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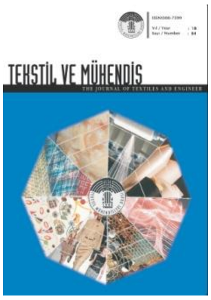

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The Effect of Properties and Positioning of Yarns Used in Jacquard Woven Fabric Pattern on Abrasion Resistance

Jakarlı Dokuma Kumaş Deseninde Kullanılan İplik Özelliklerinin ve Konumlarının Aşınma Direncine Etkisi

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Araştırma Makalesi / Research Article

THE EFFECT OF PROPERTIES AND POSITIONING OF YARNS USED IN JACQUARD WOVEN FABRIC PATTERN ON ABRASION RESISTANCE

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ABSTRACT: The effects of the woven fabrics' design parameters on the usage performances are well known, and the problems that may arise during use should be predicted and solved. In this study, the effect of different weft yarn properties, which were used to create a texture effect on the weave pattern, was investigated on the surface abrasion performance of fabrics. For this purpose, controlled jacquard fabric samples woven with different weft yarn properties (yarn linear density and yarn types such as; filament yarn, staple fiber yarn, and textured shrinkage yarn) were used. Results were evaluated by taking microscopic images before and after the abrasion process for different abrasion cycles. These results were also assessed by comparing the surface roughness values of fabric surfaces before and after abrasion. Experimental results showed that yarn properties and amount of yarn crimp affect the abrasion resistance of fabrics.

Keywords: Jacquard Woven Fabric, Yarn Properties, Surface Roughness, Abrasion Resistance

JAKARLI DOKUMA KUMAŞ DESENİNDE KULLANILAN İPLİK ÖZELLİKLERİNİN VE KONUMLARININ AŞINMA DİRENCİNE ETKİSİ

ÖZET: Dokuma kumaşların üretim parametrelerinin kumaşların kullanım performanslarına etkileri iyi bilinmeli ve kullanım sırasında çıkabilecek problemler önceden tahmin edilip giderilmeye çalışılmalıdır. Bu çalışma kapsamında jakarlı dokuma kumaşlarda desen efektlerinde kullanılan farklı özellikteki atkı ipliklerinin yüzey aşınma performansına etkisi incelenmiştir. Bu amaçla farklı atkı ipliği özelliklerine (iplik numarası, iplik tipi; filament iplik, kesikli iplik ve çeken iplik) sahip kontrollü jakar desenli kumaş üretimi yapılmıştır. Sonuçlar farklı aşınma devirlerinde ve büyütme oranlarında mikroskop görüntüleri çekilerek değerlendirilmiştir. Elde edilen sonuçlar aşınma öncesi ve sonrası kumaş yüzeyinin pürüzlülük değerleriyle karşılaştırılarak değerlendirilmiştir. İplik özelliklerinin ve iplik kıvrım miktarının, kumaşların aşınma direncini etkilediği gözlenmiştir.

Anahtar Kelimeler: Jakarlı Dokuma Kumaş, İplik Özellikleri, Yüzey Pürüzlülüğü, Aşınma Dayanımı

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1. INTRODUCTION

Abrasion is the mechanical and also surface appearance deterioration of fabric components by rubbing against another surface. Abrasion resistance is one of the essential features characterizing fabrics' durability, and it depends on the fabric's physical properties such as fiber, yarn, and fabric structural parameters. The most important influences on the abrasion can be summarized as fiber type, physical and mechanical properties of fibers, yarn spinning properties, yarn linear density, yarn twist and ply number, yarn crimp, warp and weft yarn density, fabric thickness, and weave pattern, etc. [1].

Yarn structure is one of the most determining parameters affecting the abrasion resistance of fabrics. As the yarn becomes thicker, resistance to abrasion forces increases. Yarns with low twist wear more easily than high twist yarns. When the twist level is less, it is easier for the fibers to move away from the fabric surface. As the twist level increases, the yarn diameter becomes smaller, and a tighter yarn structure is formed, and abrasion resistance is increased [2, 3]. Removal of fibers from the yarn structure is one of the causes of abrasion. The longer fiber yarn structures that make up the fabric provide better abrasion resistance than short-fiber yarn structures because it is more difficult to remove them from the fabric. Therefore, filament yarns are more resistant to abrasion than staple yarns produced from the same fiber [4-6].

The warp and weft yarn densities are also a factor affecting the abrasion resistance of fabric. Abrasion is a factor in how much material absorbs energy. Abrasion resistance increases as the fabric's yarn density increases. The yarn absorbs much more energy against the abrasion force, reducing the amount of tension per single yarn [2, 3]. However, it should be considered that yarn movement is restricted in fabric structures with very high yarn density. As a result of this, these yarns are exposed to more deformation because they cannot dissipate the wear effect [1, 4].

The fabric weave pattern is also an essential factor in abrasion resistance. Since the weave structure of the fabric determines the surface area of the yarns subject to abrasion on the fabric surface, there will be more wear on the yarn's surface, which is predominant on the surface. On fabric surfaces with different yarn floating lengths, the floating yarns' movement capabilities absorb the tension on the surface. The dominant yarn group on the fabric surface will wear more while the other yarn group will wear less. This situation also occurs on fabric surfaces with different yarn float lengths, and floating yarns absorb the surface tension. In fabric woven with varying weave structures, as the intersection and holding forces between yarns will change depending on the weave structure, this situation will affect the fabric's abrasion resistance. Long yarn floats wear out faster and may even cause yarn breakage in the fabric surface.

Fabrics with low yarn floats, such as plain weave, have improved abrasion resistance because the yarns are more tightly intersected in fabric structure, and the wear is spread more evenly over all of the yarns in the fabric [1, 5-7]. In a study evaluating the effect of weave patterns on abrasion resistance, it was found that weave patterns with more floating yarn were more affected by abrasive loads. Also, it was stated that the loosely structured yarns, in which the fibers' ability to adhere to the yarn structure was low, had a weaker performance against abrasive forces [8]. In a study on the change of mass loss of woven fabrics with different structure fancy yarns after abrasion, it was found that the fabrics with loop fancy yarns have the highest abrasion resistance, and those with spiral structure fancy yarns have the lowest abrasion resistance [9].

The changes in the appearance of fabrics, such as reflectance and color difference on the fabric surfaces after abrasion, vary depending on the number of floats and intersections of the yarns in the fabric, as the floating length of the yarns on the fabric surface increases, the color difference values that occur after the abrasion increases. Results showed that the fabrics with high yarn intersections are more resistant to the abrasion effect regarding the change in color properties [10].

