(REFEREED RESEARCH)

SUBJECTIVE AND OBJECTIVE EVALUATION OF THE HANDLE PROPERTIES OF SHIRT FABRIC FUSED WITH DIFFERENT WOVEN INTERLININGS

FARKLI DOKUMA TELALAR İLE BİRLEŞTİRİLMİŞ GÖMLEKLİK KUMAŞIN TUTUMUNUN SUBJEKTİF VE OBJEKTİF OLARAK DEĞERLENDİRİLMESİ

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ABSTRACT

Interlining is a layer of knitted, woven or non-woven fabric placed between the garment fabrics and facing to reinforce, to give form and to prevent stretching. Although interlining is an invisible interior part of a garment, the interlining construction and the fusion process of interlining and shell fabric affect sewability, appearance, durability, handle and mechanical properties of the garment. In this study, the handle properties of a woven fabric fused with 6 different woven fusible interlinings that are usually used for manufacturing of shirts were examined by subjective and objective methods. The aim of this paper is to research the effects of different woven interlinings to the handle properties of shirt fabric.

Key Words: Fabric handle, Interlining, Shirt fabric, Subjective evaluation of fabric handle, Drape angle, Compressibility.

ÖZET

Tela, dayanımı desteklemek, form kazandırmak ve esnekliği önlemek amacıyla, giysi kumaşı ile astar arasında yer alan, örme, dokuma veya dokusuz yüzey kumaşlardan elde edilen bir ara katmandır. Tela giysinin iç kısmında kalan görünmez bir parça olmasına rağmen, telanın konstrüksiyonu ile tela ve kumaşın birleştirilme işlemi giysinin dikilebilirliğini, görünümünü, dayanıklılığını, tutumunu ve mekanik özelliklerini etkilemektedir. Bu çalışmada, gömlek üretiminde sıklıkla kullanılan dokuma kumaş ile birleştirilmiş 6 farklı yapışkan dokuma telanın tutum özellikleri subjektif ve objektif metotlar yoluyla incelenmiştir. Farklı dokuma telaların gömleklik kumaşın tutumuna etkisinin araştırılması amaçlanmıştır.

Anahtar Kelimeler: Kumaş tutumu, Tela, Gömlek kumaşı, Kumaş tutumunun subjektif değerlendirme, Dökümlülük açısı, Sıkıştırılabilirlik.

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1. INTRODUCTION

The products of the clothing industry are generally based on flat textiles that should have the same properties along the whole surface, although the required properties show different values at different locations on a garment. The required properties of textile surfaces on certain locations of a garment could be achieved on the basis of stabilization. For the purpose of garment parts' stabilization, the fusible and non-fusible interlinings or other substances that can be fused on the surface of a cloth part can be used (1).

Interlining is a layer of knitted, woven or non-woven fabric placed between the shell fabric and facing (2). Interlining which uses a thermoplastic resin for attaching the face fabric is known as an adhesive or fusible interlining and it is usually used nowadays because of its convenience (3).

Interlinings play an important role in building shape into the detail areas of clothes, such as the fronts of coats, collars, lapels, cuffs, and pocket flaps. Also, they stabilize and reinforce areas subject to extra wearing stress, such as necklines, facings, patch pockets, waistbands, plackets, and button holes (4).

Functions of fusible interlining in garments can be summarized as the ease of garment manufacturing due to stability of shell fabric, endowment of volume due to good formability, silhouette and shape retention of garment due to repetition of dry cleaning (5), achievement of appropriate flexibility, improvement of the look, fall and applicable properties of a produced garment (1).

To ensure the above-mentioned properties of stabilized garment parts, the following properties are important from the point of view of mechanical and physical properties of shell fabrics and interlining: tensile and elastic properties, bending, shearing and surface properties. Tensile and elastic properties of shell fabric, on the one hand, influence the properties of stabilized garment parts and, on the other hand, influence the compatibility with the interlining. The bending properties of shell fabric and interlining ensure the suitable appearance and the “fall” of stabilized garment parts (1). As far as the handle and drape of garment are concerned, the mechanical properties of fabric or fused fabric assemblies play a determining role (6).

