

Araştırma Makalesi / Research Article

COMPARISON ON COMPRESSIBILITY BEHAVIORS OF SISAL LOOK, LOOP AND CUT PILE CARPETS

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ABSTRACT: This study aims to reveal compression characteristics of carpet samples with cut pile, loop pile and sisal look construction, such as resilience, thickness loss, etc. With this purpose, carpet samples were subjected to compression/recovery and dynamic loading tests and the obtained data were analyzed statistically. Experimental results exhibited that cut pile carpet had the lowest resilience property, whereas sisal look carpet performed the best. Additionally, the highest thickness loss was observed on cut pile carpet, while the lowest was seen on sisal look carpet. Moreover, statistical analyses showed that all experimental results obtained are statistically significant.

Keywords: Cut pile, loop pile, sisal look, compressibility, thickness loss.

SİSAL GÖRÜNÜMLÜ, BUKLE VE KESİK HAVLI HALILARIN SIKIŞTIRILABİLİRLİK DAVRANIŞLARININ KARŞILAŞTIRILMASI

ÖZ: Bu çalışma, kesik havlı, bukle havlı ve sisal görünümlü yapıya sahip halı numunelerinin rezilyans, kalınlık kaybı vb. gibi sıkıştırılabilirlik karakteristiklerini ortaya koymayı amaçlamaktadır. Bu doğrultuda, halı numuneleri sıkıştırma/geri dönme ve dinamik yükleme testlerine tabi tutulmuş ve elde edilen veriler istatistiksel olarak analiz edilmiştir. Deneysel sonuçlar, kesik havlı halının en düşük rezilyans özelliğine sahip olduğunu, sisal görünümlü halının ise en iyi performansı gösterdiğini ortaya koymuştur. Bunun yanı sıra en yüksek kalınlık kaybı kesik havlı halıda, en düşük ise sisal görünümlü halıda gözlenmiştir. Ayrıca, istatistiksel analizler, elde edilen tüm deneysel sonuçların istatistiksel olarak anlamlı olduğunu göstermiştir.

Anahtar Kelimeler: Kesik hav, bukle hav, sisal görünümlü, sıkıştırılabilirlik, kalınlık kaybı.

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1. INTRODUCTION

Carpet is a floor covering textile that can be used in both indoor and outdoor applications for living areas. However, indoor and outdoor carpets are expected to be different properties, since the effects of being exposed to carpets differ from each other. For indoor usage, softer and more comfortable carpets are preferred; on the other hand, durability is a more important parameter due to heavy traffic, for outdoor applications. Pile yarn is the major component of a carpet and constitutes its visible surface. For this reason, the usage performance and functionality of a carpet mainly depend on pile characteristics such as pile height, pile density, pile type, etc. Carpet pile types can be classified as cut pile and loop pile for conventional production methods, besides, in recent years sisal look pile type has also gained prominence. Each variation of pile types offers distinct characteristics and benefits. Cut pile carpets are composed of individual tufts that provide a soft and plush surface; however, they are suitable for low traffic spaces. On the other side, loop pile carpets, which have a surface that's texture is firmer, withstand matting in high traffic areas and maintain their appearance [1,2]. Also, sisal look carpets have popularity since they allow following the increasing tendency towards nature and carpets with a natural look, durability and long-life usage.

Cut pile carpet is made by cutting or shearing the tip of pile yarn that exposes the ends of the fiber. For this reason, there are two points of yarn for each pile in cut pile carpet construction. In contrast, loop pile carpet has yarns that are looped and uncut on the carpet surface. In other words, loop pile carpet comprises piles by looping the yarns backing into the ground structure, in this way, a rounded surface is obtained. In today's technology, cut pile carpets are generally produced on face to face looms using both double rapier and triple rapier systems, while loop pile carpets can be manufactured on both single face and face to face looms with either double or triple rapier systems. The schematic illustrations of cut pile and loop pile carpet structures are shown in Figure 1.