As well as the woven fabric's structural parameters, the crimp amount of the yarn in the fabric is a factor affecting the abrasion resistance of the fabrics. Since the yarn crimp curves are more protruding in fabrics with a high crimp yarn, abrasion is more in these regions. The approximate uniformity of the weft and warp yarns will result in less abrasion on the fabric surface. The abrasion force will be distributed evenly across the two yarn groups [1, 4, 7].

Roughness is the surface micro geometry that expresses the total unevenness (geometric deviations) on the surface with relatively small lengths in small distances [11]. Generally, there are two kinds of irregularities; systematic variation arising from uniform fabric structures and random variation caused by uneven yarns or yarn spacing [12]. Roughness defines woven surfaces in textile; it can be expressed as the average deviation of the surface profile in one direction (warp or weft) [11]. The increase in surface roughness is ascribed to an increase in the mechanical interlocking of the yarn crowns [13]. In general, surface roughness affects important fabric properties such as garment comfort (handle), pilling tendency, abrasion resistance, adhesion, print quality, drape, and aerodynamic performance [11].

In a study on the surface roughness of polyester woven fabrics, it was observed that the surface roughness of fabrics was affected mainly by their physical properties, such as the number of threads per centimeter, number of yarn intersections per unit area, and fabric balance. A systematic increase in these parameters decreased the surface roughness properties [14]. In a study investigating the abrasion effect on the surface roughness values of polyester woven fabrics, it was observed that abrasion eliminated the effect of texture, especially at the fabrics with initially high surface roughness value. The surface roughness of fabrics with initially high surface roughness values decreased to a greater extent than those with low surface roughness values after abrasion. Also, experimental results showed that the fabrics' surface roughness values regularly decreased as the abrasion cycles increased [15].

In a study on the tribological properties of upholstery woven fabrics, it was observed that the changes in the surface roughness parameters after abrasion in the fabrics made by one-to-one yarn intersection were low while the fabrics have the consecutively long yarn floats were high. Also, it was found that it might be appropriate to use double-layered structures in upholstery fabrics to minimize the effect of abrasion on the upper layer fabric surface, in other words, reducing the mobility of the yarns during the abrasion [16].

This study aimed to investigate the effect of various yarn properties used in pattern effects on the abrasion behavior of jacquard woven fabrics. The effects of yarns with different properties used in jacquard pattern design on the abrasion performance of the fabrics were evaluated for the following three different pattern areas; i) regions where the yarns have high intersections, ii) regions where the yarns have long floating, iii) and the transition areas between these two zones. The wear effect of fabric surfaces was evaluated comparatively with the changes in the fabric surface roughness values and the microscopic analysis of the fabric surfaces.

2. MATERIAL AND METHOD

2.1. Material

In this study, the effects of different weft yarn properties used in weave patterns on the abrasion resistance of double-faced jacquard fabrics were evaluated. Warp yarn properties (yarn linear density and yarn density) were kept constant to observe the effect of weft yarn properties on abrasion resistance. 100% polyester yarn was used in warp and weft yarns. Four different types of weft yarns, such as 300/144 denier/filament textured yarn (F1) (filament fineness: 2.083 denier), 300/144 denier/filament twisted linen-like staple fiber yarn (F2) (filament fineness: 2.083 denier), 150/72 denier/filament textured shrinkage yarn (F3) (filament fineness: 2.083 denier), 75/96 denier/filament twisted yarn (F4) (filament fineness: 0.781 denier), were used. The structural parameters of the fabric samples were given in Table 1. Fabric samples were woven under controlled mill conditions to obtain the exact constructional properties. Abrasion measurements were conducted on finished fabrics (washed at 60ºC for 30 min and heat-treated at 180ºC for 60 s).

Yarns called "shrinkage yarn" added the dimension to the fabric by collecting other yarns used in the fabric after heat treatment. It is considered that, like mechanical properties, thermal properties (especially the temperature-dependent dimensional stability) are mainly managed by the amorphous regions. Upon heating, the oriented molecules tend to curl (improved entropy), resulting in the shrinkage of the yarn [17].

The microscopic images of the warp and weft yarns forming the fabric were presented in Figure 1. The digital image of the weave pattern and woven fabric samples were presented in Figures 2 and 3, respectively.

Table 1. Structural properties of fabrics

Fabric No	Yarn Linear Density [Denier/filament]		Yarn Twist [T/m]		Yarn Density [thread/cm]		Yarn Crimp [%]		Fabric Thickness [mm]	Fabric Unit Weight [g/m^2]
	Warp	Weft	Warp	Weft	Warp	Weft	Warp	Weft		
F1	75/72	300/144	680	Textured	120	24	16	3	0.70	220.5
F2	75/72	300/144	680	800	120	24	16	5	0.65	224.8
F3	75/72	150/72	680	Textured	120	24	11	7	0.60	238.3
F4	75/72	75/96	680	480	120	24	10	3	0.55	185.6

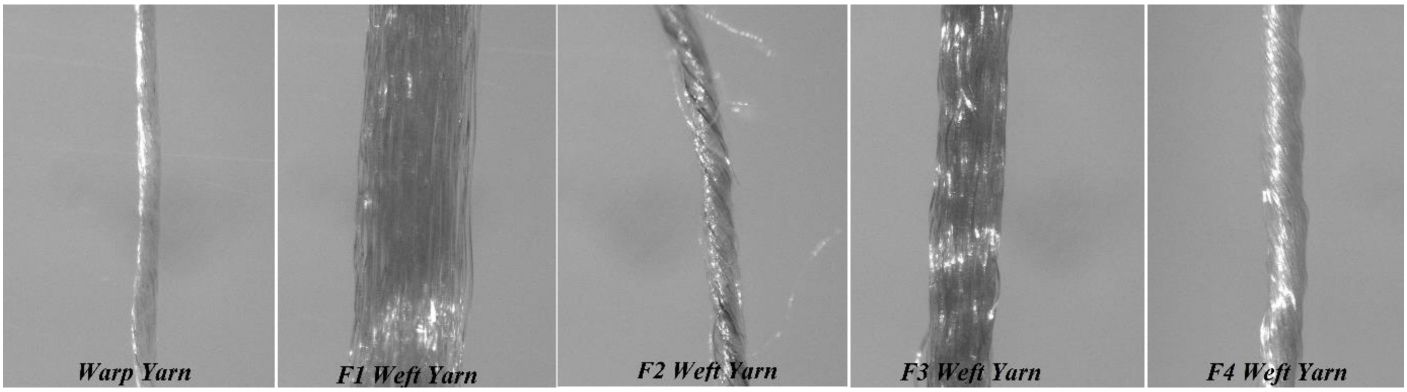

Figure 1. Microscopic images of warp and weft yarns (20 times magnified)