Touching a fabric is the first action that buyers perform in order to evaluate the fabric quality to choose a suitable fabric for garments and to estimate the performance of the fabric for the end use (7). The fabric handle, which represents the psychological perception of fabric’s character, such as soft, plain, rigid, etc. is measurable and could be defined on the basis of fabric’s mechanical and physical properties. The characteristics of textile surface, which are determined visually or by subjective estimation of a handle, are important for evaluation of fused garment parts’ quality (1).

The smooth surface and being comfortable are the demanded properties for the garments especially in the part of collar, cuffs areas which directly contact the skin. So the physical properties like as thickness, compressibility, surface friction and stiffness of the shell fabrics fused with interlining are very important and define the usage comfort.

Although interlining is an invisible interior part of a garment, the interlining construction and the fusion process of interlining and shell fabric affect sewability, appearance, durability, handle and mechanical properties of the garment.

In the study the handle properties of a shell fabric fused with 6 different woven fusible interlinings, which are usually used for manufacturing of shirts, were examined both subjectively and objectively. The effects of woven interlinings on the handle properties of the shirt fabric were determined.

2. MATERIAL AND METHOD

2.1. Material

In this study, plain woven shell fabric produced from 65% PET – 35% Co yarn that is usually used for shirts and 6 different woven interlinings in plain structure produced from 100% Co yarn in different mass per unit area were supplied. The mesh number is constant in all of the interlinings (28 mesh HDPE).

Shell fabric was fused with 6 different woven fusible interlining respectively by sandwich fusing method with two outer fabrics on the outside of the sandwich and one interlining on the inside. The fusing was performed on a press machine and the fusing parameters are as follows:

- Fusing temperature T = 150°C;
- Fusing time t = 15s;
- Fusing pressure = 2 kg/cm^2.

In order to characterize the shell fabric and the fusible interlinings, the basic parameters were determined and all of them are presented in Tables 1 and 2.

2.2. Method

2.2.1. Subjective tests

In subjective assessments, it is possible to work with a jury of either experts that have knowledge and experience in the field or non-experts that have no experience (8). A panel of 29 female experts (researchers and students from the textile and clothing sectors) between the ages of 25 and 55 was chosen for fabric hand evaluation.

Experience of the other researches shows that to control the climatic conditions where the subjective evaluation carried out is important (9). For that reason, the tests were performed in standard atmosphere conditions (20±2°C temperature and 65±4% relative humidity).

20x20 cm specimens were prepared from each fused panel for subjective tests. The participants made an assessment using a 5-point scale. Before the evaluation, control fabrics with the values 1 and 5 were given to the members and they were asked to evaluate the thinness/thickness and softness/stiffness attributes of the specimens. The rating numbers for the attributes were given in Table 3.

Table 1. The characteristics of shell fabric

Material Type	Fabric Construction	Mass per Unit Area (g/m^2)	Yarn Count (Ne)		Fabric Density	
			Warp (Ne)	Weft (Ne)	Warp (ends/cm)	Weft (picks/cm)
65% PET - 35% Co	Plain weave	120	40	44	36.8	48.0

Table 2. The characteristics of woven fusible interlinings

Interlining Code	Mass per Unit Area (g/m^2)	Yarn Count (Ne)		Fabric Density (thread/cm)	
		Warp	Weft	Warp	Weft
1	63	64	64	30	22
2	85	30	30	26	18
3	130	16	16	18	15
4	145	16	16	20	16
5	155	16	16	20	18
6	170	18	18	24	22

Table 3. Rating numbers for the attributes

Sensory attribute	Rating number
Thinness/Thickness	1 – thickest ….. 5 - thinnest
Softness/Stiffness	1 – stiffest ……. 5 - softest

In the subjective assessment procedure, the thickness-thinnest of the fabric is described as the distance between the face and back of the fabric. The smaller the distance, the thinner the fabric is, likewise the bigger the distance, the thicker the fabric is. Based on the recognition and objective method, the jury holds the fabric in the most used hand, squeezes it with the thumb and index finger and defines the thickness according to what he/she feels (8).