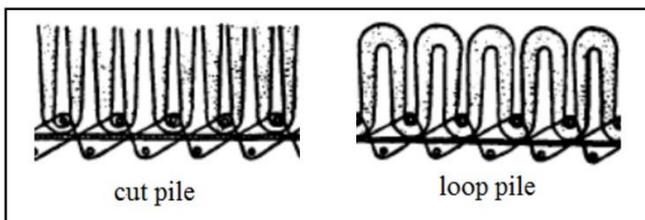


Figure 1. Structure of cut and loop pile types [3]

Sisal look carpets, which have a structured pile surface, preferably woven with thick pile yarns. Sisal look carpets can be woven both on double rapier single face and on triple rapier face to face carpet weaving looms [4-6]. The pile surface can be formed over a thick filling, or alternatively, the pile yarns form long floats directly over the normal ground wefts. In double rapier systems, the

rapiers insert the ground wefts and then the thick pile yarn floats over these wefts to form the pile surface. In triple rapier system, top and bottom carpets are not connected and so cutting motion is not required. Three rapiers insert three different weft yarns simultaneously; top rapiers insert a filling for the backing of the top carpet, the bottom rapiers one for the backing of the bottom carpet and the middle rapiers insert a thick filling that is alternately woven in the top and bottom carpet. The pile yarns float over these thick wefts and provide a textured effect on the carpet surface. Through this technique, sisal look weave structure is achieved [2,7]. Figure 2 shows different types of pile formations of sisal look carpet structure.

In literature, there are several studies conducted to determine the mechanical behaviors of carpets such as compressibility, thickness loss, matting, flattening, resilience, etc. Korkmaz and Kocer studied the thickness loss recovery of cut pile acrylic carpet samples with varied pile height and pile density, under short and long term static loadings [9]. In their other study, thickness loss under dynamic loading and appearance retention of cut pile polypropylene carpets with different pile height and density were analyzed [10]. Sheikhi et al. have examined the compression behaviors of cut pile acrylic carpets that consist of pile yarns with different fiber blend ratios [11]. Çelik has investigated the effect of fiber linear density on the compressibility performances of cut pile acrylic carpets under compression/recovery, dynamic and static loading [12]. Fidan et al. evaluated the resilience and appearance retention performance of cut pile polyester carpets produced with different filament fineness under compression/recovery and dynamic loading [13]. Fidan has also evaluated the comparison of resilience and thickness loss properties of cut pile polyester and polypropylene carpets after compression/recovery and dynamic loading [14]. Erdoğan showed the influence of fiber cross-section on compression properties of cut pile polypropylene carpets under short and long term static loading [15]. Sarioğlu et al. investigated the compressibility and thickness loss of cut pile acrylic carpets with different pile height and pile density by applying compression/recovery, static and dynamic loading tests [16]. Koç et al. studied the thickness loss of cut pile wool, acrylic and polypropylene carpets under long term static loading [17]. In another study conducted by Çelik and Koç, wool, acrylic and polypropylene cut pile carpets were analyzed in terms of thickness loss under dynamic loading [18]. Yaz et al. have also investigated the compressibility performance and thickness loss of polypropylene tufted carpets composed of polyblend pile yarns after compression/recovery, dynamic and static loading tests [19]. Moghassem and Gharehaghaji examined compression and matting characteristics of handmade wool carpets [20]. Choubisa et al. have also analyzed the influence of different pile height and tuft density on compression behaviors of wool and acrylic hand tufted carpets under static and dynamic loading [21]. Daulta and Varshney examined the compressibility properties of hand tufted wool/nylon blended cut pile carpets with different pile density and pile height in their research [22]. Laughlin and Cusick evaluated the compression behaviors of

wool, acrylic, nylon and polypropylene cut pile and loop pile tufted carpets composed of varied pile density and pile height, under cyclic loading [23]. Kaynak and Çelik have investigated the performances of cut pile and loop pile carpet samples produced with splittable microfilament pile yarns after compression/recovery, static and dynamic loading tests [24]. Önder and Berkalp have studied physical properties of wool, acrylic and polypropylene cut pile carpets varying in pile height and pile density [25].

There are numerous carpet production methods and techniques available in today's technology, such as Wilton, Axminster, tufting, etc. Wilton-type weaving machines are widely preferred in the machine-made carpet industry, as they offer a wide variety of surface weaving possibilities. In Wilton technology, besides single-face and face-to-face weaving systems, several weft insertion mechanisms are used, including single, double, and triple rapier systems. With these various techniques, it is possible to produce cut pile, loop pile and sisal look carpet surfaces. According to literature survey, it was determined that most of the studies focused on the resilience, compressibility and thickness loss properties of cut pile carpets and also, there are just a few studies that have examined loop pile carpets. To the best of our knowledge, research about sisal look carpet structure has not been in literature, due to the fact that carpets woven from sisal fiber have been used for many years; however, sisal look carpet structures made from other textile fibers have recently become

trendy machine-made carpet industry. The main objective of this research is to comparatively analyze the mechanical behaviors of carpets with sisal look, loop pile and cut pile structures. Since pile construction directly influences the mechanical performance of carpets, this study focuses on evaluating their thickness loss under dynamic loading and their compression/recovery characteristics. The most significant difference of this study from the previous ones is that it compares and evaluates the alterations of compressibility behaviors of sisal look, loop pile and cut pile carpets, since the carpet compressibility concept is the most essential feature that demonstrates wear characteristics.