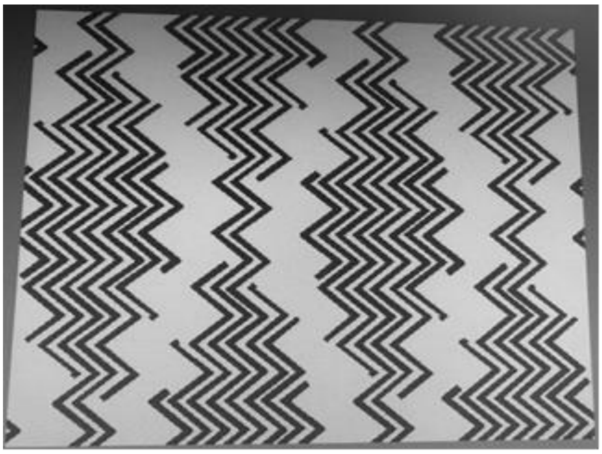

Figure 2. Digital image of the weave pattern

2.2. Method

2.2.1. Abrasion Test

The abrasion tests of fabrics were carried out under the load of 12 kPa, in Nu-Martindale abrasion test device, by the standard of ASTM D 4966 (ASTM D 4966-12:2012), and three different abrasion cycles (10000, 20000, and 40000) were applied. This study was aimed at the assessment of appearance change that needs to be carried out. For this reason, larger fabric sample pieces (140 mm in diameter) were required. The roles were reversed and the abradant was placed in the holder with the specimen as the base platform. Therefore, higher abrasion cycles were chosen as a larger fabric surface area would be abraded.

2.2.2. Microscopic Analysis

Microscopic images of original (non-abraded) and abraded samples, taken under by a microscope (Mshot Digital Microscope Camera MS60) coupled to a digital camera, were presented with 10, 20, and 30 times magnification.

2.2.3. Surface Roughness Measurement

In order to evaluate the effect of the abrasion on the fabric surface texture, it was aimed to measure the changes in the average surface roughness values of fabric surfaces before and after abrasion. It was envisaged to examine the deformation on the surface caused by a mechanical effect such as abrasion and the related changes on the surface texture by evaluating the average surface roughness value of the fabrics.

In this study, for the characterization of the changes in the fabric surface roughness properties, the arithmetic average height (*Ra*) value was evaluated. *Ra* is defined as the average absolute deviation of the roughness irregularities from the mean line over one sampling length [18].

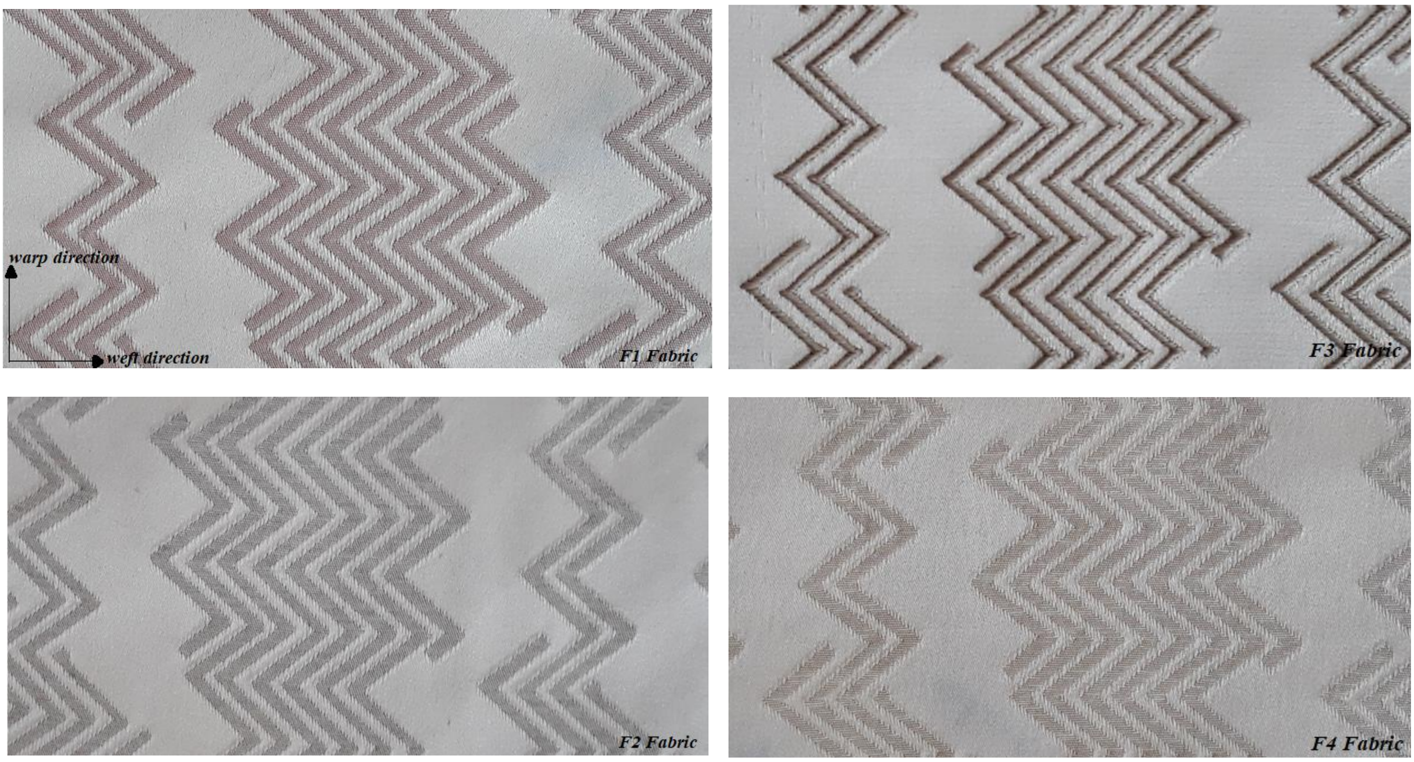

Figure 3. Digital image of woven fabrics

Arithmetic average height values of samples were measured by a roughness tester (Accretech Surfcom 130A), and roughness values were recorded according to ISO 4287-1997 (ISO 4287-1997, 2005). The measurement was performed on a steady-state without causing any tension in the sample. Because of the consideration of different pattern locations on the fabric surface, the surface roughness was measured in both the warp and weft directions. Ten roughness measurements were made in each direction (warp and weft) with the selected measurement parameters of 50 mm evaluation length (0.8 mm cut-off value) and 1.5 mm/s measurement speed.

