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Roughness and frictional properties of cotton and polyester woven fabrics

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The roughness and frictional properties of cotton and polyester fabrics and relationship between these properties have been investigated and compared. Two sets of test samples comprising nine cotton and twelve polyester fabrics have been woven by systematically changing parameters such as weave type, weft setting and linear density of weft yarn. The fabric roughness measurements are conducted by using a new surface roughness tester for textile applications and the fabric friction measurements are performed with a friction attachment adaptable to a tensile tester. All the results are statistically evaluated in relation to the structural parameters of the test fabrics by using multivariate variance analyses. The relationship between roughness and frictional properties is examined by correlation analyses. For all the test fabrics, it can be noted that an increase in weft setting causes decrease in fabric roughness values for every weave type and this tendency is in accordance with the fabric friction results. When the relationships between the frictional and roughness values are examined, statistically significant and high correlations are determined for both of the cotton and polyester fabrics.

Keywords: Cotton, Fabric friction, Fabric roughness, Polyester, Woven fabric

1 Introduction

Surface properties of textile materials are important for all textile products in many situations from production to performance of final product. When clothing fabrics is the subject, these properties affect consumer preference for a garment or a fabric. For fabrics which are directly in contact with the skin, fabric handle and tactile properties are especially important in connection with clothing comfort[1,2]. The physical interaction between fabric and skin is always subjected to a complex mechanical load[3] and the distribution of this load on contact areas of skin is assessed subjectively. Thus surface properties have always examined for years because of having considerable importance for clothing fabrics in both of technological fields and subjective perception.

In some textile applications such as laying out of fabrics before cutting operations, high friction is preferred to hold fabric layers together although low friction is preferred between fabric and lining layer especially during wearing of a garment. When fabric roughness is considered individually, it is possible to say that it is one of the main reasons of the tactile perceptions such as prickle, harshness, scratchy, warmness and coolness.

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Fabric friction is affected by a lot of factors, such as type of fibre, type of blend, blend proportion, yarn structure, fabric structure, crimp, compressibility, etc.[4]. At the beginning of the researches on frictional properties, especially fibre friction, yarn friction and inter-yarn friction were studied and then fabric friction and the factors affecting fabric friction were examined. In addition to the studies of Kawabata on fabric friction and fabric roughness by KESF, many researchers focused on the measurement of surface properties while some of them studied the factors which affect these properties[5-16].

Roughness and frictional properties often determine the useful performance of materials or objects. When the clothing fabrics and the relationships of surface properties with fabric handle and clothing comfort are considered, it is clear that keeping these properties under control is necessary, however these activities are very difficult and expensive during manufacturing processes. So it is important to predict these properties before manufacturing stages by the help of the systematic studies conducted on this topic. This study therefore aims at investigating the frictional and roughness properties of woven fabrics together by using a known method for the friction measurements and a new method for the roughness measurements. Also another aim of this study is to compare the surface properties of fabrics having systematic structural parameters and to examine the relationship between these surface properties in detail.

2 Materials and Methods

To investigate the roughness and friction properties of fabrics, two sets of fabric samples comprising nine cotton (fabrics C1-C9) and twelve polyester (fabrics P1-P12) woven fabrics were used. Hence, a total of 21 woven fabrics with different structural properties were tested. All of the cotton and polyester fabrics were produced systematically changing the weave type and weft setting and the weft yarn linear density in case of polyester fabrics. All of the test fabrics were woven under controlled circumstances in mill conditions. The yarn linear densities and twist values (800T/m) of warp and weft yarns were kept constant for cotton fabrics while yarn linear density and twist value of warp yarn and warp setting were kept constant for polyester fabrics. Multifilament polyester FDY (fully drawn yarn) were used both in warp and weft directions of polyester fabrics, and all the warp yarns having 36 filaments were twisted by 650 T/m. The weft yarns having no twist in the polyester fabrics were composed of two different numbers of filaments such as 96 filaments (P1-P3 and P7-P9 coded fabrics) and 48 filaments (P4-P6 and P10-P12 coded fabrics). The properties of all the test fabrics are given in Table 1.

