RESEARCHES UPON MECHANICAL CHARACTERISTICS OF DIFFERENT TYPES OF LEATHER USED IN FOOTWEAR MANUFACTURING

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This paper presents the results of the research upon the mechanical characteristic of some types of leather used in footwear manufacturing. Tensile tests were carried out in order to observe the breaking strength and elongation for a load of 10 N/mm^2, using the tensile testing machine SATRA (STM 466) with 466F attachment, and SATRA software, providing quick and simple-to-understand results. The graphs resulted at the tensile testing machine, namely the dependence of force and elongation at break, give useful information for describing how the tested leather breaks. The force-elongation graphs registered allow establishing the values of elongation for highlighting the deformation capacity of leather at the lasting process.

Keywords: stress, tensile, breaking, elongation, strength.

INTRODUCTION

Nowadays, in the manufacturing process of leather and leather substitute products (like footwear, bags, gloves, technical and protection articles) various types of leather and leather substitutes are used.

In the manufacturing process, and especially during wearing, the materials have to meet several conditions in order to ensure a pleasant appearance, shape and size retention during use, resistance to mechanical stress (tensile, compression and bending).

During the lasting process, the footwear uppers are submitted to a tensile stress – that occurs when they are pulled on the last – and have to maintain their spatial shape. The behavior of materials in the manufacturing process and use is established through a series of features such as:

- Elongation at target load (10 N/mm^2), ε_i, which allows to highlight the deformation capacity of the leather during the lasting process;
- Elongation at break, ε_r, namely the break extension;

The elongation at break results from the relation:

$$E_r = (L_r - L_0)/L_0 * 100 = \Delta L/L_0 * 100 \quad (1)$$

where:

L_0- the initial length of the sample;
L_r- the sample's length between clamps at break;
ΔL- the absolute value of the elongation at break.

- Elongation at break of the leather's grain, ε_{cf}, namely the elongation when the leather's grain breaks under a tensile stress.

If the grain breaks under 10 N/mm^2 it is probable that the leather's grain breaks as well during the lasting process, and if the break occurs at over 10 N/mm^2, then, the leather will behave well both in manufacturing and use.

The elongation at break depends on the type of leather for which, in the footwear manufacturing process, it is necessary to take into account the direction of leather's minimum stretch on maximum stress.

The tensile strength at break, characterized by the load at break, in N/mm^2, is dependent on the nature and structure of the leather type, the width and resistance of

fibers, the felting and the degree of compactness of the tissue, the filling substances of interfibrillary spaces, the fat content, humidity etc.

The value of strength at break depends on different types of leather, and also on a series of factors like: genre, age, animal gender, leather measuring type, tanning method, mechanical processing, grease type and nature. Usually, for leather, strength at break values of between 0.7 and 0.8 daN/mm^2 can be registered, depending on the leather type.

Starting from these aspects, the paper presents the results of research on the breaking strength and elongation at load for different types of leather currently used in footwear manufacturing process.

EXPERIMENTAL

The behavior of these leather substitutes has been observed using the tensile testing machine SATRA (STM 466) with 466F attachment, with PC control and SATRA software that provides quick and simple-to-understand results.

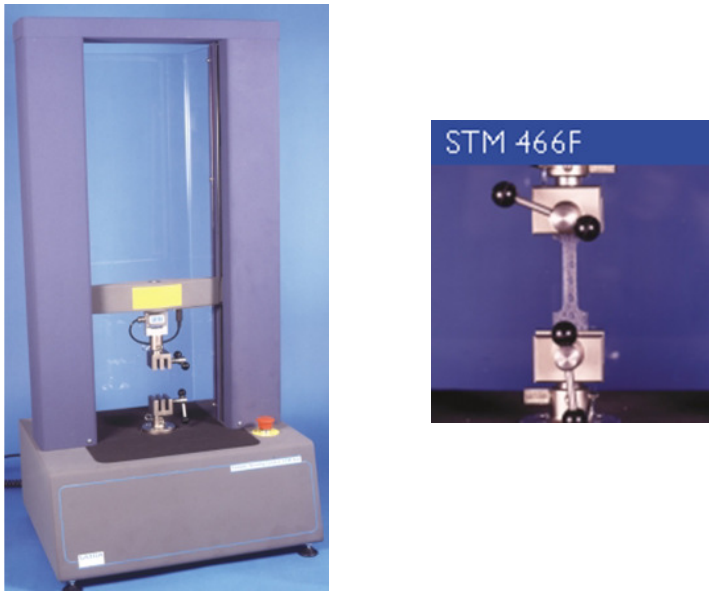

Figure 1. Tensile testing machine SATRA (STM 466) with 466F attachment

The tests were carried out on natural-grain leather and corrected-grain leather.