3. RESULTS AND DISCUSSION

3.1. Evaluation of the Effect of Abrasion on Fabric Surface Roughness Values

In order to objectively evaluate the deformation caused by the abrasion process on the fabric surfaces, the changes in the surface roughness values of the fabrics before and after abrasion were examined (Figure 4). First of all, it should be noted that the roughness test device could not measure on the F3 fabric surface. Since the surface contacting stylus of the roughness tester was attached to the embossed areas in the pattern regions of the F3 fabric, the measurement of the F3 fabric surface could not be obtained. This was because the weft yarn forming the F3 fabric had the feature of shrinkage yarn; the stylus probe of the roughness measurement device caused it to be caught on the raised protrusions formed by the yarn patterns on the fabric surface.

In Figure 4, the changes in the warp and weft direction surface roughness values of the fabrics were presented. It was observed that there was no significant change in the warp direction surface roughness values of the fabrics after abrasion; only a slight decrease was observed. It was seen that there was a considerable change in the weft direction surface roughness values. In Figure 4, the % reduction rates in the roughness values of the fabrics after each abrasion cycle compared to the non-abraded fabric were given. It was observed that the weft direction surface roughness values decreased at a high rate as the abrasion cycle number increased. It was thought that the decrease in the surface roughness values of fabrics after abrasion was caused by the flattening of the protrusions on the surface caused by the abrasion effect of the fabric surface texture. While it was observed that the reduction rates in the warp direction roughness values were between ≈ 2 - 5%, it was observed that the weft direction roughness values decreased by approximately 10 - 45%. This was considered to be stem from the greater change in the texture of the fabric surface after abrasion of fabrics with initially high surface roughness. The weft direction initial surface roughness values of the examined fabrics were significantly higher than the warp direction roughness values. Abrasion eliminated the effect of texture, especially at the fabric samples with initially high surface roughness. The surface roughness of fabrics with initially high surface roughness decreased to a greater extent than the ones with low surface roughness after abrasion.

When the warp and weft direction roughness values of fabrics (Fig. 4) were examined, it was observed that the weft direction roughness values were higher than the warp direction roughness values. This result stemmed from the fabric structural parameters. When the structural properties of the fabric were examined in Table 1, it was seen that the crimp value of warp yarns was significantly higher than the crimp value of weft yarns. During the roughness measurement in the weft direction, the stylus probe of the roughness measurement device moves in a direction perpendicular to the warp yarns. Therefore, the high crimp values of the warp yarns constitute high peak values during the weft direction measurement.

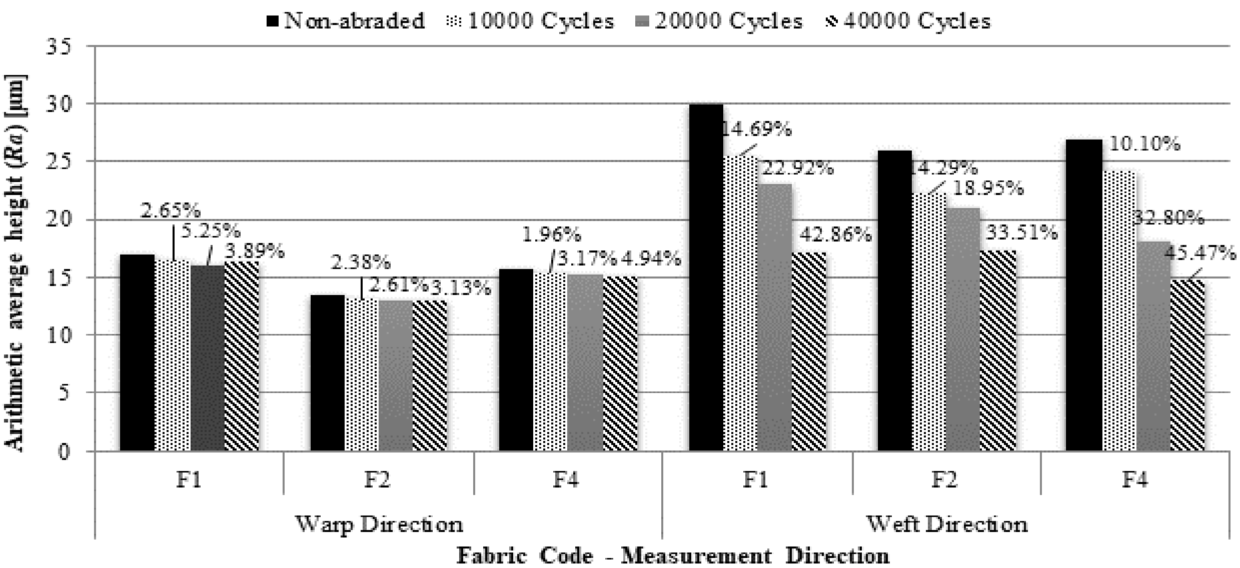

Figure 4. Arithmetic average height (Ra) values of fabrics

When the non-abraded surface roughness values of the fabrics were examined, it was seen that the roughness value of the F1 fabric was higher than F2, although the warp yarn crimp values of the F1 and F2 fabric were the same. It was considered that this was due to the textured weft yarns of the F1 fabric. The texture yarn structure, which has a bulky structure compared to the twisted yarn structure, was thought to cause a higher surface roughness value on the fabric surface.

In experimental study, the warp yarn thicknesses made up the fabrics were the same, and different thicknesses were used as weft yarns. It was observed that the changes in weft yarn thicknesses affect the amount of yarn crimp taken by the intersecting warp and weft yarns. As a result, it was found that the difference between warp and weft yarn crimps affected the surface wear behavior of fabrics.

The effect of different yarn thicknesses used in weft yarns was evaluated in terms of the changes in *Ra* values of the fabrics. In Fig.4, when the changes in *Ra* values of fabrics, especially in the weft direction, were examined, it was observed that the changes in the *Ra* values of F1 and F2 fabrics (14.69% and 14.29%, respectively) were higher than the changes in the *Ra* value of F4 fabric (10.10%) at 10000 abrasion cycles. This was considered to be because the yarn crimp difference between warp and weft yarns. In Table 1, it was observed that the yarn crimp differences between warp and weft yarns of F1 and F2 fabrics were higher than in F4 fabric. This was due to the high crimp that the warp yarns received as a result of the intersecting with the weft yarns with high thicknesses (300 denier) in F1 and F2 fabrics. It was seen that the crimp values of the warp yarns have the highest values in F1 and F2 fabrics where thick weft yarns were used. It was considered that this situation caused the warp yarns to increase the yarn crimps' peak heights on the fabric surface and caused them to be more affected by the abrasion effect. When the yarns that make up the F4 fabric and their crimp values were examined (Table 1), it was observed that the warp and weft yarns of the F4 fabric had the same thickness. Also, it was seen that the yarn crimp differences between warp and weft yarns was lower than the F1 and F2 fabrics.

