ISSN 1392–1320 MATERIALS SCIENCE (MEDŽIAGOTYRA). Vol. 13, No. 3. 2007

The Fabric Weave's Influence on the Character of Fabric Break

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Received 28 November 2006; accepted 24 August 2007

In this article fabric weave, expressed by weave factor P_1, influence on fabric's breaking force and elongation at break is analyzed. Weaves are distributed into two groups, i. e. weaves, the floats of which are distributed in even intervals throughout the entire surface of fabric, and horizontally striped weaves. It was determined that the character of break in various weave group fabrics, as well as their stress-strain curves, are different. In addition, the dependencies of breaking force and elongation at break in the fabrics with these weave groups on the factor P_1 are different. After analyzing dependence of breaking force of individual groups on the weave factor P_1, we determined that results of breaking force of horizontally striped fabrics are higher than those of weaves with evenly distributed floats. Determination coefficient of equations is low. After evaluating all the weaves we can affirm that dependence between fabrics breaking force and weave factor P_1 was not established. The change of the curve of elongation at break is more intensive in weaves with evenly distributed floats in comparison with across stripped weaves. Determination coefficients of all dependences of elongation at break on weave factor P_1 are high.

Keywords: woven fabric, weave factor, breaking force, elongation at break.

INTRODUCTION

Fabric structure can be evaluated by seven parameters: warp and weft raw material, warp and weft linear densities, warp and weft settings and the weave of fabric. From these parameters the most difficult to evaluate is the weave, because it is a graphic view of the fabric structure. It can be evaluated quite precisely by weave matrix factors, which are proposed by different authors: Ashenhurst [1], Galceran [2], Brierley [3], Milašius [4]. Some of them proposed only single thread interlacing, while others evaluate weave as a whole. These factors are more widely described in reference [5]. In previous investigations [6] it was established, that the best way to evaluate weave is to use weave factor P_1 proposed by Milašius. This factor is determined in the direction of warp, because a fabric is getting formed in this direction in the weaving loom. While investigating fabric's weavability [7], it was established, that if the weave factor increases, the maximal weft setting also increases.

As noted, all above-mentioned fabric structure parameters influence many mechanical and end-use properties. Various authors studied influence of fabric structure on various end use properties. Milašius and others [8] analyzed influence of fabric structure on fabric's air permeability and abrasion resistance. It was established during the experiment, that, as fabric's structure stiffens, fabric's air permeability decreases, and abrasion resistance increases.

Nikolic and others [9] expressed fabric strength in terms of threads strength, fabric setting and threads strength coefficient. It was established, that, as threads strength increases, fabric strength also increases. Fabric strength in the direction of warp is higher than that in the direction of weft, and plain weave fabric is the strongest.

Frydrych and others [10] analyzed influence of finishing, raw material and weft setting on fabric's elongation at break. They established the dependence between the change of friction and the area of warp and weft thread contact. However, different experiments were conducted to study various fabric properties, but fabric's strength properties, especially their connection with fabric structure, were little researched. This connection between fabric weave and strength properties (breaking force and elongation at break) will be investigated in this article.

METHODS

To conduct the above mentioned experiments, the fabrics, woven with gripper STB-2-180 loom of PES 29.4 tex, twist 100 m^{-1} multifilament threads, warp setting 284 dm^{-1}, weft setting 229 dm^{-1}, were used. The fabrics were woven in 12 different weaves as shown in Fig. 1. The weaves were chosen in such a way, that they could be woven with the same loom setting. The weave factor P_1 of all chosen weaves was changed in the widest possible range (from 1 to 1.9). From the chosen weaves, six weaves (1, 2, 4, 5, 6, 7) had floats evenly distributed through the full fabric surface, and six weaves (3, 8, 9, 10, 11, 12) were horizontally striped. Some of the weaves were striped in both, horizontal and vertical directions. We do not pay attention to the vertical stripiness of these weaves, because the fabric properties are interested us just in warp direction. Weaves were distributed according to the character of their break.

Fabric tensile tests were done accordingly to the international standard ISO 13934-1 [11] with a tensile testing machine Zwick/Z005. Stretching speed was 100 mm/min, distance between clamps was 200 mm. Test specimens were cut only in the direction of warp, because it was determined earlier [6], that fabric properties in this direction are most important.