2. MATERIAL AND METHODS

2.1 Material

In this study, three carpet samples were produced in sisal look, loop and cut pile constructions by using polyester pile yarns. In order to obtain a texture similar to conventional carpet surface with sisal look carpet construction, pile yarn with a coarser linear density was used. Cut pile and loop pile carpet samples were woven on a triple rapier face to face carpet weaving machine, and sisal look carpet sample was manufactured on two rapiers single face carpet weaving loom. All sample specifications were kept constant as given in Table 1. After the weaving process, the back of carpet specimens was coated with latex.

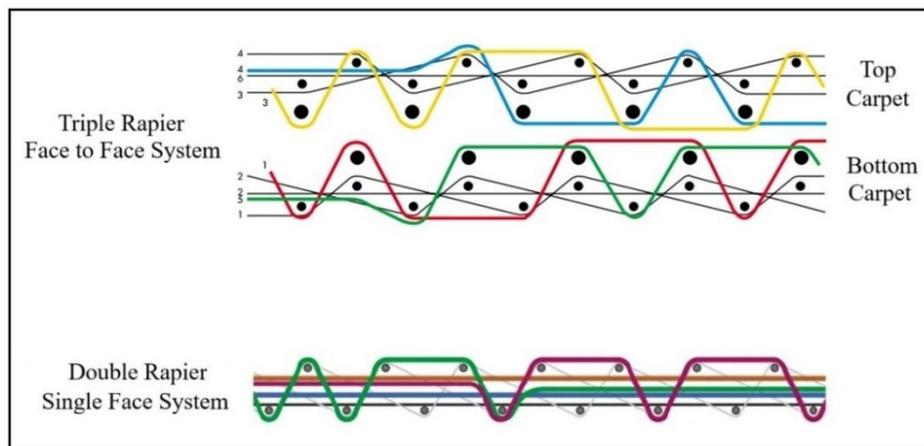


Figure 2. Sisal-look weave structure produced with triple rapier on face to face system (above), double rapier single face system (down)[7,8]

Table 1. Production parameters of carpet samples

	Ground weave	Weft sett (picks/10cm)	Warp sett (ends/10cm)	Weft yarn (Nm)	Warp yarn linear density (denier)	Pile yarn linear density (denier)	Carpet thickness (mm)	Pile height (mm)
Sisal look								
Loop pile	1/2 V	40	16	1.40/2 Jute	600 PES	13500 PES	7	5
Cut pile								

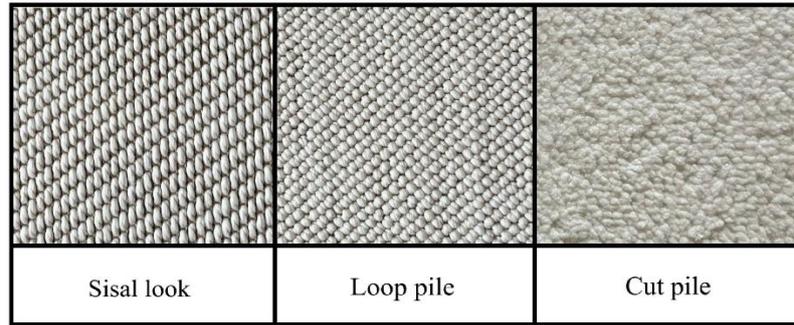


Figure 3. Images of carpet samples

2.2 Method

In order to compare the effect of different carpet constructions on the mechanical performances of carpet pile yarns, compression/recovery and dynamic loading tests were carried out to the samples. All carpet specimens were conditioned with 65 ± 4 % relative humidity and 20 ± 2 °C temperature according to ISO 139:2005 before the tests were conducted.

Compression and recovery test was performed with SDL Atlas Digital Thickness Gauge test device, according to standard of BS 4098 with the aim of determining the compressibility performances of carpet samples by applying the loadings from 2 to 200 kPa gradually and then removing the loadings gradually from 200 to 2 kPa at 30 s intervals [26]. Result assessments were carried out depending on the average value of 5 experimental data for each specimen. The percentage compression recovery of samples after loading-unloading was determined with Equation (1), where, t_2 is the thickness under 2 kPa pressure at the beginning of the loading process (Figure 4, point A), t_r is the thickness at 2 kPa pressure after unloading all weights (Figure 4, point C) and t_{200} is the thickness at 200 kPa pressure (Figure 4, point B).