As a result of the higher the yarn crimp differences between warp and weft yarns in F1 and F2 fabrics, it was observed that the higher surface deformation of these fabrics in the initial abrasion cycles. However, when the changes in *Ra* values at 20000 and 40000 abrasion cycles were examined, it was seen that the changes in *Ra* values of F4 fabric (32.80% and 45.47%, respectively) consisting of thinner weft yarns (75 denier) was higher than the F1 (22.92% and 42.86%, respectively) and F2 (18.95% and 33.51%, respectively) fabrics.

As a result of the evaluation of the effects of the changes in the weft yarn thicknesses used in the fabrics, it was observed that the difference between the warp and weft yarn crimp values was effective on the fabric surface deformation, especially in the initial abrasion cycles. The higher the yarn crimp differences between warp and weft yarns in fabrics, it was observed that the higher surface deformation of these fabrics in the initial abrasion cycles. However, in the increasing abrasion cycles, it was obtained that the high fabric surface deformation in terms of the magnitude of the change in *Ra* values, although the difference between warp and weft yarn crimp values was lower in the fabric structure with thinner weft yarns.

3.2. Evaluation of Abrasion Behavior of F1 Fabric

While the pattern effect was created in the examined fabrics, it was observed that there were three different areas on the fabric surface (Figure 5). 1st areas where the warp yarns have long floats, 2nd areas where the warp and weft yarns have intersections, and 3rd areas consist of transition regions between two patterns. For this reason, in jacquard fabrics, it was observed that the pattern areas and the transition areas between the pattern areas might be affected differently from the abrasion process depending on the yarn properties and the pattern arrangements in the fabric surfaces.

The surface images of the F1 fabric before (non-abraded) and after 10000, 20000, and 40000 abrasion cycles were presented in Figure 5. When the F1 fabric's surface appearances were examined, it was observed that the most damaged yarns on the surface were the warp yarns. In the F1 fabric structure, it was observed that the warp yarns of the fabric were finer than the weft yarns and the warp yarn densities were considerably higher than the weft yarn densities and also, the warp yarns making long floats in the fabric surface. As a result of all of these factors, it was observed that the warp yarns were more influenced by the abrasion process.

When the effect of the number of abrasion cycles was examined, the F1 fabric surface carried considerable deformation at 40000 abrasion cycles. Particularly at the 40000 abrasion cycles, it was observed that the warp yarns were most affected by abrasion in the 2nd areas where the warp and weft yarns have intersections. This result could be considered to be two reasons. The first reason was that the warp yarns (75 denier) were finer than the weft yarns (300 denier). The second reason was that the warp yarns have high crimp than the weft yarns (Table 1), and therefore the warp yarn crowns were more affected by the abrasion process.

3.3. Evaluation of Abrasion Behavior of F2 Fabric

The surface images of the F2 fabrics before (non-abraded) and after 10000, 20000, and 40000 abrasion cycles were presented in Figure 6.

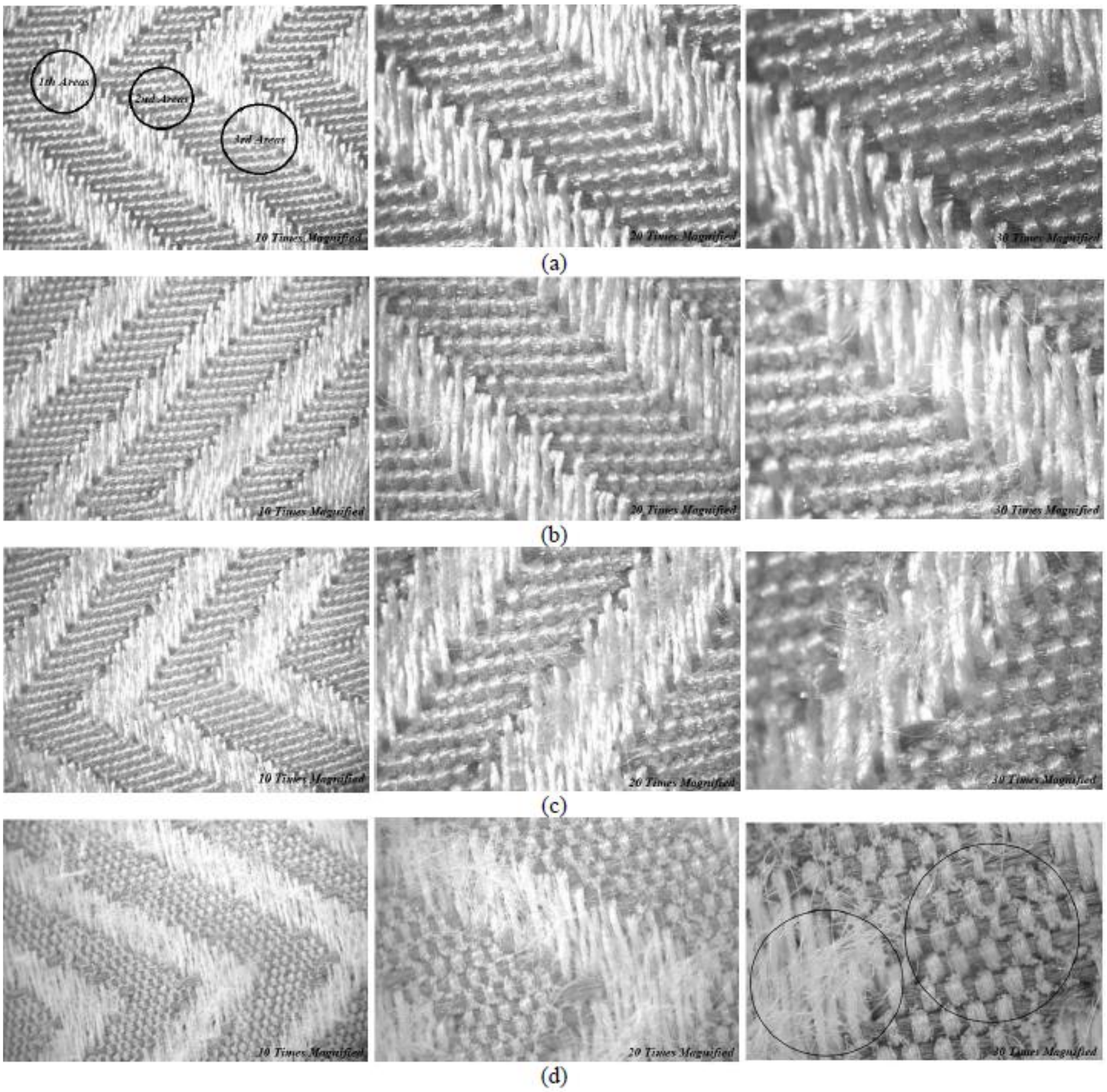

Figure 5. Microscopic images of F1 fabric
a) non-abraded b) 10000 abrasion cycles c) 20000 abrasion cycles d) 40000 abrasion cycles