All the experiments were performed at 20±2°C and 65±2% relative humidity. For the measurements of fabric roughness, Mitutoyo SJ 301 surface roughness tester (suitable for soft materials) was used. For the measurements of fabric friction, a friction attachment which was produced similar to that proposed by Ajayi[8] and adaptable to a tensile tester was used. For statistical evaluation, variance analyses were conducted separately for the friction and roughness measurements and the differences among the groups for the main factors were performed by using post-hoc Student-Newman-Keuls (SNK) procedure. Correlation analyses were performed to determine the relationships between the test parameters belonging to friction and roughness properties, and SPSS 16.0 was used for all statistical evaluations at 95% confidence level.

2.1 Measurement of Fabric Roughness

Mitutoyo SJ 301 surface roughness tester was used for the measurements of fabric roughness. This instrument has been used in some previous studies[16,17] and is found to be capable to test the surface

Table 1—Basic structural properties of all the test fabrics

Fabric code	Raw material	Weave	Yarn count tex		Yarn setting threads/cm		Level of weft setting	Mass per unit area, g/m^2
			Warp	Weft	Warp	Weft		
C1		Plain	29.53	29.53	36	14	Loose	148
C2	Cotton	Plain	29.53	29.53	36	18	Medium	163
C3		Plain	29.53	29.53	36	22	Tight	175
C4		2/1 Twill	29.53	29.53	36	18	Loose	158
C5	Cotton	2/1 Twill	29.53	29.53	36	22	Medium	171
C6		2/1 Twill	29.53	29.53	36	26	Tight	186
C7		3/1 Twill	29.53	29.53	36	18	Loose	161
C8	Cotton	3/1 Twill	29.53	29.53	36	22	Medium	186
C9		3/1 Twill	29.53	29.53	36	26	Tight	190
P1		Plain	10	33.33(96f)	60	14	Loose	118
P2	Polyester	Plain	10	33.33(96f)	60	17	Medium	131
P3		Plain	10	33.33(96f)	60	20	Tight	142
P4		Plain	10	16.66(48f)	60	20	Loose	105
P5	Polyester	Plain	10	16.66(48f)	60	23	Medium	108
P6		Plain	10	16.66(48f)	60	26	Tight	118
P7		3/1 Twill	10	33.33(96f)	60	24	Loose	154
P8	Polyester	3/1 Twill	10	33.33(96f)	60	27	Medium	170
P9		3/1 Twill	10	33.33(96f)	60	30	Tight	185
P10		3/1 Twill	10	16.66(48f)	60	30	Loose	122
P11	Polyester	3/1 Twill	10	16.66(48f)	60	33	Medium	129
P12		3/1 Twill	10	16.66(48f)	60	36	Tight	136

f — Number of filaments in yarn structure.

roughness of fabrics. It shows a good correlation between the roughness results obtained from the instrument and the subjective trials. The surface roughness tester is a stylus type measuring instrument and is capable of evaluating surface textures with a variety of parameters according to various standards. According to the user's manual of the instrument, the stylus of the SJ–301 detector unit traces the minute irregularities of the work piece surface. Surface roughness is determined from the vertical stylus displacement produced during the detector traversing over the surface irregularities. The electrical signals are subject to various calculation processes. The measurement results are displayed digitally/graphically on the touch panel. The measured and/or statistical data are printed out.

For the roughness measurements, five fresh test specimens for all fabrics were tested both in warp and weft directions on a granite plate (400×400×60mm) that has a roughness class of '0'. Measurement on the granite plate and a sample graph for roughness measurement are given in Figs 1 and 2. Roughness graph is drawn according to the movement of the stylus on the fabric surface in positive and negative directions. In the present study, three parameters (Ra, Rq and Rp) were used to reflect fabric surface roughness characteristics. Ra is defined as the arithmetic mean of absolute values of the profile deviations (peaks in positive and negative directions).

Fig. 1—Measurement on granite plate by using Mitutoyo SJ 301 surface roughness tester [1–detector stylus of instrument, 2–granite plate, 3–fabric sample, 4–control panel and thermal printer]

Rq is defined as the square root of the arithmetic mean of squares of profile deviations from the mean line. Rp is defined as the mean of the profile peak heights for each sampling length of the assessed profile.

All the roughness tests were performed in two directions such as warp and weft. The arithmetic mean values of each roughness parameters were calculated for warp and weft test directions and new parameters to represent fabric roughness were calculated as the arithmetic mean values of each roughness parameters for warp and weft directions (Ra_{mean}, Rq_{mean} and Rp_{mean}).