- P1– matte natural-grain leather
- P2 – shiny natural-grain leather
- P3 – matte corrected-grain leather
- P4 – reptile embossed leather (crocodile)
- P5 – matte glossy corrected – grain leather

The tested samples have been cut following the dimensions indicated in SR EN ISO 3376/2003 standard with:

- total length l= 190 mm;
- length between SATRA's clamps l_0=100;
- width b=20 mm.

After the conditioning process, according to ISO2419 standard, the samples have been tested until break at a speed of 100 mm/minute.

RESULTS AND DISCUSSIONS

The testing of samples has been done as to register the maximum breaking force in N/mm^2, the elongation at break and the longitudinal elasticity modulus, E, in N/mm^2 using the testing machine STM 466 with SATRA software that provides quick and simple-to-understand results. In these cases it is possible to register the load – elongation graphs, the medium values and the variation coefficient. The SATRA software allows graphs visualization during the tests.

In Figures 2, 3, 4, 5 and 6 the load – elongation graphs registered on SATRA tensile testing machine are illustrated.

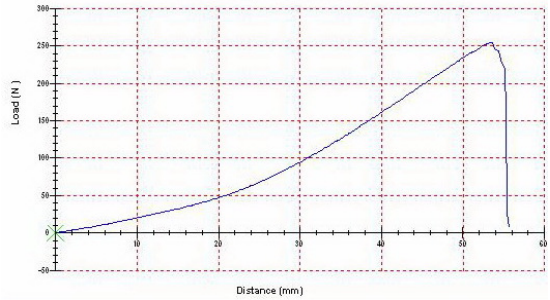

Figure 2. Load - distance graph for P1

According to Figure 2, the leather P1 (matte natural-grain leather, brown color) break has registered at an elongation of 55.46%, corresponding to a breaking force of 255.33 N. The elongation is inferior to the corresponding one at 1daN/mm^2, and the force of 280N. In this case, the lasting process has to be done with a tensile stress of 0.7daN/mm^2.

The leather P2, shiny natural-grain leather, with a width of 1.1 mm, according to Figure 3, the elongation at break is 41.25%, corresponding to a breaking force of 164.8 N. The first crack on leather appears at a force of 151 N, which corresponds to an elongation of 36.8%. The elongation at break and the maximum force at break is 220 N, corresponding to a tensile stress of 1daN/mm^2.

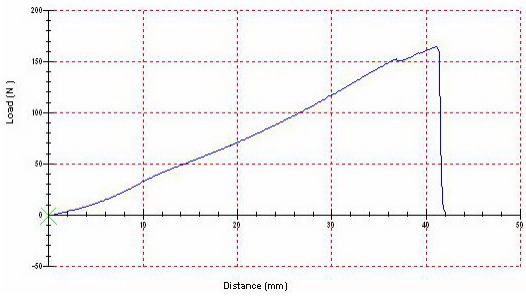

Figure 3. Load-distance graph for P2

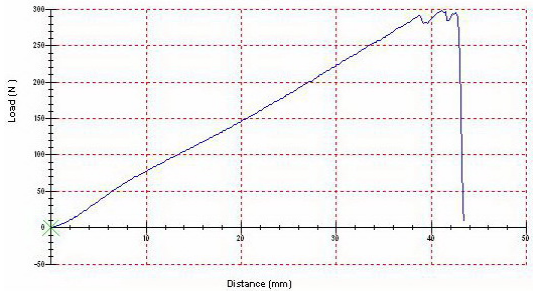

Figure 4. Load - distance graph for P3

The maximum breaking force for P3 (matte corrected-grain leather), as in graph from Figure 4 is 270 N, at an elongation of 44.14%. In this case, the value of the breaking force is superior to the one registered for a tensile stress of 1daN/mm^2, and a force of 220 N. Using this value, the value for the elongation, 38.5%, can be seen from the graph.

For this type of leather, P4 (reptile embossed leather) according to the graph from Figure 5, the maximum breaking force is 436.5 N, with an elongation at break of 39.5%. The value of the breaking strength is well above the value corresponding to the elongation at the breaking strength of 10 N/mm^2. Thus, for a required value of the breaking strength under 10N/mm^2 (with the force of 200 N) an elongation of almost 19% is necessary.