When the surface appearance of the F2 fabric woven with the linen-like effected polyester weft yarn was examined, it was observed that the abrasion behaviors in the 1st areas where the warp yarns were dominant were similar to the F1 fabric due to similar reasons explained for the F1 fabric. However, in the 2nd areas, it was observed that there were significant amounts of fiber ends on the surface after abrasion cycles due to the effect of the staple fiber weft yarn. When the abrasion cycle was increased, it was observed that the ends of the fibers pulling out of the linen-like staple fiber weft yarn and the ends of the broken fibers from the continuous filament warp yarns remain on the fabric surface. This result was because the F2 fabric woven with the staple fiber weft yarn was more affected by the abrasion process and further deteriorated the surface appearance of the fiber ends on the surface.

3.4. Evaluation of Abrasion Behavior of F3 Fabric

The surface images of the F3 fabrics before (non-abraded) and after 10000, 20000, and 40000 abrasion cycles were presented in Figure 7. When the patterns of the F3 fabric were examined, 1st areas were composed of long floating regions of warp yarns as in F1 and F2 fabrics, and 2nd areas were composed of long floating regions of weft yarns. Furthermore, when the property of the weft yarn used in this fabric was examined (Table 1), it was seen that the high shrinkage yarn was used. Yarns with different shrinkage levels shrink after the heat treatment process. This shrinkage effect gave a three-dimension appearance on the fabric surface.

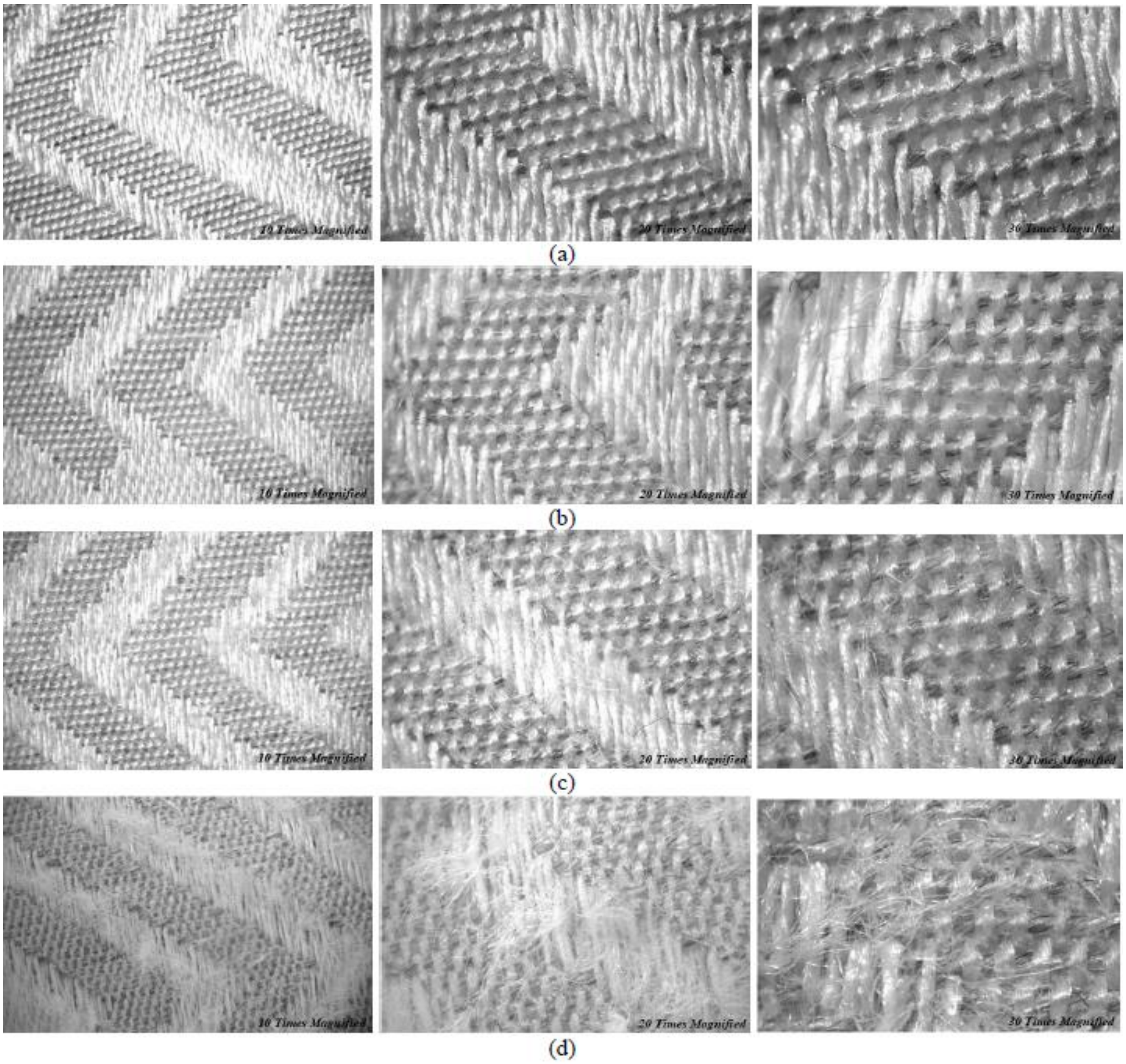

Figure 6. Microscopic images of F2 fabric
a) the non-abraded b) 10000 abrasion cycles c) 20000 abrasion cycles d) 40000 abrasion cycles

Because of the weft yarns' shrinkage properties, after the thermal finishing process of the fabric, the pattern areas formed by these yarns gave an embossed effect to the fabric surface. As a result, it was observed that the weft yarn floating areas, which provided an embossing pattern effect on the fabric surface, were more affected by the abrasion process. Unlike the F1 and F2 fabrics, while the embossed pattern effects on the surface of this fabric structure were affected by the abrasion process, the areas where the warp yarns formed the ground pattern were composed of long warp yarn floats, were not affected by the abrasion process. In F3 fabric, when the surface appearance was examined after 20000 and 40000 abrasion cycles (Figure 7), it was observed that weft yarns were the most damaged yarns on the fabric surface after the abrasion process. In F3 fabric, it was seen that since there was a shrinkage weft yarn effect, it created embossed effects on the fabric surface. Therefore, weft yarns undergo more deformation on the fabric surface as a result of the abrasion process.

