STUDY REGARDING THE STITCHING STRENGTH OF MATERIALS USED FOR FOOTWEAR UPPERS MANUFACTURING

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Abstract: The shoes manufacturing implies the use of various types of leathers, leather substitutes and fabric. The sewing plays a very important role in shoe making, having an impact both in terms of functionality and outlook. One of the most important indicators of the sewed products quality is seam strength, which is influenced by a series of technological parameters such as: the shape of the needle's top, the needle's diameter, the seam thickness, the number of seams, the gauge of the thread, the type of seam and the material type. This paper studies the stitching strength of the full grain leather and full grain leather shiny surface used for footwear uppers, in order to improve productivity and seam quality.The experimental researches obtained for the stitching strength allow calculating the weakening coefficient of the material in the process of sewing (a= 0.33-0.48). The "a" coefficient is dependent on the stitch density, the shape of the needle's top and the joined materials. In terms of stitching strength, the results indicate that the full grain leather obtains higher values than the full grain leather shiny surface.

Key words: leather, stitch strength, needle, stitch density, open seam, lapped seam

1. INTRODUCTION

The shoes manufacturing implies the use of various types of leathers: full grain leather, full grain leather shiny surface, sheep leather, pig leather etc

One of the process in typical footwear manufacturing facility is stitching. It consist of sequential processes, requires higher operator skills and relatively needs longer time compared to other shoes processing. Stitching line serve as assembly process to form upper-part of footwear [1].

The sewing of the footwear uppers provides a stitch strength that assures a corresponding choice of the thread and needle. The stitching of patterns uses synthetic threads that present a good breaking strength and elongation.

The stitching is dependent to the strength of materials and also seams strength [2, 3, 4, 5].

The materials' strength for a stitch of 1cm is given by the relation:

$$R_c = R_i (1 - a \cdot d \cdot n) \tag{1}$$

where: R_i-the materials' strength before stitching, daN/cm;
 a- the weakening coefficient of the material during stitching;

d- the blade's diameter, cm;

n- the seam's thickness, stitches/cm [1].

The material's strength reduces through the stitching in connection to several parameters: the shape of the needle's point, the needle's diameter, the thickness of the seam and the number of seams.

The most used needle point shapes are illustrated in figure 1.

LR   LL

Fig.1: *Usual shapes of theneedle's point section [3]*

The shape of the needle's point section plays a significant part on the stitch density.

The thread strength depends on the initial characteristics of the thread and its weakening during stitching and also on the technological parameters of the stitch, as it follows:

$R_a = 2\,n\,r\,s$ **(2)**

where: n- the seam's density, stitches/cm

r- the thread breaking strength, N;

s- the weakening coefficient of the material during stitching (s=0.6-0.8).

A higher quantity of thread is neccesary as the number of stitches/cm (the stitch density) is bigger, which determine a growth of the thread stength from the stitch.
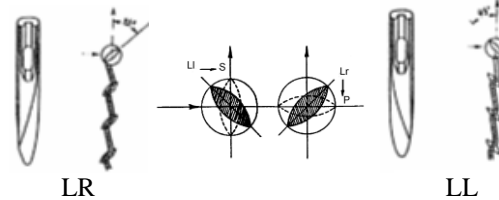
Instead, as the stitch density grows the material has more holes which results in a decrease of its strength.

In order to obtain a maximum joint strength on tensile test there has to be achieved the next condition: the stitch strength (R_c) is equal to thread stitch (R_a).

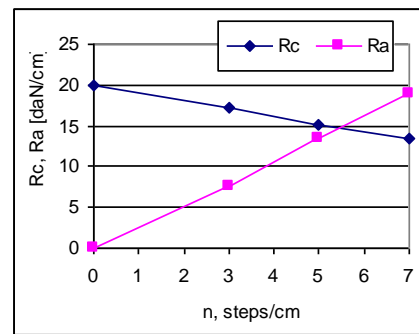**Fig. 2:** *Materials and threads strength as function of the stitch*

For example, figure 2 shows the influence of the stitch density (steps / cm) on the thread and material strength, for a leather with PU film, needle NM 100, thread NM 65/3.

