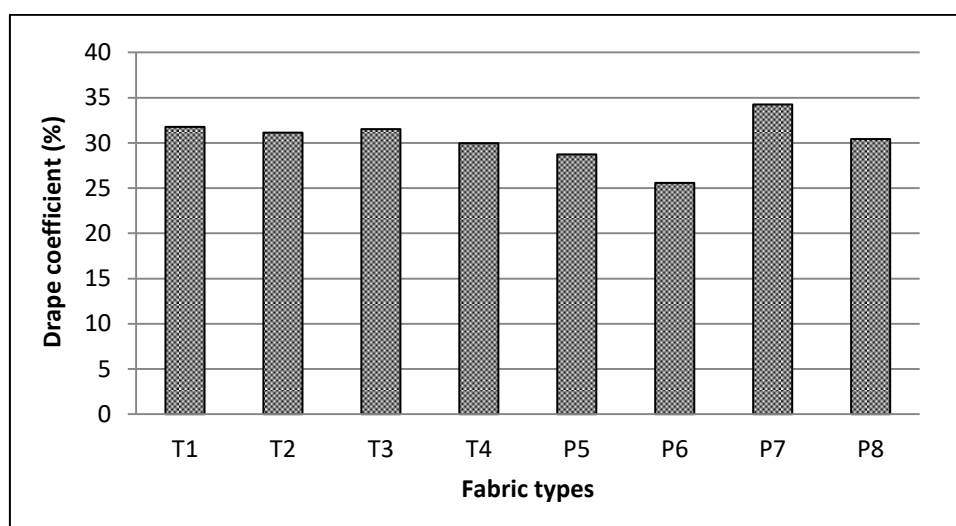


Figure 6:
Drape coefficient of fabric samples

Table 3. Statistical analysis (ANOVA and SNK test) results for Drapability

Fabric Code	Drape Coefficient (%)	
T1	0.000*	31.76 c
T2		31.13 c
T3		31.52 c
T4		29.97 b
P5		28.72 b
P6		25.56 a
P7		34.25 c
P8		30.43 b

*:statistically significant ($P < 0.05$)

(a),(b),(c),(d),(e),(f) represent the statistical difference ranges according to SNK test.

Table 4. Correlation between bending and drape coefficient

		Overall Rigidity	Warp Bending Length	Weft Bending Length	Warp Flexural Rigidity	Weft Flexural Rigidity	Drape Coefficient
Overall Rigidity	Pearson Correlation	1	.948**	.914**	.938**	.955**	.837**
	Sig. (2-tailed)	.	.000	.000	.000	.000	.000
	N	24	24	24	24	24	24
Drape Coefficient	Pearson Correlation	.837**	.869**	.739**	.850**	.798**	1
	Sig. (2-tailed)	.000	.000	.000	.000	.000	
	N	24	24	24	24	24	24

** Correlation is significant at the 0.01 level (2-tailed)

CONCLUSION

Bending properties and drapability of fabrics have received major attention in fashion designing since designers have exploited the bending and drapability properties of fabric in creating new styles in accordance with changing fashion trends.

Fabric parameters like fabric thickness, density, weave type and weight play the main role in determining fabric bending and drapability properties. Fabric drapability is an important factor from an aesthetic point of view. The quality of “drape” is important to a designer as it influences a garment’s appearance. Softness and drapability are very important for light weight women’s dress fabrics.

Drape is of much importance for the selection of appropriate fabric for intended garment, and therefore relation between fabric structures and bending, drapability properties must be known.

The stiffness of a fabric in bending is very dependent on its thickness. The thicker the fabric, the stiffer it is, if all other factors remain the same.

Drape is of much importance for the selection of appropriate fabric for intended garment, and therefore the correlation between the drape and fabric properties must be known. Drape modelling, in particular 3-D visualisation of designed garments in draped form, is one of the key technologies in computer-aided garment design (CAD).

In this study, we investigated influence of the structure of light weight women’s dress viscose woven fabrics on their bending and drapability properties.

Fabric parameters like fabric thickness, density, weave type and weight play the main role in determining fabric bending properties and drapability. Therefore, any factor, such as weave structure especially thickness, density and weight of the fabric samples will increase the fabric bending stiffness, and therefore the fabric drape coefficient increase, too. Increasing drape coefficient and overall rigidity of fabric means decreasing fabric drapability.

It can also be observed that the drape coefficient has very strong correlation with bending length, flexurall and overall flexural rigidity of viscose woven fabrics.

ACKNOWLEDGEMENT

We are grateful to Savcan Textile Factory Bursa- Turkey and Textile Engineer Miss Ebru Kümbetlioğlu for their help during this study.

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