2.2 Measurement of Fabric Friction

The components of the friction device included a horizontal platform (50×15cm) which is fitted on the bottom jaw of the tensile tester, a wooden sled (7.9×4.9cm), a frictionless pulley and an inextensible yarn which was used to provide the connection of the sled to the load cell of the instrument (Fig.3). The fabric to be tested is placed on the platform without any creases and clamped on the two sides to prevent any wrinkle or buckle during the tests. During friction measurements, five fresh samples were used for all tests and fabric-to-fabric friction was measured in two arrangements such as warp-warp and weft-weft. Face sides of specimens were tested with a constant speed of 50 mm/min for test duration of 3 min. The static and kinetic friction loads were handled from the friction graphs and two sample graphs for the friction measurements are given in Fig 4. Normal load (N) was selected as $1.2 g/cm^2$ and two values of friction coefficients namely static (μ_s) and kinetic (μ_k) were determined. The coefficient of friction (μ) was calculated by using the simple linear equation between the frictional resistance and normal load, as shown below:

$$= \frac{\boldsymbol{F}}{\boldsymbol{N}} \qquad \ldots (1)$$

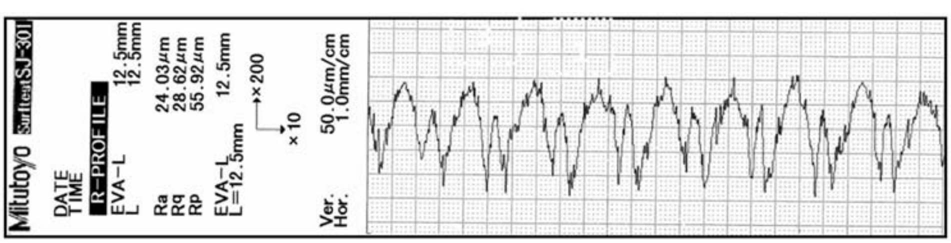

Fig.2—A sample graph for the roughness measurements of C1 coded cotton plain fabric

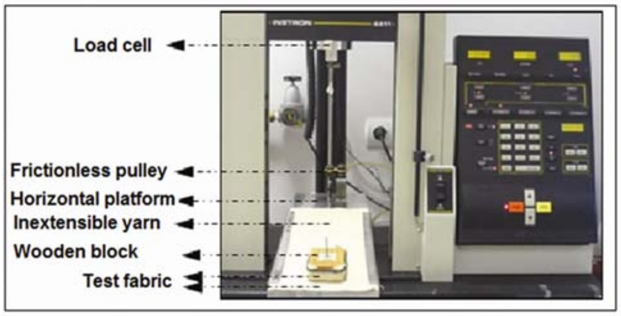

Fig.3—Measurement of fabric-to-fabric friction by using a friction attachment adaptable to a tensile tester

where ***F*** is the frictional resistance; and ***N***, the normal load.

The arithmetic mean values of friction coefficients were calculated for warp-warp ($_{s\ warp}$) and weft-weft ($_{s\ weft}$) directions for each fabric type and new parameters namely fabric friction coefficients was calculated by the arithmetic mean value of friction coefficients (warp-warp and weft-weft) of $_{S\ mean}$ and $_{k\ mean}$ separately.

3 Results and Discussion

Fabric roughness and fabric friction results of cotton and polyester fabrics are discussed hereunder. The results of variance analyses of the friction and roughness measurements and the differences amongst each group have been explained by using the results of SNK procedure. Relationships between the roughness and the friction results are also discussed.

3.1 Fabric Roughness

3.1.1 Cotton Fabrics

The fabric roughness results of cotton fabrics obtained by using SNK procedure are shown in Table 2. It is observed that the changes in roughness values determined for different test directions are found to be generally parallel to each other for all the three different roughness parameters and the roughness tendency is similar for these parameters. When the roughness results for warp and weft directions are compared, the similar and decreasing tendency in roughness values is observed with the increase in weft density. This situation is distinct and noteworthy especially in weft direction results, showing the effect of changes in weft density.

As seen in Table 2, an increase in the weft setting value causes decrease in fabric roughness for all the weave types. An increase in weft density causes decrement in the gaps between neighbour yarns in fabric structure and this may be the possible reason of decreasing fabric roughness values. When the effect of weave type is taken into consideration according to common weft setting values, generally it can be said that 3/1 twill fabrics are smoother than plain and 2/1 twill weaves. Increasing yarn inter-sections in weave unit provides to get the yarns closer to each other in contact points and this may cause decrease in roughness values. When all the roughness results of cotton fabrics are examined, it is revealed that the smoothest fabric surface is obtained for the highest setting value for each weave type of the cotton fabrics.