3.5. Evaluation of Abrasion Behavior of F4 Fabric

The surface images of the F4 fabrics before (non-abraded) and after 10000, 20000, and 40000 abrasion cycles were presented in Figure 8. When the effect of the abrasion on the F4 fabric was examined, it was observed that it has a relatively good abrasion resistance at 10000 abrasion cycles. At 20000 abrasion cycles, wear was observed in areas where the long yarn floats dominated the fabric. When the surface images of 40000 abrasion cycles were examined, it could be seen that the warp yarns have a high degree of wear in the 1st pattern areas. In the 2nd areas, where the yarns had one-to-one intersect, it was observed that the yarn filament breaks at the yarn crimp peaks, and as a result of which broken-fiber ends were observed.

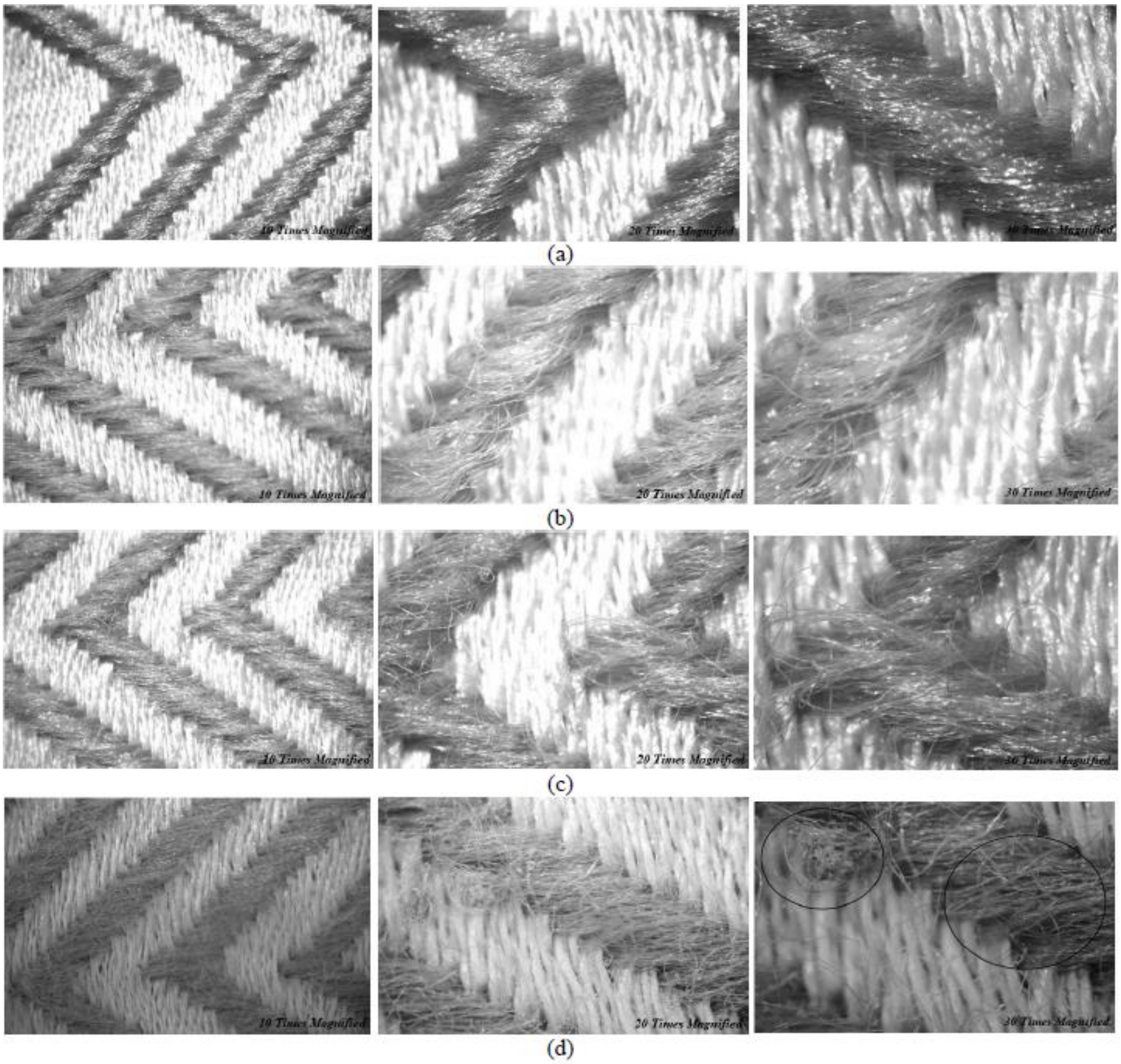

Figure 7. Microscopic images of F3 fabric
a) the non-abraded b) 10000 abrasion cycles c) 20000 abrasion cycles d) 40000 abrasion cycles

Although the weft yarns forming the F4 fabric were finer than the other weft yarns, it was observed that the abrasion behavior on the surface of the F4 fabric was relatively less than the other fabrics in especially initial abrasion cycles (at 10000 cycles). Since the weft yarns constituting the F4 fabric were finer than the weft yarns forming the fabric F1 and F2, the crimp value of the warp yarns of the F4 fabric was lower than that of the fabrics F1 and F2. This result was thought to be because the yarn linear density of warp and weft forming the F4 fabric were the same, resulting in a more homogeneous surface profile in yarn crimp peak heights on the fabric surface. These areas might be less affected by the abrasion process in especially initial abrasion cycle since the warp threads would have lower crimp heights in the second pattern area on the fabric surface. Because of the yarn linear density of warp and weft forming the F4 fabric were the same, resulting in a more homogeneous surface profile in yarn crimp peak heights on the fabric surface. To make the fabric surface relatively more homogeneous in transitions between different pattern areas, the same fineness of the warp and weft yarns would ensure that the fabrics were relatively more homogeneously affected by the abrasion effect in especially initial abrasion cycles. However, in the increasing abrasion cycles, it was observed that the fabric surface deformation increased in the fabric structure with thinner weft yarns.