In the subjective assessment procedure, softness-stiffness property is associated with bending. Fabrics easily bent are described as soft where the ones resistant to bending are described as stiff. Based on the assessment technique, the jury member holds the fabric between the thumb and the other four fingers of his/her most used hand. While moving the fabric back and forth, the resistance is evaluated. The more the resistance, the stiffer the fabric is, likewise, the less the resistance, the softer the fabric (8).

The evaluation was always performed in blind condition to minimize the effect of fabric properties on the perception. The experts individually evaluated and ranked each fabric attribute.

2.2.2. Objective tests

Mass per unit area, thickness, circular bending rigidity, drape angle, friction coefficient and compressibility were tested and the results were analyzed. All the measurements were performed after conditioning of the fused panels for 24 hours under the standard atmosphere conditions.

Mass per unit area was measured according to TS 251 standard. Thickness values were measured according to TS 7128 EN ISO 5084 standard by SDL ATLAS Digital Thickness Gauge. Stiffness test of the fabric specimens was carried out in circular bending rigidity tester, developed according to ASTM 4032. In this method, the force which is generated while pushing a fabric specimen through a ring is measured (7). Surface friction properties of studied fabrics were measured by FricTorq instrument and indicated as “friction coefficient (μ_{kin})”. Frictorq is based on a method to measure the coefficient of friction of the fabrics, using a rotary principle and, therefore, measuring torque (10, 11, 12).

Drape properties of the specimens were determined by using a Sharp Corner Drape Angle Tester (Figure 1), developed by Hes. The principle of the fabric drape tester is based on the bending of a fabric across a horizontal plate with a 90 degree sharp corner. As an indicator of the fabric drapability, it provides the sinus of the angle between the fabric edge and horizontal plane. The fabric becomes harder as the drape angle gets smaller (7, 10, 13).

Figure 1. Sharp corner drape angle tester

Compressibility is known as an important mechanical property of textiles. It is a decrease of initial thickness that occurs with suitable increase of compressive force (14). The fabric compressibility, which is a percentage change in fabric thickness at different pressure levels (3g/cm^2 and 45g/cm^2) was used for evaluating the fabric compression and the relative compressibility was calculated according to following formula:

$$Compressibility\ (\%) = (h_2-h_1) / h_2 * 100 \quad [1]$$

h_2: The thickness of the fabric under lower pressure (3g/cm^2)

h_1: The thickness of the fabric under higher pressure (45g/cm^2)

In order to investigate the effect of interlining type on the handle properties ANOVA tests were applied. To determine the test results of all the specimens statistically, homogeneity test of variance (Levene test) was performed. According to the Levene Homogeneity test results, Student-Newman-Keuls and Tamhane’s T2 Post Hoc Tests were conducted. To deduce whether the parameters were significant or not, p values were examined.

3. RESULTS AND DISCUSSION

3.1. Subjective evaluation of fabric handle

The mean values and standard deviations of the thinness-thickness and softness-stiffness evaluations of 29 panelists were given in Table 4.

Since the subjective test results show normal distribution, test values were evaluated by using variance analysis method. The difference between rating numbers of the panelists were found statistically insignificant according to 95% confidence level.

