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# Flame Resistance of Hand Made Wool Carpets

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## ABSTRACT

Handmade wool carpet production in Albania constitutes an important outcome for local producers. In order to guarantee the continuity of production, the quality of the products should be assured. Apart from various physical and mechanical properties necessary for the production line and long-life usage, the fire resistance of the carpet, in particular concerning flammability, is an important property mentioned in EU regulations. Hence, this paper focuses on testing the flammability of handmade carpets used primarily for floor coverings. In this research project five different handmade carpets, randomly chosen and consisting of sheep and goat fibers, are considered. Samples were tested according to ISO 6941:2003. Based on the obtained results, the tested products demonstrate very good behavior in terms of fire resistance and appear to meet the EU standard regarding the flammability of floor coverings.

***Keywords:*** Wool products, hand-made carpets, flame resistance.

## 1. INTRODUCTION

Throughout the years Albania is known as a handmade carpet producer. Carpets that have seen different international trades and very often sold under the name of "Persian carpets" and not "Made in Albania" by confirming once more the absolute quality in respect of all parameters regarding the processing parameters and performance in the use of the products.

Albania has a good tradition in the production of carpets made 100% of wool from sheep's or goats [1]. Until the end of the 80-s, the production of carpets was well organized. Yarns need to be used for carpets were produced in industrial line and well-controlled by offering different ranges of quality, finesses and other parameters in regard the density of carpets, motives and final destination of use [2]. The industrial production line at that time guaranteed the closed-loop of the production of the carpets; starting from control of breed of sheep's or goats until to the industrial line of yarn production to the carpets. This closed line on one hand resulted to a well-controlled quality of all processes which precedes the quality of yarns and following products and on the other hand created a balance in socio-economical aspect in different regions of Albania.

A different panorama is now regarding organized carpets production. There are some small group of people surviving in this "industry" and trying to save this tradition. This situation is caused due to the lack on no spinning lines (as used to be) which is the key factor for the continuation of fibre processing and of increase in the interest of livestock farmers in raising sheep/goat heads.

The use of wool has several advantages compared with other fibers such as warm, lightweight, wrinkle-resistant, absorbent, dyes well, durable, creases well, easy to tailor, a

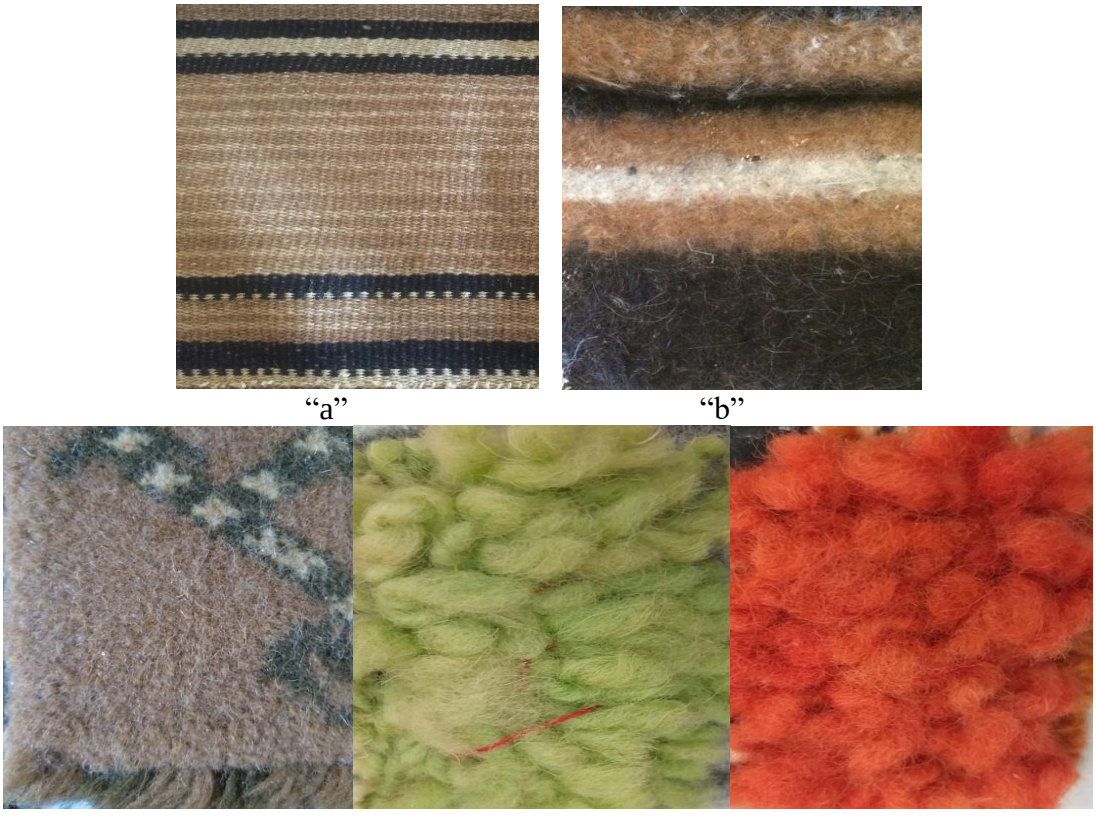
recyclable fiber and a fire retardant or flame resistance fiber [3]. All these properties are due to the morphology structure of the fiber [4]. Among several properties, the last one is the subject of this paper as one of the properties that must be fulfilled, especially for floor coverings products. In Albania these products are completely handmade and not much is known regarding the treatment of fibers or yarns in order to fulfil the EU-standards of fire protection.