$$\text{Percentage Compression Recovery (\%)} = \frac{t_r - t_{200}}{t_2 - t_{200}} \times 100 \quad [1]$$

Compression work, which defined in J/m^2 , was measured by calculating the area under the loading curve (Figure 4, area ADB), by using following Equation (2), where; t_2 is the thickness at 2 kPa (mm), t_5 is the thickness at 5 kPa (mm), etc.

$$1.5t_2 + 4t_5 + 7.5t_{10} + 20t_{20} + 40t_{50} + 50t_{100} + 50t_{150} - 173t_{200} \quad [2]$$

Recovery work is also defined in J/m^2 and measured by the area under the unloading curve (Figure 4). The area (BEC) was determined by using following Equation (3), where; t_r is the thickness at 2 kPa (mm), t_5 is the thickness at 5 kPa (mm), etc.

$$1.5t_r + 4t_5 + 7.5t_{10} + 20t_{20} + 40t_{50} + 50t_{100} + 50t_{150} - 173t_{200} \quad [3]$$

The percentage work recovery was calculated by the ratio of recovery work to the compression work as shown in Equation (4).

$$\text{Percentage Work Recovery (\%)} = \frac{\text{Area}_{BEC}}{\text{Area}_{ADB}} \times 100 \quad [4]$$

Dynamic loading test was performed on WIRA dynamic loading test device, with the purpose of determining thickness loss of pile yarns under dynamic forces. Thickness loss measurements in the dynamic loading test were obtained from two points on each of two samples and a total of four readings. Test procedure is based on simulating two main actions of walking that are compression and the shearing effect at the edge of the shoe. The test was carried out in accordance with the standard of TS 3375 ISO 2094, by applying the samples to 50, 100, 200 and 1000 impacts in order to obtain percentage of thickness loss by calculating with Equation (5), where, h_0 is the initial thickness and h_i is the thickness after impacts [27,28].

$$\text{Thickness Loss (\%)} = \frac{h_0 - h_i}{h_0} \times 100 \quad [5]$$

One-way ANOVA, Duncan test and correlation analysis were applied to reveal the statistical significance carpet test results. SPSS 25.0 statistical software was used to interpret experimental data. All test results were assessed at 95% confidence interval.

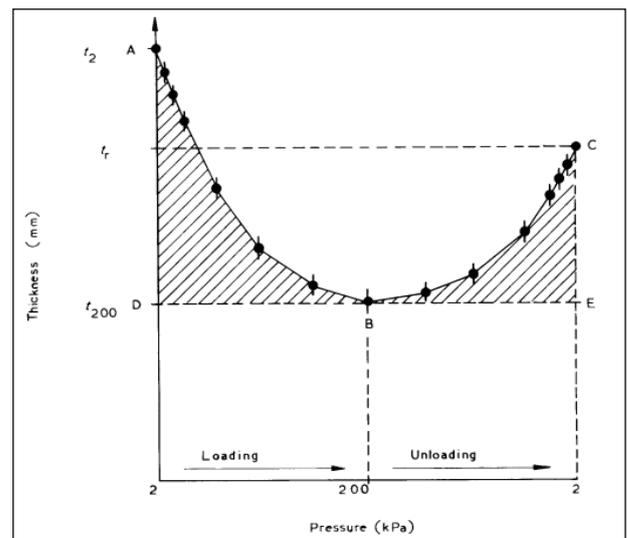


Figure 4. Typical thickness versus pressure curve [26]

3. RESULTS AND DISCUSSION

3.1 Compression and recovery test results

Compression and recovery test enables evaluation of the behavior of pile yarns under continuing loading and unloading, and due to its principle of applying the forces gradually, it differs from other carpet performance tests. Percentage compression recovery phenomenon, which can also be stated as elastic recovery or resilience, is the tendency of pile yarn to return to its initial state after loading and unloading. The term resilience is also known as the ability of a material to absorb energy during compression to elastic deformation and then release the energy upon unloading. Compression recovery results of carpet samples are exhibited in Figure 5. Data obtained from the experiments showed that sisal look carpet performed the highest compression recovery, in other words, the best resilience behavior. On the other hand, cut pile carpet exhibited the lowest compression recovery result among all carpet constructions. The obtained results are consistent with findings of Laughlin and Cusick who stated that cut pile carpets had higher matting and compressibility compared to loop pile carpets [23]. This situation can be explained by the laying out of pile yarns in carpet structure. Pile form on sisal look carpet construction comprises looping by floating on weft yarns, this situation provides pile yarn to show better resilience performance against loading forces and so lesser deformation. In other respects, loop pile carpet also had greater compression recovery than that of cut pile carpet. This is also associated with the pile formations of the carpets. Although the loop pile and cut pile structures are constituted in a similar process, loop form of pile leads the yarn to behave more compactly, compared to cut pile which has two points of yarn for each pile form. Due to the fact that cut pile structure is composed of two separate points of yarn, cut pile yarns had more movement capability and can also be compressed more than loop pile and sisal look carpets, so cut pile carpet shows the lowest bending rigidity and also resilience performance.