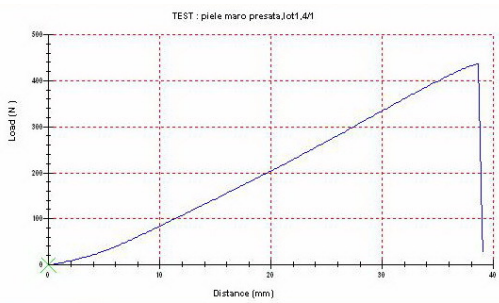

Figure 5. Load - distance graph for P4

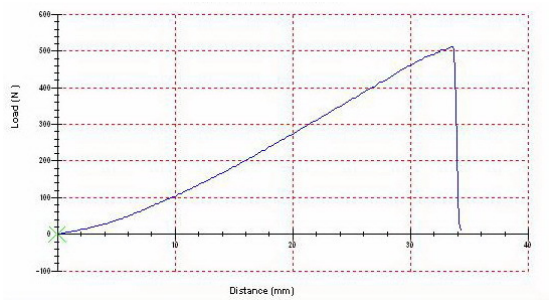

Figure 6. Load - distance graph for P5

According to the graph from Figure 6, the P5 leather (P5 – matte glossy corrected-grain leather) has the maximum value of the breaking force, 510 N, corresponding to an elongation at break of 32%. From the graph the elongation of 17% can be measured for the required value of the tensile stress of 10 N/mm^2 (with a force of 220 N).

In Figure 7 the maximum force at break can be seen, in comparison to the breaking force corresponding to the first crack of the leather grain. These are represented for an illustration as suggestive as possible of the experimental data.

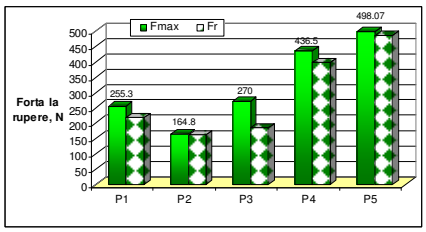

Figure 7. Variation of the breaking force

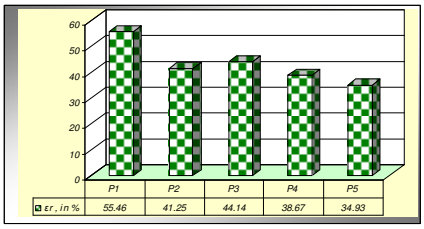

Figure 8. Variation of the elongation at break

From the graphical representation of elongation it results that the values obtained are between 35 and 56%, which are lower values than 60%, according to the available standards.

Among the tested leather, P1 (matte natural-grain leather) presents the highest value of the elongation at break, and the lower value in case of P5 leather.

The tensile strength at break and the maximum value of the breaking force are shown in Figure 9. The leather with the lower elongation value has the highest value for the strength at break, namely of 22.64 N/mm^2.

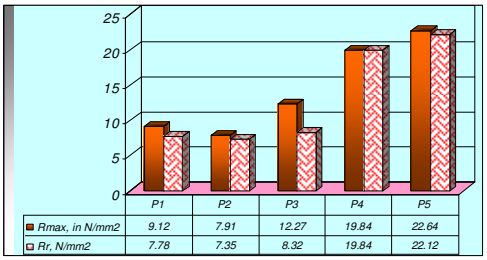

Figure 9. Variation of the tensile strength at break

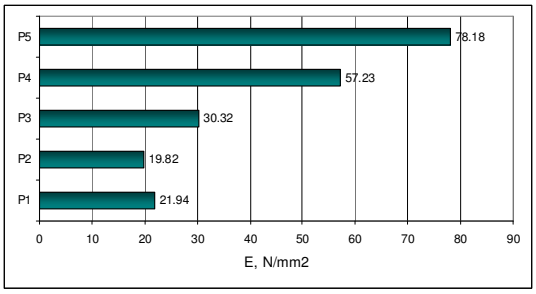

Figure 10. Variation of the longitudinal elastic modulus

Figure 10 shows the variation of the longitudinal elastic modulus. Obviously, the leather with the highest value of strength at break has the highest value for the modulus of elasticity.

CONCLUSIONS

- The graphs resulted at the tensile testing machine SATRA, the dependence of force and elongation at break respectively, give useful information for describing how the tested leather breaks.
- The tensile elongation at break of the tested leather has values between 35 and 56%, namely lower values than 60%, according to the available normative.
- The force-elongation graphs registered at the tensile testing machine (STM 466) SATRA highlight the maximum breaking force of the leather, the breaking force of the leather grain respectively.
- The strength at break of the tested leather has value between 7-22 N/mm^2.
- The force-elongation graphs registered at the tensile testing machine (STM 466) SATRA allow establishing the values of elongation a load of 10 N/mm^2, for highlighting the deformation capacity of leather at the lasting process considering the fact that the tensile load during the lasting process is of 7-8 N/mm^2.

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