Table 4. Subjective evaluation results

Fused Panel Code	Thinness-Thickness				Softness-Stiffness			
	Mean $(\bar{x})$	Std. Dev. (s)	Min.	Max.	Mean $(\bar{x})$	Std. Dev. (s)	Min.	Max.
1	**4.59**	**0.501**	**4**	**5**	**4.79**	**0.412**	**4**	**5**
2	**3.66**	**0.721**	**3**	**5**	**4.07**	**0.704**	**3**	**5**
3	**1.79**	**0.559**	**1**	**3**	**1.79**	**0.774**	**1**	**3**
4	**1.83**	**0.889**	**1**	**4**	**1.66**	**0.614**	**1**	**3**
5	**1.34**	**0.484**	**1**	**2**	**1.28**	**0.455**	**1**	**2**
6	**3.24**	**0.739**	**2**	**5**	**2.93**	**0.593**	**2**	**4**

Table 5. Results of Tamhane's T2 test indicating the subjective evaluations

Fabric Test	Group (I)	Group (J)	p	Group (I)	Group (J)	p
Thickness-Thinness	1	2	0.000*	4	1	0.000*
		3	0.000*		2	0.000*
		4	0.000*		3	1.000
		5	0.000*		5	0.188
		6	0.000*		6	0.000*
	2	1	0.000*	5	1	0.000*
		3	0.000*		2	0.000*
		4	0.000*		3	0.028*
		5	0.000*		4	0.188
		6	0.416		6	0.000*
	3	1	0.000*	6	1	0.000*
		2	0.000*		2	0.416
		4	1.000		3	0.000*
		5	0.028*		4	0.000*
		6	0.000*		5	0.000*
Stiffness-Softness	1	2	0.000*	4	1	0.000*
		3	0.000*		2	0.000*
		4	0.000*		3	1.000
		5	0.000*		5	0.140
		6	0.000*		6	0.000*
	2	1	0.000*	5	1	0.000*
		3	0.000*		2	0.000*
		4	0.000*		3	0.048*
		5	0.000*		4	0.140
		6	0.000*		6	0.000*
	3	1	0.000*	6	1	0.000*
		2	0.000*		2	0.000*
		4	1.000		3	0.000*
		5	0.048*		4	0.000*
		6	0.000*		5	0.000*

* The mean difference is significant at the 0.05 level

According to average values (Table 4) and statistical test results (Table 5), it can be stated that, specimen having code "1" was found as the thinnest and softest fabric by the panelists. On the other hand, specimens having code "3", "4" and "5" were identified as the stiffest and thickest fabrics and there is not a statistically significant difference between these rating values. 6^{th} specimen has softer and thinner structure than the specimens coded "3", "4", "5". This is the result of the thinner warp and weft yarn and higher yarn density of the interlining fabric.

3.2. Objective evaluation of fabric handle

The test results of studied fused panels are given in Table 6. The results of Student-Newman-Keuls tests are given in Table 7 and the results of Tamhane's T2 test are given in Table 8.

Table 6. The objective test results of the fused panels

Measured/Calculated Parameters	Fused Panel Code					
	1	2	3	4	5	6
Mass per unit area (g/m^2)	291.5	316.75	377.25	392.38	395.13	405.25
Thickness (mm)	0.75	0.82	0.90	0.92	0.91	0.90
Circular bending rigidity (N)	3.76	5.40	22.94	21.71	33.48	14.20
Drape angle (º)	49.42	45.58	30.94	24.21	27.10	33.45
Friction coefficient (μ_{Kin})	0.2862	0.2786	0.2908	0.2772	0.3105	0.2790
Relative compressibility under 3 and 45 g/cm^2	27.088	24.627	20.000	21.154	19.749	19.342

Table 7. Results of Student-Newman-Keuls test

Fabric Test	Group	N	Sub groups			
			1	2	3	4
Circular Bending Rigidity	1	4	3.762500			
	2	4	5.400000			
	6	4		14.200000		
	4	4			21.712500	
	3	4			22.937500	
	5	4				33.475000
	Sig.		0.471	1.000	0.588	1.000
Thickness	1	3	0.750000			
	2	3		0.816667		
	3	3			0.900000	
	6	3			0.903333	
	5	3			0.910000	
	4	3			0.916667	
	Sig.		1.000	1.000	0.862	
Compressibility	6	3	19.341552			
	5	3	19.748462			
	3	3	20.000000			
	4	3	21.153846			
	2	3		24.626866		
	1	3			27.737106	
	Sig.		0.270	1.000	1.000	

