ANALYSIS OF THE SEAMS TENSILE PROPERTIES

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REZUMAT. În această lucrare ne-am propus să analizăm rezistența la tracțiune a cusăturilor folosind testul cu bandă. Pentru a face față diverselor cerințe în timpul coaserii, o ață de cusut trebuie să aibă o rezistență și o alungire adecvate, caracteristici care depind de materia primă și de procesul de finisare. Materialul de bază pe care au fost confecționate cusăturile a fost o țesătură de bumbac 100%, pe care au fost cusute trei tipuri de cusături, cu trei tipuri de ațe de cusut 100% PES.

Cuvinte chele: proprietăți tensionale, ațe de cusut, cusătură simplă, cusătură lănțișor, cusătură de surfilare.

ABSTRACT. In this paper we aimed to analyze the tensile strength of the seams by determining the maximum breaking force of the seams using the strip test. To withstand the various demands during sewing, a sewing thread must have adequate strength and elongation, characteristics that depend on the raw material and the process of finishing. The basic material on which the seams were made was a 100% cotton fabric, on which were sewn three types of seams with three types of sewing threads 100% PES.

Keywords: tensile properties, sewing threads, lock stitch, chain stitch, over stitch.

1. INTRODUCTION

The sewing operations, for which sewing threads are designed and manufactured impose very severe conditions on them. In order to withstand the various demands which it is subjected to during processing, but also to the use of the products obtained with their help, the sewing thread not only has to be well constituted, but it must be protected by lubrication.

During high speed sewing, the needle thread is subjected to repeated stretching efforts with high values. The needle thread is also subjected to heating, compression bending and friction. The effects of the above actions are particularly complex under dynamic conditions, which ultimately cause the thread breakage, thus affecting the sewing efficiency. The properties of the seam, such as appearance and durability, are influenced by the characteristics of the sewing thread.

Among the most important conditions that sewing threads must meet are those related to slipping and rubbing. The forces that appear in the thread are due, in particular, to the friction between the sewing thread and the elements of the machine, the strongest interaction taking place between the thread and the needle and between the needle and the sewing material.

During the sewing operation, due to the friction between the needle and the fibers in the threads forming the material, heat is produced. The degree of heating depends on the working speed of the machine, the size, shape and degree of finishing of the needle surface, the sizing, the thickness and the finishing of the material and the type, the fineness and the finishing of the sewing thread. The effect of heating also depends on how it is dissipated. The heating effect on the needles depends not only on the temperature of the needle, but also on the size of the contact surface of the needle with the thread, on how long this contact lasts and on the size of the pressing force exerted perpendicular to the contact surface. Often, the heating causes traces of burning on natural fibres such as cotton or wool and the softening or melting of synthetic fibres, weakening the seam or leaving melting marks on the surface of the material. Also the sewing thread can melt and break. [1-4]

The quality of the seams is decisive for the quality of the garments. Defective seams can affect the appearance of the garments and cause their final failure. The characteristics of an appropriate seam are: breaking strength (resistance), elasticity, durability, stability and appearance, which depend on the type of assembly and the number of stitches per unit length (stitch density), the tensile strength of threads and the fabric sewing behaviour. The partial

dependence of the quality of the seams on the characteristics of the sewing thread results from here.

The choice of sewing threads for a material depends on the dimensional and mechanical characteristics of the material and threads, their compatibility in the sewing process and the destination of the product. On the other hand, the garments modern manufacturing processes involve high-speed sewing operations, for which the threads selection criteria become even more severe.

2. ANALYSIS OF THE SEAMS TENSILE STRENGTH

Among the most important mechanical characteristics of sewing threads are high tear resistance, high elongation, and high modulus of elasticity, constant friction coefficient and good wear resistance. By using sewing threads with high resistance, the number of thread breaks and the stopping time are reduced. The sewing capacity is determined by the characteristics of the stress-strain curves. To withstand the various demands during sewing, a sewing thread must have adequate strength and elongation, characteristics that depend on the raw material and the process of finishing. The elongation at break is decisive in appreciation of the seam strain.

The friction that appears between the sewing thread and the elements of the machine generates forces in the sewing thread, the most powerful being those between the thread and the needle and between the needle and the sewing material. All needle threads, especially those made from synthetic fibers, require a lubricant applied in the finishing process to reduce friction to an appropriate level.

Sewing threads must withstand thermal stresses (high temperatures) and mechanical stresses (shocks). A level of medium to high resistance (the area under the stress - deformation curve) helps to improve the behavior of sewing thread by reducing the number of breaks or the number of damage caused by different stresses. Although in some research articles, sewing threads are compared on the basis of their strength, so far no study results have been released. If the resistance is high due to a longer elongation of the thread with a lower modulus of elasticity, a sewing thread cannot behave well during high speed sewing operations; therefore resistance cannot be considered a suitable indicator.

It can be considered that the proper resistance of the sewing thread, the elongation maintained within certain limits, the stress-strain characteristics in the working range of the thread tension, as well as the recovery behavior (after stopping the test), determines the thread behavior during sewing. In addition, the variation of the above properties must be controlled and maintained within tight limits, to ensure the quality of sewing thread.