Across EU, there are fire safety standards and regulations– including EN standards or national regulations as in Germany, France, Italy, and the United Kingdom. In the Furniture and Furnishings (Fire Safety) Regulations 1988 (as amended in 1989, 1993 and 2010) are set levels of fire resistance for domestic upholstered furniture, furnishings and other products containing upholstery [3, 5 and 6]. On these standards, amendments there are requests for floor coverings products.

Therefore, the purpose for this paper is to see at which level, in regard to fire protection, are the handmade carpets produced in Albania.

## 2. MATERIALS AND METHODS

In order to be as representative as possible samples are randomly chosen from different producers. In figure 1 are presented the pictures of described samples. Tests were carried out at the Department of Textiles and Fashion (Polytechnic University of Tirana, Albania) according to the ISO standards. Sample preparation is performed according to ISO 1130:1975 Textile fibers - Some methods of sampling for testing [7].



"a" "b"

"c" "d" "e"

Figure 1. Samples of tested carpets; "a" carpet of 100% goats yarns in both directions, "b" carpets with 100% goats fibers with almost no spinning, "c" carpet with higher density 36 000 knots/$m^2$ and 100% sheep wool of pile layer, "d" and "e" samples with the same density and 100% sheep wool.

The first line was carpets produced from goat's hair; two different carpets are selected. The first one was able to be produced from goat fibers taken from the Hasi region, named as sample "a". The structure of the carpet is plain weave and both warp and weft yarns are 100% of goat's fibers with the same thickness. Densities of warp and weft yarns are respectively 23 y/10 cm and 34 y/10 cm.

The second sample is from Gramshi region in Albania, named as sample "b". The warp yarns are 100% cotton and weft yarns are 100% goat's fibers but there is almost no spinning applied for these yarns. This way of producing the carpet makes it difficult to measure the density. However, for the purpose of this paper the parameters of the products are not important, as we are not comparing products by each other.

The second line carpets produced by 100% sheep's wool; three samples are randomly selected from different handmade producers of carpets, named respectively as sample "c", "d" and "e". The origin of wool is from different regions in Albania. The density and the length of the pile layer (100% wool) of tested carpets are the same.

Density is measured according to ISO 1763:2020 Textile floor coverings -Determination of a number of tufts and/or loops per unit length and per unit area [8]. Composition of pile layer yarn, weft yarn and warp yarn are calculated based on ISO 1833, 5088 Textiles - Ternary fibre mixtures - Quantitative analysis. [9].

Measurement of flame resistance is performed according to ISO 6941:2003 Textile fabrics - Burning behaviour - Measurement of flame spread properties of vertically oriented specimens [10]. A series of six test specimens per carpet are prepared; three in the warp direction and three in the weft direction. Sample size are 560 mm x 170 mm. Samples should be conditioned in an atmosphere with a temperature 20 ± 2 ºC and relative humidity, 65 ± 5 % for at least 24 hours as shown in Figure 2 (a). The fire resistance test is performed to the apparatus YG-815B presented in Figure 2 (b). Testing of each sample should begin within 2 min after removal from the conditioning atmosphere. The conditioning is completed according to the standard (ISO-6941) [10].


(a) (b)

Figure 2. (a) Conditioned samples at (20 ± 2) ºC and relative humidity (65 ± 5), (b) Testing apparatus YG-815B – placed sample in the frame in the vertical position.

Each sample is placed in the test specimen holder and the holder is placed in the mounting frame vertically. In the Figure 2 (b) is presented the way sample that is settled in the apparatus YG-815B.

In Figure 3 is presented the application of flame to the fixed sample.