Table 8. Results of Tamhane's T2 test

Fabric Test	Group (I)	Group (J)	p	Group (I)	Group (J)	p
Drape Angle	1	2	0.967	4	1	0.000*
		3	0.000*		2	0.017*
		4	0.000*		3	0.032*
		5	0.000*		5	0.779
		6	0.010*		6	0.055
	2	1	0.967	5	1	0.000*
		3	0,074		2	0.025*
		4	0.017*		3	0.414
		5	0.025*		4	0.779
		6	0.102		6	0.239
	3	1	0.000*	6	1	0.010*
		2	0.074		2	0.102
		4	0.032*		3	0.976
		5	0.414		4	0.055
		6	0.976		5	0.239
Kinetic Friction Coefficient	1	2	0.318	4	1	0.947
		3	1.000		2	1.000
		4	0.947		3	0.849
		5	0.999		5	0.989
		6	0.172		6	1.000
	2	1	0.318	5	1	0.999
		3	0.879		2	0.992
		4	1.000		3	1.000
		5	0.992		4	0.989
		6	1.000		6	0.993
	3	1	1.000	6	1	0.172
		2	0.879		2	1.000
		4	0.849		3	0.900
		5	1.000		4	1.000
		6	0.900		5	0.993

* The mean difference is significant at the 0.05 level

Thickness

Fabric thickness is generally evaluated by measuring the distance between two parallel plates separated by a fabric sample, with a known arbitrary pressure applied and maintained between the plates. The response of fabric thickness to applied forces normal to its plane is known as fabric compression behavior. Fabric thickness and compression are strongly related to handle, drape, comfort and thermal insulation properties (15).

The thickness values of the fused panels can be seen in Figure 2. When the results were evaluated in terms of fabric thickness, it is observed that, the fabric thicknesses vary between 0.75 mm and 0.92 mm.

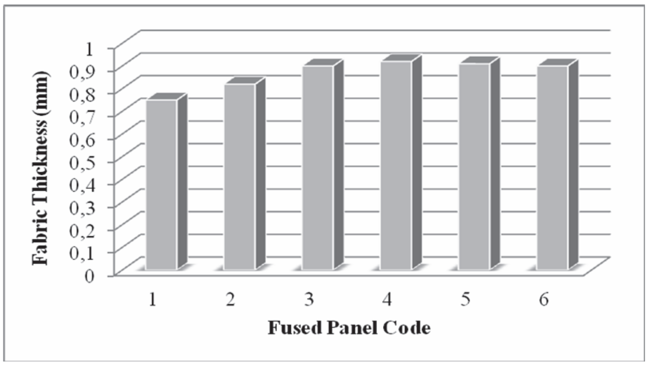

Figure 2. Thickness values of fused panels

According to statistical test results (Table 7) and average thickness values (Figure 2), it can be stated that, specimens having code "3", "4", "5" and "6" have higher thickness values and there is not a statistically significant difference between these rating values. It can be stated that, specimen coded "1" has the lowest thickness value. This result can be attributed to the finest warp and weft yarn of the interlining 1 (Table 2).

Circular Bending Rigidity

Bending rigidity was considered as an important property for garment appearance when considering mechanical properties of interlinings (3). The bending rigidity, in turn, is one of the basic parameters which are decisive for the handle of flat textile products. A lower value of bending rigidity supports the positive impression of sensorial comfort, and is at the same time a feature of fabrics which are susceptible to the formation of pleats (16).

Bending rigidity reflects the flexibility of the fabric and higher bending rigidity values indicate greater resistance to bending motions (17). The higher the rigidity, the lower the fabric handle is expected to be (18). The circular bending rigidity values of the fused panels can be seen in Figure 3.