Compression work is described as the amount of work done for compression of pile yarns; in other words, it is a measure of compressibility of carpets. Additionally, recovery work is also defined as the amount of work done for recovery of pile yarns to

initial position and is described as a criterion of released energy after the load is removed. Figure 6 and Figure 7 demonstrate compression work and recovery work results of samples, respectively. In the light of the figures, cut pile carpet absorbed and released the highest energy during loading and unloading periods, followed are loop pile and sisal look pile constructions. As mentioned before, the cut form of pile yarn caused to have lowest bending rigidity compared to others, and this situation resulted in the yarn performing higher compression work, which induced the yarn to become more compressed. The open ended structure of the pile yarns in cut pile carpets allows them to have lower bending resistance compared to loop and sisal carpets. Thereby, this situation allows the yarn to absorb more energy by increasing compressibility of pile yarns during loading. In consideration of the recovery work results, the trend is similar to the findings of compression work; the highest recovery work belongs to cut pile carpet construction and then loop pile and sisal look pile samples followed one by one. It was an expected result since the amount of work done during loading and unloading process directly depends on the shape of pile yarn.

Percentage work recovery, which is a measure of the resistance of pile yarns against compression, is determined by the ratio of recovery work to compression work of pile yarns and the results are given in Figure 8. Depending on the outcomes, sisal look and loop pile carpets demonstrate work recovery values close to each other, and also more than that of cut pile carpet, similar to the findings of percentage of compression recovery. Due to the fact that cut pile structure comprises two identical points and open ended structure, the pile yarn shows the lowest bending resistance under compression. Although the cut pile carpet absorbed and released greater energy than those of the others, considering the ratio of the two work done amounts, it can be stated that cut pile carpet performed worse resilience and also resistance against compression. However, due to the reason of loop pile and sisal look pile structures formed by looping, behaviors of cut or looped pile yarns differ from each other during compression and recovery period. Pile yarns that have more resistance against bending and less energy on the structure, also perform higher resilience after unloading, as seen in percentage compression recovery results.