The breaking force of the sewing thread is found in the strength of the seam, but it cannot be considered as the sole criterion for assessing the quality of the seam. In the case of sewing threads made of synthetic fibers, stretching can cause them to move. An exaggerated stretch modifies the chronological order of the stitching, narrowing the use of such threads. It follows from here that the study of the characteristics of the stress-strain curves can be useful for the design of sewing threads with improved efficiency.

The breaking force of a seam is influenced by a multitude of factors, of which the most important are: the type of seam, the number of stitches per cm, the thickness and nature of the basic material, the thickness and shape of the needle, the sewing speed, the nature of the sewing thread (natural or manmade).

3. MATERIALS AND METHODS

In this paper we aimed to analyze the tensile strength of the seams by determining the maximum breaking force of the seams when the force is applied perpendicularly to the seam. The test was done in accordance with the standard SR EN ISO 13935-1 / 2014, which specifies that the method used is the strip test. [6]

The basic material on which the seams were made is a twill weave cotton fabric, weighing 250 g/m^2. They were subjected to the analysis of specimens that were sewn with three types of seams (301 lockstitch, 401 chain stitch, and 504 overlock stitch).

The sewing threads used to make the seams were: Coats ASTRA - 100% polyester fiber sewing thread, Coats ATLAS - 100% textured sewing thread, which was subjected to a special heat treatment and Coats GRAMAX - 100% PES textured sewing thread. It should be mentioned that for all the variants tested the thread of the needle was Coats ASTRA and the sewing needles used were from the company GROZ-BECKERT.

Taking into account as factors of influence (the type of thread and the type of stitch) nine experimental variants have resulted, illustrated in Table 1. [5]

Table 1. **Experimental variants**

Thread type	Number of threads	Needle type	Type / symboll / stitches
Swing thread – Coats astra	2	10 NM 80/14, 134, FG/SUK	301 – Lock stitch  3 stitches /cm
Swing thread – Coats atlas			
Swing thread – Coats gramax			
The looper thread – Coats astra	2	10 NM 90/14, B/63, FG/SUK	401 – Chain stitch  4,7 stitches /cm
The looper thread – Coats atlas			
The looper thread – Coats gramax			
The looper thread (inferior and superior) – Coats astra	3	10 NM 80/14, B27, FG/SUK	504 – Overlock stitch  4 stitches/cm
The looper thread (inferior and superior) – Coats atlas			
The looper thread (inferior and superior) – Coats gramax			

4. RESULTS

The test specimens were prepared in accordance with the provisions of SR EN ISO 13935-1 / 2014, which replaces ISO 13935-1 / 1999. [6]

For these tests, the breaking force, respectively the elongation at break was determined on the dynamometer, the values being presented in Table 2.

5. CONCLUSIONS

The following conclusions can be drawn from the experimental data presented above:

The tensile strength (the breaking force) of the highest seams is recorded if the polyester fiber yarn is used as a seam thread (202 N), following the breaking force value heat treated textured polyester filament yarn (151.6 N) and the lowest value was obtained for textured polyester filament yarn (94.3 N) when the lock stitch is used. This can be explained by the fact that the staple fiber polyester yarn is from the structural point of view a ply-twisted yarn, while the atlas and gramax yarns are simple polyfilament yarns. The variation of the elongation at break for the three variants of lock stitch follows the same tendency, decreasing from 5.80% for staple fibers thread to 5.30% for heat treated textured yarns, respectively to 4.60% for textured yarn. This variation is also justified due to the structure of the three variants of polyester yarns used.

In the case of using chain stitch, it is found that the highest value of tensile strength of the stitch was obtained when using staple fibers thread (330 N), following the value for tensile strength for heat treated textured filament yarn (284 N) and the lowest value was recorded for thread from textured filament yarns (282 N). The value of the tensile elongation of the seams through the overlock stitch decreases from 6.70% for staple fibers threads, to 6.05% for heat treated textured yarns, respectively to 6.30% for the textured yarn.

Table 2. **The seams tensile strength and elongation**

Thread type	Seam type	Breaking force [N]	Elongation at break [%]
Swing thread – Coats astra	301 – Lock stitch	202	5,80
Swing thread – Coats atlas		94,3	4,60
Swing thread – Coats gramax		151,6	5,30
Swing thread – Coats astra	401 – Chain stitch	330	6,70
The looper thread – Coats atlas		282	6,30
The looper thread – Coats gramax		284	6,05
The looper threads (inferior and superior) – Coats astra	504 – Overlock stitch	193,3	5,85
The looper thread (inferior and superior) – Coats atlas		266	7,10
The looper thread (inferior and superior) – Coats gramax		252	6,75

In the case of overlock stitch, it is found that the lowest value of the seam tensile strength was obtained when using staple fiber thread (193.3 N), following by the value for the tensile strength for the heat treated textured yarn (252 N) and the highest value was recorded for textured yarn (266 N). The value of the seams elongation for the three variants increases from 5.85% for staple fibers thread, to 6.75% for yarn from heat treated filament yarns, respectively to 7.10 % for yarn from textured filament yarn.

From the tensile strength analysis of the three variants of seams, it is found that the highest values of the breaking force are recorded at the chain stitch with two threads regardless of which thread was used, which indicates that the better stitch strength is obtained using the chain stitch.

From the analysis of the elongation of the lock and chain stitches it is found that when using the chain stitch the elongation is higher by more than 15% for each of the three variants of threads used, which indicates that the elasticity of stitching is higher for the chain stitch.

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