As illustrated in the graphic, an uniform increase of the thread strength for a length of 1cm, both with an uniform decrease of the material's strength material, according to stitch density. The two straight lines meet at a density of 5.5 steps/cm (Rc = Ra).

This paper presents the results of the research concerning the stitch strength of two types of leather used for uppers shoes manufacturing.

2. EXPERIMENTAL RESEARCHES

The experimental investigations were carried out using samples of 25 x 65 mm, assembled through simple stitches with 2 threads (type 301), with one or two rows of stitching.

The needles (LR) used are of 1,1mm (NM 110) diameter and the thread is PES (NM 30/3). The samples have been stitched at various densities such as 3, 4, 5 6 and 7stitch/cm. There have been done open seams (figure 3a) and lapped seams (figure 3b) using 2

a)   b)
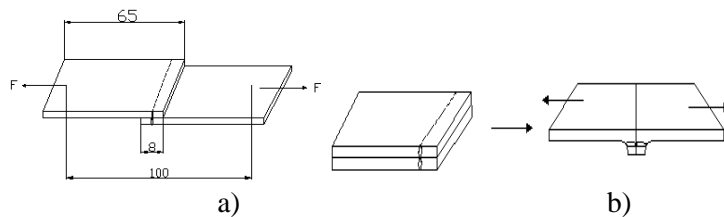
Fig. 3: *Lapped seam (a) and open seam (b)*

types of leather, full grain leather and full grain leather shiny surface (δ=1,1 mm).
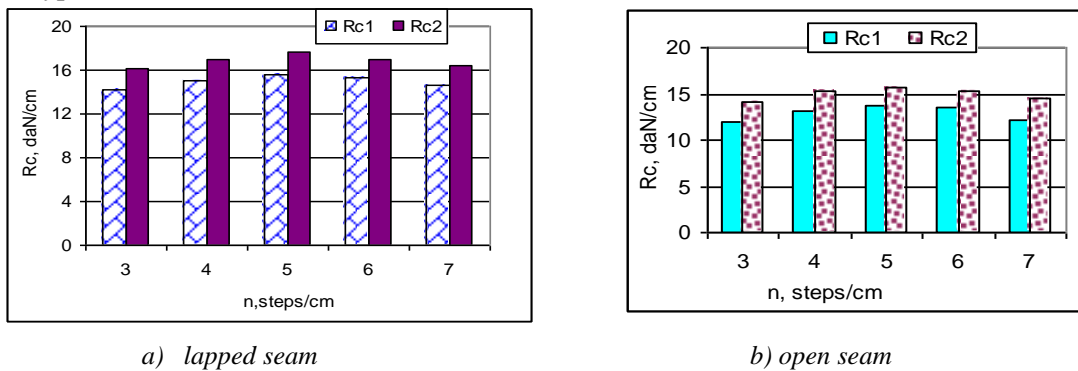The stitch strength (R_c) is determined experimentally with the relation:

$$R_C = \frac{F}{L}$$ **(3)**

where: F-the breaking force, N;

L-the seam's length, cm.

3. RESULTS AND DISCUSSIONS

The variation of the strength as function of the stitch density is illustrated in figure 4a for the lapped seam and in figure 4b for the open seam. The stitches have been done with materials of the same type.

a) lapped seam   *b) open seam*
Fig. 4*:The dependence of the stitch strength on the stitch density (n)*
Rc_1- the stitch strength of full grain leather; Rc_2- the stitch strength of full grain leather shiny surface