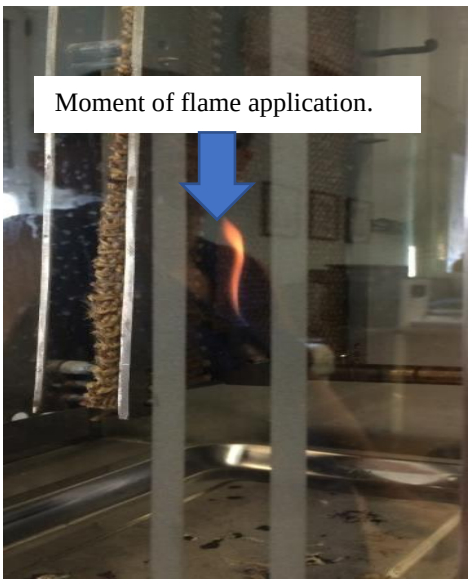
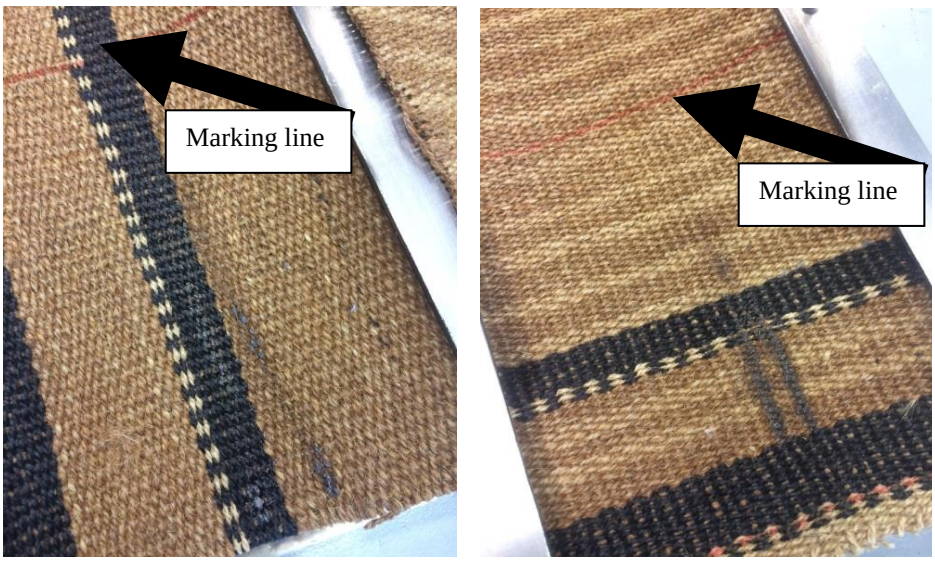



Figure 3. Frame sample in the vertical position under the flame for 20 seconds in YG-815B apparatus.

## 3. RESULTS AND DISCUSSIONS

The ISO 6941:2003 specifies a method for the measurement of flame spread times of vertically oriented carpet in the form of a single component when subjected to a small defined flame for 20 seconds as presented in Figure 3.

Each sample has two marking lines, 20 cm from each other. After performing the test, samples are removed from the apparatus and are observed closely. From the observations it can be seen that the "damage" from the flame does not pass the first line as showed in Figure 4.




(a) (b)

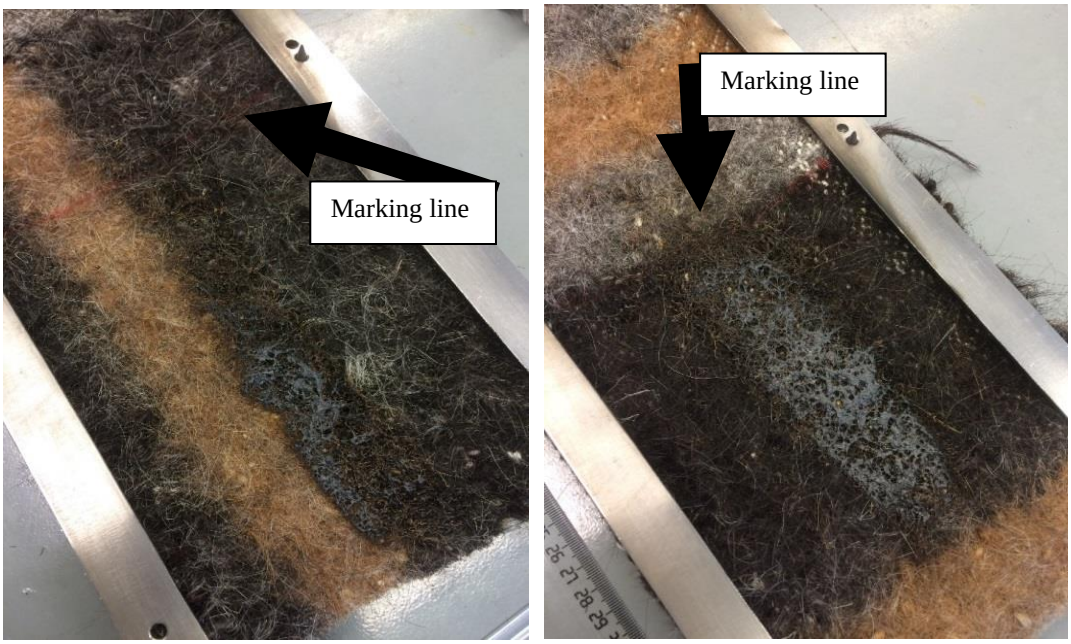
Figure 4. Pictures of sample "a" after tested in both directions respectively, warp and weft.