When the surface appearances of F1, F2 and F4 fabrics were examined (Figures 5, 6 and 8), it was seen that the crimp crowns of the warp yarns were more prominent on the fabric surface in the areas where the yarns intersect in the fabric pattern (2nd area). When Table 1 was examined, it was observed that the crimp values of the warp yarns that made up these fabrics were significantly higher than the weft yarns. In particular, it was seen that the crimp values of the yarns in the regions where the warp and weft yarns intersect, and accordingly, the crimp peak heights of the yarns on the surface affect the surface wear.

4. CONCLUSION

In this study, the changes occurring after the abrasion process in the pattern regions of the jacquard woven fabrics and transitions between the different pattern regions were investigated. The effects of the various yarn properties forming the pattern effects of fabrics on the abrasion resistance were evaluated comparatively with the changes in the fabric surface roughness values and the fabrics' microscopic analysis.

The experimental results showed that the amount of crimp received by the yarns in the fabric structure was an important parameter on the abrasion behavior of the fabrics. In areas where the long yarn floating on the fabric surface, a large deformation occurred in the yarn surfaces that floating due to abrasion. In areas where the yarns intersecting on the fabric surface, a large deformation occurred in the yarn crowns with high crimp due to abrasion. It was seen that the high differences between warp and weft yarn thicknesses used in the fabric structure significantly affect the amount of yarn crimps and as a result that yarns with high crimp values were more affected by the abrasion effect on the fabric surface. In particular, it was found that yarn linear density values of warp and weft yarn systems were close to each other, showing relatively better abrasion resistance at initial abrasion cycles. It was observed that the high differences in the yarn linear densities between warp and weft yarn and hence the high differences between warp and weft yarn crimp values of fabrics caused more surface deformation.

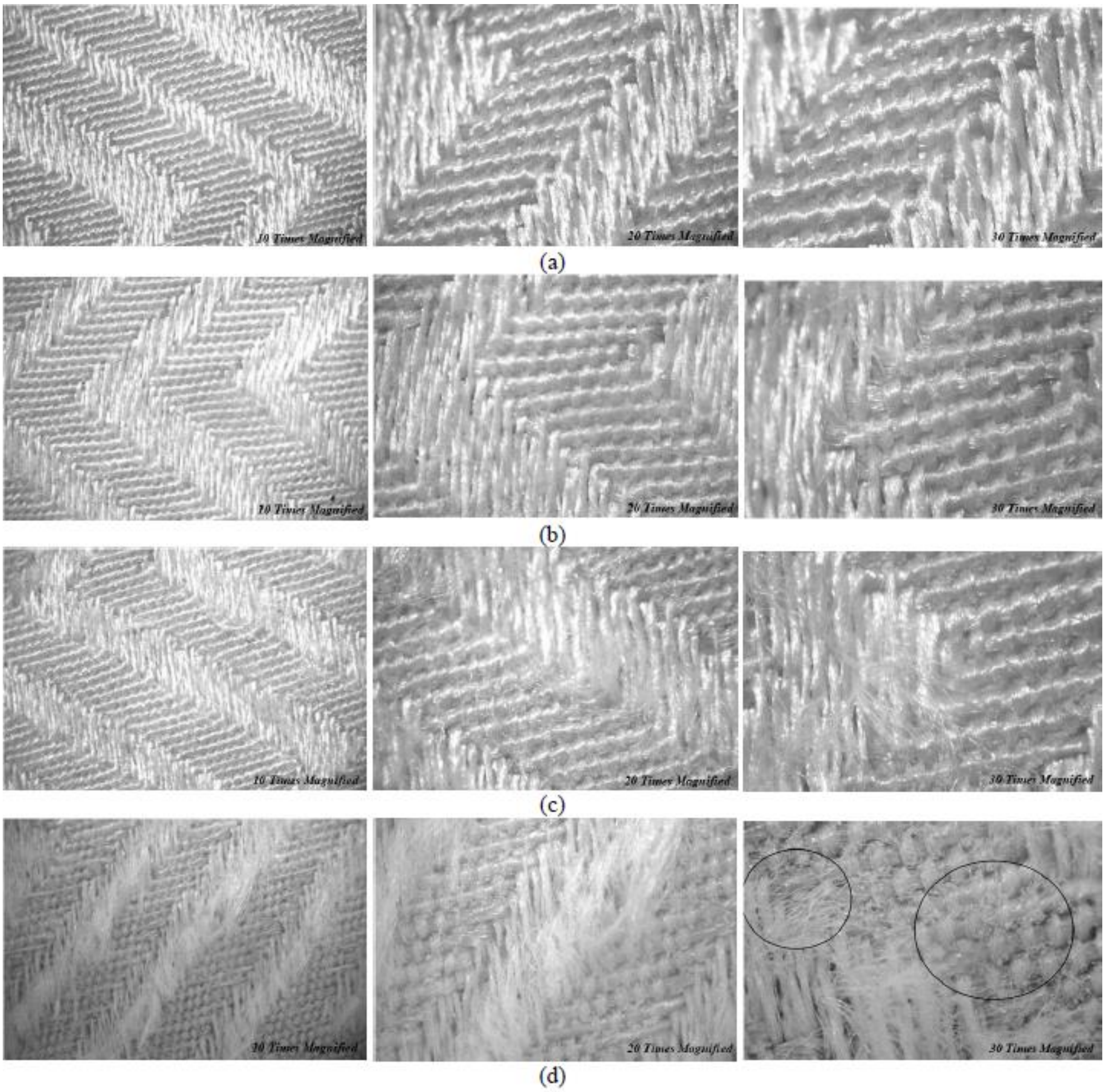

Figure 8. Microscopic images of F4 fabric
a) the non-abraded b) 10000 abrasion cycles c) 20000 abrasion cycles d) 40000 abrasion cycles

In this study, besides evaluating the effects of the abrasion process on the fabric appearance, the changes in the roughness values of the fabric surfaces were also evaluated. In evaluating the fabrics' surface deformations after the abrasion, it was observed that the change in roughness values of the fabric surface gave considerable results. The experimental results showed that the weft direction fabric surface roughness values significantly decreased due to abrasion. It was observed that there was no significant change in the warp direction roughness values depending on the abrasion compared to the weft direction. This was considered to be stem from the greater change in the texture of the fabric surface after abrasion of fabrics with initially high surface roughness. The weft direction initial surface roughness values of the examined fabrics were significantly higher than the warp direction roughness values. Abrasion eliminated the effect of texture, especially at the fabric samples with initially high surface roughness. The surface roughness of fabrics with initially high surface roughness decreased to a greater extent than the ones with low surface roughness after abrasion. It was considered that the decrease in the surface roughness values of fabrics after abrasion was due to the flattening of the raised texture of fabric pattern in the surface.

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