As statistical test results (Table 7) and the circular bending rigidity values (Figure 3) are examined, it can be observed that specimen having code "5" has the highest circular bending rigidity value (the difference between the rating value of this fabric is statistically significant than the others). On the other hand, specimens having code "1" and "2" have the lowest values (the differences between the rating values of these fabrics are not statistically significant). It can be said that the lower the value obtained from the experimental tests, the softer the fabric is. For this reason, the specimen coded "5" is the stiffest whereas specimens coded "1" and "2" are the softest fabrics. Specimens "1" and "2" have lower fabric weight and thickness values due to the lower weight and finer yarn of the interlinings. This situation causes lower circular bending rigidity. Conversely, specimen "5" has the highest fabric density among the fabrics which have coarser weft and warp yarns.

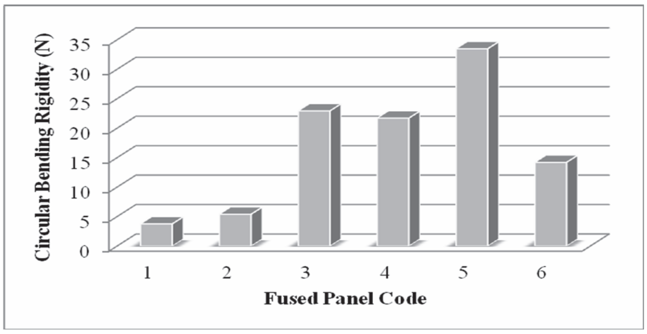

Figure 3. Circular bending rigidity values of fused panels

Drape Angle

The drape angle (degree) values of the fused panels can be seen in Figure 4. Drape angle values of the fabrics mostly show a similar tendency with the circular bending rigidity results. Softness of the fabrics increase with the increase of drape angle.

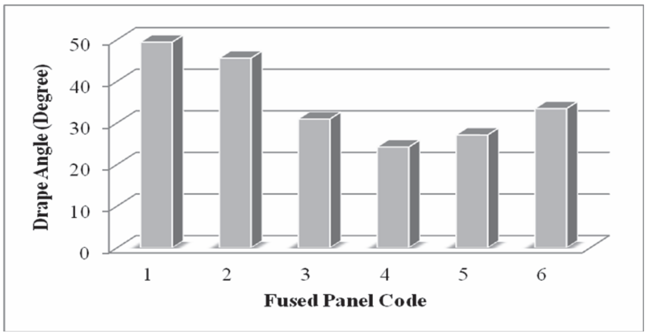

Figure 4. Drape angle values of fused panels

When statistical test results (Table 8) and the drape angle values (Figure 4) are analyzed, it can be stated that specimens having code "1" and "2" have the highest drape angle values. On the other hand, specimens having code "4" and "5" have the lowest values. The lower the value, the stiffer and the lower drapability of the fabric is. So, the results indicate that 4^{th} and 5^{th} specimens have the lowest drapability, whereas 1^{st} and 2^{nd} specimens have the highest drapability.

Kinetic Friction Coefficient

Traditionally, the quality and surface characteristics of apparel fabrics is evaluated by touching and feeling by hand, leading to a subjective assessment. Therefore, one of the most important characteristics of fabrics, either for clothing or technical applications is the coefficient of friction. This is an important factor regarding the objective measurement of the so-called parameter fabric hand (11). Friction coefficient is not an inherent characteristic of a material or surface, but results from the contact between two surfaces (19). The kinetic friction coefficient values of the fused panels can be seen in Figure 5.