For carpet tested in the warp direction, as presented in Figure 4 (a), it is noticed that when the flame is applied the carpet does not catch fire. When the flame is removed the carpet fades and remains only a few light grey marks where it was touched by the flame. The length of the burned surface is 10 cm. The flame does not reach the first marking line.

The same behaviour seems to be for samples tested on weft direction, as presented in Figure 4 (b), of this carpet. The only difference is that the length of the burned surface is longer than warp direction; it is 15 cm.

In Figure 5 are presented two pictures (of two directions) of sample "b", after flame applications. As showed in Figure 5, the sample is burned much easier than previous one.

There is no flame spread after removing the flame. The distance of burned surface is 17 cm, for both directions. In both cases the distance of burn does not pass the marking line which is 20 cm. In the same way are tested and observed all the samples. Results are summarized in Table 1. Based on the test performance all the carpets are evaluated as "behaved very well". All the tested carpet samples did not reach the marked line of 20 cm, which presume the first level of burning of samples.




(a) (b)

Figure 5. Sample "b" tested in both directions and the distance of burned per each one.

Carpet produced by goat's hair showed the best values. Sample "1" shows a smaller distance of "damage" in comparison with other samples. This might be due to a sample produced by 100% goat's hear and because the yarns are spun. This behavior proves ones more result of previous paper [11] where samples of goat's fibers from Hasi region showed a high level of limitation oxygen index (LOI). It was 41 %, a comparable value with the special fibers used for fire protection.

Sample "b" is produced by yarns with almost no spinning application therefore it was much easier for fibers to catch the fire.

In general, wool is known to have a high ignition temperature, high LOI and a low heat release from the combustion, but it varies depending on the type of wool as well as the region of the collected samples [12].

Table 1. Present the results of measurements performed according to ISO 6943:2003

| Sample | Damage length of flame [cm] | | | | | |
|---|---|---|---|---|---|---|
| | Warp direction | | | Weft direction | | |
| | Measures | Average | Std | Measures | Average | Std |
| "a" | 10 | | | 15.0 | | |
| | 10.5 | | | 15.0 | | |
| | 10.8 | 10.4 | 0.3 | 14.9 | 15.0 | 0.0 |
| "b" | 17 | | | 20.0 | | |
| | 19 | | | 17.8 | | |
| | 18.7 | 18.2 | 0.9 | 17.0 | 18.3 | 1.3 |
| "c" | 19.5 | | | 20 | | |
| | 18 | | | 18 | | |
| | 18.5 | 18.7 | 0.6 | 18.5 | 18.8 | 0.8 |
| "d" | 18 | | | 18.0 | | |
| | 18 | | | 18.4 | | |
| | 17.8 | 17.9 | 0.1 | 18.0 | 18.1 | 0.2 |
| "e" | 19 | | | 18.3 | | |
| | 18.7 | | | 18.0 | | |
| | 18.3 | 18.7 | 0.3 | 18.6 | 18.3 | 0.2 |

None of the samples continues to burn after removing the source of flame. All the samples have damages on the surfaces and not in depth. After removing the flame burning does not continuing in all the samples. Wool is known as a flame-resistant and these fibers are used as materials for flame and heat protection [4, 13].

These results are evidence of the profit of pure wool fibers from Albania regions. The flame resistance could be improved even more if other treatments are performed. However, all these could be done when all the steps of processing, from fibers to final products - carpets, will be in and industrial organized line.

## 4. CONCLUSIONS

This paper includes information regarding the flammability of different handmade carpets randomly chosen in different regions in Albania. From obtained results, it seems that all carpets meet the standard of flammability by being evaluated as "very good behaviour". Among tested carpets, carpets produced by goat's hair show the best behaviour. The other carpets produced by sheep wool show almost the same damage length, between 18 and 19cm.

These results are evidence of the profit of pure wool fibres from Albania regions. The flame retardant property of wool make an ideal fibre for carpets, curtains, upholstery as this reduces the risk of fire spreading inside the houses or other places.

Based on the results of this work it is highly recommended to invest on the fibre processing technology in Albania; this will lead to organize the carpet production in industrial level and in financial benefit as economic activity in Albania.

## CONFLICT OF INTERESTS

The authors would like to confirm that there is no conflict of interests associated with this publication and there is no financial fund for this work that can affect the research outcomes

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