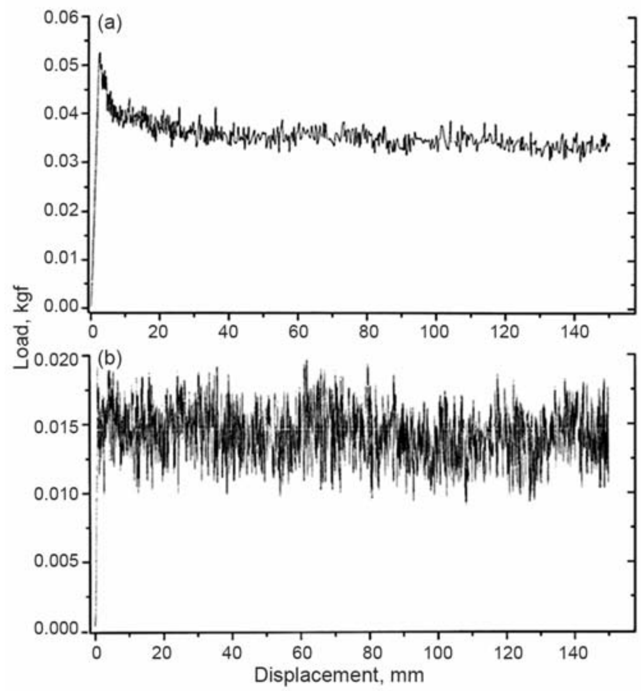

Fig.4—Fabric friction graph of (a) C1 coded plain cotton fabric (weft-weft direction), and (b) P1 coded plain polyester fabric (weft-weft direction)

When the variance analyses results are examined, it is found that the effect of weave and weft setting on all the roughness parameters of the cotton fabrics are statistically significant at 95% confidence level. When the test results are analyzed separately for warp and weft, it is found that the differences between weaves are statistically significant for all the roughness results determined in warp direction and the effect of weave type is significant for Rp values in weft direction. Besides, it can be concluded that any change in the weft setting values causes significant differences in each test direction. According to the SNK results given in Table 2, the roughness parameters (Ra, Rq and Rp) can separate the test

Table 2—Student-Newman-Keuls (SNK) test results showing the effects of weave type and setting on the roughness results of cotton fabrics

Weave type	Setting	Ra_{warp}	Rq_{warp}	Rp_{warp}	Ra_{weft}	Rq_{weft}	Rp_{weft}	Ra_{mean}	Rq_{mean}	Rp_{mean}
Plain	Tight	20.90 a	24.99 a	52.66 a	15.86 a	18.78 a	49.64 a	18.38 a	21.89 a	51.15 a
	Medium	24.45 b	29.16 b	63.05 a	22.90 b	27.36 b	62.86 b	23.67b	28.26 b	63.00 b
	Loose	27.79 c	32.76 c	65.61 a	31.25 c	35.86 c	72.15 c	29.52 c	34.31 c	68.90 b
2/1 Twill	Tight	16.30 a	20.06 a	31.10 a	18.16 a	22.31 a	49.25 a	17.23 a	21.19 a	40.18 a
	Medium	18.39 b	22.57 b	41.51 ab	22.20 ab	26.60 ab	56.59 a	20.29 b	24.59 b	49.05 a
	Loose	22.49 c	27.68 c	54.75 b	26.20 b	30.85 b	69.79 b	24.35 c	29.27 c	62.30 b
3/1 Twill	Tight	14.41 a	17.87 a	35.56 a	20.92 a	25.31 a	52.37 a	17.67 a	21.59 a	43.97 a
	Medium	16.90 b	21.23 b	39.11 a	23.47 a	27.60 a	53.01 a	20.40 b	24.80 b	46.06 a
	Loose	18.83 c	23.43 c	40.36 a	23.97 a	28.31 a	53.90 a	21.10 b	25.50 b	47.13 a

The average values are arranged such that the letter ‘a’ shows the lowest average value and the letter ‘c’ shows the highest average value. Any two average values not sharing ‘a’ letter in common mean that they are significantly different from each other at 95% confidence level.