Test variation coefficient values of breaking force and elongation at break did not exceed 5 %.

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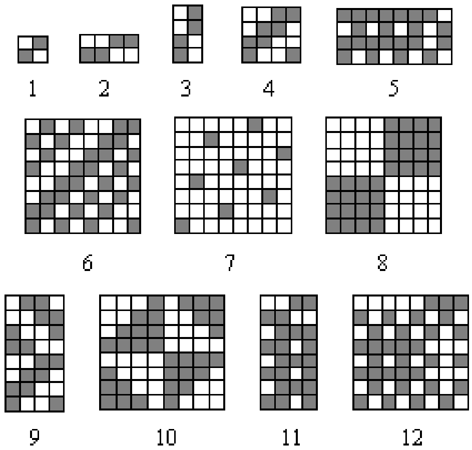
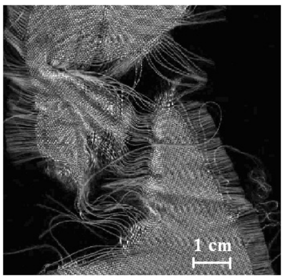


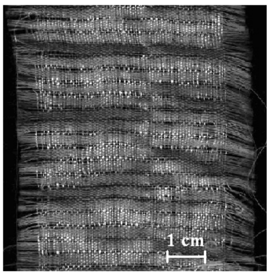
Fig. 1. The weaves used in experiment: 1 – plain weave (P_1 = 1); 2 – weft rib (P_1 = 1); 3 – warp rib (P_1 = 1.31); 4 – twill 2/2 (P_1 = 1.26); 5 – weft direction Bedford cord (P_1 = 1.27); 6 – fancy twill (P_1 = 1.11); 7 – sateen (P_1 = 1.79); 8 – basket weave (P_1 = 1.88); 9 – broken twill (P_1 = 1.18); 10 – crape weave (P_1 = 1.41); 11 – warp direction Bedford cord (P_1 = 1.18); 12 – mock leno (P_1 = 1.12)

RESULTS

To establish influence of fabric weave on the fabric strength, tensile tests were conducted with fabrics of both types. It was noted, that character of break in fabrics, which floats distributed evenly throughout the entire fabric's surface, and horizontally striped fabrics is different. Character of the breaking is shown in Fig. 2.



a



b

Fig. 2. The views of break: a – weaves, the floats of which are evenly distributed within the whole area of the woven fabric; b – across striped weaves

Fabrics with evenly distributed floats broke in the weakest location, i. e. localized, and horizontally striped fabrics broke in the full area of test fabric. It is thought that this happens, because weakest parts of the threads in horizontally striped fabrics are in the location of the horizontal stripe edge, and they are distributed in the entire fabric's surface. This is the reason why fabric's threads are breaking in different places.

Stress-strain curves in fabrics from these groups, shown in Fig. 3, are also different. It can be seen, that the weaves with evenly distributed floats do not have the expressed yield point in stress-strain curve. It can be explained, that threads in horizontally striped fabrics start breaking sooner, but threads break takes more time until the fabric broke up completely.

During the test, dependencies of breaking force and elongation at break on weave factor P_1 in different fabric groups were established, and overall dependencies of all fabrics were established as well.

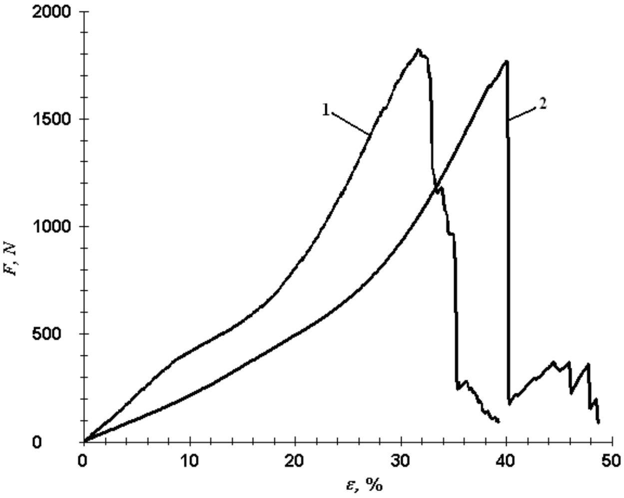


Fig. 3. Stress-strain curves of: 1 – across striped weave (3 weave, in Fig. 1) and 2 – weave with floats evenly distributed within the entire area of the fabric (1 weave in Fig. 1)