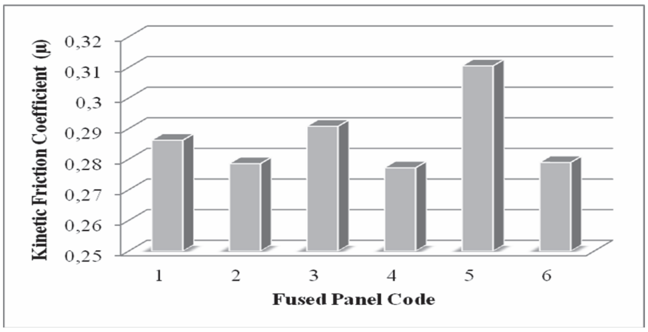

Figure 5. Kinetic friction coefficient values of fused panels

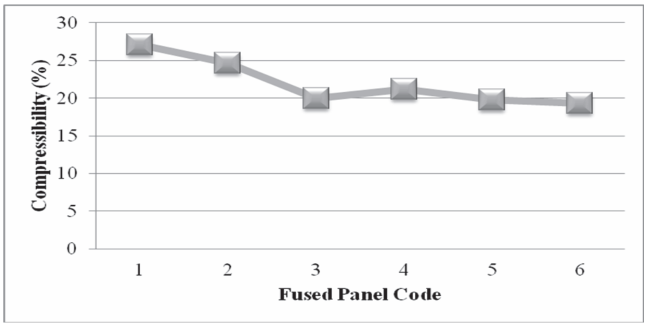

Figure 6. Relative compressibility values of the fused panels

According to the experimental results (Figure 5) and statistical analysis (Table 8), it can be denoted that, the differences between the specimens are statistically insignificant. This result can be explained by the covered structure of the interlining material with a standard woven shell fabric, which has a friction coefficient between 0.27 and 0.31.

Compressibility

Compressibility properties of the specimens were measured, by using 2 different pressure loads as 3 and 45 g/cm^2, which were applied respectively. The results are given in Figure 6.

According to compressibility values (Figure 6) and the variance analyses results (Table 7), it can be stated that, specimen which is coded as “1”, has higher relative compressibility than the other samples under the pressures of 3 g/cm^2 and 45 g/cm^2. Since the sample coded as “1” is more compressible, it absorbs more energy during load application. The difference between the specimens coded “3”, “4”, “5” and “6” was not found statistically significant.

3.3. Correlation between objective and subjective values

The correlations between subjective evaluations and the correlations between objective evaluations were found and are shown in Table 9 and Table 10.

Table 9. Correlation between subjective evaluations

		Thickness-Thinness	Stiffness-Softness
Thickness-Thinness	Pearson Correlation	1	0.871**
	Sig. (2-tailed)		0.000
	N	174	174
Stiffness-Softness	Pearson Correlation	0.871**	1
	Sig. (2-tailed)	0.000	
	N	174	174
**. Correlation is significant at the 0.01 level (2-tailed).			

When the correlation between subjective evaluations is analyzed, it can be seen that there is a high correlation between thickness-thinness and stiffness-softness. It means that thicker fabrics have stiffer structure; oppositely thinner fabrics have softer fabric structure.

Table 10. Correlation between objective evaluations

		Thickness	Kinetic Friction Coefficient	Weight	Circular Bending Rigidity	Drape Angle	Compressibility
Thickness	Pearson Correlation	1					
	Sig. (2-tailed)						
	N	24					
Kinetic Friction Coefficient	Pearson Correlation	0.141	1				
	Sig. (2-tailed)	0.511					
	N	24	24				
Weight	Pearson Correlation	0.933**	0.139	1			
	Sig. (2-tailed)	0.000	0.518				
	N	24	24	24			
Circular Bending Rigidity	Pearson Correlation	0.757**	0.505*	0.763**	1		
	Sig. (2-tailed)	0.000	0.012	0.000			
	N	24	24	24	24		
Drape Angle	Pearson Correlation	-0.925**	-0.195	-0.896**	-0.823**	1	
	Sig. (2-tailed)	0.000	0.362	0.000	0.000		
	N	24	24	24	24	24	
Compressibility	Pearson Correlation	-0.877**	-0.240	-0.929**	-0.739**	0.812**	1
	Sig. (2-tailed)	0.000	0.258	0.000	0.000	0.000	
	N	24	24	24	24	24	24
**. Correlation is significant at the 0.01 level (2-tailed).							
*. Correlation is significant at the 0.05 level (2-tailed).							