It results a maximum of strength for a stitch density of 5 steps/cm.The graphic shows that the lapped seam is more resistant than the open seam.
The stitch strength increases in the case of joining full grain leather using two rows of stitching, figure 5a. /The joints' strength through stitching grows in the case of full grain leather shiny surface, figure5b.
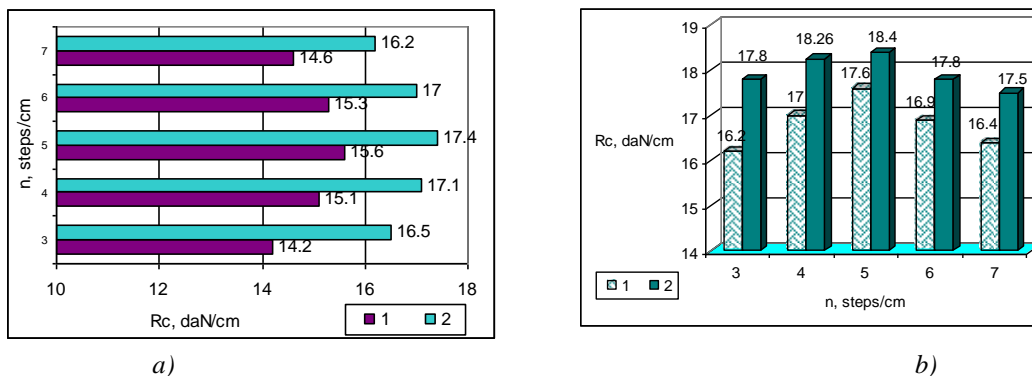
a)   *b)*
Fig.5*: The variation of t he stitch strength (R_c) as function of the stitch density (n) --- lapped seam*
1- the stitch strength for one row of stitching;   2- the stitch strength for two rows of stitching

As the graphic shows, the maximum stitch strength is Rc=18,4daN/cm corresponding to 5 stitches/cm, two rows of stitching.

The experimental values of the stitch strength have allowed a calculation of the material's weakening coefficient through equalizing relation 1 with relation 3:

$$R_{exp}= R_i(1-a \cdot d \cdot n) \tag{4}$$

The weakening coefficient of the material during stitching is calculated as bellow:

$$a = \frac{R_i - R_{exp}}{R_i \cdot d \cdot n} \tag{5}$$

In the case of the analysed materials: Ri =19.8daN/cm for full grain leather şi Ri=22.1daN/cm for full grain leather shiny surface. The experimental results show a weakening coefficient of 0.33-0.45 for full grain leather and 0.36-0.48 for full grain leather shiny surface.

4. CONCLUSIONS

The stitching strength is dependent on the layer's nature, the needle's diameter, the stitch density, the components layout and the number of seams. The stitching strength increases with the number of rows of stitching.The strength of the lapped seam has higher values than the strength of the open seam, therefore it is recommended to reinforce the open seam.

The experimental values for the stitching strength are highr than the minimum values specified in standard EN 9689/3-1984 leather: 8da6N/cm (one row of stitching) and 10 daN/cm (two rows of stitching). The experimental researches show that the stitching strength for the full grain leather is higher than the one of the full grain leather shiny surface.

The experimental researches obtained for the stitching strength allow calculating the weakening coefficient of the material in the process of sewing (a= 0.33-0.48).

REFERENCES

[1] JC. Chen, J.Chen, Yung-Sheng Su, Simulation Modeling and Analysis for Stitching Line of Footwear Industry, Proceedings of the 2014 International Conference on Industrial Engineering and Operations Management Bali, Indonesia, 2014, Available from http://ieomsociety.org/ieom2014/pdfs/249.pdf

[2] Harnagea F, Stabilirea influenţei unor parametri tehnologici asupra rezistenţei cusăturilor, Lucrările celei de a XI Conferinţe române de Textile pielărie, vol.IV,Ed. Ankarom, Iaşi, 2012, Available from http://www.ius.edu.ba/sites/default/files/articles/16-53-1-PB.pdf

[3] Harnagea F, Stabilirea influenţei unor parametri tehnologici asupra rezistenţei cusăturilor, Lucrările celei de a XI Conferinţe române de Textile pielărie, vol.IV,Ed. Ankarom, Iaşi,1997

[4]] Harnagea F., Cocea M., Aspecte cu privire la influenţa unor parametri tehnologici asupra rezistenţei cusăturilor utilizate la confecţionarea mănuşilor, Analele Univ. din Oradea, fascicula Textile-pielărie, vol.III, p 127-137, 2003

[5] Cociu V., Mălureanu G., Bazele tehnologiei produselor din piele şi înlocuitori,Rotaprint, Iaşi 1993

[6] The Influence of Stitch Density and of the Type of Sewing Thread on Seam Strength, D. Barbulov – Popov, Nenad Cirkovic, Jovan Stepanović, TEM Journal – Volume 1 / Number 2 / 2012.104, Available from https://www.academia.edu/3323698/The_Influence_of_Stitch_Density_and_of_the_Type_of_Sewing_Thread_on_Seam_Strength?auto=download