Table 3—Student-Newman-Keuls (SNK) test results showing the effects of weave type, weft setting and linear density of weft yarn on the roughness results of polyester fabrics

Weave type	Linear density of weft yarn	Weft setting	Ra_{warp}	Rq_{warp}	Rp_{warp}	Ra_{weft}	Rq_{weft}	Rp_{weft}	Ra_{mean}	Rq_{mean}	Rp_{mean}
Plain	Coarse	Tight	27.72 a	32.97 a	62.35 a	23.51 a	26.09 a	49.32 a	25.61 a	29.53 a	55.63 a
		Medium	27.38 a	32.73 a	60.06 a	25.83 a	28.65 a	51.20 a	26.61 a	30.69 a	55.84 a
		Loose	28.11 a	33.51 a	62.50 a	31.07 b	34.29 b	62.07 b	29.59 b	33.90 b	62.29 b
Plain	Fine	Tight	23.72 a	27.33 a	53.86 a	22.90 a	25.11 a	46.05 a	23.31 a	26.22 a	49.96 a
		Medium	23.35 a	27.07 a	54.27 a	24.99 a	27.28 ab	49.64 b	24.17 a	27.17 ab	51.95 a
		Loose	24.18 a	28.37 a	55.33 a	26.66 a	29.35 b	53.59 c	25.42 a	28.86 b	54.46 b
3/1 Twill	Coarse	Tight	23.32 a	28.50 a	49.77 a	18.97 a	21.32 a	48.96 a	21.15 a	24.91 a	49.37 a
		Medium	23.74 a	29.15 a	50.96 a	19.34 a	22.21 a	49.17 a	22.54 ab	25.68 ab	50.06 a
		Loose	23.83 a	29.74 a	50.61 a	21.03 b	23.52 a	52.64 a	22.43 b	26.63 b	51.63 a
3/1 Twill	Fine	Tight	17.56 a	22.70 a	44.39 a	17.23 a	19.65 a	45.91 a	17.40 a	21.17 a	45.15 a
		Medium	18.49 b	23.97 b	45.66 a	18.07 a	20.98 a	47.61 a	18.28 b	22.47 b	46.63 ab
		Loose	19.75 c	27.78 c	47.26 a	20.04 b	23.41 b	51.62 b	19.90 c	24.60 c	49.44 c

The average values are arranged such that the letter ‘a’ shows the lowest average value and the letter ‘c’ shows the highest average value. Any two average values not sharing ‘a’ letter in common mean that they are significantly different from each other at 95% confidence level.

fabrics generally in three groups, relating to different setting levels. On the other hand, the tight setting of 3/1 twill weave causes a sharp decrease in fabric roughness in comparison to the other fabrics in this group.

3.1.2 Polyester Fabrics

Fabric roughness and SNK results of polyester fabrics are given in Table 3. It is clearly observed that the changes in roughness values of polyester fabrics are parallel to each other for three roughness parameters used in the study. When we compare the roughness results for warp and weft directions, it is clear that an increase in weft density causes decrease in roughness and this result is in accordance with the roughness results of cotton test fabrics. The decreasing tendency in roughness is more evident for the results obtained in weft direction. When the effect of weave type is evaluated, it can be said that plain fabrics are rougher than 3/1 twill fabrics. As seen in Table 3, the fabric having the highest weft density for each weave type has the smoothest fabric surface.

Variance analyses results show that the effect of weave type, weft setting and yarn linear density on all roughness parameters of polyester fabrics are statistically significant at 95% confidence level (***p***<0.05). The SNK results (Table 3) clearly show the

Table 4—Student-Newman-Keuls (SNK) test results showing the effects of weave type and weft setting on the friction results of the cotton fabrics

Main effects		$\mu_{s\ warp}$	$\mu_{k\ warp}$	$\mu_{s\ weft}$	$\mu_{k\ weft}$	$\mu_{s\ mean}$	$\mu_{k\ mean}$
Weave type	Weft setting						
	Tight	0.69 a	0.35 a	0.79 a	0.44 a	0.74 a	0.39 a
Plain	Medium	1.01 b	0.66 b	1.02 b	0.65 b	1.02 b	0.65 b
	Loose	1.14 c	0.68 b	1.14 b	0.72 b	1.14 c	0.70 b
	Tight	0.68 a	0.18 a	0.75 a	0.25 a	0.72 a	0.21a
2/1 Twill	Medium	0.90 b	0.48 b	1.06 b	0.52 b	0.98 b	0.50 b
	Loose	1.03 b	0.56 b	1.06 b	0.54 b	1.04 b	0.55 b
	Tight	0.57 a	0.12 a	0.72 a	0.23 b	0.67 a	0.18 a
3/1 Twill	Medium	0.71 b	0.17 a	0.73 a	0.15 a	0.72 a	0.15 a
	Loose	0.76 b	0.19 a	0.77 a	0.13 a	0.74 a	0.17 a