As the correlation analysis between the objective values examined (Table 10), a high correlation was found (r= -0,925) between thickness and drape angle. However, the correlation (r= 0.757) between thickness and circular bending rigidity was found comparatively lower. As the thickness of the fabric increases, the drape angle value decreases that mean higher thickness causes lower drapability. Opposite to that as the thickness increases, the circular bending rigidity increases that means higher thickness causes stiff fabric structure.

Similarly higher correlation was found between the fused fabric weight and compressibility (r= -0,929), drape angle (r= -0,896), circular bending rigidity (0,763). As the fabric weight increases, the stiffness of the fused panel increases and drapability decreases. As a result of that the compressibility decreases.

The higher correlations (r= -0,823) also found between the drape angle and circular bending rigidity. The higher drape angle, the lower bending rigidity is.

Correlation analyses were carried out to examine the relations between subjective and objective values and the results were given in Table 11 and Table 12.

Table 11. The correlation between subjective thinness-thickness ratings and objective thickness values

		Objective	Subjective
Objective	Pearson Correlation	1	-0.886*
	Sig. (2-tailed)		0.019
	N	6	6
Subjective	Pearson Correlation	-0.886*	1
	Sig. (2-tailed)	0.019	
	N	6	6
*. Correlation is significant at the 0.05 level (2-tailed).			

Table 12. The correlation between subjective softness-stiffness ratings and circular bending rigidity values

		Objective	Subjective
Objective	Pearson Correlation	1	-0.959**
	Sig. (2-tailed)		0.003
	N	6	6
Subjective	Pearson Correlation	-0.959**	1
	Sig. (2-tailed)	0.003	
	N	6	6
**. Correlation is significant at the 0.01 level (2-tailed).			

The correlation coefficient *(r)* between the objective and subjective thickness values were found *-0,886,* whereas it is found *-0,959* between objective and subjective stiffness results. Due to the high correlation coefficients between objective and subjective results, objective values can be used to determine the subjective handle properties.

4. CONCLUSION

The aim of this paper is to research the effects of different woven interlinings to the handle properties of shirt fabric.

6 woven interlinings which have different yarn count and fabric density but the same mesh number were used together with same type of woven shell fabric used for shirts. In subjective assessments, thinness/thickness and softness/stiffness attribute of the fabrics were evaluated by the experts individually and ranked using a 5-point scale. Mass per unit area, thickness, circular bending rigidity, drape angle, friction coefficient and compressibility were tested objectively and the results were analyzed.

The fabric fused with 1^{st} and 2^{nd} interlinings which have thinner warp and weft yarn and higher fabric density were found softer and thinner than the others either objectively or subjectively. These fused panels also were found better drapeability and compressible. Stiff and thicker values obtained for the fabrics fused with the interlinings which are higher weight and have thicker yarns. Insignificant differences were found between the specimens in terms of kinetic friction coefficient because of the usage of the same shell fabric for all fused panels although usage of different interlinings.

As the fused panels having codes “1” and “2” are softer, they may be used when soft handling is needed, however, fused panel having code “5” is suggested to be used when rigidity is preferred as its handle is stiffer.

The correlations between subjective evaluations and the correlations between objective evaluations were found high. Thicker fabrics caused stiff fabric structure as well. As the correlation analysis between the objective values examined, higher correlations were seen between the thickness and weight values. And the same relations were found between these values and the circular bending rigidity, drape angle and compressibility properties of the specimens.

In the study, high correlation coefficients were found between the subjective and objective values. Consequently, it can be denoted that objective measurements can be used in comparing subjective sensorial properties of the fused shirt fabrics.

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