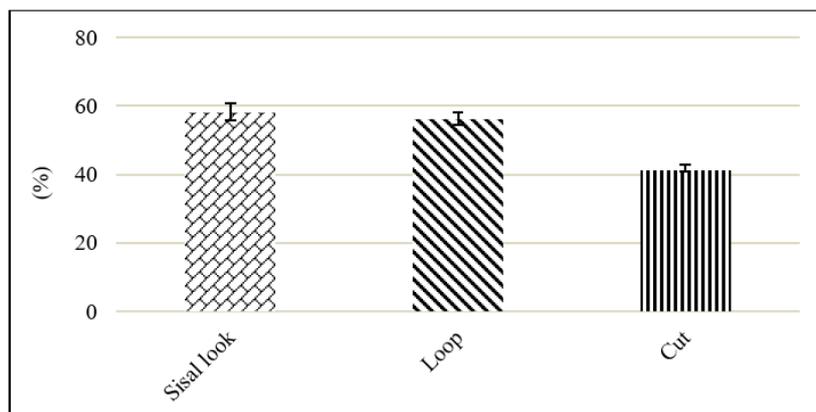


Figure 5. Percentage of compression recovery results of carpet samples

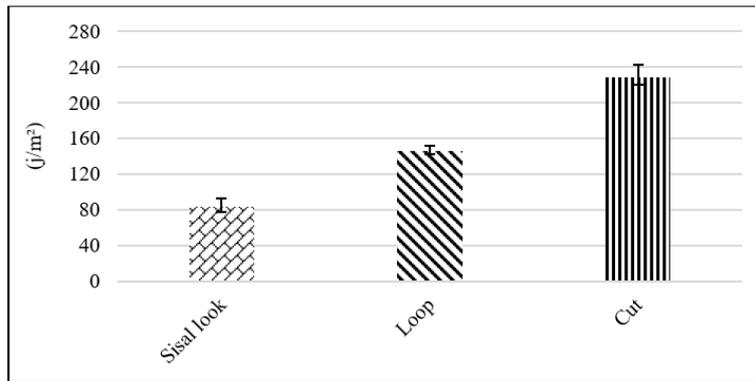


Figure 6. Compression work results of carpet samples

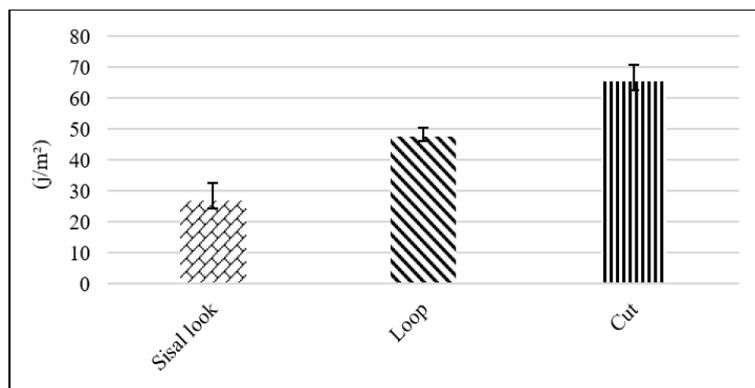


Figure 7. Recovery work results of carpet samples

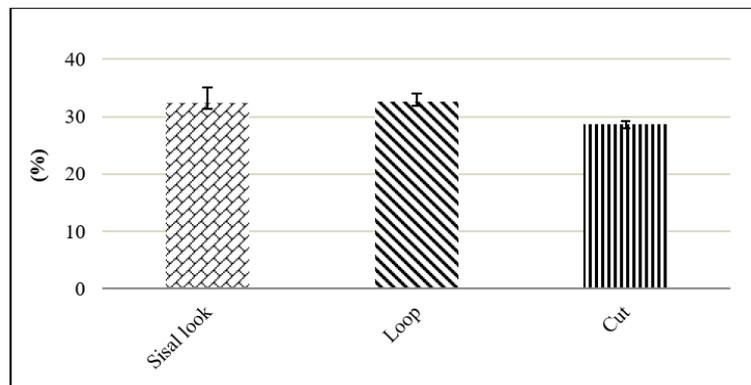


Figure 8. Percentage of work recovery results of carpet samples

One-way ANOVA results for compression and recovery test of carpet samples are summarized in Table 2. It can be clearly seen on the table that pile structure type is detected to have a statistical significance ($p=0.000<0.05$) at the 95% confidence interval for all evaluations obtained from compression recovery test, as also supported by the experimental findings.

Duncan test results for percentage compression recovery of carpet samples are given in Table 3. Depending on the table, it can be stated that there is not a significant difference between loop pile and sisal look carpet samples, while cut pile carpet sample has the lowest percentage compression recovery. The findings reveal that

cut pile sample differs significantly from the loop-structured ones, while the sisal and loop pile carpets can be evaluated in the same group.

Duncan test results for compression work of carpet samples are listed in Table 4. As seen on the table, a significant difference is observed between all carpet samples, as sisal look carpet absorbed the lowest energy, whereas cut pile carpet had the highest.

Table 5 represents the results of Duncan test for recovery work of carpet samples. Similar to compression work results, a statistical significance is obtained between all carpet samples. Sisal look

carpet released the lowest energy upon unloading period, while cut pile carpet had the highest energy.

Duncan test results for percentage work recovery of carpet samples are shown in Table 6. According to the table, a significant difference is not observed between loop pile and sisal look carpet samples, whereas cut pile carpet sample differs from them with

the lowest percentage work recovery. Although the compression work and recovery work values of the samples differ from each other, in the percentage work results that is calculated as the ratio of recovery work to compression work of pile yarns, the sisal and loop pile samples exhibited similar behavior, whereas the cut pile sample showed a lower percentage work value. This result indicates that the samples were classified into distinct groups.

Table 2. One-way ANOVA results of carpet samples for compression and recovery test

		Sum of Squares	df	Mean Square	F	Sig.
Percentage compression recovery	Between Groups	852.706	2	426.353	153.090	0.000
	Within Groups	33.420	12	2.785		
	Total	886.126	14			
Compression work	Between Groups	52697.776	2	26348.888	564.532	0.000
	Within Groups	560.086	12	46.674		
	Total	53257.862	14			
Recovery work	Between Groups	3732.716	2	1866.358	234.633	0.000
	Within Groups	95.453	12	7.954		
	Total	3828.169	14			
Percentage work recovery	Between Groups	46.391	2	23.195	20.834	0.000
	Within Groups	13.360	12	1.113		
	Total	59.751	14			

Table 3. Duncan test results for percentage compression recovery

Carpet construction	N	Subset for alpha = 0.05	
		1	2
Cut pile	5	41.3260	
Loop pile	5		56.2640
Sisal look	5		58.2000
Sig.		1.000	0.092