Dependence of breaking force of different fabrics on the weave factor P_1 is shown in Fig. 4. It can be asserted that in the case of horizontally striped weaves, as weave factor P_1 increases, fabric's breaking force has a tendency to decrease. In the case of weaves with evenly distributed floats breaking force decreases in initial part of curve, and after it achieves its minimum values in the center of curve the breaking force of these fabrics started to increase. The threads in thin fabrics with evenly distributed floats are almost straight and the breaking force depends mainly on the strength of threads. The crimp of threads in weaves with average P_1 can be the reason of minimum value of breaking force in the central part of curve.

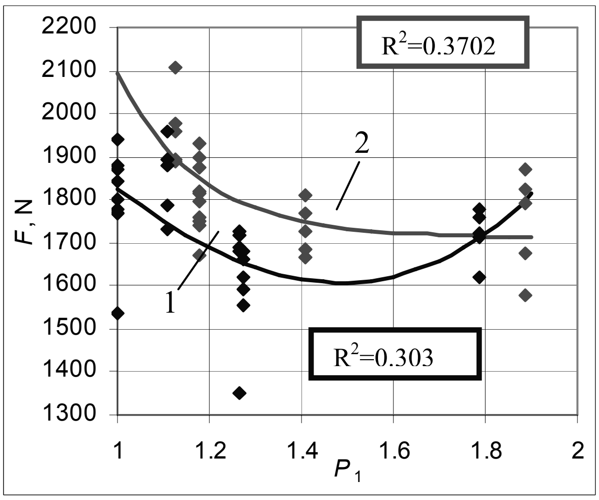


Fig. 4. Dependencies of fabric breaking force on the weave factor P_1: 1 – weaves with evenly distributed floats; 2 – horizontally striped weaves

We can see that breaking force values of horizontally striped weaves are higher than those of evenly distributed floats. It can be implied that, even though horizontally striped weaves start breaking sooner, but until all fabric's threads break completely, higher breaking force value is achieved. Because of this reason, resulting breaking force values of horizontally striped fabrics are higher than those of weaves with floats evenly distributed throughout entire fabric's surface. Determination coefficients of dependencies are low and we can affirm that the dependence of the fabric breaking force on weave factor P_1 is not established.

After summarizing all the weaves, the resulting dependence is shown in Fig. 5. In this dependence, tendency of breaking force to decrease manifests itself, as the weave factor P_1 increases. Just in the case of thin weaves with high factor P_1 the breaking force increases slowly. The real reason of this curve tendency is not known. Determination coefficient of dependence is low. We can assert that, after summarization of all the weave points, the relation between the fabrics breaking force and fabric weave factor P_1 was not established. Underlying reasons, leading to these results, are difficult to explain at this point.

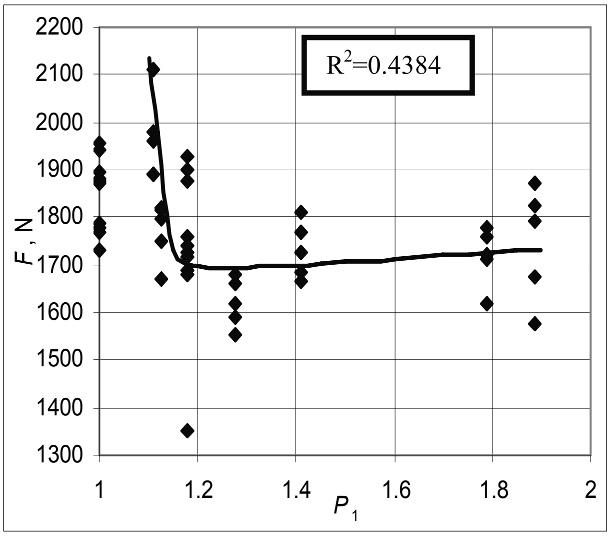


Fig. 5. Overall dependence of fabric breaking force on the weave factor P_1

Dependencies of elongation at break on the weave factor P_1 for separate weave groups and overall dependence on all weave points were also obtained during the experiment.