The average values are arranged such that the letter ‘a’ shows the lowest average value and the letter ‘c’ shows the highest average value. Any two average values not sharing ‘a’ letter in common mean that they are significantly different from each other at 95% confidence level.

different groups of roughness values. The roughness results are separated into different groups with respect to different weft settings and this situation is found to be distinct for the results determined in weft direction. Especially it is noticed that the roughness results of 3/1 twill fabrics having finer yarn (16.66 tex, 48f) are divided into three roughness groups according to three setting levels.

3.2 Fabric Friction

3.2.1 Cotton Fabrics

The fabric-to-fabric friction and SNK results of cotton fabrics are given in Table 4 considering static (μ_s) and kinetic (μ_k) friction coefficient values. It can be noted that the changes in friction coefficient values are parallel to each other for two friction parameters. It can generally be seen that increase in weft setting causes decrease in fabric friction for all the weave types and this tendency is similar for μ_s and μ_k. Also this result is in accordance with the fabric roughness results. 3/1 twill fabrics have the lowest friction coefficients values while plain weave fabrics has the highest. These results are in agreement with previous findings[18]. The plain fabric having 14 yarns/cm in weft direction has the highest values for μ_s and μ_k. According to results of variance analyses, weave and weft density have statistically significant effect on friction results of cotton fabrics. As per two findings, test fabrics are generally divided into two groups in accordance with the settings and the fabrics having higher setting show different friction behavior amongst others.

3.2.2 Polyester Fabrics

The fabric-to-fabric friction and SNK results of polyester fabrics are given in Table 5 considering the static (μ_s) and kinetic (μ_k) friction coefficient values. It can be noted that the coefficient of friction values of the polyester fabrics are much lower in comparison to that of the cotton fabrics. Fabrics woven from continuous filament yarns are likely to show lower coefficients of friction values than those woven from staple fibres. This result supports the previous findings [19]. Besides, it is observed that the increment in weft setting values causes decrement in friction values and this result is parallel to the result of cotton fabrics. The plain polyester fabrics (P1, P2, P3) show the highest coefficient of friction values both in warp and weft directions (Table 5). These fabrics have the lowest weft setting values amongst the polyester test fabrics and also have the highest number of filament yarns in plain fabrics. When the plain polyester fabrics having the same weft setting values are examined, the effect of linear density of weft yarn on the coefficient of friction values could be seen clearly. It is observed that the decrease in linear density of the weft yarn causes slight decrease in the friction values for common weft setting values. This may be due to the decrease in yarn protrusions with the finer yarns in the plain fabric structure. The higher coefficient of friction values are determined for the plain fabrics. 3/1 twill fabrics having coarser yarn (P7, P8, P9) has higher coefficient of friction values

Table 5—Student-Newman-Keuls (SNK) test results showing the effects of weave type and weft setting on the friction results of the polyester fabrics

Main effects			$\mu_{s\ warp}$	$\mu_{k\ warp}$	$\mu_{s\ weft}$	$\mu_{k\ weft}$	$\mu_{s\ mean}$	$\mu_{k\ mean}$
Weave type	Linear density of weft yarn	Weft setting						
Plain	Coarse	Tight	0.19 a	0.13 a	0.32 a	0.25 a	0.26 a	0.19 a
		Medium	0.20 a	0.14 b	0.33 a	0.25 a	0.27 a	0.20 a
		Loose	0.24 b	0.17 c	0.44 b	0.32 b	0.34 b	0.24 b
Plain	Fine	Tight	0.17 a	0.12 a	0.31 a	0.21 a	0.24 a	0.16 a
		Medium	0.19 a	0.13 a	0.32 a	0.21 a	0.25 a	0.17 a
		Loose	0.20 a	0.14 b	0.32 a	0.22 a	0.26 a	0.18 a
3/1 Twill	Coarse	Tight	0.18 a	0.13 a	0.34 a	0.21 a	0.26 a	0.17 a
		Medium	0.17 a	0.13 a	0.37 a	0.23 ab	0.27 a	0.18 a
		Loose	0.19 b	0.15 b	0.36 a	0.26 b	0.28 a	0.21 b
3/1 Twill	Fine	Tight	0.16 a	0.12 a	0.25 a	0.17 a	0.20 a	0.14 a
		Medium	0.18 b	0.13 a	0.31 b	0.23 b	0.25 b	0.18 b
		Loose	0.18 b	0.13 a	0.34 b	0.25 b	0.26 b	0.19 b