Table 4. Duncan test results for compression work

Carpet construction	N	Subset for alpha = 0.05		
		1	2	3
Cut pile	5	82.9330		
Loop pile	5		146.1280	
Sisal look	5			227.7300
Sig.		1.000	1.000	1.000

Table 5. Duncan test results for recovery work

Carpet construction	N	Subset for alpha = 0.05		
		1	2	3
Cut pile	5	26.8850		
Loop pile	5		47.6790	
Sisal look	5			65.4870
Sig.		1.000	1.000	1.000

Table 6. Duncan test results for percentage work recovery

Carpet construction	N	Subset for alpha = 0.05	
		1	2
Cut pile	5	28.7560	
Loop pile	5		32.3320
Sisal look	5		32.6240
Sig.		1.000	0.669

3.2. Dynamic loading test results

Dynamic loading test simulates the walking effect on carpet surface. The test was carried out to determine the thickness loss of pile yarns under 50, 100, 200 and 1000 impacts. Figure 9 demonstrates the results of thickness loss of carpet samples. Based on the experimental data, cut pile and sisal look carpet samples had the highest and lowest thickness loss results, respectively. Thickness loss phenomenon presents the deformation mechanism of pile yarns, on that account pile yarn that has less bending rigidity exhibits more compression and deformation on carpet surface. Pile yarn, which has more compressibility, performs less bending rigidity and exhibits more deformation on carpet surface or in other words, more thickness loss. As expected, the findings had a similar trend with the outcomes of compression test and were also associated with the pile yarn structure. It was observed from the results that cut pile sample had the worst performance in terms of thickness loss, whereas sisal look sample performed the best. Different from the percentage compression recovery test results, there is also a significant difference detected between sisal look and loop pile carpet samples. This is a probable result of

construction of the pile form of sisal look carpet which takes shape by floating on weft yarns that ensure the piles to behave resistively against dynamic impacts. Meanwhile, cut pile carpet sample had quite higher thickness loss than those of the others, by virtue of its lowest bending rigidity arising from open ended structure. As a consequence, higher bending rigidity provides less deformation and so lower thickness loss.

One-way ANOVA results for thickness loss of carpet samples under dynamic loading after 1000 impacts are listed in Table 7. According to the table, pile structure type is found to be statistically significant ($p=0.000<0.05$) at the 95% confidence interval. The findings are consistent with the results obtained from the experimental analyses.

Duncan test results for thickness loss of carpet samples after 1000 impacts are summarized in Table 8. According to table, it is recorded that there is a significant difference between all carpet samples. Cut pile carpet sample has higher thickness loss percentages than those of the others, in parallel with the experimental observations.

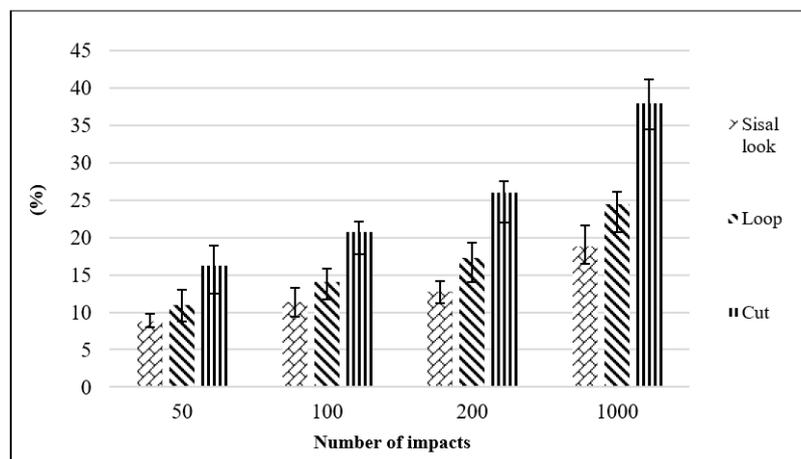


Figure 9. Thickness loss of carpet samples after 50, 100, 200, and 1000 impacts under dynamic loading

Table 7. One-way ANOVA results for thickness loss of carpet samples after 1000 impacts under dynamic loading

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	768.775	2	384.387	62.585	0.000
Within Groups	55.276	9	6.142		
Total	824.051	11			

Table 8. Duncan test results for thickness loss of carpet samples under dynamic loading

Carpet construction	N	Subset for alpha = 0.05		
		1	2	3
Sisal look	4	18.8175		
Loop pile	4		24.4725	
Cut pile	4			37.9025
Sig.		1.000	1.000	1.000