Elongation's at break dependence on weave factor P_1 in fabrics weaved with evenly distributed floats and horizontally striped weaves is shown in Fig. 6. We can assert that, as weave factor increases, fabric's elongation at break decreases. We can see that shape of the curve changes, in comparison with the weaves that have floats evenly distributed throughout the entire fabric's surface. It is much lower in fabrics with horizontally stripped weaves. It can be explained, that horizontally striped weaves elongate evenly, with warp threads breaking slowly, and so overall fabric elongation is less dependent on the weave. This could be the reason explaining differences in the character of determined dependencies. Dependencies have high determination coefficients.

After evaluation of all the weaves with help of overall curve, resulting breaking force dependence on the weave factor P_1 is shown in Fig. 7. Elongation's at break tendency to change remains the same, i. e. as weave factor increases, elongation at break decreases. Determination coefficient of dependence is high.

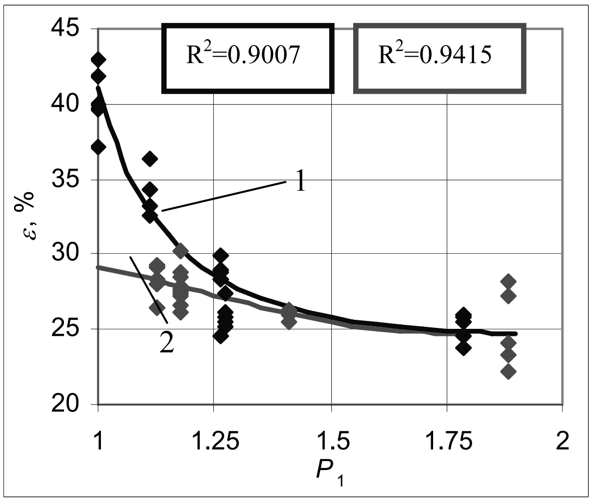


Fig. 6. Dependencies of fabric elongation at break on the weave factor P_1: 1 – weaves with evenly distributed floats; 2 – horizontally striped weaves

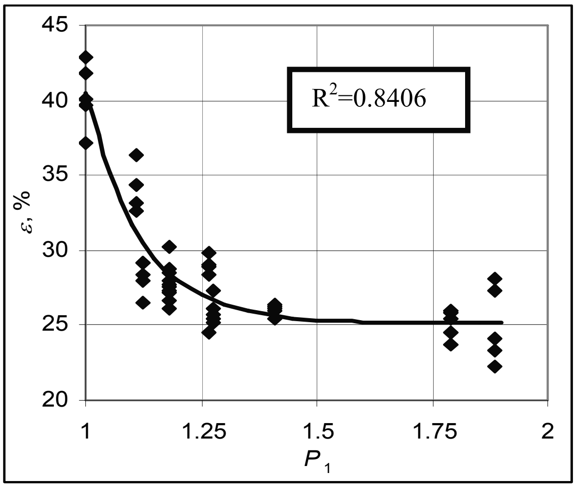


Fig. 7. Overall dependence of fabric breaking force on the weave factor P_1

Similar dependencies were also obtained in the case of other weave factors, but due to the similarity of the results, these dependencies are not being presented in this article.

CONCLUSIONS

After weaving fabrics with STB-2-180 gripper loom from PES 29.4 tex twisted multifilament threads in different weaves and conducting tensile tests on these fabrics, we can come to these conclusions:

1. Character of fabric break in weaves with evenly distributed floats and horizontally striped weaves and form of breaking curves is different.
2. As weave factor P_1 increases, elongation at break has a tendency to decrease.
3. Breaking force of fabrics in weaves with evenly distributed floats is lower than those in horizontally striped weaves.

4. The dependence of fabrics breaking force on the weave factor P_1 was not established.
5. As weave factor P_1 increases, fabric's elongation at break has tendency to decrease.
6. Rate of change of elongation at break dependencies of horizontally striped weaves on the weave factor P_1 is lower than in the case of weaves with evenly distributed floats.

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