The average values are arranged such that the letter ‘a’ shows the lowest average value and the letter ‘c’ shows the highest average value. Any two average values not sharing ‘a’ letter in common mean that they are significantly different from each other at 0.05 level.

in comparison to the other fabrics having finer yarn in this group. It can be due to the long floats and the knuckle effect of neighbor yarns in weave structure. Both warp and weft yarn crimps increase gradually as the weft density is increased and an increase in yarn crimp producing a knuckle effect could be an explanation of this situation. When 3/1 twill fabrics having finer yarns (P10, P11, P12) are examined, a sharp decrease in friction values is observed. The frictional force may decrease on the contact points by increasing the weft density, and decreasing gaps between yarns in weave structure may cause decrease in the friction values.

According to the variance analyses, the effect of weave type, weft setting and linear density of weft yarn on most of the fabric friction parameters (except $\mu_s$weft for weave type) are statistically significant at 95% confidence level ($\boldsymbol{p}<0.05$). The results of SNK tests are given separately in Table 5 according to the main effects. It can be seen that the friction values of polyester fabrics are divided into two main groups in relation to weft setting values such as loose and medium-tight.

3.3 Relationship between Fabric Roughness and Fabric Friction

In this part, relationship between fabric roughness and fabric frictional properties is examined for cotton and polyester test fabrics. Pearson correlation coefficients are calculated and the relationships are examined for warp, weft and mean values respectively. The correlation coefficients belonging to mean parameters of each property are given in Table 6 to provide a general view of the results.

Table 6—Pearson correlation coefficients between fabric roughness and fabric friction parameters of the cotton and polyester test fabrics

Parameter	Ra_{mean}	Rq_{mean}	Rp_{mean}	$\mu_{s\ mean}$	$\mu_{k\ mean}$
Cotton fabrics					
Ra_{mean}	1				
Rq_{mean}	0.998**	1			
Rp_{mean}	0.916**	0.909**	1		
$\mu_{s\ mean}$	0.868**	0.872**	0.895**	1	
$\mu_{k\ mean}$	0.768*	0.759*	0.905**	0.944**	1
Polyester fabrics					
Ra_{mean}	1				
Rq_{mean}	0.989**	1			
Rp_{mean}	0.966**	0.988**	1		
$\mu_{s\ mean}$	0.715**	0.781**	0.815**	1	
$\mu_{k\ mean}$	0.667*	0.754**	0.800**	0.936**	1

* Statistically significant at 95% confidence level. ** statistically significant at 99% confidence level.

Table 6 shows that most of the correlation coefficients between all the friction and the roughness parameters of cotton fabrics are statistically significant at 99% confidence level. When the mean parameters of the surface properties are examined (Table 6), it can be noted that these high correlation coefficient values show strong relationship between surface properties of the cotton and polyester fabrics. It can be clearly seen that in accordance with the correlation results of the cotton fabrics, there is a high and positive relationship between the surface properties of the polyester fabrics. For all fabrics, especially very high correlations are determined for the Rp parameter in comparison to the other parameters used in the study.

4 Conclusion

The coefficient of friction values of the polyester fabrics are much lower in comparison to those of the cotton fabrics. An increase in weft setting value causes decrement in fabric friction for all weave types and this result is in accordance with the fabric roughness results. For every fabric set, the fabric having the highest weft setting value is determined to have the lowest friction. The changes in μ_s and μ_k values, determined according to different fabric structural parameters, are parallel to each other for all the test fabrics and this situation is similar for the roughness parameters used in the study. When the roughness results are examined, it is seen that the plain fabrics have higher roughness values in comparison to the twill fabrics for both of the cotton and polyester fabrics. 3/1 twill cotton fabrics are found to be smoother than 2/1 twill cotton fabrics for the common weft setting values. It is determined that the fabric having the highest weft density for each weave type has the smoothest fabric surface for all of the test fabrics.

The positive and high correlation coefficient values determined between friction and roughness values show strong relationship between the surface parameters used in the study and these results may be helpful for further approaches on the prediction of fabric surface properties which is very important for fabric handle and clothing comfort studies.

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