Table 9. Correlation analysis between carpet test results

		Percentage compression recovery	Compression work	Recovery work	Percentage work recovery	Thickness loss
Percentage compression recovery	Pearson Correlation	1	-0.907**	-0.849**	0.884**	-0.936**
	Sig.		0.000	0.000	0.000	0.000
Compression work	Pearson Correlation	-0.907**	1	0.990**	-0.739**	0.953**
	Sig.	0.000		0.000	0.002	0.000
Recovery work	Pearson Correlation	-0.849**	0.990**	1	-0.642**	0.929**
	Sig.	0.000	0.000		0.010	0.000
Percentage work recovery	Pearson Correlation	0.884**	-0.739**	-0.642**	1	-0.770**
	Sig.	0.000	0.002	0.010		0.001
Thickness loss	Pearson Correlation	-0.936**	0.953**	0.929**	-0.770**	1
	Sig.	0.000	0.000	0.000	0.001	

** . Correlation is significant at the 0.01 level.

Correlation analyses were carried out with the aim of revealing the interaction between the applied tests to carpet samples and the results are given in Table 9. As far as the correlation analysis results are examined, it is seen that there is a positive and significant relation between the percentage compression recovery and percentage work recovery results; as the percentage compression recovery results increase, the percentage work recovery results also increase ($r=0.884$; $p=0.000$). However, a negative and significant relation is obtained between percentage compression recovery and compression work ($r=-0.907$; $p=0.000$), recovery work ($r=-0.849$; $p=0.000$) and thickness loss ($r=-0.936$; $p=0.000$). Based on these results, it can be noted that the percentage compression recovery, which is known as resilience behavior, exhibited by the pile yarns and the percentage work recovery that is the resistance against compression increases, accordingly. On the other hand, percentage compression recovery and the other phenomena are opposite to each other; therefore, a negative correlation is observed between them. In consideration of the correlation analysis of compression work results, the obtained results showed that there is a positive and significant correlation between compression work and recovery work ($r=0.990$; $p=0.000$) and thickness loss ($r=0.953$; $p=0.000$). There is also a negative and significant relation between compression work and percentage work recovery ($r=-0.739$; $p=0.002$). Depending on the correlation analysis of recovery work, a negative and significant relation is found between recovery work and percentage work recovery ($r=-0.642$; $p=0.010$), while a positive and significant correlation is obtained between recovery work and thickness loss ($r=0.929$; $p=0.000$). In other respects, there is a negative and significant relation observed between

percentage work recovery and thickness loss ($r=-0.770$; $p=0.001$) on the correlation analysis for percentage work recovery. Finally, there is a positive relationship between the thickness loss values obtained from the dynamic loading test and compression/recovery works. As the amount of work done during the compression and recovery of pile yarns increases, the thickness loss of the pile yarns also increases.

4. CONCLUSION

In this study, compressibility behaviors of polyester carpets with different types of pile structure: sisal look, loop pile and cut pile were investigated. In order to determine the compressibility behaviors of the carpets, compression/recovery and dynamic loading tests were carried out on the samples. Experimental data indicated that percentage compression recovery of cut pile carpet sample was observed to be less than sisal look and cut pile samples, which had similar resilience properties. Besides, cut pile sample was found to absorb and release greater energy compared to others, since the movement capability of cut pile yarn is higher than sisal look and loop pile because of the open ended form of the piles. On the other hand, considering the ratio of the two work values, it can also be deduced that cut pile sample exhibited lower resistance to compression. In addition to compression/recovery test results, dynamic loading test also revealed that cut pile carpet sample had the highest thickness loss, while sisal look carpet sample showed the best performance. Overall, it can be concluded that the higher the bending rigidity, the lesser deformation on the carpet surface, the lesser thickness loss and consequently improved compression recovery.

Indoor and outdoor carpets are exposed to different walking traffic. In general, softer and more voluminous carpet structures are preferred for indoor areas, while carpet structures that have higher durability are preferred for outdoor usage. Cut pile structure enables carpet to have comfortable properties due to its softer and voluminous characteristics. However, thanks to its uncut and looped form, loop pile structure has higher durability and strength in comparison to cut pile type under exposure to loading. Furthermore, the durability of sisal look carpet is observed to be better than loop pile carpet, since the pile is composed of by floating on the weft yarns. Weft yarns provide the pile yarns to show better strength features against loadings and resilience performance. Consequently, it can be stated that sisal look or loop pile carpet structures may be preferred for the usage of outdoor applications which require high durability against heavy traffic, whereas cut pile carpets are more suitable for indoor areas.

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